TERRA PETRAEA

The Archaeological Landscape of the Petraean Hinterland from the Hellenistic to the Byzantine Period

Will M. Kennedy

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Supplement to the Bulletin of Nabataean Studies, 2

The publication of this work was supported by the Open Access Publication Fund
and the Kultur-, Sozial- und Bildungswissenschaftliche Fakultät of Humboldt-Universität zu Berlin.

This publication is a revised version of the author's doctoral thesis presented to
Humboldt-Universität zu Berlin, Kultur-, Sozial- und Bildungswissenschaftliche Fakultät,
Institut für Archäologie, Lehrbereich Klassische Archäologie – Winckelmann-Institut,
Unter den Linden 6, 10099 Berlin, Germany.

Bibliographic information published by the Deutsche Nationalbibliothek

The Deutsche Nationalbibliothek lists this publication in the Deutsche Nationalbibliografie
detailed bibliographic data are available in the Internet at http://dnb.d-nb.de .

Cover: Contour lines created by W. M. Kennedy in an ArcGIS 10.3 environment on the basis of SRTM-1
elevation data. © W. M. Kennedy. Photo: Panorama view over the Petraean hinterland from ar-Rajif.
View to the northwest. © W. M. Kennedy.

Layout and typesetting: Florian Hawemann | www.satzundlayout.com

ISBN 978-3-8325-5171-1
DOI 10.30819/5171

Logos Verlag Berlin GmbH
Georg-Knorr-Str. 4, Geb. 10
D-12681 Berlin
Tel.: +49 (0)30 42 85 10 90
Fax: +49 (0)30 42 85 10 92
INTERNET: http://www.logos-verlag.de

To my family.

And to Suleiman Mohammed al-Bdul, Abu Ranin,
without whom this work would not have been possible.

الى عائلتي الكريمة و السيد سليمان محمد البدول (ابو رنين)
لولا دعمهم و وقوفهم بجانبي لما استطعت اتمام هذا العمل.

Preface

The present study is a revised version of my doctoral thesis originally entitled *Terra Petra. An Archaeological Landscape Characterization of the Petra Hinterland in Nabataean-Roman Times*. The thesis was written as part of a doctoral fellowship within the Cluster of Excellence 264 Topoi in the research group A-1 'Marginal Habitats,' which was incorporated in the doctoral program 'Landscape Archaeology and Architecture' of the Berlin Graduate School of Ancient Studies (BerGSAS). I was accepted into the doctoral program in October 2014 and was granted a three-year long stipend to conduct research on the landscape organization of the Petraean hinterland. I submitted the thesis in October 2017 to Humboldt-Universität zu Berlin and defended it in April 2018.

I would like to thank the Cluster of Excellence 264 Topoi and the BerGSAS not only for offering me financial support, but also for providing the necessary infrastructure and research environment that allowed me to accomplish this study.

I would also like to express my deepest gratitude to my supervisors, Stephan G. Schmid and Oliver Hülden, for giving me the chance to proceed with this research and for guiding me along the way. Without their helpful guidance and kind support, this study would not have reached the present form.

I also owe many thanks to the scientific committees and anonymous reviewers of Humboldt-Universität zu Berlin and the German Archaeological Institute for the helpful comments on the original draft and for awarding this study with the Humboldt Prize in 2018 and the Wülfing Travel Stipend in 2019-2020. My thanks also go out to the Faculty of Humanities and Social Sciences and the Open Access Publication Fund of Humboldt-Universität zu Berlin for kindly supporting the publication costs of this study.

I sincerely thank the Department of Antiquities of Jordan for giving me permission to conduct the Petra Hinterland Survey Project in 2016, which was essential for gaining more detailed insights into the archaeological landscape of rural Petra.

There are a number of individuals who greatly aided me in successfully conducting this research: Tali Erickson-Gini is much thanked for her kind hospitality and for taking me in during my stay in the Negev in 2015. I greatly appreciate Chaim Ben David's valuable advice on the various routes and tracks in the Petraean hinterland and for guiding me along the first steps of many taken in the Petra area. Burton MacDonald kindly forwarded me the site catalogue of the *Shammakh to Ayl Archaeological Survey* before its final publication in 2016. This greatly expedited and facilitated the analytical process. For this, I am very grateful. I am also thankful to Fawzi Abudanh who not only shared his important work on the Udruh area, but took the time to discuss the archaeology of the Petra region with me on many occasions. Laurent Tholbecq kindly provided me with the report of the Jabal Shara Survey, which was invaluable for this study and is most appreciated. I also profited from the many scholarly discussions over the years, for which I am very thankful.

I am most grateful to Daniel Knitter for his constructive advice and help for conducting the spatial statistical methods applied in this study. Many thanks are owed to Jonas Berking and Sarah Isselhorst for clarifying specific hydro-technological issues. Gisela Eberhardt and Nadine Riedl are once again thanked for their invaluable editorial support in the final draft.

I will be forever grateful to Elizabeth Conway for her patient corrections of the original texts, especially knowing that the subject matter was not always "her cup of tea."

Anna Bechtle, Angelika Walther and Tom Müller greatly helped with fixing bibliographical references in the original draft. Anna Bechtle is particularly thanked for her constant and unquestionable understanding, endurance and support.

A large number of additional individuals contributed to the completion of this study in various ways, for which I am very grateful: Regina Attula, Rizek Ali al-Bdul, Wiebke Bebermeier, Fabian Becker, Robert Bewley and APAAME, Ricarda Braun, Marco Dehner, Veronika Egetenmeyr, Raphael A. Eser, Jana Falkenberg, Werner Feist and the Naturhistorische Gesellschaft Nürnberg, Wolfgang Filser, Andreas Grüner, Elisabeth Günther, Felix Hahn, Elke Kaiser, Sophia Kennedy, Christoph Klose, Bernhard Kolb, Jan Krause, Bernd Kruse, Noah Kruse, Undine Lieberwirth, Dominik Lukas, Andreas Maier, Carmen Marcks-Jacobs, Julia Meister, Christina Michel, Oliver Nakoinz, Laila Nehmé, Jan Reimann, Corinna Reinhardt, Torsten Renner, Veit Vaelske, Lucy Wadeson, Laura Weis, Robert Wenning and Hannes Winter.

I also owe my sincere gratitude to Volkhard Buchholtz and Katharina Kruse from the Logos Verlag Berlin GmbH. The same goes for Florian Hawemann of satz + layout in Berlin. This publication would not have been possible without their always friendly and constructive input as well as flexibility, patience and endurance. This is much appreciated.

Finally, without the guidance and friendship of Suleiman Mohammed al-Bdul, who has truly showed me the depths of *Terra Petraea*, this study would not have been possible. Shukran gazilan.

Last, but not least, my sincere gratitude is owed to Zbigniew T. Fiema who has suffered through the entire original draft and has saved me – on countless occasions – from falling into deep argumentative pitfalls and interpretative dead ends. The present form of this study would not have been possible without Zbigniew Fiema's immense input and advice. For this, I will always be incredibly grateful.

Athens, June 2021.
Will Kennedy

Content

Chapter 1
Background and Research Objectives

Introduction

In the mid-2nd century AD, Ptolemy of Alexandria composed his geographical register of the ancient world – including a description of three distinct 'Arabias.'[1] In his account, Ptolemy not only refers to *Arabia deserta* (referring mainly to northern and central Arabia) and *Arabia felix* (South Arabia and the Arabian Peninsula), but also, *Arabia Petraea*. This specific distinction is largely ignored by other ancient writers. Most likely, Ptolemy used the term 'Petraea' synonymously with 'Nabataea,' referring to the main territories of the former Nabataean kingdom with its capital Petra in modern-day southern Jordan.[2] Consequently, *Arabia Petraea* never gained official designation as a geographical area in antiquity, and Ptolemy's use of the term reflects only the general political circumstance of his time shortly after the Roman annexation of the Nabataean realm in 106 AD and when there is generally no more reference to the Nabataeans or the Nabataean royal dynasty in other historical sources.

Following the rediscovery of Petra by the Swiss explorer J.L. Burckhardt in 1812 however, Ptolemy's *Arabia Petraea* found widespread acceptance among early explorers and travelers to the Petra area and other parts of former Nabataea. These include L. Laborde's *Journey through Arabia Petraea, to Mount Sinai, and the excavated city of Petra: the Edom of the prophecies* from 1838, F.W. Londonderry's *A journey to Damascus through Egypt, Nubia, Arabia Petræa, Palestine, and Syria* from 1847 or A. Musil's *Arabia Petraea* from 1907.

Since then, *Arabia Petraea* continues to be referred to by modern studies when discussing various archaeological and historical issues within the former Nabataean kingdom. For example, D. Graf's *Nabataean settlements and Roman occupation in Arabia Petraea* from 1992 or *The Via Nova Traiana in Arabia Petraea* from 1995 can be listed as well as Abudanh et al.'s *The Via Nova Traiana Between Petra and Ayn al-Qana in Arabia Petraea* from 2016 and, most recently, M. Castro's *The Function of the Roman Army in Southern Arabia Petraea* from 2018.

While the present study also assesses archaeological and historical evidence from the wider Nabataean realm – which many studies evidently continue to designate as *Arabia Petraea* – the main objective is to research the overall landscape organization of the rural hinterland of the Nabataean capital of Petra. This study is therefore not concerned with *Arabia Petraea* in its entirety, but instead primarily focuses on the extensive evaluation of Petra's immediate rural surroundings which can be adequately referred to as *Terra Petraea*.

The aim is to present an extensive landscape archaeological characterization of the rural environs of Petra in Nabataean-Roman times and to research overall strategies of the spatial organization of Petra's hinterland. From a diachronic perspective and following a state-of-the-art landscape archaeological approach, this study investigates a vast amount of archaeological data offering insights into rural settlement patterns and subsistence strategies, aspects of rural water management, the extensive infrastructural network, the funerary and religious landscape, the military disposition, as well as the industrial potential of the Petraean hinterland.

Various archaeological surveys have been carried out in the Petra area since the 1970s. These contributed to the acquisition of archaeological data in the immediate Petra environment and raised research questions concerning the understanding of its rural landscape. Recent studies have synchronized the archaeological data of preselected surveys in the Petraean hinterland, but mainly concentrate on rural civilian settlements and changes in land use. Additionally, more archaeological data has since come to light that could not be considered by these studies. An overall, in-depth archaeological and culture-historical contextualization of the now almost overwhelming amount of various archaeological sites recorded in the Petra area therefore remains missing. By following a strong and, for

1 Ptol. Geog. 5, 17, 19; 6, 7. See Bowersock 1988 for a critical discussion of the three Arabias listed in Ptolemy's geography.

2 Cf. Graf 1992, 253; Bowersock 1988.

the Petra area to date, unique landscape archaeological approach, this study offers a differentiated analysis of the various archaeological sites and features to provide a broad, regional understanding of the spatial organization of the Petraean hinterland.

The main chronological focus of this study is clearly set on the Nabataean (1st centuries BC and AD) and Roman periods (2nd and 3rd centuries AD). However, a chronological 'preview' is provided by also discussing the preceding Iron Age (12th – 5th centuries BC) and Hellenistic periods (4th – 2nd centuries BC). As a chronological 'outlook,' the Byzantine periods (4th – 7th century AD) are assessed as well.

To delineate the study area, P. Kouki's definition of the Petraean hinterland was adopted. This is understood as a 20 km radius around Petra.[3] Kouki based her definition on previous claims expressed by M. Lindner, who assumed a similar extent of a 'Greater Petra,' and on the 6th century AD Petra Papyri mentioning that the settlements of Udruh (Augustopolis) and Saddaqa (Zadacathon) were still under the jurisdiction of Petra in the Byzantine period.[4] The study area thus covers a vast geographical area measuring over 1250 km² and features all unique topographical and environmental characteristics of the Petra region. It also includes a large archaeological dataset of over 1700 sites. Acknowledging the fact that defining an archaeological study area is almost always an artificial construct meant to meet the requirements of particular research objectives, this study's definition of the Petraean hinterland is nevertheless a representative and valid study area as it is, first, based on historical accounts from the region (Petra Papyri), second, covers all particular landscape characteristics of the Petra area and, third, discusses an archaeological dataset of significant quantity.

Methodologically, the vast amount of archaeological data validates the substantial use of complex and state-of-the-art quantitative spatial methodologies ranging from spatial statistics to GIS-based analyses. Such landscape archaeological analyses are essential quantitative tools in investigating intricate spatial characteristics of the available archaeological dataset and studying the relationship between archaeological sites and the natural landscape. The results of the applied landscape archaeological analyses are then critically evaluated, considering a more in-depth archaeological and culture-historical discussion.

As an extremely broad range of different archaeological site types is investigated – most of which undoubtedly require more detailed and farther-reaching archaeological and historical research – this study makes no claim to being an exhaustive analysis of all archaeological categories discussed here. Instead, it provides a representative overview and critical reassessment of Petra's socio-political and administrative, military, economic and infrastructural area of influence over its rural surroundings. It is therefore aimed to offer a unique, modern and up-to-date synthesis of the spatial organization of the Petraean hinterland and provide an essential contribution for future research endeavors.

In order to achieve these objectives, chapter 1 offers an overview of the research history as well as a brief and general introduction into the historical and environmental context of the study area. This is followed by a detailed discussion of the core methodological issues (chapter 2). First, the available physical base dataset is described that underlies all farther-reaching landscape archaeological, GIS-based analyses. The subsequent part is devoted to critically presenting the core archaeological dataset accumulated for this study based on the various archaeological surveys conducted in the Petraean hinterland. This important subchapter gives the definitions of the various archaeological site classes identified here, and are consistently followed throughout the entire study. Subsequently, problematic chronological inconsistencies inherent to the archaeological base dataset were worked out for all archaeological sites through all periods to achieve comparable temporal information. This is followed by a methodological introduction into the different landscape archaeological analyses applied here. These analyses include the spatial statistical method of *point pattern analysis* as well as *cost-surface* and *visibility analyses*, which are conducted within a Geographical Information System (GIS) and form the basis of this study's landscape archaeological approach. To fully assess the reliability and value of these complex analytical methods for a farther-reaching archaeological and culture-historical discussion of the Petraean hinterland, it is important to make their methodological advantages, shortcomings and underlying premises transparent. A critical methodological appraisal of the applied landscape archaeological analyses thus concludes chapter 2.

After the overall methodological framework is set, chapter 3 offers an overview of the Petraean hinterland during the Iron Age periods. As it would overreach the scope of this study, an in-depth and comprehensive

3 Kouki 2012, 17.

4 Kouki 2012, 17; Lindner 1992a, 266. Udruh is located c. 20 km to the east and Saddaqa c. 20 km to the south of Petra.

analysis of the Iron Age periods cannot be expected here. Instead, the available Iron Age evidence is presented in terms of superordinate topics: subsistence strategies and the settlement pattern, communication infrastructures, the military disposition as well as the religious and funerary landscape. The Iron Age periods are summarized in a synthesis, which may serve as a basis for future research.

The following chapters then proceed with a detailed and critical presentation of this study's landscape archaeological approach to the various archaeological site types evidenced in the Petraean hinterland from the Hellenistic to Byzantine periods by strictly adhering to the defined site classes.

Chapter 4 therefore deals with the subsistence strategies in the Petraean hinterland, evaluating the recorded agricultural installations, water structures as well as exploitation/industrial sites. This chapter also presents 'other archaeological structures and/or features' that could not be positively assigned to any of the other site categories, but are presumably related to subsistence strategies other than agriculture. Particularly, this subchapter deals with possible archaeological evidence pertaining to more mobile, pastoral subsistence strategies in the Petra region.

Rural civilian settlements are discussed in chapter 5, followed by an extensive investigation of the various communication infrastructures, most notably the archaeologically evidenced roads and routes in the Petra area (chapter 6).

The discussion of the recorded military sites hopes to provide further insights into the military disposition of the Petra area (chapter 7). Rural Petra's funerary and religious landscape is finally discussed in chapter 8.

The detailed landscape archaeological overview of the various archaeological site classes serves as a solid argumentative basis for further discussing and critically assessing the socio-political and administrative, military, economic and infrastructural aspects of the Petraean hinterland during the Hellenistic, Nabataean, Roman as well as Byzantine periods (chapter 9). The overall results are finally concluded in chapter 10.

By following the approach outlined above, this study provides an extensive landscape archaeological characterization of the Petraean hinterland through time and hopes to offer new and valuable insights into *Terra Petraea*.

This study is also published digitally, open-access.[5] This includes the site catalogue of all discussed archaeological sites (Appendix I) as well as the relevant R-scripts for the conducted point pattern and visibility analyses and for evaluating the chronological inconsistencies (Appendices II–IV). The digital publication also allows to enlarge the various maps and figures to make up for the obvious practical limitations of the printed edition.

Research History

Despite the clear focus on the archaeological exploration of *urban* Petra shortly after its rediscovery by J.L. Burckhardt in 1812, various expeditions were carried out in the larger Petra area that can be considered as the first archaeological and ethnological 'surveys' of the region. Since then, a large number of archaeological investigations and surveys carried out in the wider Petra region starting from the late 19th century to the present day can be listed (cf. TABLE 1).[6]

Early research explorations include the seminal works of A. Musil, R.E. Brünnow and A. von Domaszewski, G. Dalman, W. Bachmann et al. as well as N. Glueck.[7] However, after Glueck's surveys in the 1930s, research interest in rural Petra seems to have ceased until, in the 1970s, M. Lindner and his team initiated their comprehensive archaeological research not only in Petra but in the city's surroundings as well. Over the years, Lindner's research also included intensive archaeological surveys of major Nabataean settlements such as Sabra, Abu Khusheiba, Umm Rattam or as-Sadeh.[8] Following this revived interested in further investigating the archaeological potential of Petra's immediate environment, A. Killick initiated his survey in the Udruh area 20 km east of Petra from 1980–1982 recording 200 archaeological sites with a clear chronological focus on the (Late) Roman and Byzantine periods.[9] In 1982, E.B. Banning and I. Köhler-Rollefson then began their *Beidha Ethnoar-*

5 Follow https://doi.org/10.30819/5171 to access the digital, open-access version of this study.

6 This list excludes smaller private travel ventures to the region. An overview of early travelers and explorers to the Petra region is given, for example, in Lewis 2003 and Llewellyn 2003.

7 Musil 1907; Brünnow – von Domaszewski 1904 and 1905; Dalman 1908 and 1912; Bachmann et al. 1921 and Glueck 1934; 1935; 1939; 1945; 1959.

8 Lindner 1987; Lindner 1992a; Lindner 1992b; Lindner – Zeitler 1997; Lindner et al. 2000 and most importantly for this study Lindner 2003a. Also note D. Graf's survey of Nabataean-Roman military sites in the Hisma, Ras an-Naqb and Aqaba areas that was initiated in the late 1970s (Graf 1979).

9 Killick 1987; Killick 1983a; Killick 1983b. Also note W.J. Jobling's *'Aqaba – Ma'an Epigraphical and Archaeological Survey* which was also initiated in the early 1980s (e.g. Jobling 1985; 1984; 1983 and 1982).

chaeological Survey (BS) in the Beidha area just north of Petra, mainly aiming at investigating possible archaeological evidence for ancient mobile subsistence strategies, but documenting 63 other archaeological sites as well.[10] Between 1984 and 1985, S. Hart's *Edom Survey* (ES) aimed at surveying archaeological sites in areas immediately south- and northeast of Petra.[11]

In 1987, the first to have attempted a comprehensive overview of the various Nabataean sites then known in Petra's surroundings, was R. Wenning's seminal contribution *Die Nabatäer – Denkmäler und Geschichte. Eine Bestandsaufnahme des archäologischen Befundes* that still forms a valuable basis for studying Nabataean sites in the Petra region today.[12]

Moreover, Z. T. Fiema discussed the then known archaeological dataset from southern Jordan in his doctoral thesis entitled *Economics, Administration and Demography of Late Roman and Byzantine Southern Transjordan* which was submitted to the University of Utah in 1991.

Graf subsequently conducted his important survey of the *via nova Traiana*. While following the Roman road from the Petra area south to Aqaba (ancient Aila) he further investigated a number of archaeological sites along the *via nova*, including e.g. the major settlement of Saddaqa.[13] Z. T. Fiema later investigated stretches of the *via nova* north of Petra as well.[14]

In 1994, 1996 as well as one season in 1998, A. M. Smith II set out to research the archaeological landscape in the surroundings of ancient Aila and also extended his survey northwards into the Wadi Arabah documenting 330 archaeological sites as part of the *Southeast Araba Archaeological Survey* (SAAS). SAAS was part of Smith's additional survey projects in the Wadi Arabah that continued as far north as Bir Madkhur situated c. 17 km northwest of Petra. These additional surveys include the *Wadi Arabah Archaeological Research Project* (WAARP), the *Southern Araba Archaeological Resource Survey* (SAAR), the *Central Arabah Survey* (CAS) as well as the *Bir Madkhur Project* (BMP). While the findings of these separate surveys were briefly discussed in shorter journal contributions, in 2010 Smith published the important monograph *Wadi Araba in Classical and Late Antiquity. An Historical Geography* in which the main research results of his various surveys in the Wadi Arabah were presented and discussed (in total 115 sites).[15]

Between 1994 and 1996 G. M. Findlater conducted the *Dana Archaeological Survey* (DAS) in the Dana region just north of the Petraean hinterland and documented over 400 archaeological sites ranging from the Iron Age to the Byzantine periods. While the original survey data remains unpublished, Findlater discussed the results of DAS in correlation with other archaeological survey data in the region as part of his doctoral thesis *Imperial control in Roman and Byzantine Arabia. A landscape interpretation of archaeological evidence in southern Jordan*, which was submitted to the University of Edinburgh in 2003.[16] In 2009, N. G. Smith reconsidered and published spatial archaeological data of 48 sites already evidenced in the DAS area as part of his *Showbak-Dana L2HE Survey* which served as the base dataset of his doctoral research *Social boundaries and state formation in ancient Edom: a comparative ceramic approach* analyzing Iron Age (Edomite) ceramics in order to gain further insights into the social characteristics of the area during the Iron Age.[17]

Shortly after the completion of DAS, L. Tholbecq initiated the *Jabal Shara Survey* (JSS) in 1996 and which continued until 1997. The survey aimed at recording more archaeological data in the immediate Petra region, specifically along the Jabal Shara escarpment encompassing an area of over 70 km² and documenting nearly 180 archaeological sites ranging from the Iron Age to the Late Islamic periods. To date, the survey results are only published as shorter journal articles, but L. Tholbecq kindly provided the unpublished, preliminary site catalog of the JSS to the author, which is greatly appreciated.[18]

Simultaneously, K. ʾAmr and others documented various archaeological sites in the study area (most notably the Wadi Musa, Umm Sayhoun, Beidha, at-Tayyiba, Jitha, Rashid (previously al-Qa') and Ayl areas) while accompanying the *Wadi Musa Water Supply and Wastewater Project* (WMWS). This was designed by the Jordanian Ministry of Water and Irrigation to further enhance the existing infrastructure and water supply of the Petra region.[19] Specifically aiming to monitor ongoing construction activities, the project was initially carried out in 1996 and continued in a

10 Banning – Köhler-Rollefson 1983. Later, in the early 2000s, Bikai et al. conducted the *Beidha Documentation Project*, aiming at further investigating the archaeological remains around Beidha, immediately north of Petra. However, the published report of the project focuses strongly on the 'Dionysian Hall' of Umm Qussah (Bikai et al. 2008).

11 Hart 1987a; Hart – Faulkner 1985.

12 Wenning 1987.

13 Graf 1995a.

14 Fiema 1997.

15 Smith 2010. For other contributions on the various surveys in the Wadi Arabah, see Smith – Kay 2018; Smith 2018; Ramsay – Smith 2013; Smith 2007; 2005 and 1997.

16 Findlater 2003.

17 Smith 2009.

18 Tholbecq 2013a; Tholbecq 2001.

19 ʾAmr – al-Momani 2001; ʾAmr et al. 1998.

second phase between 1998 and 2000. In total, the survey recorded 132 archaeological sites not only in rural areas but also within the limits of urban communities such as Wadi Musa, Umm Sayhoun or at-Tayyiba.

D. Graf discussed Nabataean-Roman and Byzantine settlement patterns in southern Jordan in 2001 and Fiema subsequently provided a seminal review of the Roman (in 2003) and Byzantine periods (already in 2002) in the Petra region considering the then available archaeological survey data.[20]

Between 2003 and 2004, F. Abudanh conducted an important regional survey in the Udruh area for his doctoral thesis entitled *Settlement Patterns and Military Organisation in the Region of Udruh (southern Jordan) in the Roman and Byzantine Periods I–II*, which was submitted to the University of Newcastle upon Tyne in 2006.[21] Abudanh's extensive survey expanded greatly on Killick's earlier survey in the region and covered an extremely large area of 700 km² overlapping in part with Hart's *Edom Survey*, the WMWS and B. Macdonald's *Ayl to Ras en-Naqb Survey* and *Shammakh to Ayl Survey* (see below). Currently, the Dutch-Jordanian *Udruh Archaeological Project* (UAP), initiated in 2011, investigates a 48 km² large area around Udruh and continues Abudanh's important work in the Udruh region.[22]

One year after the completion of Abudanh's survey in 2005, the *Finnish Jabal Harun Project* (FJHP) ended their intensive pedestrian survey of a 4,8 km² large area around Jabal Harun, 5 km southwest of Petra, which already began in 1997.[23] Under the overall direction of J. Frösén, the FJHP included a broad survey component led by M. Lavento that aimed at complementing the Finnish excavations of the Byzantine monastic complex (directed by Z. T. Fiema) by gaining further information on the settlement history and land use in the Jabal Harun area. Between 2005 and 2007, the FJHP also explored the archaeological remains further eastwards towards Petra as well as westwards to the Wadi as-Sabra, thus enlarging the original survey area to 6,5 km². This 'extended survey area' was covered by means of more extensive pedestrian survey techniques. The extensive survey area of the FJHP documented 172 and the intensive survey area 189 archaeological sites. With 361 recorded sites in total, the FJHP survey forms an important archaeological dataset for this study.

Simultaneous to the FJHP's extensive survey activities, B. MacDonald launched a large archaeological survey of the region between Ayl and Ras an-Naqb along the eastern high plateau southeast of Petra between 2005 and 2007.[24] The *Ayl to Ras an-Naqab Archaeological Survey* (ARNAS) covered an extremely large area of 860 km² and identified 389 archaeological sites in the area.

Three years later, between 2010 and 2011, MacDonald continued regional survey work along the eastern high plateau and ventured further north than the survey area of ARNAS. The *Shammakh to Ayl Archaeological Survey* (ShamAyl) covered an area of c. 600 km² between the settlement of Shammakh in the north and Ayl in the south, and documented additional 366 archaeological sites.[25]

The *Petra Area and Wadi Silaysil Survey* (PAWS) also started in 2010 and was completed in 2012. Together with the *Petra Routes Project* (PRP), this project constituted the survey component of the *Brown University Archaeological Project* (BUPAP), Brown University's umbrella project (codirected by S. E. Alcock and C. A. Tuttle) that carried out archaeological research both in urban Petra as well as in its immediate hinterland.[26] The primary aim of both PAWS as well as the PRP was to document the material remains within Petra's immediate northern hinterland and to offer insights into the settlement history of the area through time. While the PRP focused specifically on exploring the archaeological remains along the two access routes of Wadi al-Mu'aysirah East and West that connected Petra with the Beidha area to the north, PAWS carried out an intensive pedestrian survey of a c. 10 km² large area around the significant Nabataean sites of Beidha and Ras Slaysil. The survey documented 1036 archaeological 'features' and recorded tens of thousands of archaeological artifacts ranging from the Palaeolithic to the modern periods. As the PAWS archaeological dataset was not available before the recently published survey results of the project by Knodell et al. in October 2017, the project's findings could not be incorporated into this study's landscape archaeological analyses.[27] From the BUPAP surveys,

20 Graf 2001a and Graf 2001b; Fiema 2002a and Fiema 2003.
21 Abudanh 2006.
22 Driessen – Abudanh 2019; 2018; 2015 and 2013.
23 See the recently published final publication of the FJHP survey results in Kouki – Lavento 2013 with further references to the numerous preliminary survey reports of the project.
24 MacDonald et al. 2012.
25 Although there is a great overlap with Abudanh's survey of the Udruh area. MacDonald et al. 2016; 2011 and 2010.
26 On the results of PAWS, see Knodell et al. 2017; Alcock – Knodell 2012 and Knodell – Alcock 2011. On the PRP, see Berenfeld et al. 2016 and Rojas – Berenfeld 2012. A. R. Knodell and S. E. Alcock were primarily responsible for PAWS. The PRP was conducted by M. Berenfeld and F. Rojas.
27 Cf. Knodell et al. 2017, 634 (and n. 59) stating that the project's database is now accessible by request.

only sites documented by the PRP could be included here as they were published already in Berenfeld et al. 2016.[28] However, as the author was able to investigate the PAWS survey area during the PHSP intensively as well (see below), the exclusion of the PAWS archaeological data does not dramatically impact this study's results.

By the time BUPAP concluded their field work in 2012, L. Wadeson and F. Abudanh began their reinvestigations of already previously surveyed, but only poorly documented monumental Nabataean-Roman tombs (in total twelve) along the Jabal Shara escarpment and the eastern high plateau as part of their *Petra Hinterland Tombs Project* (PHTP).[29]

Also in 2012, L. Nehmé published her comprehensive archaeological and epigraphical survey of the urban environments of Petra in the *Atlas archéologique et épigraphique de Pétra* which is also an important work of reference for this study's research of rural Petra.[30]

The year of 2012 also marks the date of an additional publication which is of seminal importance for the study of Petra's rural environs. P. Kouki published her doctoral thesis entitled *The Hinterland of a City. Rural Settlement and Land Use in the Petra Region From the Nabataean-Roman to the Early Islamic Period* in which she amalgamated preselected archaeological survey data of the Petra area in order to model spatial and temporal distributions of the selected data and to investigate rural settlement patterns, site hierarchies and land use changes in the Petraean hinterland.[31] While this study adopts Kouki's definition of the Petraean hinterland, Kouki could only base her analysis on sample sites from three surveys in the study area for which (spatial) archaeological data was then available.[32] Kouki was therefore not able to consider a vast amount of archaeological survey data now available to this study from the JSS, ARNAS, ShamAyl, the PRP, the PHTP, (to some extent) PAWS as well as the PHSP. Importantly, Kouki considered only profane, civilian settlements for her analysis. Structures that were interpreted to have had a cultic, funerary or military function were not considered in her study. Kouki thus evaluated 162 rural settlements of profane, civilian character only. With more data available, the archaeological dataset of this study is now ten times larger and covers the entire spectrum of archaeological site categories documented in the Petraean hinterland. This includes not only rural civilian settlements (towns, villages, farms etc.), but also agricultural installations, water structures, industrial sites, military, religious and funerary structures, communication infrastructures as well as other structures and/or features presumably related to alternative subsistence strategies. This study therefore expands Kouki's seminal work both quantitatively and qualitatively.

As an appraisal of Kouki's work, in her Master's thesis from 2015 entitled *Petra's Hinterland from the Nabataean through Early Byzantine Periods (ca. 63 BC–AD 500)*, S.E. Wenner also evaluated changes in land use and the settlement pattern within the Petraean hinterland.[33] The surveys considered in Wenner's thesis were Lindner's survey of the (singular) site of Qasr Umm Rattam northwest of Petra, the JSS (although based on the published reports only; cf. above), the WMWS, the (singular) site of Bir Madkhur, the FJHP (although based mainly on Kouki 2012) as well as PAWS. However, Wenner was less concerned with any systematic spatial analysis of the various archaeological sites, but instead aimed at contextualizing her analysis of ceramic finds collected by the Udruh Archaeological Project with other survey results in the region.

Finally, apart from C. Hamarneh's research project *Ancient Terraces in the Hinterlands of Petra* as well as B. Lucke et. al.'s geoarchaeological investigations on ancient terraces in the Petraean hinterland[34], recent archaeological survey activities in the Petra area were carried out by the *Petra Hinterland Survey Project* (PHSP) in 2016, which was codirected by the author and S.G. Schmid.[35] The PHSP served mainly the author's doctoral research purposes and aimed at reassessing already documented archaeological sites as

28 Berenfeld et al. 2016, 105–107.
29 Wadeson – Abudanh 2016, 83, 97–98.
30 Nehmé 2012a.
31 Kouki 2012, 15–17.
32 Kouki 2012, 29, 77–78. These surveys include the WMWS, Abudanh's survey of the Udruh region, the FJHP as well as other pre-selected individual sites that were archaeologically already well-explored by previous scholars but not necessarily part of larger regional surveys (i.e. specifically Sabra, Abu Khusheiba, Qasr Umm Rattam, Bir Madkhur and as-Sadeh).
33 Wenner 2015.
34 As part of Hamarneh's work on ancient terraces in the Petra region, see e.g. al-Qudah et al. 2016. On Lucke et. al.'s investigations, see Lucke et al. 2019.
35 This study constitutes the final report of the survey results. The PHSP 2016 was funded by the Cluster of Excellence Topoi (Berlin), Humboldt-Universität zu Berlin (Berlin), Freie Universität Berlin, the Association for the Understanding of Ancient Cultures (AUAC, Basel) and the Fachhochschule Lübeck. Many thanks are owed to the Department of Antiquities for their support and for granting the working permit. An additional aim of the PHSP was to explore aspects of the Nabataean water management system of Petra's rural environment, i.e. not only how the applied water technologies responded to local climate and natural landscape conditions, but also how hydraulic engineering choices affected settlement strategies within Petra's immediate hinterland. This geoarchaeological aspect of the PHSP served mainly the

well as identifying new archaeological finds in Petra's immediate surroundings in order to propose a revised landscape characterization of the Petraean hinterland. In total, the PHSP recorded 165 archaeological sites. It was also in the context of the PHSP that the author walked and mapped the various routes in the study area discussed in the relevant chapters below (particularly chapter 6).

In total, over 4000 archaeological sites were documented in the more extended Petra region by the various archaeological surveys following different survey intensities and methodologies.[36] While previous studies have discussed aspects of rural settlement patterns and land use changes in the Petra area, they are based on a far smaller archaeological dataset than is now available to this study. More importantly, previous research on rural Petra has focused almost entirely on civilian settlements. A broader discussion of the various archaeological site types evidenced in the Petraean hinterland is yet missing. To date, a diachronic analysis of rural Petra's religious and funerary landscape, its military disposition as well as a more detailed investigation of its communication infrastructure forms a desideratum in the research history of Petra's hinterland. In addition, such aspects have not been further researched by a modern landscape archaeological approach as followed by this study.[37] Quantitative, spatial statistical methodologies and GIS-based analyses shall therefore offer further insights in addition to an in-depth archaeological and culture-historical discussion of the Petraean hinterland through time.

Historical Context

The Iron Age Periods

The historical scope of this study begins with the Iron Age period (c. 1200 BC). Major supra-regional powers that previously controlled Transjordan during the Late Bronze Age, i. e. Pharaonic Egypt and the Hittite Empire, lost their hegemony over the region as a consequence of major political upheaval in the Near East during the 12th and 11th centuries BC (often attributed to invading peoples from the northern Levantine and/or Anatolian coastal areas).[38] As a result, Iron Age kingdoms and city-states gradually formed in the Levant and Palestine during the 10th century BC. While territorial conflicts continued to characterize the region, the political framework nevertheless remained largely stable until Assyria reemerged as a Near Eastern superpower by the early 9th century BC. Under Tiglah-Pileser III (745–727 BC), the Neo-Assyrian Empire (883–612 BC) extended beyond Mesopotamia conquering ancient Urartu and the Fertile Crescent, reaching the borders of Pharaonic Egypt in Palestine.[39]

The smaller kingdoms of Transjordan and Syria were either subjugated to the empire as vassal kingdoms or were incorporated as imperial provinces. One of the most powerful of these former kingdoms was Damascus as it controlled large parts of Syria and thus the main trade routes between Egypt and Mesopotamia. South of Damascus, the former kingdom of Israel, which held Transjordanian territories between the Sea of Galilee and the Dead Sea, was re-formed into the Assyrian province of Gilead. The ancient kingdom of Ammon, which controlled an area roughly comparable to the capital of modern-day Jordan, Amman, and profited by long-distance caravan trade, was also made into an Assyrian province.[40] The regions further south of the provinces of Gilead and Ammon, roughly set between the Dead Sea and the Wadi al-Hasa in modern-day Jordan, were held by the kingdom of Moab which controlled fertile lands along the Wadi al-Hasa and Wadi al-Mujib.[41]

The Iron Age kingdom of Edom controlled vast territories south of Moab ranging from the Wadi al-Hasa to modern Aqaba (ancient Aila) at the Red Sea and expanded into parts of the Wadi Arabah in the west as well as the vast desert areas to the east.[42]

Before the Edomite kingdom was incorporated into the Neo-Assyrian Empire in the last quarter of the 8th century BC, it also included the mountainous regions of the Petra area including, for example, the settlements on Umm al-Biyara or Tawilan. As an Assyrian province, Edom's regional economic importance grew significantly. The former kingdom not only

doctoral research purposes of S. Isselhorst and L. Weis, and are not of primary concern for this study. The hydrological investigations of the PHSP were carried out by S. Isselhorst, L. Weis and M. Strauß.

36 Only half of this dataset actually lies within this study's research area.

37 The only relevant study that applies spatial analyses is M. Castro's recently published Master's thesis entitled *The Function of the Roman Army in Southern Arabia Petraea* (Castro 2018) in which she aims to reexamine archaeological and historical discussions of known Roman military structures in southern Jordan. Cf. Oleson 2019a for a critical review.

38 Jouvenel 2013; Hackl et al. 2003, 9–12; Bienkowski 2000 and 1992a.

39 More on the 'Assyrian/Arabian Matrix' in Graf 2013, 48–50.

40 Hübner 1992 and Bienkowski 1992b.

41 Routledge 2004.

42 Generally, on the Iron Age kingdom of Edom (particularly in the Petra region), see e. g. Bienkowski 2013; 2011; 2007; Bienkowski – van der Steen 2001 and Bienkowski 1992b.

profited greatly from the extensive copper production in the Wadi Faynan (c. 40 km north of Petra), but it also controlled major important caravan trade routes that ran through its core territories – most notably the 'Kings Highway' or the *Darb ar-Rasif*, that continued further north to Mesopotamia. The 'Incense Road' leading westwards to the Mediterranean seaport town of Gaza also ran through Edomite territory – including the Petra area.

While the former Transjordanian Iron Age kingdoms generally enjoyed economic growth and overall security as Assyrian vassal kingdoms or provinces, the overall political situation of the region was greatly affected by the outbreak of civil war in Assyria following the death of the last Assyrian king Assurbanipal in 627 BC.[43] This eventually led to the downfall of the Assyrians and the rise of the Neo-Babylonian Empire during the last quarter of the 7th century BC, which triggered political unrest and conflicts throughout Transjordan:[44] For example, in 598 and 587 BC the Israelites attempted a revolt against the Babylonians. This was eventually crushed by Nebuchadnezar II (604–562 BC) leading to the massive deportation of the Jewish population to Babylonia and the end of the kingdom of Judah. Shortly after, in 582 BC, Ammon and Moab were also incorporated into the Neo-Babylonian Empire. In Edom, archaeological evidence from major Edomite settlements, most notably the former capital Busayra (Tafilah), also suggest that at least local conflicts were carried out at some point shortly after the establishment of the Neo-Babylonian Empire.[45] The destruction of Busayra is probably related to the campaign of the Neo-Babylonian king Nabonid, as is suggested by his monumental rock relief at as-Sela dating to c. 551 BC.[46]

By the time Cyrus the Great (559–529 BC) ascended the Babylonian throne, the now Achaemenid Empire controlled all of Transjordan, now belonging to the satrapy of Syria. However, although there is singular material evidence for settlement activities at major Edomite sites such as Tawilan, there is a noticeable lack of Persian period sites in Edom.[47] During the reign of Cyrus' son, Cambyses II (529–522 BC), the empire conquered Egypt in 525 BC and thus also controlled southern Palestine.[48] After Cambyses' death in 522 and during the reigns of Darius the Great (521–486 BC) and Xerxes I (486–465 BC), the Achaemenid Empire reached its greatest extent including the entire Near and Middle East. However, by the end of the 5th century BC the Achaemenids were forced to retreat from Egypt to southern Palestine rendering the region of *Judaea* into border territory. The Achaemenids also abandoned territories further inland to the east – including the Edomite heartlands and the Petra region, which was now presumably left in the hands of local Arab tribes.

The Hellenistic Period

The historical sources on Transjordan during the 5th and 4th centuries BC are largely silent.[49] After Alexander the Great's campaign through Phoenicia in 332 BC, the Macedonians also conquered Judaea. While Alexander continued to Egypt, his general Parmenion was first left in charge of the former Achaemenid satrapy. After Alexander's death in 323 BC, the satrapy was heavily fought over during the Diadoch Wars and the region was then controlled by quickly alternating satraps: Laomedon was succeeded by Perdikkas, who was then followed by Ptolemy (since 306 BC Ptolemy I Soter, founder of the Ptolemaic dynasty in Egypt) until the diadoch Antigonos Monophthalmos and his son Demetrios (later Demeterios *Poliorketes*) took control of the satrapy between 316 and 303 BC. For yet unknown reasons, in 311 BC the Antigonids launched two campaigns against the Nabataeans, a former nomadic tribe which now held territories in the former heartlands of Edom.[50] These events were originally described by the contemporary Hieronymos of Cardia, whose accounts were later taken up by Diodorus Sicilus and Plutarch.[51] It is reported that the Nabataeans were able to fend off the attacks by retreating on

43 Under Assurbanipal (668–627 BC), the empire conquered Thebes, the capital of Upper Egypt, thus experiencing its widest geographical and politically most significant influence.

44 For a brief overview of the region after the downfall of the Assyrian Empire until the Diadoch Wars, see e.g. Wenning 2013, 9–11 and Hackl et al. 2003, 11–12.

45 Although material evidence belonging to the Neo-Babylonian and later 'Persian' (Achaemenid) period was excavated at Busayra, Tawilan as well as in Petra's city center. Cf. e.g. Bienkowski 2013, 31–32.

46 Nabonid continued the conquest of other territories in Transjordan along his way to the Hijaz in 553/552 BC. On the rock relief at as-Sela, see e.g. Crowell 2007 and Dalley – Goguel 1997 with further references. Most recently, compare the works of the team surrounding R. Da Riva (e.g. Da Riva 2015).

47 Cf. e.g. Bienkowski 2008. Also consider Wenning 2013, 11.

48 Hdt. 3, 4–9.

49 For a general introduction into the historical setting of Transjordan during the Hellenistic period, see Graf 2013; Wenning 2013, 11–19; Schmid 2008a; Hackl et al. 2003, 36–40.

50 On the origins of the Nabataeans, see e.g. Wenning 2013, 7–8 with further references.

51 Diod. Sic. 19, 94–100, 3; Plut. Demetr. 7, 1. Cf. also Patrich 2015.

a "rock" (pétra) which is generally identified as their later capital Petra.[52] Also, Diodorus reports that the Antigonid attempt to take over the Nabataean bitumen production in the Dead Sea region failed as well.[53]

After the defeat of Antigonos and Demetrios at the battle of Ipsos in 301 BC, political supremacy over the Near and Middle East was now divided between Seleucus who controlled the former Achaemenid heartlands in the Near East and Ptolemy who reigned over Egypt. Judaea as well as the Phoenician coastal regions of the Levant were regrouped into the new province of *koile Syria* (κοῖλη συρία) which was under Ptolemaic rule until the end of the 3rd century BC when the Seleucids were able to conquer the province after the 5th Syrian War (201-c. 195 BC).[54] Apart from the accounts of Antigonos's attempts to take over Nabataean territories, there is almost no mention of the Nabataeans during the time of the Diadoch Wars in the historical sources. The earliest reference of the Nabataeans as a cultural group is only given in the 'Zenonpapyri' (the accounts of a certain Zenon who served Apollonius, the finance administrator of Ptolemy II) found in the Egyptian Fayyum and dating between 261 and 229 BC.[55] There are additional accounts by Diodorus and Strabo that indicate a trade war with the Ptolemies at some point during the 3rd century BC and in the mid-3rd century BC Poseidippos of Pella refers to an unspecified *Ναβαταῖος…βασιλεύς*.[56]

While the Seleucid conquest of *koile Syria* seemingly had no effect on the Nabataeans (at least there is no literary evidence for this), it impacted Judaea considerably: During Ptolemaic rule the Jewish community was divided into followers of the traditional belief system and those who adapted to a Hellenized way of life. It is in the context of these partisan conflicts that the first specific reference to Nabataean royalty is made in 168 BC when the Jewish high priest Jason is forced to flee from Judaea to the Nabataeans.[57] Antiochos IV Epiphanes then further fostered internal unrest amongst the Jewish community by forbidding the practice of the Jewish faith and introducing the cult of Zeus on the Temple Mount in Jerusalem. This triggered the armed revolt of the Maccabaeans – also known as the Hasmonaeans – who were able to eventually reclaim the Temple in Jerusalem in 164 BC. From this position of strength, the Maccabaeans aimed at extending their territories into eastern Jordan against the Seleucids, but, at first, maintaining amicable relations to the Nabataeans.[58]

However, with the growing weakening of the Seleucid and Ptolemaic rulers during the 2nd century BC, both the Maccabaeans and the Nabataeans aimed at territorial expansion which eventually led to armed conflicts between the two neighbors that should characterize the regional history until the Roman annexation of Nabataea in 106 AD. Most notably, the first major conflict was the Maccabaean siege of Gaza in 100 BC, which was previously held by the Nabataeans who, by that time, have already risen to a significant supra-regional power controlling both the long-distance trade routes and access to Mediterranean trade at Gaza.[59] With the promise of gaining control over the 'Kings Highway' leading northwards to Mesopotamia, both the Maccabaeans and Nabataeans were interested in reigning over the territories in northern Transjordan. In 90/93 BC, it thus inevitably came to battle in the Golan Heights where the then Nabataean king Obodas I defeated the Maccabaean ruler Alexander Iannaios.[60] In the 80s BC, the ruler over Damascus, Antiochos XII subsequently launched two attacks against the Nabataeans. The second attack resulted in the death of both Seleucid and Nabataean rulers (either

52 Diod. Sic. 19, 95–98. On the problematic identification of the Nabataean "rock," see recently Wenning 2013, 12–15: According to Diodorus, the Antigonids supposedly marched 2,200 *stadia* from Phoenicia to Petra (approx. 400 km) in only three days and nights. This being highly unrealistic, Diodorus hardly seems reliable in this case. However, he mentions that the Dead Sea – where Demetrios retreated after the second attack against the Nabataeans – is only 300 *stadia* from Petra (c. 55 km), which fits the distance to the Edomite stronghold of Khirbet as-Sela that also meets the characteristics described by Diodorus for the Nabataean "rock" (c. 65 km north of Petra). As the biblical Sela may be Khirbet as-Sela and *Sela* means "rock" in Hebrew, this has led some scholars to identify Khirbet as-Sela with Diodorus' pétra of the Nabataeans. Arguing that Diodorus's accounts (or those of Hieronymos) are unreliable and should be considered as a "highly stylized literary description" (Graf 2006, 48), others favor various mountaintops around Petra – particularly Umm al-Biyara (cf. e. g. Patrich 2015, 478; Wenning 2013, 13; Hackl et al. 2003, 451). Neither Khirbet as-Sela, nor Umm al-Biyara show evidence of Early Hellenistic occupation. In any case, one description cannot correspond to two different places in the same region. As Petra is undoubtedly identified as the Nabataean capital in later sources, Wenning hypothesizes that the Nabataeans could have abandoned Khirbet as-Sela after the Antigonid expeditions and re-settled at Petra (Wenning 2013, 13). While this can also only remain speculative, it is certainly correct to dismiss Khirbet as-Sela as the Nabataean "rock," if one qualifies Diodorus' accounts as unreliable.

53 Diod. Sic. 2, 48, 6; 19, 100, 1.

54 Hackl et al. 2003, 37.

55 Also see Hackl et al. 2003, 363.

56 Graf 2012a, 56–57; Hackl et al. 2003, 37: Diod. Sic. 3, 43, 5; Str. 16, 4, 18 and P.Mil.Vogl. VIII, 309, Col. II, 15–16.

57 2 Ma. 5, 8.

58 Hackl et al. 2003, 38: 1 Ma. 5, 24–28 and 9, 32–42; Jos. Ant. Iud. 12, 335–336 and 13,7–11.

59 Cf. Jos. Ant. Iud.13, 360–361.

60 Jos. Ant. Iud. 13, 374–375; BI 1,89–90.

Obodas I or Rabbel I).[61] As Damascus was otherwise left unprotected against the neighboring Ituraeans, the city accepted subordination to the new Nabataean king Aretas III.[62] Nabataean rule over Damascus lasted for c. 15 years during which Aretas III minted coins with his image in the tradition of the former Seleucid kings in order to further substantiate his reign.[63] From Damascus, Aretas then marched into Maccabaean territory and defeated Alexander Iannaios. However, he retreated immediately afterwards as a result of peace negotiations, which possibly reflects both Alexander Iannaios' weakened position due to continued internal unrest in Judaea since the battle at the Golan Heights as well as the arguably fragile Nabataean grasp of the Syrian territories around Damascus.[64] Together with the subsequently re-strengthened position of Alexander Iannaios, this possibly led to the loss of Nabataean territories in northern Transjordan until the death of Alexander Iannaios in 76 BC.[65]

From Pompey's Conquest of the Near East until the Roman Annexation

Simultaneous to the conflicts between the Nabataeans and the Maccabaeans over territories in Transjordan, Roman influence over the region grew increasingly powerful.[66] Most notably, this was first marked by the confirmation of Antiochos XIII as the last Seleucid king under L. Licinius Lucullus in 69 BC. However, as Antiochos failed to stabilize the remaining Seleucid territories in Syria, during the last years of the 3rd Mithridatic War (75–63 BC) Pompey intervened and took control over Damascus in 65 BC, thus dissolving the Seleucid kingdom. The city was presumably left by the Nabataeans already in 72 BC due to the growing threat posed by the Ituraean Ptolemaios.[67]

At the same time, disputes over the Judaean throne between the sons of Alexander Iannaios, John Hyrcanos II and his brother Judas Aristobulos II, left the Jewish kingdom in a weakened state and Hyrcanos turned to the Nabataean king Aretas III for assistance in 65 BC promising Aretas the northern Transjordanian territories in the Moabitis.[68] Agreeing to the terms, Aretas launched military campaigns against Aristobulos and eventually besieged his troops at Jerusalem.[69] However, after the conquest of Damascus, Pompey's *proquaestor* Aemilius Scaurus also lead Roman troops into Judaea and came to the aid of Aristobulos, presumably because he offered the larger sum and Scaurus disapproved of Hyrcanos' alliance with the Nabataeans. Scaurus threatened to declare the Nabataeans as enemies of Rome if they would not retreat from Jerusalem. Aretas complied and thus ended the first contact between Nabataeans and Romans without major conflicts.[70] Meanwhile, Pompey further proceeded with the provincialization of Syria, which was first governed by Scaurus. In 58 BC, Syria was later declared as a proconsular province, governed by Aulus Gabinius since 57 BC.[71]

In the spring of 63 BC, Pompey met with Aristobulos and Hyrcanos (both hoping for Roman support to their power claims) in Antiochia and expressed his plans to first form a military alliance against the Nabataeans before clarifying the situation in Judaea and to march against Petra. Instead of adhering to Pompey's plan, however, Aristobulos turned his armies back into Judaean territories. This only led to his defeat by Pompey who then sent Aristobulos to Rome as a hostage where he was eventually assassinated in 49 BC.[72] Although Pompey's campaign against Petra never came to be, he nevertheless celebrated himself as victor over the Nabataeans during his triumphal processions in Rome. Although remaining somewhat resistant to acting as a subservient Roman client kingdom, the Nabataean realm was henceforth, at least temporarily, dependent on Rome until its annexation in 106 AD.[73]

Pompey dissolved the Maccabaean kingom and Hyrcanos was only allowed to rule over significantly diminished territories as the Jewish High Priest. The northern Transjordanian territories were given to the Ituraeans and major coastal cities were now part of the Syrian province. Major northern Transjordanian cities that were once held by the Nabataeans (Cancatha, Gerasa and Philadelphia (Amman)) were incorporated into the *Dekapolis*.[74]

61 Jos. Ant. Iud. 13, 387–391 ; BI 1,99–102 ; St.Byz. 466, 5–7; 482, 15–16.
62 Jos. Ant. Iud. 13, 392; BI 1,103 and St.Byz. 144, 19–26.
63 Hackl et al. 2003, 39.
64 Cf. also Hackl et al. 2003, 39.
65 Cf. Ios.AJ 13,395–397; 14, 18.
66 For an overview over the historical development between the provincialization of Syria and the early Principate, see Hackl et al. 2003, 40–43.
67 Jos. Ant. Iud.14, 29; BI 1, 127.
68 Jos. Ant. Iud.14, 121–122; BI 1, 181.
69 Jos. Ant. Iud. 14, 8–21; BI 1,123–126.
70 Jos. Ant. Iud.14, 29–32 ;BI 1,127–129. Hackl et al. 2003, 41, 137.
71 App. Syr. 51.
72 Jos. Ant. Iud. 14, 46–48; BI 1,131–133; vgl. Cass. Dio 37, 15, Oros. 6, 6, 1, and Plut. Pomp. 41–42, 1.
73 On Pompey's celebration of his supposed defeat over the Nabataeans, see App. Mith. 106; Diod. Sic. 40, 4, Plin. HN. 7, 97–98 and Plut. Pomp. 45, 1–2. The status and nature of the Nabataean realm as a Roman client kingdom is much debated. Cf. e.g. most recently Schmid 2017; Kropp 2013a, 10–13, 41–43 and 2013b, 24–26, 31–36.
74 Hackl et al. 2003, 41–42.

After Pompey returned to Rome in 62 BC, Scaurus besieged Petra, but retreated soon after the Nabataeans payed of a significant bribe.[75] Scaurus' immediate successors as provincial governor, Marcius Philippus (61/60 BC) and Lentulus Marcellinus (59/58 BC), stood in no conflict with the Nabataeans. Only Gabinius marched victoriously against the Nabataeans in 55 BC, presumably following continued disputes between Judaeans and Nabataeans over Jerusalem.[76]

During the Roman civil wars, the Nabataean king Malichos I, together with Hycarnos in Judaea, quickly supported Caesar and came to his military aid at Alexandria in 47 BC.[77] After Caesar's death and Marc Anthony took control over the eastern provinces, Antigonos, the son of Aristobulos, was able to drive the powerful sons of Antipater, the advisor to Hyrcanos, Phasaël and Herod, out of Judaea with Parthian support. In seek of protection, Herod was forced to flee to Malichos I in Petra where he demanded the return of the northern territories given to the Nabataeans by Hyrcanos.[78] As the Nabataeans refused to meet Herod's demands, he proceeded further to Rome where the senate declared him king of the Jews.[79]

After Anthony successfully pushed the Parthians out of Syria, punitive fines from the client kingdoms that supported the Parthian invasion were ordered – also from the Nabataeans under Malichos I.[80] However, Cleopatra VII demanded from Anthony to bequeath her all Transjordanian territories, including all of Judaea and Nabataea, which Anthony in part followed.[81] Cleopatra's demands furthermore ignited armed conflicts between Herod and the Nabataeans[82], but these remained without major consequences after Octavian defeated Anthony and Cleopatra at the battle of Actium in 31 BC. Both Herod and Malichos I attempted to appease the new Princeps and Malichos I thus destroyed Cleopatra's fleet in the Red Sea and prevented her from fleeing.[83] After Herod had Hyrcanos assassinated, the two regional powers were flanked by the two major Roman provinces of Syria and Egypt and were thus at the constant mercy of Rome.

As reward for their support, it is presumed that Octavian returned the territories previously claimed by Cleopatra to the Nabataeans.[84] Malichos's successor, Obodas II (formerly Obodas III), continued to comply with Roman demands.[85] Such was presumably the case in 26/25 or 25/24 BC when the Roman governor of Egypt, Aelius Gallus, launched a campaign into Southern Arabia and was accompanied by a Jewish and Nabataean contingent. The latter was led by the Nabataean high-ranking official, Syllaios, who was held accountable for the disastrous outcome of Aelius Gallus' attempt to take territories in Southern Arabia (most notably those belonging to the Sabaeans) resulting in the loss of a large number of Roman troops.[86] After Augustus annexed further territories in northern Transjordan (the Trachonitis, Batanaea and Auranitis) that were held by local 'Arabs' and gave them to Herod in 23 BC, local inhabitants revolted against the Jewish king and were supported by Syllaios who encouraged them to continue to take arms against Herod. With the approval of the Roman governor in Syria, however, Herod subsequently launched a successful attack against the Nabataeans in 9 BC.[87] Meanwhile, Syllaios travelled to Rome attempting to defame both Herod as well as a certain Aineias who, without Augustus' consent, ascended to the Nabataean throne as Aretas IV after the death of Obodas II, while Syllaios also had royal ambitions.[88] Despite these attempts and, in part, also due to the negotiations of Herod's envoy, Nikolaos of Damascus, Augustus eventually accepted Aretas IV as Nabataean king, although he first considered to bequeath Nabataea to Herod.[89] Presumably, he dismissed the idea due to the continuing internal quarrels among the Herodians. After several unsuccessful assassination attempts against Aretas IV, Syllaios returned to Rome in 6 BC hoping to gain the trust of Augustus. This, however, also failed and Syllaios was subsequently executed in Rome.[90]

The events of the following years are unknown except that Herod died in 4 BC, Augustus in 14 AD, but Aretas IV continued to reign over Nabataea until

75 Jos. Ant. Iud.14, 80–81; BI 1, 159.
76 Jos. Ant. Iud.14, 103; BI 1, 178.
77 Jos. Ant. Iud.14, 128 ; BI 1, 187 and Bell. Alex. 1,1.
78 Jos. Ant. Iud.14, 370–371; BI 1,274–275.
79 Jos. Ant. Iud.14, 372–376; BI 1,276–279.
80 Cass. Dio 48, 41, 5.
81 Jos. Ant. Iud.15, 92; BI 1, 360–361. On the territories taken from Anthony, see Cass. Dio 49, 32, 5, Plut. Ant. 36, 1–3, Jos. Ant. Iud.15, 94; BI 1,361
82 Jos. Ant. Iud.15,111; BI 1, 366; Jos. Ant. Iud.15, 147–160; BI 1,380–385.
83 Plut. Ant. 69, 5, Cass. Dio 51, 7, 1.
84 For an overview of the time between the early Principate and the annexation, see Hackl et al. 2003, 44–46.
85 On Obodas II/III, see the recent numismatic study of Barkay 2016.
86 Str. 16, 4, 22–24; Plin. HN. 6, 160. Graf 2016, 128–134; Roche 2012a, 54–64.
87 Jos. Ant. Iud. 16, 271–285. This complex and intricate episode in the history of the Nabataeans and their relationship with Herod and Rome, i. e. particularly the dealings of Syllaios and Aretas IV's ascension to the Nabataean throne, is covered only very schematically here. For a far more differentiated discussion, cf. most recently Schmid 2017, 277–280; Graf 2016 and Roche 2012a.
88 Hackl et al. 2003, 44; Jos. Ant. Iud.16, 286–294.
89 Jos. Ant. Iud.16, 335–355.
90 Jos. Ant. Iud.17, 54–57; BI 1,574–577 and Str. 16, 4, 24.

40 AD. While internal unrests were triggered all over Judaea after Herod's death and the Roman governor of Syria, P. Quinctilius Varus, only succeeded to suppress them with the help of Nabataean forces, Aretas has proven himself as a trustworthy ally of Rome.[91] It was also under Aretas IV that the Nabataean realm reached its farthest extent including major Nabataean settlements in the Hijaz, for example, at Dumat al-Jandal and Medain Salih. Similar to Petra, these sites experienced great prosperity as is archaeologically evidenced by their extensive urban development. Particularly in Petra, major building activities date to the late 1st century BC and early 1st century AD, thus contemporary with the reigns of Obodas II and Aretas IV.[92] For example, this extensive urban development in Petra is manifested by the numerous rock-cut Nabataean tombs, the major temples in the city center such as the Qasr al-Bint or the Temple of the Winged Lions, the so called 'Great Temple', the presumed *basileia* of the Nabataean kings as well as more private, luxurious mansions such as ez-Zantur.[93]

However, as Herod's sons continued to battle each other over his heir, the Nabataeans entered the internal Judaean conflicts after marital disputes between Herod Antipas and a daughter of Areats IV escalated.[94] Herod Antipas complained to Tiberius who then ordered the then Roman governor of Syria, Vitellius, to launch a punitive attack against the Nabataeans.[95] After Tiberius' death and Caligula's ascension to power in 37 AD, however, Vitellius no longer pursued the attack. Instead, after the death of Herod's other son, Philippos, as well as that of the Ituraean, Lysanias, Caligula gave their lands to Herod's grandson, Agrippa I. Shortly after, Herod Antipas was exiled and Agrippa gained controlled over his lands as well. In 41 AD, the new Roman emperor Claudius also bequeathed the territories formerly held by Herod Archelaos (yet another son of Herod the Great) to Agrippa who thus controlled territories similarly large as those held by Herod the Great and which was a threat to the new Nabataean king Malichos II. However, Agrippa I died already in 44 AD and his entire kingdom was subsequently incorporated into the Roman Empire as the province of *Iudaea*.

During the Jewish revolt against the Romans in 66 AD, the surrounding client kings were forced to send military assistance and Malichos II dutifully followed the call in 67 AD and further supported Titus in the siege of Jerusalem one year later.[96]

Nabataea under Roman Rule

Historical information concerning the events of the mid-1st century AD until the Roman annexation of Nabataea in 106 AD are rare and the documentary evidence on the annexation process itself is also not clear.[97] Scholars therefore still dispute whether, after the death of the last Nabataean king Rabbel II, the annexation occurred peacefully or whether it was met by armed Nabataean resistance. The incorporation of Nabataea into the new *Provincia Arabia* is first documented on milestones discovered along the *via nova Traiana* (following the former King's Highway) that extended over 430 kilometers between *a finibus Syriae usque ad mare rubrum* and was constructed between 111 and 114 AD.[98] The annexation occurred during the reign Trajan. However, the emperor did not take over the honorific title of *Arabicus* on his coinage issued immediately after the annexation and it reads only *Arabia adquisita* instead of *capta*. This has led some scholars to believe that the annexation occurred peacefully.[99] This viewpoint has been challenged, however, as archaeological evidence in the region, at least, points to local conflicts that were carried out during the time of the annexation.[100] Moreover, although dating more than a century later, there is literary reference to the annexation process that stands in conflict with the assumption of a peaceful annexation: Cassius Dio mentions that the annexation troops were commanded by the then governor

91 Jos. Ant. Iud.17, 286–296; BI 2,66–76.
92 There are, however, convincing archaeological indications for more substantial urban activities in Petra as early as the late 3rd century BC, particularly in the (later) *temenos* area of the Qasr a-Bint: Cf. e.g. Renel – Mouton 2013 and Graf 2013.
93 Cf. e.g. Schmid et al. 2012 and Schmid 2012a with further references.
94 Jos. Ant. Iud.18, 109–112.
95 Jos. Ant. Iud. 18, 113–115.
96 Jos. BI 3, 68; Tac. Hist. 5, 1, 2.
97 For a historical overview on the political history following the annexation, see Hackl et al. 2003, 52–59. For a more detailed discussion on the annexation process, see e.g. Parker 2009a; Kennedy 2004, 45–46; Fiema 2003, 43–47 and Freeman 1996 with further references. Also note that there are indications that Rabbel II had a son, Malichos III, who may have continued to control Nabataean territories in the northern Hijaz after the establishment of *Provincia Arabia* (Hackl et al. 2003, 53). However, this Malichos III was probably disposed quickly at some point during his first regnal year, as the northern Hijaz was fully incorporated in the province of Arabia (cf. Fiema et al. 2015, 376).
98 Fiema 2003, 45; Freeman 1996, 113–114 and Graf 1995a, 241.
99 Bowersock 1983, 81; Spijkerman 1978, 32. Trajan did adopt the victor's titulature of *Dacicus* or *Parthicus* after his victory over the Dacians during the Second Dacian War (105/106 AD) shortly before the annexation of Arabia, as well as Trajan's conquest of Parthia in 114 AD (cf. e.g. Hackl et al. 2003, 52).
100 See e.g. Parker 2009a and Schmid 1997. For a more recent archaeological discussion on the destruction in urban Petra around the time of the annexation, see Horacek 2016.

of Syria, Cornelius Palma, and in the 4th century AD Ammianus Marcellinus later alludes to the use of force taken by the Romans against the Nabataeans.[101] Palma most likely mobilized a substantial amount of troops as suggested by the epigraphically evidenced presence of the *legio VI ferrata* at Bostra and Gerasa as well as the deployment of the *legio III Cyrenaica* from Egypt to the Petra area directly after the annexation in 107 AD as is documented by papyri discovered at Karanis in Egypt.[102] In addition, for yet unknown reasons, Cornelius Palma was awarded the *ornamenta triumphalia* in 107 AD, which must be associated with Roman military action somewhere within Nabataea during the time of the annexation.[103]

After 106 AD, there is no reference to the Nabataean royal dynasty or the name *Nabataea* and there are no indications that members of the Nabataean aristocracy were incorporated into the Roman senate.[104] This has led some scholars to suggest that the Nabataeans received some kind of a *damnatio memoriae*.[105] Although the exact reasons for this remain unknown, this is considered at least indirect evidence for conflict.

Earlier scholars have raised this as a supportive argument for claiming that the capital of the Roman province – which encompassed the core Nabataean territories in the Hawran, northern Transjordan, Edom, the Negev and the Hijaz[106] – was moved to Bostra in southern Syria.[107] The provincial governor and thus commander of the legions stationed in Arabia indeed resided in Bostra, but this does not support the claim of any 'Era of Bostra,' which is based mainly on unsupportable and ambiguous epigraphical evidence.[108]

There is, however, ample epigraphical evidence that, together with Bostra, Petra maintained its important civic status after the annexation.[109] Already under Trajan, Petra was acknowledged as a *metropolis* of Arabia and later, probably after Hadrian's visit to Petra during his travels through the Near East in 130–131 AD, the city received the honorific title of *Hadriana Petra metropolis*.[110] Later, between 209–212 AD, it was probably Caracalla who granted Petra the status of *colonia*. There is also further epigraphical evidence in Petra attesting to the city's status of *metrocolonia* at some point during the 3rd century AD. Considering the various honorifics given to Petra in the course of the 2nd and 3rd centuries AD which amassed to *Augusta colonia Antoniniana nobilis ingenua mater coloniarum (*or *metrocolonia) Hadriana Petra Metropolis Arabiae*, Fiema et al. note that *nobilis* (distinguished) and *ingenua* (native/indigenous) are not attested for Bostra, possibly suggesting that the inhabitants of Petra took particular pride in the fact that their city's colonial status was bestowed "[…] *without an influx of Roman citizens.*"[111]

The 3rd century AD is generally characterized by deep political and economic crises throughout the empire. Particularly the Near East was marked by the Parthian Wars and the occupation by the Palmyrene Empire under Zenobia (269–272).[112] Petra appears only rarely in contemporary historical sources. This not only suggests that the region was not greatly affected by these conflicts, it more importantly indicates the decreasing political and economic importance of the city. Reflecting the general unstable political conditions of the empire, the 3rd century AD marks the decline and shift of long-distance trade routes.[113] The city's commercial significance declined substantially which greatly benefitted seaport towns along the Red Sea (e.g. Aila) that prospered from the increasing seaborne trade with South Arabia and India. Additionally, caravan routes between Syria and the Hijaz shifted further east on the fringes of the vast desert areas benefitting large settlements east of Petra such as Udruh or Khirbet Jarba. With major structures being abandoned, there are several archaeological indications in Petra suggesting an overall deterioration or stagnation of urban development that reflects Petra's declining commercial prosperity during the later 3rd century AD. In 363 AD the city also suffered from severe earthquake damage from which it never recovered.[114]

The Byzantine Period

As a result of several provincial reorganizations, beginning with Diocletian and continuing throughout the 4th century AD, *Provincia Arabia* was finally divided into two parts with Petra being the capital of

101 Cass. Dio 68, 14, 5 and Amm. 14, 8, 13. There are also three 'Safaitic' texts mentioning conflicts between Nabataeans and Romans that have been associated with the annexation. However, this is also disputed, for example, by Graf 1989, 376, n. 141 who raises serious doubts whether the texts can be related to the annexation.
102 Cf. e.g. Kennedy 2004, 47–48.
103 Hackl et al. 2003, 429.
104 Parker 2009a, 1591; Graf 1989, 381–382 and most recently followed by Fiema et al. 2015.
105 Cf. Bowersock 1988, 51–52.
106 E.g. Fiema et al. 2015.
107 See Fiema 2003, 39–43 and Fiema 1988 for a critical appraisal of these assumptions.
108 Fiema 1988.
109 For the honorific titles of Bostra, see Fiema 2003.
110 Recently on the honorific titles bestowed on the city of Petra, see Fiema et al. 2015, 378–379 with further references.
111 Fiema et al. 2015, 378–379.
112 For a recent historical overview of the Petra region during the 3rd century AD, see Fiema et al. 2015, 383–385 and Fiema 2003, 47 with further references.
113 Cf. e.g. Erickson-Gini 2010, 72–73; Fiema 2003, 50.
114 Cf. e.g. Fiema 2015, 357 and 2003, 49.

Palestina Salutaris (later Tertia), which encompassed territories in southern Jordan, the Negev and probably also Sinai.[115] The *Notitia Dignitatum* lists no garrisons south of Aila where the *legio X Fretensis* was stationed and it is assumed that provincial administration did not extend further south of Aila either.

From the 4th century AD onwards, the regional history of the Petra region must also be set in the context of the increasing activities of large tribal confederations in the region. In order to maintain dominance over the province, the Byzantine Empire was now heavily reliant on political and military alliances with such Arab confederations, some of which were given the status of *foederati*. This is particularly highlighted when Justinian grants Abu Karib (Abochorabos), the leader of the tribal confederation of the Ghassanids, the *phylarchy* over *Palestina* from 529–581 AD, which included the Petra area.[116] Although there is no direct literary evidence that indicates an Arab *foederatus* in the region, the Petra Papyri (most likely dated to 544 AD) mention Abu Karib as the Ghassanid *phylarch* who mediated a civil dispute over property rights at *Zadacathon* (Saddaqa).[117]

The introduction of Christianity in the Petra region first occurred gradually and slowly as evidenced by the accounts of Eusebius from the early 4th century AD stating that pagan rituals commemorating the old Nabataean supreme deity Dushara continued to be practiced in Petra despite the construction of churches. Moreover, he mentions Christian pilgrims travelling to Jabal Harun (the "Mountain of Aaron"), situated c. 5 km southwest of Petra's city center, who visited the spring supposedly created by Moses during the Exodus.[118] In the late 4th century AD, Epiphanius and Sozomen also describe the mixed practice of pagan cults alongside Christianity and there are indications that pagan idolatry continued even into the early 5th century AD.[119] By that time, however, Petra's ecclesiastical importance grew, particularly after it received the status of the Metropolitan See of the Patriarchate of Jerusalem with Johannes as the first metropolitan bishop of Petra in 451 AD. Simultaneous to Petra's elevated ecclesiastical status, there is first archaeological evidence for church construction in Petra, including the conversion of the former monumental Nabataean 'Urn Tomb' into a church in 446 AD, the construction of the 'Ridge Church' and 'Blue Chapel' during the 5th – 6th centuries AD as well as the large 'Petra Church' in the late 5th century AD. However, other major buildings in the city center continued to be abandoned.[120]

In addition to the churches, monasticism is evidenced in Petra on top of the mountain of ad-Deir. More importantly, however, by the late 5th century AD a large monastic complex was built on top of an earlier Nabataean sanctuary on Jabal Harun which included "[…] *a large church, a chapel with baptismal fonts, a pilgrims' hostel, and other associated structures.*"[121]

As this underlines Petra's ecclesiastical significance in the 5th and early 6th centuries AD, the last known bishop of Petra is already listed at the end of the 6th century AD (or slightly later). At some point during the 7th century AD, Petra no longer enjoyed the status of the Metropolitan See. Although there are no specific historical references to Petra during the time of the Persian and Muslim conquests of the Near East, the invasions probably further impacted the continuing decline and deterioration of the city as is indicated by the archaeological evidence in the city center. There are, however, Early Islamic historical accounts mentioning the peaceful capitulation of major towns in the immediate Petra area, including Udruh and Khirbet Jarba, to the Muslim forces in 630 AD that further confirms Petra's decline. Archaeological evidence in the city center suggests that Petra finally ceased to function as an urban center by the late 7th or early 8th century AD.

The Physical Landscape of the Petra Area

Petra's unique geographical setting immediately comes to mind when researching the ancient city. It is situated in a steep valley and is therefore vulnerable to both severe seasonal flash floods and drought rendering the control of its water sources and water flow vital to maintain a safe and comfortable living environment. The relation between archaeological sites in and around the Nabataean capital and the natural

115 On the late Roman provincial rearrangements in Arabia, see Sipilä 2009 and 2004. For a general historical overview on Late Roman/Byzantine Arabia, see Fiema et al. 2015, 385–390, 394–395; Fiema 2003, 52–53 and Fiema 2002a, 192–195.

116 Procop. Pers. 1, 19, 8–13.

117 Fiema 2007, 316. Abu Karib also controlled regions beyond the Byzantine provincial borders including an area known as the *phoinikon* (the "Palm Groves") (Procop. Pers. 1, 19, 8–13) which most likely refers to the major oases in the Hijaz, including Tayma, al-Ula, Medain Salih (Hegra), Khaybar and Yathrib (Fiema et al. 2015, 388, n. 78). Abu Karib eventually bequeathed the oases to Justinian although he continued to administer the "Groves" on behalf of the Byzantine emperor.

118 Euseb. On. 176, 7.

119 Fiema et al. 2015, 389: Epiph. Panar. 2, 51, 22, 11 and Sozom. Hist. eccl.7, 15.

120 Fiema 2015, 374.

121 Fiema et al. 2015, 391.

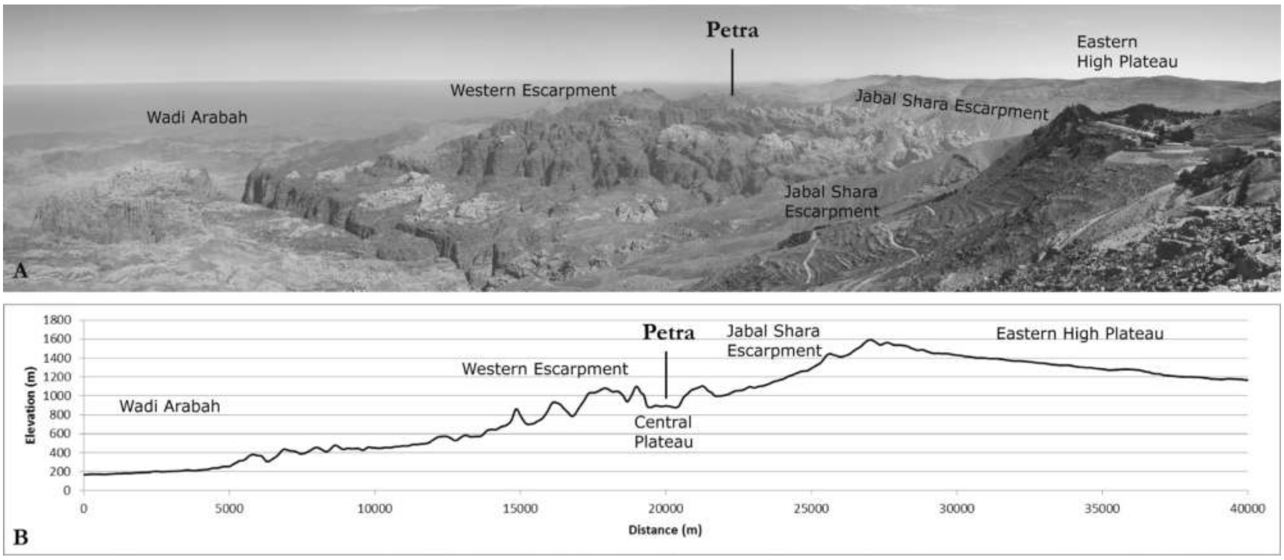


FIG. 1 A: View over the Petraean hinterland from ar-Rajif (view to NW) showing the location of Petra and the main geographical zones referred to in the text. B: East-West running elevation profile of the Petraean hinterland (20 km radius around the city).

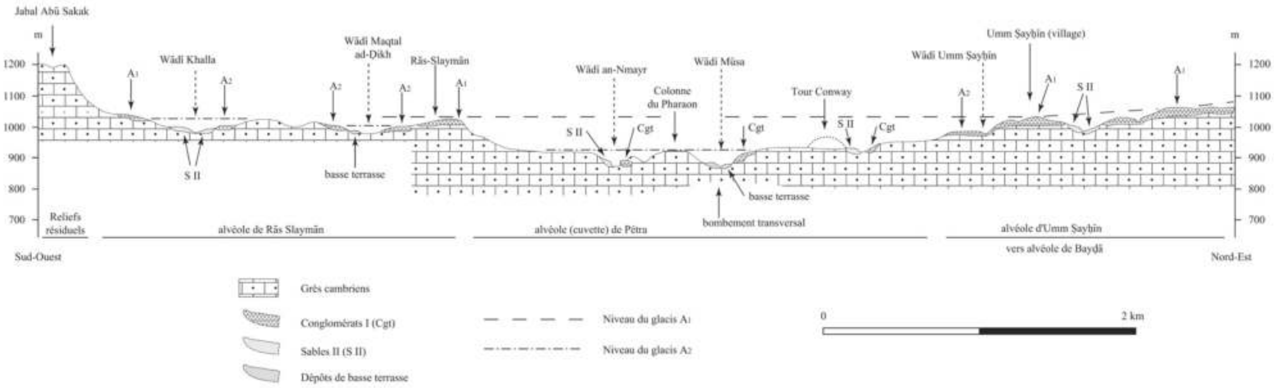


FIG. 2 East-West running elevation profile of the 'central plateau' sowing the comparatively flat plateaus and gentle slopes of the Petra valley and its immediate surrounding. After Besançon 2010, 27, fig. 5.

landscape becomes immediately obvious. However, rural archaeological sites beyond Petra's urban limits are only beginning to be contextualized more comprehensively with their natural environment.[122] This is a particularly welcomed trend, as archaeological investigations of the spatial distribution of sites and the assessment of rural Petra's cultural landscape cannot be divorced from natural landscape factors that often impacted settlement strategies and further determined specific site locations and types.

The following therefore serves as a brief and very general introduction into the environmental setting of the Petraean hinterland as this forms the basis of a more nuanced study on the relationship between the natural landscape and the discussed archaeological sites and features. The physical landscape description includes information on topography, geology, past and present climate conditions, hydrology and vegetation.

Topography

Belonging to the 'Eastern Highlands' of southern Jordan, Petra lies between the north-south running rift valley of the Wadi Arabah in the western periphery of the study area, followed by the ascending 'western escarpment' immediately east of the Arabah rift that eventually opens onto the 'central plateau' which the Petra valley (*urban* Petra) is part of (FIG. 1).[123] Contin-

122 Cf. e.g. Knodell et al. 2017; Kouki – Lavento 2013 or Kouki 2012. Cf. also similar claims already expressed in Kennedy 2016a.

123 For more on the topographical setting of the Petra, see e.g. Barjous 2013; Beckers et al. 2013, 335–336 and Beckers 2012; Kouki 2012, 55–59; Besançon 2010, 39–40; Macumber 2008 or Bender 1974.

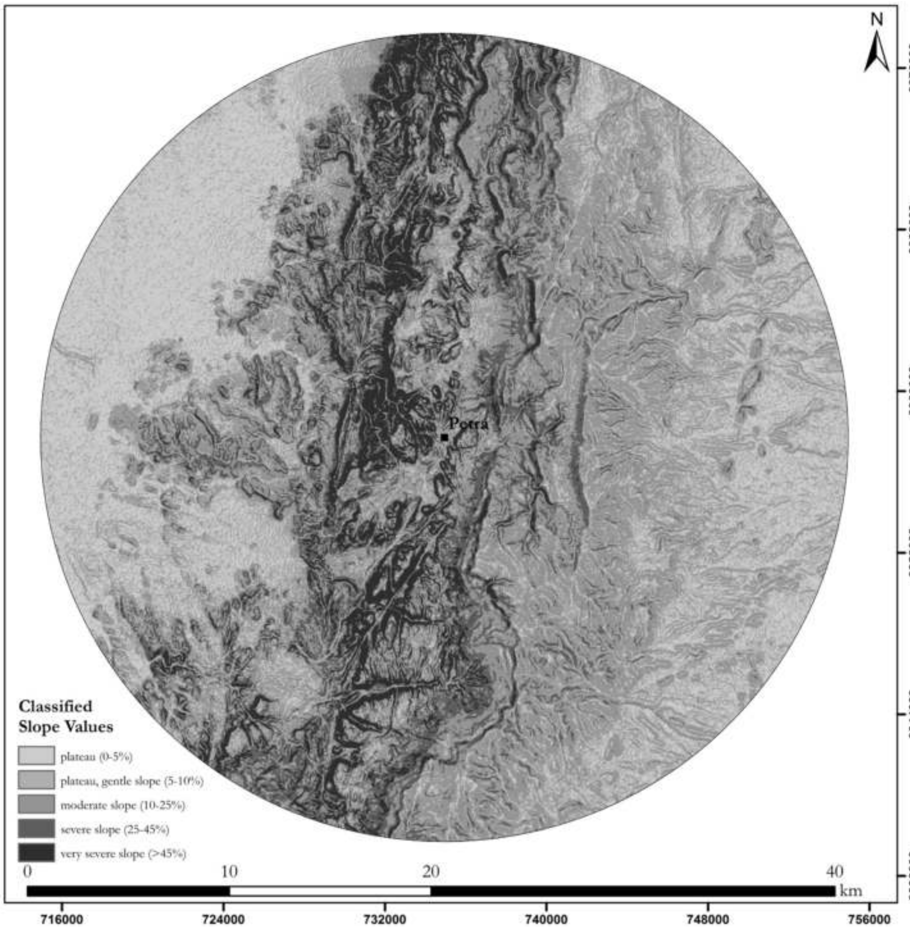


FIG. 3 Reclassified slope map of the Petra area on the basis of SRTM-1 elevation data.

uing further eastwards, the topography then ascends the 'Jabal Shara escarpment' which subsequently opens onto the wide 'eastern high plateau' that extends as far east as the major town of Udruh before shifting into the vast desert steppe.

Within a distance of not even 20 km, the elevation values of the Petra region range from c. 100 m a. s. l. along the rift valley of the Arabah in the west to almost 1800 m a. s. l. along the Jabal Shara escarpment in the east. Elevation values along the eastern high plateau drop again slightly to c. 1200 m a. s. l.. Undoubtedly, this extremely rugged topographical setting is one of the most striking landscape features of the Petra region.

As clearly shown in the elevation profile of the study area (cf. FIG. 1[124]), from c. 1200 m a. s. l. the landscape slopes steeply in a westerly direction from the eastern high plateau down the Jabal Shara escarpment before flattening slightly at the level of the Petra valley, which is situated at an elevation value of roughly 900 m a. s. l.. The topography then continues its dramatic drop towards the Wadi Arabah. Apart from the eastern high plateau, the urban center of Petra lies well within the flattest area of the region (cf. FIGS. 1 and 2). A GIS-based slope map (FIG. 3) emphasizes these difficult and complex topographical conditions of the Petra area even more as it clearly demonstrates Petra's unique situation between ascending severe slopes (25–45 %) in the east (Jabal Shara escarpment) and the descending very severe slopes (≥ 45 %) of the western escarpment.[125] Particularly to the north and southwest, however, the landscape immediately around the city is characterized by flat plateaus (≤ 5 %) and gentle slopes (5–10 %). This is also demonstrated in FIG. 4 depicting the major regions of the Petraean hinterland referred to in the course of this study.[126]

124 The elevation profile is based on a SRTM-1 DEM (cf. chapter 2).

125 Cf. Kennedy 2016a. Slope values were calculated on the basis of a SRTM-1 digital elevation model and subsequently reclassified according to E. Farinetti's slope classes (cf. chapter 2) (Farinetti 2011, 17).

126 The mapped regions in FIG. 4 were drawn by the author under the guidance of Suleiman Mohammed al-Bdul on the basis of satellite imagery in a GIS environment, which is most appreciated.

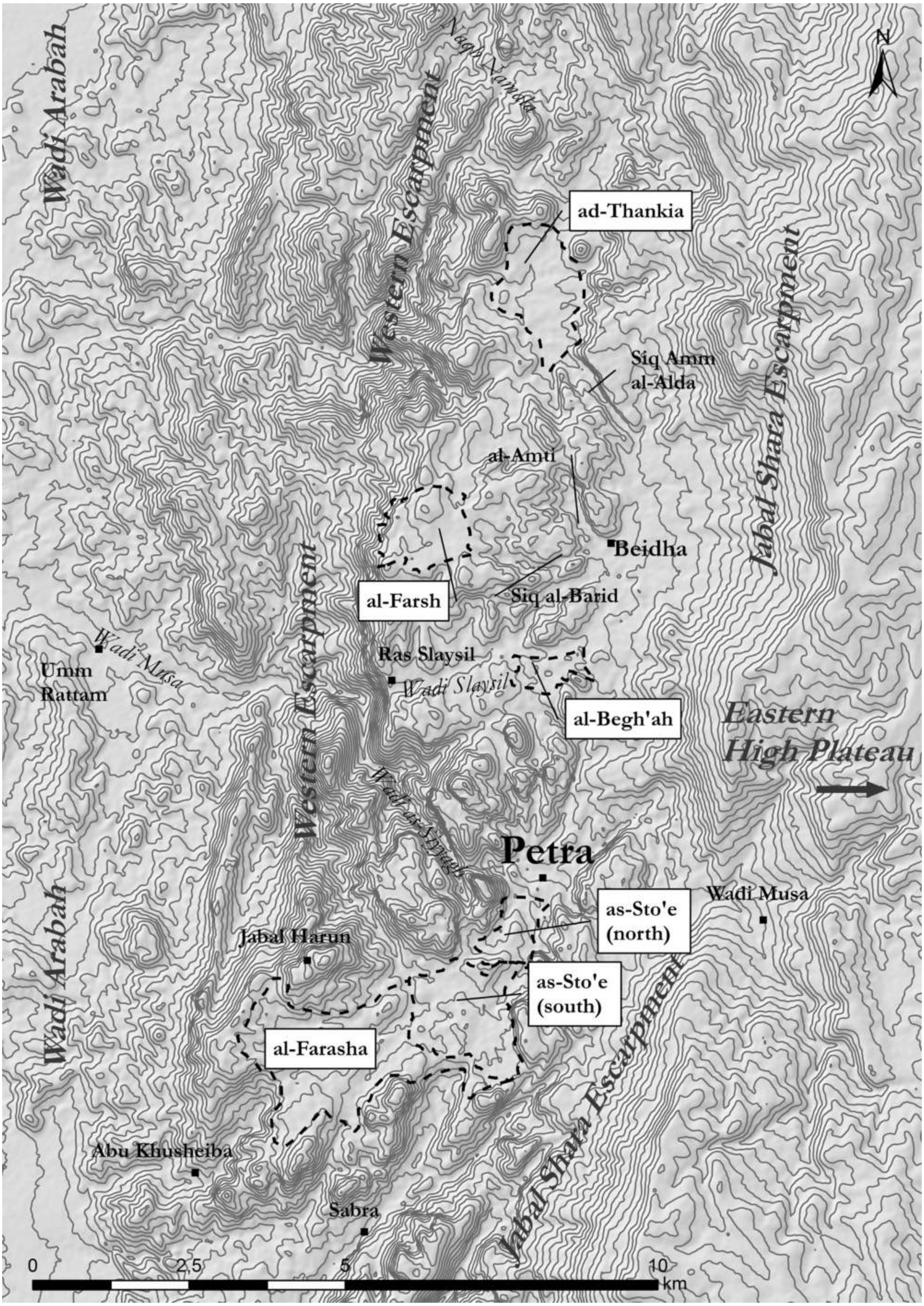


FIG. 4 Overview map of the major geographical regions referred to in the text.

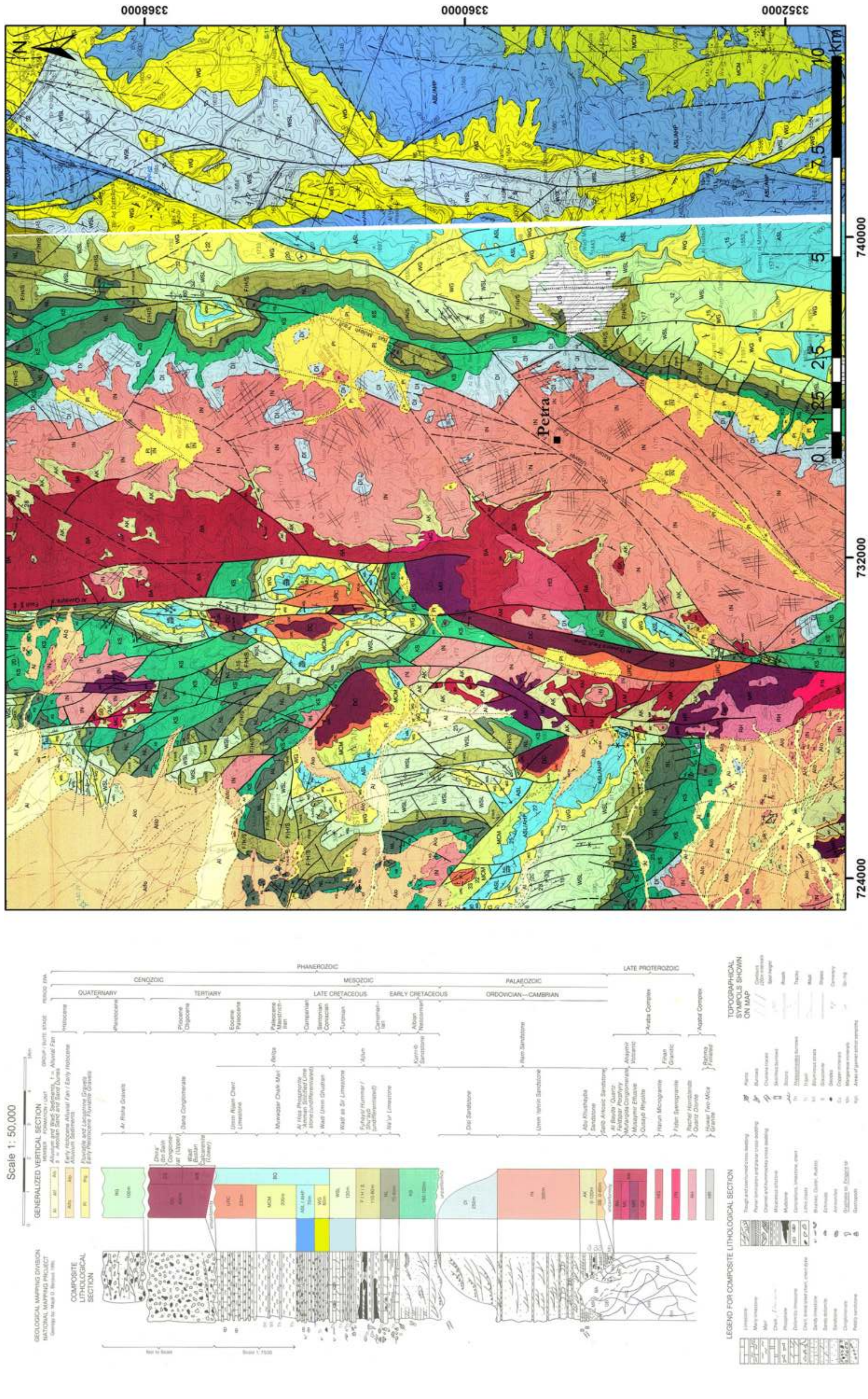


FIG. 5 Geological zones of the Petra area. Based on the georeferenced 1:50,000 geological maps of the Jordanian Natural Resources Authority from 1995, Sheets 3050-I and 3050-IV (Petra & Wadi al Layyana) and 3150 IV (Bir Khidad).

Geology

The dramatic descent of the western escarpment borders not only with the immediate edge of the flatter plateaus and gentle slopes of the central plateau north of Petra (cf. FIGS. 1–4), but that same border zone also represents a dramatic change in geology:

Although the lithology varies along his topographical border zone, known as the 'al-Quwayra' and 'Wadi Arabah Fault Zones,' it marks the same western transition from the sandstone formation of the central plateau into a dominant strip of dark volcanoclastics running north-south across the entire study area (FIG. 5).[127] This formation is referred to by local al-Bdul Bedouins as the 'al-Somrah' – the dark stone (cf. chapter 6). In the west, the al-Somrah is bordered by the wide alluvial and fluviatile plain of the Arabah. To the east, the volcanic stone shifts into the rugged Cambrian (Umm Ishrin formation) and Ordivician (Disi formation) sandstones characteristic of the central plateau and the Petra valley. [128] Further east, Cretaceous limestones dominate the Jabal Shara escarpment. From there, the landscape shifts into the marine layers of limestone, marl and phosphorites, which characterize the eastern high plateau.[129]

Modern Climate of the Petra Area

The Petra area is part of the semi-arid to arid zone of the Levant (the arid variant of the Mediterranean zone).[130] Main sources of moisture are Eastern Mediterranean cyclones shifting eastwards. While in the alluvial lowlands of the Wadi Arabah annual rainfall rates average at c. 50 mm with mean temperatures of 25 °C (up to 50 °C in the summer months), the Petra valley enjoys mean annual rainfall rates of c. 150 mm with an average summer temperature of 22 °C and maximum summer temperatures reaching 35–45 °C. Torrential (winter) rainfall occurs mainly in the mountainous uplands with generally higher annual rainfall rates along the Jabal Shara escarpment that eventually reach 180–200 mm along the eastern high plateau. Due to bedrock exposure, the steepness of slopes and the dominant topographical relief, the Jabal Shara escarpment has a high run-off coefficient. This also applies to the mountainous areas of the al-Farasha and as-Sto'e plains southwest of Petra (cf. FIG. 4). Thus, particularly in the winter months (January and February), flash floods are channeled through the numerous wadis and gorges during heavy rainfall events, which discharge far into the Wadi Arabah mainly along the Wadi Musa and Wadi as-Siyyagh.

There is also evidence of extensive deforestation particularly in the Jabal Shara region causing soil erosion that further impacted flood magnitude and frequency. In addition to seasonal flash floods, the regional spring horizon runs along the Jabal Shara escarpment including the most important natural springs that supplied urban Petra with water: 'Ain Dibidbi, 'Ain Musa and 'Ain Braq.[131]

The mean annual temperature of the upper Jabal Shara escarpment and the eastern high plateau is c. 15 °C. Along the eastern desert steppe, which begins immediately east of the ancient settlement of Udruh, mean annual rainfall rates drop below 100 mm.

Vegetation

Being an extension of the Sudanian and Saharo-Arabian vegetation provinces, the Wadi Arabah is characterized mainly by desert bush vegetation and, occasionally, acacias and tamarix.[132]

Along the central plateau, soils are shallow and poor in nutrients, thus only allowing dry farming or run-off cultivation.[133] Recent archaeobotanical analyses from the Petra region, i. e. particularly the Jabal Harun area as well as ez-Zantur, indicate that the most common cultivated cereal was barley. However, Juniper and fig trees as well as oaks also grow along the gorges of the sandstone formation of the central plateau, which can thus be characterized as a montane forest steppe. Also, numerous olive and wine presses found mainly in the Beidha area are clear indications that viticulture was practiced in addition to the cultivation of olive trees. This is also indicated in the 6th century AD Petra Papyri.[134] Generally, however, vegetation in the Petra

127 Cf. Kennedy 2016a, 141–145.

128 For a general overview on the geology and geomorphology of the Petra area, see e.g. Barjous 2013; Beckers et al. 2013, 335–336; Beckers 2012; Kouki 2012, 55–59; Besançon 2010; Kühne – Wanke 1989, 233–234; Bender 1974.

129 Bienkowski 2011, 3; Macumber 2008, 9, 16; Lindner 1997a, 25.

130 For an overview of the modern climatic and hydrological conditions of the Petra area, see e. g. Beckers et al. 2013, 336; Tenhunen – Kouki 2013, 60–62; Beckers 2012 and Kouki 2012, 60–64.

131 Cf. e. g. Bellwald 2012.

132 For an overview of the modern vegetation of the Petra area, see Beckers et al. 2013, 336; Tenhunen – Kouki 2013, 60–62; Kouki 2012, 61.

133 On the archaeobotanical evidence from Jabal Harun, see Tenhunen 2016 and 2013. From ez-Zantur, see Bouchaud et al. 2017. For more on cultivated plants in the Petra area, see Kouki 2012, 108–109.

134 Cf. Nasarat et al. 2012.

area consists mainly of Irano-Turanian shrub steppes. At higher elevations along the Jabal Shara escarpment and eastern high plateau, Mediterranean-type dry woodland also thrives. Due to higher rainfall rates as well as cooler mean temperatures, the eastern high plateau offers the best environmental conditions for cereal and plant cultivation. The vast desert steppe of the Transjordanian plateau further east, however, are not suitable for crop cultivation.

Past Climate of the Petra Area

Environmental data from the Sahara-Sahel regions as well as from the Arabian Peninsula indicates that climate changes grew both temporally and spatially more variable since the Holocene wet period (c. 11,500 BP).[135] During the Late Chalcolithic and Early Bronze Age (c. 2500 BC), regional humidity rates reached a maximum and isotope analyses from Red Sea corrals suggest higher summer and cooler winter temperatures in the Near East than is presently the case. This led to higher precipitation. Moreover, as the Dead Sea level dropped towards the end of the Early Bronze Age (c. 2300–2100 BC), it is assumed that the climate grew increasingly arid. This development continued until the 3rd century BC. However, with the rising level of the Dead Sea from the late 3rd/early 2nd century BC, humidity rates increased and culminated in the late 1st century BC. This resulted in higher flood frequencies, which facilitated the cultivation of cereals and the practice of run-off agriculture. By the 1st century BC, the regional climate were thus moister than the present conditions. Again indicated by fluctuating Dead Sea levels, it is assumed that rainfall rates decreased again during the 1st century AD, although this is immediately followed by an increase in the 2nd and 3rd centuries AD. However, as speleothem isotope data suggests, annual rainfall rates supposedly dropped significantly by the early 5th century AD with drought periods more common and wet periods growing increasingly less frequent. Longer humid phases probably occurred during the Byzantine period as well.[136] It is generally agreed, however, that by the Early Islamic period (7th – 9th century AD), the Petra region experienced increased aridity and dry climatic conditions prevailed. From the mid-9th century AD, the climate again grew more humid until the end of the 11th century AD. Regional rainfall rates increased again during the 12th and 13th centuries as well as from the late 17th to late 19th centuries AD.

135 For a far more detailed discussion on reconstructions of past climatic conditions in the Levant, cf. e. g. Fuks et al. 2017; Büntgen et al. 2016 and Hirschfeld 2004 with further references. Specifically on the Petra area, cf. Tenhunen – Kouki 2013, 56–57 and Kouki 2012, 64–68, 115–121 with further references.

136 Macrofossil analyses from the extended Jabal Harun area also suggest an increased aridity of the Petra region. Cf. Tenhunen 2016 and 2013.

Chapter 2
Methodology

This study follows a strong landscape archaeological approach, which entails the application of complex and highly advanced, mainly computer-based analytical methods ranging from spatial statistics to GIS-based analyses. Before delving into the technical particularities of the applied methods, a brief introduction into this study's understanding of landscape archaeology is in order to explain the underlying objective when applying the various landscape archaeological methods. However, any attempt at offering an extensive epistemological assertion of landscape archaeology as a discipline, or of the various concepts of 'landscape' within archaeological theory would exceed the limits of this study.[137] It suffices to note that the term 'landscape archaeology' is frequently used undifferentiated in archaeological contexts, often resulting in an unclear understanding of the method. For example, at least in German archaeological circles, landscape archaeology includes other archaeological sub-disciplines such as mining archaeology, settlement archaeology, geoarchaeology and environmental archaeology.[138] As landscape archaeology has become a disciplinary trend within archaeological studies in recent years, a clear definition of the method has grown increasingly obscure. As T. Meier stated in 2010 at the first International Landscape Archaeology Conference in Amsterdam:

> *Nowadays the word 'landscape' is in. It obviously sounds sexy to archaeologists* [...]. *Does this reflect a new type of research, a new topic in archaeology – or is it just one of the fashionable sound bites of the new millennium?* [...] *The word 'landscape' today at least partly act*[s] *as an envelope for anything* [...].[139]

Landscape archaeology has become a superordinate umbrella term for all disciplines researching the social construction of past landscapes and now also encompasses originally non-archaeological research fields.[140] Although its strong interdisciplinary aspect is clearly emphasized, giving a straightforward terminological definition of landscape archaeology remains difficult.[141] Following Haupt however, in addition to simply highlighting landscape archaeology's focus on interdisciplinarity, further terminological clarity may be gained when considering the specific research objectives of the numerous landscape archaeological studies. Independent of any particular methodological emphasis, it may be argued that landscape archaeological studies generally aim at providing further insights into what historical geographers refer to as *Kulturlandschaftsgenese* – cultural landscape genesis – which can be generally defined as any form of landscape changes that were caused or influenced by humans.[142]

Kulturlandschaftsgenese describes the dynamic relationship and interaction between humans and the natural environment. Importantly however, while the geographical concept of the term clearly emphasizes the human impact on the *natural* environment (e.g. by studying changes in vegetation, soil properties, surface characteristics etc.), landscape archaeology researches *Kulturlandschaftsgenese* from a profoundly archaeological perspective, i.e. the study of past human activities within a cultural landscape through the analysis of *material culture*. This study therefore considers landscape archaeology to be the archaeological research of past cultural landscape changes (*Kulturlandschaftsgenese*) with a clear focus on the study of material culture, but also following a strong interdisciplinary approach by drawing methods from related fields such as ancient history, historical and cultural geography, spatial statistics as well as computer-based spatial analyses.

With this understanding in mind, the following sets the methodological basis for this study's land-

137 For a general introduction into landscape archaeology and a critical discussion on the application of GIS within the discipline, see e.g. Knitter et al. 2018; Gillings – Pollard 2016; Paliou et al. 2014; Chrysanthi et al. 2012; Haupt 2012; Kluiving – Guttmann-Bond 2012; Hu 2011; O'Sullivan – Unwin 2010; David 2008; Conolly – Lake 2006; Posluschny 2006; Wheatley – Gillings 2002 and Lock 2000.

138 Cf. e.g. Haupt 2012, 10–11.

139 Meier 2012, 504.

140 Such as "[...] [q]*uartenary geology, taphonomy, the microhistory of nature, deterministic and possibilistic approaches to the culture-nature dichotomy, the ecological impact of ancient economies, survey techniques, settlement structures, communication routes [and] the social dimensions of space and phenomenology* [...]" (Meier 2012, 504).

141 Cf. also Knitter et al. 2018 with further references.

142 Haupt 2012, 9–11.

scape archaeological approach. It first offers a full description of the available core physical (spatial) landscape data, which underlie all farther-reaching GIS-based analyses. This is then followed by a methodological discussion on how this study created its main archaeological base dataset, critically assessing the quality of the available archaeological data provided by the various surveys and offering a thorough site classification system devised by the author. Subsequently, crucial aspects concerning the dating of the various archaeological sites are evaluated and a more transparent and, arguably, valid definition of the different temporal periods evidenced in the Petraean hinterland are presented. The next part describes the various spatial analyses conducted in this study, including point pattern analyses, cost-surface analyses and visibility analyses. Each method is described in detail in hopes of offering a comprehendible introduction in the often complex technicalities of the particular analyses. The final section concludes this chapter with an important methodological appraisal, critically discussing the advantages and disadvantages of this landscape archaeological approach. This should be kept in mind when proceeding to the analytical and interpretive chapters, as the applied landscape archaeological methodologies will not be further explained. For any clarifications concerning the applied landscape archaeological methodologies, the reader may therefore refer back to this chapter.

The Core Physical Landscape Data of the Petraean Hinterland

Any landscape archaeological study is heavily dependent on the quality of both the available landscape and archaeological information. Spatial analyses aiming at further researching past human land use strategies are based on physical landscape datasets. Not only can the lack of specific datasets limit the scope of landscape archaeological studies, the quality of the available datasets can have a significant impact on the results and their archaeological interpretations as well. Moreover, considering the often extreme size of archaeological

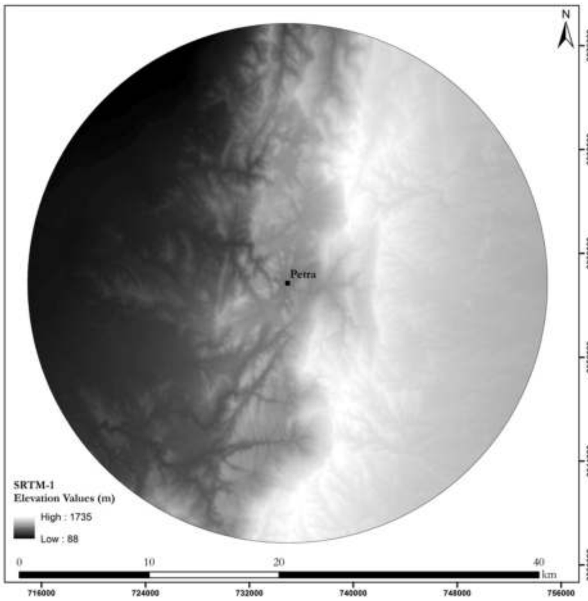


FIG. 6 SRTM-1 DEM used for all spatial analyses (spatial resolution of 30 x 30m).

datasets employed by many landscape archaeological studies, determining the quality of the available archaeological data is centrally important. Before concluding any archaeological interpretations, it is crucial to reveal and discuss the available core datasets on which farther-reaching analyses are based. The following therefore first presents and discusses the core *physical landscape data*, which is then followed by the critical presentation of the available archaeological dataset in the next section.

The Core Physical Landscape Data

The relevant datasets used for this study are divided into (1) Base data, (2) Derived data and (3) Interpreted data.[143] The following lists all the physical landscape data available for the Petraean hinterland in that order.

Base Data

Belonging to the core physical landscape datasets available for the Petraean hinterland are elevation, geological as well as soil and land cover data.

143 The division of physical landscape datasets are inspired from E. Farinetti's study on ancient Boeotia (Greece): Farinetti 2011, 15.

144 The SRTM-1 DEM is provided by the United States Geological Survey free of charge and available for scientific use at https://earthexplorer.usgs.gov/ (last accessed 19.05.2020). For more technical information on SRTM-1 elevation models, see https://lta.cr.usgs.gov/SRTM1Arc (last accessed 01.04.2019).

145 There are various technical studies that compare the quality of the ASTER-DEM and SRTM data that are mostly specific to particular regions. For a general comparative study, see e. g. Jacobsen 2010. For a detailed assessment on the quality of SRTM elevation data, see e. g. Rodríguez et al. 2006.

146 The author would like to thank S. Ißelhorst for providing scans of the hardcopy maps for further processing.

147 Many thanks are due to A. Pandazmapoo for digitizing the geological maps.

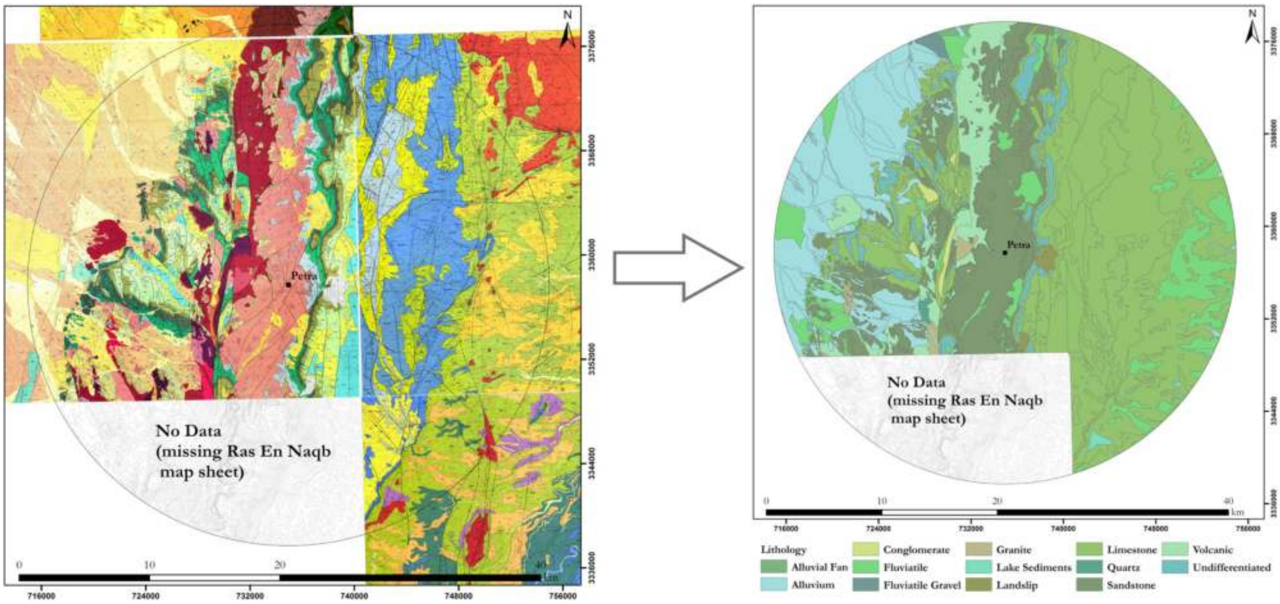


FIG. 7 Left: Digital hardcopy version of the available geological maps for the Petraean hinterland georeferenced in a GIS environment. Right: Lithological information digitized after the geological maps for further spatial analyses.

This study's *elevation data* is based on the freely accessible SRTM-1 digital elevation model (DEM) with a spatial resolution of 30 m × 30 m (FIG. 6).[144] Although SRTM-1 elevation data share the same spatial resolution as the also freely accessible ASTER-DEM, SRTM data generally have a higher resolution in terms of elevation values and are thus preferable.[145]

All *geological data* is based the 1:50,000 geological maps created by the Geology Directorate of the Natural Resources Authority of the Hashemite Kingdom of Jordan.[146] This study used the following geological map sheets: Petra & Wadi al-Lahyana Map 3050 I & 3050 IV, Ma' an Map 3150-III, Bir Khidad Map 3150 IV and Al-Quaryqira (Jabal Hamra Faddan) Map 3051 II (FIG. 7). The Ras En Naqb geological map would have covered the southwestern quarter of the study area. Unfortunately, however, the map sheet was not available to this study despite several attempts to obtain it, explaining why no geological data for the southwestern quarter of the study area is presented. Nevertheless, the geological information from the available map sheets within the study area was digitized in a GIS environment for further analytical processing.[147]

In 2013, Lucke et al. published a new and up-to-date, nation-wide *soil map* for Jordan amalgamating the various large- and small-scale soil surveys that were previously available.[148] Although simplified, the map is the most accurate soil map available for Jordan (scale: 1:250,000) to date. Ababsa also published an updated, nation-wide *land cover map* for Jordan at a scale of 1:250,000 based on interpretations of Landsat imagery of the Royal Jordanian Geographic Center.[149] However, the low resolution of both soil and land cover data does not permit any detailed GIS-based analyses.[150]

Derived Data

On the basis of the SRTM-1 DEM the following spatial datasets were derived:

A *slope map* depicting the different slope values of the study area in percent. The slope values (%) were subsequently qualitatively reclassified according to Farinetti's slope classification for mountain regions (cf. FIG. 3).[151]

148 Lucke et al. 2013, 72–76, fig. I.17. Also see the online version at http://books.openedition.org/ifpo/4867 (last accessed 01.04.2021). Also see the IUCN (International Union for Conservation of Nature) report on mapping rangeland in Jordan from 2015.

149 Ababsa 2013, 40–41, fig. I.1. Also see the online version at http://books.openedition.org/ifpo/4858 (last accessed 01.04.2021).

150 Kouki faced the same problem (Kouki 2012, 25–26). She therefore defined wider 'agro-ecological zones' for the Petraean hinterland.

151 Farinetti originally considered a 'mountain range' in Boeotia to encompasse elevation values greater than 600 m a.s.l (Farinetti 2011, 17). Slope values < 5 % are described as a 'plateau.' Values < 10 % are 'gentle slopes.' Values ≥ 10 < 25 % are 'moderate slopes.' Values ≥ 25 < 45 % are 'severe slopes.' Finally, values ≥ 45 % are 'very severe slopes.'

An *aspect map* (or anisotropic slope map) depicting the azimuth (compass direction) of slopes. The aspect map is an important base dataset for conducting cost surface analyses such as least-cost paths.

A *hillshade map* displaying the elevation data of the DEM with a 2,5-dimensional appearance and depicting the surface as if illuminated by low sunlight. Hillshade maps generally serve to optimize the visual appearance of maps only and have no analytical value. The same applies to *contour maps*. Contour lines can be calculated from the DEM at different intervals. For representation purposes, the contour lines presented in this study are all set at 30 m intervals.

Finally, a *stream network* was generated from the DEM (FIG. 8) as the numerous wadis in the Petraean hinterland could not be manually digitized from the available 1:50,000 topographical maps. The locational accuracy of the displayed wadis should therefore be considered critically. However, as they play only a limited role for further spatial analyses, the accuracy of the stream network is adequate for the purposes of this study.

Interpreted Data

Concluding the presentation of the physical landscape data used for this study, the only interpretative dataset includes first the 'accumulated cost surface' (ACS), which is comprised of slope values and geological formations, and represents the *cost value* of traversing through the study area (FIG. 9). The ACS is particularly important when conducting so called *cost surface analyses*. The technical details of how the ACS was generated is discussed below.[152]

The Core Archaeological Data of the Petraean hinterland

The main archaeological dataset of this study is based on archaeological sites distributed within the defined study area (20 km radius around Petra) previously recorded by various surveys in the Petra region and for which spatial (coordinate) information is available.

In total, the information was provided by 14 survey projects. These include the *Edom Survey* (ES), the *Beidha Ethnoarchaeological Survey* (BS), the *Southeast Araba Archaeological Survey* (SAAS), the *Jabal Shara Survey* (JSS), the *Archaeological Survey of the Wadi Musa Water Supply and Wastewater Project* (WMWS), the *Bir Madkhur Project* (BMP)[153], *Abudanh's survey of the Udruh region* (Abudanh survey), the *Finnish Jabal Harun Project* (FJHP), the *Ayl to Ras an-Naqab Archaeological Survey* (ARNAS)[154], the *Showbak-Dana L2HE Survey* (L2HE), the *Shammakh to Ayl Archaeological Survey* (ShamAyl)[155], the *Petra Routes Project* (PRP), the *Petra Hinterland Tombs Project* (PHTP) as well as the *Petra Hinterland Survey Project* (PHSP).

These archaeological surveys document over 4000 archaeological sites in the larger Petra region.[156] From these, 1737 sites are situated within the study area and date to the periods of interest forming the core archaeological dataset of this study.[157] To date, this is the largest, and geographically most widespread, archaeological dataset to be investigated in the research history of the Petraean hinterland (cf. chapter 1).

Generally, archaeological surveys offer important information on past human activities in a broader, regional context, providing a solid information basis concerning the nature and duration of archaeological sites. They produce a valuable dataset for further investigating distribution patterns and assessing cultural landscapes on a regional scale. There are, however, important constraints to be acknowledged when conducting research in this manner. Archaeological surface observations provide only limited information on size, chronology and function of the recorded archaeological sites. Particularly without excavation work and/or a broader archaeological and culture-historical discussion, survey results will always remain preliminary. Studies aiming at further interpreting and comparing regional archaeological surveys face common methodological challenges related to varying survey intensities and documentation methods, site typologies as well as chronologies. This well-known problem is addressed in the abundant literature on survey methodologies and is not further

152 As the ACS is also based on geological information, but no respective data is available for the southwestern quarter of the study area, the ACS is also missing data for that part of the Petraean hinterland.

153 The data from SAAS and the BMP is derived mainly from Smith 2010, who provides site descriptions and precise locational information on the identified sites. However, a far larger number (in total 1444) of mostly "small und unobtrusive" archaeological sites dating from the prehistoric to modern periods have since been recorded in the vicinity of Bir Madkhur (Kinzel 2018, 215, 229, figs. 3 and 4). As these sites remain largely unpublished, they could not be integrated in the landscape archaeological analyses.

154 For a critical review of ARNAS, see Graf 2015 and Banning 2013.

155 For a critical review of ShamAyl, see Abudanh 2018 and Wasse 2017.

156 For more information on the number of recorded sites by each individual survey as well as an overview of the core literature of the separate surveys, see TABLE 1.

157 A complete list of all sites (catalogue) is given in Appendix I.

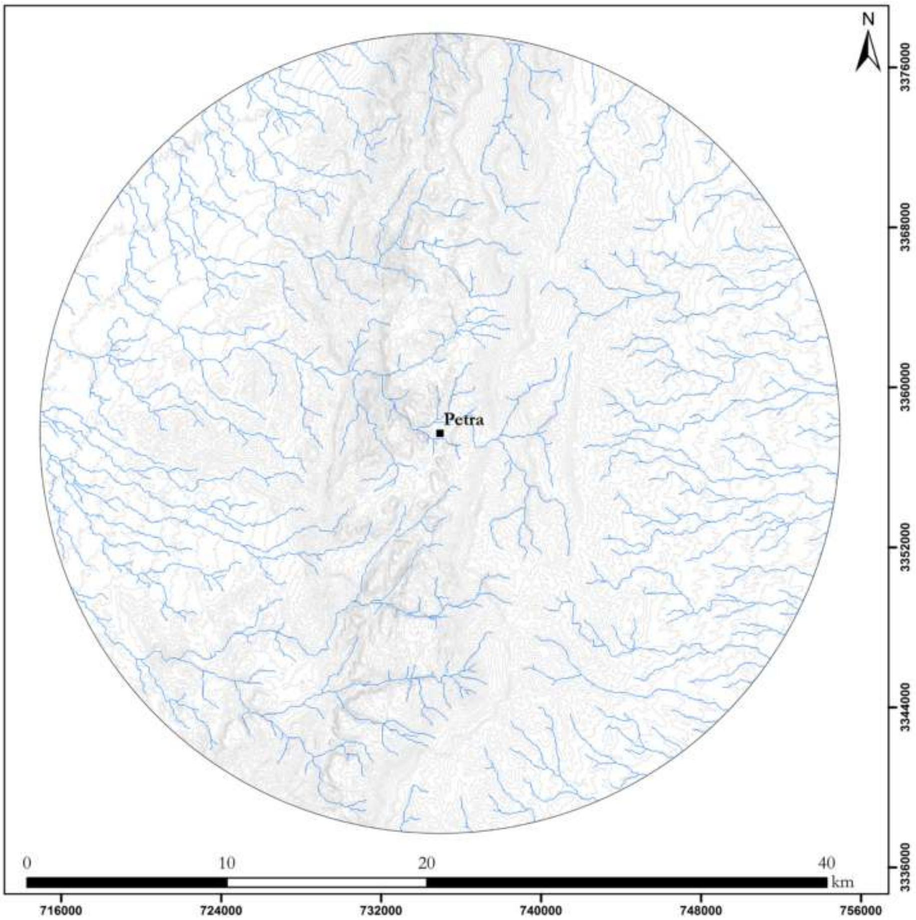


FIG. 8 GIS-based stream (wadi) network of the Petra area.

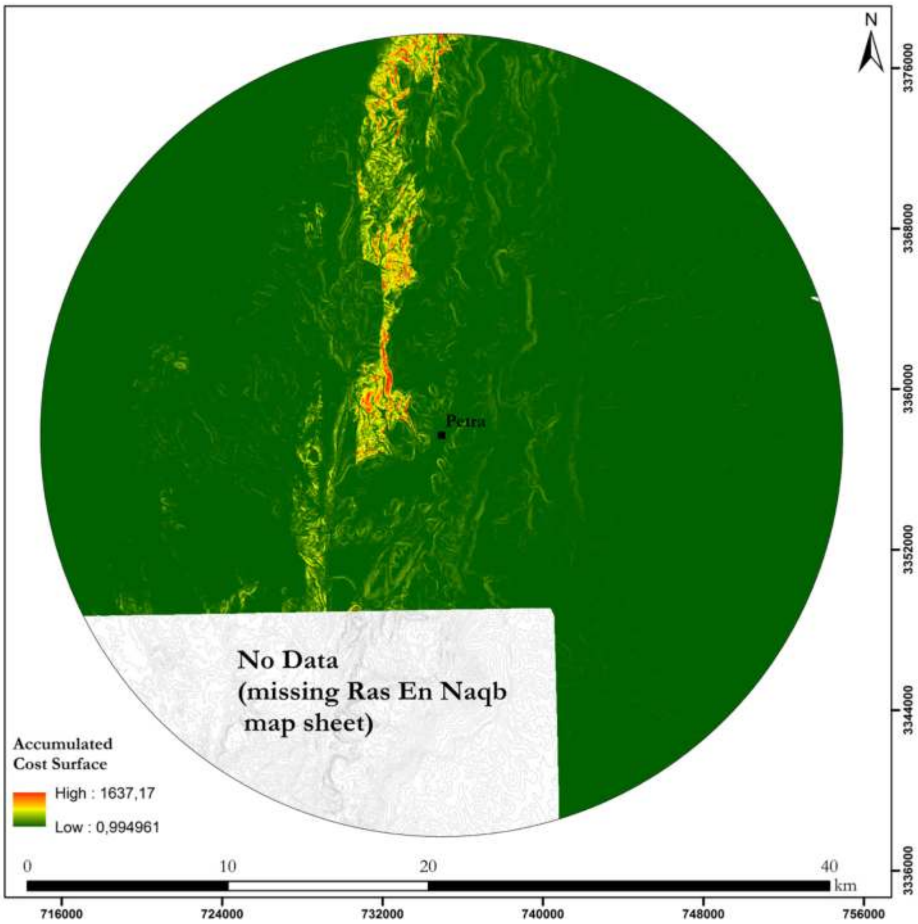


FIG. 9 Accumulated cost surface map of the Petra area.

discussed here.[158] Different survey intensities and documentation methods produce an inherent interpretative bias, which must be made transparent before conducting farther-reaching archaeological research based on survey data. Consequently, the following briefly presents the different methodologies used by the various surveys of the Petraean hinterland. These can generally be categorized into two groups: Extensive and intensive surveys.

The only intensive surveys in the Petra region have been the FJHP and PAWS/PRP that comprehensively and systematically surveyed their respective areas by means of pedestrian survey techniques. These surveys aimed not only at exhaustively documenting all archaeological sites ranging from the Palaeolithic to the modern periods, but also at recording the vast amount of surface material not directly related to the documented archaeological sites ('off-site survey').[159] While such intensive survey techniques provide detailed documentation of an extremely large archaeological dataset[160], they are immensely costly, time-consuming and limited to a comparatively small survey area. For example, the intensive survey methodologies legitimize the eight years of the FJHP's intensive survey and an additional two years for its extensive survey in an area covering (in total) 6,5 km² or the three active survey years of PAWS/PRP that surveyed an area of c. 10 km².

Such methodologies stand in contrast to extensive survey methodologies that can cover several hundred square kilometers. For example, ARNAS surveyed c. 860 km² and Abudanh covered 700 km² during his survey of the Udruh region. While such surveys document a significant number of archaeological sites within a large geographical area, 'off-site' material is often disregarded and the archaeological information of the recorded sites remain mostly very basic. Extensive surveys are often conducted under time pressure and with only limited personnel and do not permit more detailed pedestrian surveys of archaeological sites and their surroundings.[161] Most surveys of the Petra region were extensive surveys.[162]

In addition, specific research-related surveys were conducted in the Petraean hinterland that make no claim to have comprehensively documented all archaeological remains in their respective study areas. For example, the Showbak-Dana L2HE Survey formed the basis of N. G. Smith's doctoral research investigating Edomite social boundaries. Wadeson and Abudanh focused only on monumental tombs in their Petra Hinterland Tombs Project. The Beidha Ethno-Archaeological Survey aimed specifically at documenting evidence of ancient and modern nomadism in the Beidha area.[163] The Petra Hinterland Survey Project served the author's doctoral research purposes to the extent that previously surveyed sites were mainly reassessed, with sites not yet identified also being recorded. Numerous routes in the study area were surveyed more intensively as well.

Lastly, also considered an extensive survey as it grasps a large geographical area in the Petraean hinterland, is the Archaeological Survey of the Wadi Musa Water Supply and Wastewater Project. This however, was designed to accompany construction activities in the area and thus was not conducted systematically as other research surveys.

In addition to the varying survey intensities highlighted above, another major methodological challenge faced by studies amalgamating various survey data, is the problem of differing site typologies. Depending on the region, chronological focus or scientific objectives, archaeological research projects give varying definitions of archaeological sites and follow different criteria for assigning specific functions. This is particularly the case when the available dataset is based primarily on surface observations without further information from archaeological excavation. However, it is crucial to establish a coherent site classification system with standardized definitions of site types. Comparative analysis is otherwise not possible.

After the author's detailed re-evaluation of the archaeological and spatial data provided by the various surveys listed above, it quickly became apparent that one of the main methodological challenges faced by this study was indeed the creation of a coherent site classification system. The only survey offering a more detailed description of site classes is the FJHP.[164] Abu-

158 Cf. e.g. the literature cited by Knodell et al. 2017, 630; Wenner 2015, 11–33 or Kouki 2012, 26–29: Banning 2002; Alcock 1995; Barker 1991; Bowden et al. 1991; Bintliff – Snodgrass 1988 or Keller – Rupp 1983.

159 More on the respective survey methodologies of PAWS and the FJHP, see Knodell et al. 2017, 630–634 and Lavento et al. 2013a.

160 Cf. e.g. the 1036 archaeological 'features' documented by PAWS.

161 Cf. e.g. the critical methodological remarks on ARNAS (Graf 2015; Banning 2013) and ShamAyl (Abudanh 2018; Wasse 2017), particularly concerning the dating of sites.

162 These include the Edom Survey, the Ayl to Ras an-Naqab Archaeological Survey, the Shammakh to Ayl Archaeological Survey, Abudanh's survey of the Udruh region, the Jabal Shara Survey, the Southeast Araba Archaeological Survey and the Bir Madkhur Project.

163 Although other archaeological sites were recorded as well.

164 Kouki – Silvonen 2013a.

danh also gives very brief definitions of site classes, but in his site catalogue he lists additional site types that were previously not defined.[165] ARNAS and ShamAyl seem to have followed some general understanding of site types, but do not define them and the list of the recorded sites' function is often inconsistent and vague rendering any farther-reaching analyses on this basis impossible.[166] The other surveys do not define their site types at all. From the few surveys that do offer at least some indication of their defined site classes, almost 800 differing site types (nearly half of this study's entire dataset) were identified. Of these, there is no indication whether they were recorded as the same site type following comparable definitions. The original site typological information provided by the various surveys thus inadequately served this study's comparative approach.

Consequently, a rigid and strictly structured site classification system valid for this study was created, based on generally acknowledged site typological definitions fitted to the archaeological particularities of the Petra region. Effectively, this implies that every original site description from the available surveys was carefully reassessed and, based on the reported archaeological information, subsequently defined as a specific site type belonging to this study's classification system.[167] Only on this basis was it possible to conduct further comparative analyses.

Although this classification system makes no universal claim and some site typological definitions may certainly be criticized, they are clearly differentiated and consistently followed in this study. As the site classifications are transparent and the raw archaeological dataset of each site type is provided in the site catalogue (Appendix I), future research can easily appropriate this study's data and alter it according to differing site typological definitions if needed. However, despite this attempt to follow a consistent site classification system, it must be stressed that, for many sites, it remains difficult to accurately assign specific functions.

With that in mind, the site classification system devised for this study is catagorized in three levels (FIG. 10). First, all discussed sites are divided into classes belonging to the superordinate level termed as *Archaeological Evidence*. These classes are titled: Agricultural Installations, Communication Infrastructures, Exploitation/Industrial Sites, Funerary Structures, Military Structures, Religious Structures, Settlements, Other Structure(s) and/or Feature(s) and Water Structures. These superordinate classes are then broken down into subcategories comprised of certain archaeological components to define them more precisely. The subcategories of the various superordinate site classes are:

Agricultural Installations: Agricultural Processing Installations, Agricultural Storing Installations, Agricultural Terraces/Fields

Communication Infrastructures: Caravanserais, Road/Route Stations, Road/Route Markers, Roads and Routes/Tracks (naqb)

Exploitation/Industrial Sites: Industrial/Exploitation Installations, Unspecified Industrial Installations

Funerary Structures: Cemeteries, Isolated Funerary Monuments

Military Structures: Fortresses, Forts, Fortlets, Watchtowers

Religious Structures: Sanctuaries, Significant Religious/Cultic Structures, Isolated Cultic Installations

Settlements: (Cities), Towns, Villages, Farms, Clusters of Buildings and Rural Mansions,

Other Structure(s) and/or Feature(s): Epigraphical Site or Locations, Find Clusters, Natural and/or Rock-cut Structure(s) of Undetermined Function, Structure(s) of Undetermined Function, Wall(s) of Undetermined Function

Water Structures: Springs, Dams/Barrages, Water Conduits, Water Storage Installations, Wells

This system was strictly followed when creating the GIS-based database of the recorded sites. In chronological order, each site is stored in the database according to the above-mentioned site classification system. Superordinate site classes, as well as their respective subcategories, are represented by their own distinct symbols and/or colors in the various maps in order to distinguish them from each other. If neces-

165 Abudanh 2006, 50–53. Other, non-defined site types evidenced by Abudanh particularly concern possible military sites.

166 Cf. MacDonald et al. 2016, 14–24, table 1.8; MacDonald et al. 2012, 11–12, table 1.2 : "*Of course, the determination of 'function' on the part of ARNAS team members must be tentative at this stage of investigation. Generally, only the excavation of the site in question will determine, with greater certainty, its function*" (MacDonald et al. 2012, 11). The same remark was given for ShamAyl as well (MacDonald et al. 2016, 14).

167 Note that this was not limited to the recorded sites situated within the study area, but included all sites documented by the various surveys (over 4000).

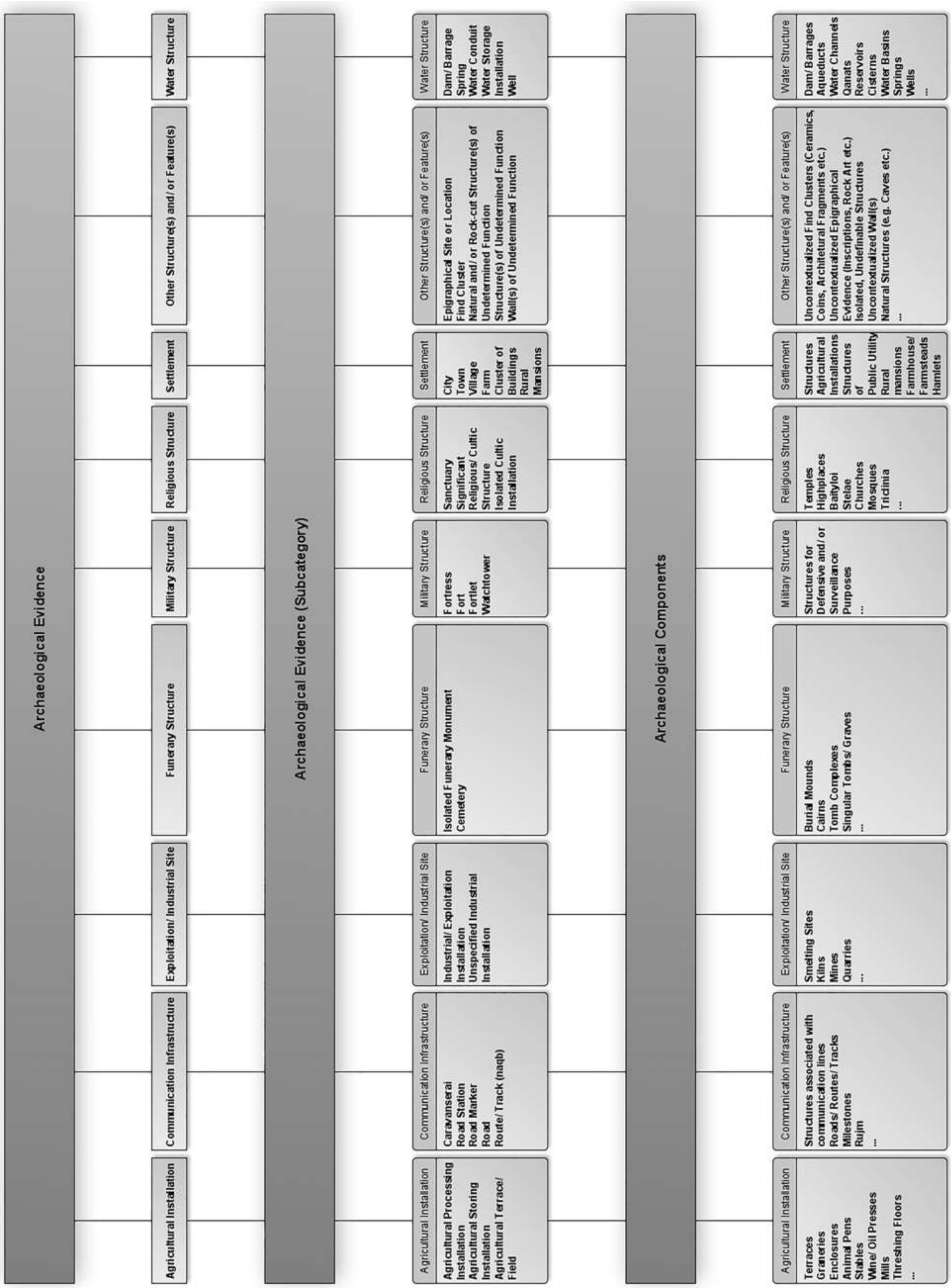


FIG. 10 Three-tiered structure of this study's site classification system.

sary, the digital publication of this study allows to enlarge the various maps and figures, as there are obvious practical limitations to the printed edition. The various sites classes and subcategories are defined in the following.

Agricultural Installations

This study groups all agricultural installations documented by the various surveys into three categories as defined in the following.

Agricultural Processing Installations

This category includes all installations that process agricultural products including e.g. wine and olive presses or threshing floors. No distinctions are made in terms of size, material or construction techniques.

Agricultural Storing Installations

In contrast to agricultural processing installations, agricultural *storing* installations describe structures that could have stored agricultural products (e.g. possible granaries) or farming equipment. This category also includes possible structures for holding animals such as animal pens (enclosures) or stables. No distinctions are made in terms of size, material or construction techniques.

Agricultural Terraces/Fields

An agricultural terrace is defined as an artificial plane of soil created along slopes to decrease soil erosion and control surface water runoff that facilitates the cultivation of crops that necessitate sufficient irrigation. Agricultural terraces are supported by terrace walls. Mostly, a series of several terraces are successively cut into slopes, thus creating the impression of large, elongated steps. As the main purpose of an agricultural terrace is to retain water and manage controlled water flow for the irrigation of crops, terraces are often interchangeably referred to as *barrages* (cf. below).[168] Specifically concerning terrace walls, this study does not differentiate in terms of measurements, material or construction technique. Agricultural terracing is only one landscaping technique commonly used to create agricultural *fields* in hilly or mountainous terrain.[169] Thus, an agricultural terrace is simply a specific type of agricultural field that is generally defined as an area of land used for the cultivation of crops – independent if situated along slopes in the form of terraces or in flat, open terrain. Agricultural terraces and fields are therefore grouped into one category.

Communication Infrastructures

This study describes all archaeological sites and features related to ancient travel under the generic term *communication infrastructures*. While these include roads as well as smaller routes/tracks, they also encompass road- and/or route-side structures (caravanserais and road/route stations) functioning as lodgings or relay stations for individual travelers as well as larger groups. Communication infrastructures also include road/route markers that were erected along roads and/or routes to guide the way for travelers.

Caravanserais

By the Hellenistic period the caravanserai was an established and well-known institution that provided large groups of travelers (mostly merchants but also pilgrims) lodging opportunities along their journeys.[170] Caravanserais are isolated structures and situated along main communication lines. Structurally, a caravanserai is characterized as a large, rectangular or square building with thick exterior walls. Numerous interior room compartments are arranged around the exterior walls and a large, open courtyard that forms the center of the caravanserai. The courtyard was accessed by a main gate. In addition to accommodations for travelers, a caravanserai also provided sufficient water supply, kitchen areas, stables and occasionally also baths.

Two examples from the Negev desert along the Petra–Gaza road (cf. chapter 6) highlight the characteristics of caravanserais as defined in this study nicely: Moyat ʼAwad and Sha'ar Ramon (ʼEn Saharonim), both dating to the 1st century BC and associated with Nabataean long distance trade.[171] While the structure at Sha'ar Ramon only consists of the caravanserai itself, the site of Moyat ʼAwad also encompasses a fort and associated agricultural fields. Both caravanserais are square in shape measuring approx. 40 × 40 m with regularly set rectangular rooms aligned around a large central, open courtyard. Both structures are built in open plains with high ground water.

168 Cf. e.g. also the FJHP's definition of "barrage and terrace wall systems" which fall under the larger category of "hydraulic structures" (Kouki – Silvonen 2013a, 342).

169 For good examples in the Near East, see e.g. Friedmann 2013; Bruins 2012; Newson et al. 2007 Evenari et al. 1982; Bruins 1986 and Mayerson 1962.

170 Scholarly literature on ancient caravanserais is vast. However, this study's definition of a caravanserai is largely based on Thareani-Sussely 2007.

171 Cf. e.g. Erickson-Gini – Israel 2013, 39–41, 44–49.

Road/Route Stations

Road/route stations are also isolated structures situated along roads and routes. In contrast to caravanserais however, they are considered here to be significantly smaller. Although they are mostly rectangular structures, their architectural layout can be far more diverse. Road/route stations mainly served as administrative control points or relay stations for resting and/or changing beasts of burden but also, although uncommonly, could have offered accommodation for travelers. They could have supplied travelers and animals with water and food along their journey as well. Road/route stations can be difficult to distinguish structurally from fortlets (see below).

Road/Route Markers

This category describes all infrastructural installations for navigating along roads and routes/tracks. No distinction is made in terms of material, size, date or type of markers. For example, road/route markers can be simple stone cairns (so called *alamat*) placed along the way, simple signposts, or Roman milestones.[172]

Routes/Tracks (naqb)

The term 'route' can be understood both in a practical as well as in a more abstract sense. While in its more abstract use, the term can express a means or method of achieving something, the main definition is

> […] *a way or course taken in moving from a starting point to a destination; a regular line of travel or passage; the course of a river, stream etc. Also: a means of passage; a way in or out.*[173]

The understanding of "way or course," however, is very general and is not defined in its physical sense. The definition does not specify any characteristics in terms of construction, measurements, function or infrastructural installations associated with it. This very general meaning of the term, *as a means to travel*, from one point to the other is indirectly also suggested by Earl's definition of 'routes of movement,' a simple typology (based on ethnological as well as archaeological evidence) of basically three different types of routes.[174] These 'routes of movement' can be defined by their physical appearance, level of construction and the human effort exerted as well as environmental constraints, from which primary functions can be deduced. Earl differentiates between three types of routes: paths, trails and roads.[175]

According to Earl, a 'path' is only used for local logistical purposes, but is not subject to any seasonal constraints. Its level of construction is set at an absolute minimum and is mostly just a beaten dirt path. Therefore, the path is trafficked only little.

Earl's 'trail,' can be used on a regional scale and can cover long distances, but may be dependent on seasonal weather conditions. Although its level of construction is relatively low, the trail can accommodate a moderate amount of traffic. Its primary function can be logistic or even ceremonial.

Ginouvès defines the French *route* in the same sense what this study considers to be a road (see below). However, his *sentier* is a rural path and/or track (according to Ginouvès both terms have the same meaning) that allows human and animal travel only, but cannot support vehicular traffic.[176] Ginouvès' definition is therefore comparable to Earl's 'trail.'

Specified as the term 'track' (*naqb* – being the Arabic translation)[177], this study accepts the definitions of 'trail' and 'sentier' presented by Earl and Ginouvès with some modifications: The spatial extent of a route/track (naqb) can be local, regional as well as supraregional. The primary functions of routes/tracks (naqb) were multitude and they could have served logistic, ceremonial, economic and even military purposes. The major difference to a road is the comparatively low level of construction of the various routes/tracks (naqb), which seems to respond directly to the natural landscape conditions. For example, while the *via nova Traiana* (see below) runs along the comparatively flat eastern high plateau east of the Jabal Shara mountains in a general north-south direction, the presented routes/tracks (naqb) connect the immediate Petra area with the more extended hinterland to the north, south and – most importantly – west.[178] Particularly the areas west of Petra towards the Wadi Arabah are characterized by steeply declining and extremely rugged terrain, that does not allow any larger road constructions. In the study area, the routes/tracks (naqb) do not support vehicular traffic.

172 Cf. Riemer – Förster 2013, 43–44.
173 Cf. "route, n.1." OED Online. December 2016. Oxford University Press. http://www.oed.com/view/Entry/168077?rskey=VZnLJD&result=1 (last accessed 06.04.2021).
174 Riemer – Förster 2013, 28; Earl 2009, 255.
175 Earl 2009, 255, table 12.1. For his definition of a road, see the section below.
176 Ginouvès et al. 1998, 192. In contrast, a *chemin* is translated as a '(secondary) road' (Ginouvès et al. 1998, 191–192).
177 In this study, 'track' is equated with 'route.' Both terms are therefore used either interchangeably or referred to as route/track (naqb).
178 Although on the way from Shawbak southwards, the *via nova* runs almost on the Jabal Shara escarpment.

Routes/tracks (naqb) are generally not paved and only 1–2 m wide.[179] Particularly in steeply declining terrain, the routes are secured by approx. 0,5 m high dry stone walls as can still be partly seen along Naqb ad-Dab'e or Naqb Slaysil quite nicely (cf. chapter 6). Despite this comparatively low level of construction, some of the routes/tracks (naqb) connecting Petra with its wider hinterland to the west are important trade routes that connected the city with the Mediterranean Sea.

Roads

Establishing a clear functional distinction to routes/tracks (naqb) is not straightforward, and the archaeological evidence does not always allow for a clear identification. The Latin term *via* (the Greek οδός) generally refers to communication lines for human, animal and vehicular traffic connecting at least two points. The term is applied in both an urban as well as a rural context and can therefore be translated as both 'street' (for the urban sense) and 'road' (for the extra-urban context).[180] Ginouvès associates the Latin, *via,* with the French *route* [181](translated as the English 'highway' or 'main road'), which he defines as a communication axis between towns and villages. He also distinguishes a *chaussée* (also translated as 'main road') being a lateral road permitting travel to larger distances and showing different techniques of surfacing to facilitate travel. These surfaces were mostly beaten soil, but also include fills of gravel or ballast as well as stone pavements.[182]

According to Earl, a road runs on a local, regional as well as long-distance scale and could be used daily, seasonally or periodically. Compared to his definition of paths and trails, Earl characterizes a road by its relatively large width and a high level of construction effort. The primary function can be ceremonial, military and economic.[183]

Following these definitions, this study considers a road to be a way for connecting at least two points on a local, regional and/or supraregional level. In contrast to the routes/tracks (naqb), a road mostly stands out due to its high level of construction in the form of (two-sided) curbstones, well-constructed surfacing that supports human, animal as well as vehicular traffic and, specifically for Roman roads, potentially also certain road markers such as milestones.[184] Admittedly, this definition seems to emphasize the military character of particularly Roman roads, the main purpose of which was to facilitate the movement of troops and connecting military *colonia*, although also serving economic and administrative purposes. In the study area, the most prominent example of a road following this definition is the *via nova Traiana* (cf. chapter 6). Compared to smaller routes/tracks and (naqb), the *via nova Traiana* is paved and sometimes shows curbstones on both sides of the road. Additionally, Roman milestones either found along the visible remains of the road or suggesting the course of the *via nova* are also good indicators of the infrastructural significance of the road.[185] However, the *via nova* appears to be the exception as, for example, the *Darb ar-Rasif* shows. This road runs along the Jabal Shara escarpment in the immediate Petra area, presumably being the major supraregional north-south running road already in the Iron Age and, most importantly, in the Nabataean period as well. Despite its economic importance for the region at the time, the Darb ar-Rasif was not paved and, at the most, only had gravel surfacing with curbstone walls approx. 5 m apart. The physical appearance of the road seems to have been nothing more than a *via glareata* or *via terrena* without any official road markers.[186] Examples of other

179 Cf. e. g. van Tilburg's definition of 'mountain roads' (van Tilburg 2007, 16–18).

180 Ginouvès et al. 1998, 178, 191: the term is then further specified: See e. g. *via publica, via vicinalis, via privata, via communis* or *via militaris* etc. For another overview of the different types of *viae*, see van Tilburg 2007, 7–9.

181 Not to be confused with the definition of the 'route' given above.

182 Ginouvès et al. 1998, 180, 191–192. Ginouvès et al. 1998, 180 also claims that the nature of road pavements may reveal information on the significance of the road : *"C'est le dallage qui constitue le système le plus solide; les plaques de pierre peuvent être disposes dans une pose ORTHOGONALE (en files perpendiculaires aux bords de la chaussée)/OBLIQUE (dans ce cas les files en diagonale ne sont pas attaquées en même temps par les deux roues, ce qui devait atténuer la force des cahots).*"

183 However Earl 2009, 267 elaborates that while a road's major function was also economic, they "[…] *were not built for economic integration prior to the establishment of mercantile states. As long as transport was primarily by foot, horses, or watercraft, goods could be moved without the major improvements associated with roads* […]. *The economy as a source of power simply did not require the development of roads prior to the much higher volumes of trade associated with integrated markets.*" Cf. also Riemer – Förster 2013, 28. Earl's emphasis on the potential ceremonial significance of roads may be specific to certain time periods or particular functional contexts.

184 There are also land markers along routes/tracks (naqb) as well.

185 For a detailed description of the *via nova Traiana* in the study area, see Graf 1995a.

186 According to van Tilburg 2007, 15, a *via terrena* is simply an unpaved road (in contrast to the paved *viae munitae* or *viae stratae*). In reference to the Darb ar-Rasif, see Graf 1997, 273.

Roman roads in Syria and northern Jordan as well as in North Africa have been characterized as mere 'pistes aménagées,' although accompanied by milestones.[187] Nevertheless, the main physical difference to routes/tracks (naqb) is the comparatively better and more extensive construction as well as its larger dimensions to support more traffic (including vehicles). Furthermore, it can be argued that the construction of a road follows a tangible concept and a primary function, while routes/tracks seem, but not necessarily must, be multifunctional.

Exploitation/Industrial Sites

This category describes all sites relative to the exploitation of natural resources and the production of goods of commercial value. The latter include all tangible products that were manufactured and subsequently made available for further individual or commercial use.

Industrial/Exploitation Installations

Industrial/exploitation installations include all sites that (a) exploit natural resources for commercial and utilitarian purposes such as clay pits, copper mines or stone quarries and (b) further process these exploited resources to produce commodities, including e. g. ceramic workshops as well as possible metal smelting sites. Sites where it can only be assumed that they had an industrial function fall under 'unspecified industrial installations.'

Funerary Structures

In the Petraean hinterland, the archaeological evidence for funerary structures is manifold. It encompasses Nabataean rock-cut façade tombs, monumental *hypogea*, shaft tombs, burial cairns as well as simple pit graves. These funerary structures could be further categorized into more detailed typologies. The following classification reflects the different burial types well and is archaeologically informative without delving into typological details.

The Petraean rock-cut *façade tombs* are the most well-known Nabataean funerary monuments. Carved into the natural sandstone, the monumental façades show both Graeco-Roman as well as ancient Near Eastern architectural designs and frame the entrance to a rock-cut burial chamber. The façade tombs have attracted much scholarly attention and were further classified into eight different types.[188] Incorporating such detailed typologies into the presented analysis of rural funerary structures would entail a far more differentiated and detailed study of the façade tombs, requiring an independent and comprehensive study of these funerary monuments which would overreach the scope of this study.

Hypogea describe monumental underground burial chambers with several burial *loculi*. Most likely, these structures also had monumental superstructures marking the location of the tombs in the landscape.

Shaft tombs consist of a rectangular shaft cut into the natural bedrock surface giving access to one or several communal burial chambers that may include individual *loculi*. Shaft tombs are not built, but completely rock-cut and are generally less monumental. They only very rarely show evidence of superstructures. The main difference between shaft tombs and *hypogea* is that shaft tombs are accessed only by the rock-cut shafts while the burial chambers of *hypogea* are accessed by built corridors or staircases.

Burial cairns are simple stone piles of varying width and height mounded over a simple burial.

There are also simple *pit graves* in the study area.[189] Most often, these are rock-cut, but are also simply dug into the ground. Rock-cut pit graves are characterized by a single rectangular grave shaft of varying size and depth. In contrast to a shaft tomb, they do not give access to a larger burial chamber (although in most cases, this is impossible to determine without excavations). Depending on their depth, they instead only hold single, or in some cases also several burials laid on top of each other, separated by stone slabs. The earthen parallel to this simple burial type is often lined by natural stone slabs or, more rarely, by ashlars.

To better manage the funerary structures recorded by the various surveys, the burial types mentioned above were further categorized by site density and location and were thus fitted into the following categories:

Cemeteries

In contrast to isolated funerary monuments, a cemetery is simply defined as a spatial concentration or cluster of funerary structures within a limited area. The burial type is irrelevant. It is common that only one type of funerary structure is documented within

187 Graf 1997, 272–273, n. 17 and 24.
188 Cf. Wadeson 2010, 54.
189 Wadeson 2012a, 101–103; Perry 2002, 266. Note that the FJHP refers to these as "shaft graves" or "grave pits" (cf. Kouki – Silvonen 2013b, 302, 314–315, n. 5).

cemeteries. However, they may also consist of different types of funerary monuments as well.

Isolated Funerary Monuments

All single funerary structures that are spatially isolated from other funerary sites are referred to as 'isolated funerary monuments.' These are (a) façade tombs, (b) shaft tombs, (c) burial cairns, (d) hypogea and (e) simple pit graves (cf. definitions above).

Military Structures

As Jordan has some of the best examples of Roman-Byzantine fortifications in the Near East, numerous previous studies offer varying detailed typologies of these military structures.[190] Despite such distinguished scholarly focus on the country's Roman-Byzantine military architecture, giving a precise definition of military structures for this study is nevertheless difficult. Most of the presumed military structures in the study area are identified based on surface observations alone. This is problematic as the presumed military character of the documented sites often overshadows possible different or additional functions of the structures.[191] Additionally, previous works on Jordan's ancient military structures and organization have naturally focused strongly on the analysis of military structures dating to Roman-Byzantine periods. The discussed sites were therefore referred to by their appropriate Roman-Byzantine terminologies and their inherent functions. However, dealing with pre-Roman military structures as well, one should be careful not to follow a too Romanized typology for these structures.[192] A universally applicable classification of military sites – independent of specific periods – is favorable. Therefore, based on site size, architectural and structural layout as well as site location, four types of military structures are distinguished.

Fortresses

This study defines a fortress as a very large, rectilinear structure of purely military function enclosed by a substantial defensive wall with gate(s) giving access to the structure's interior.[193] The walls are equipped with interval and/or corner towers. Within the walls, there are also various structures of specific functions serving the daily needs of the military units within the fortress. This category corresponds to the Roman *castrum* (Greek κάστρον). In a Roman context, fortresses are defined to have accommodated a complete legion. The only legionary *castra* in Jordan can be found in Udruh and al-Lejjun (both measuring between c. 4–5 ha), which are of Late Roman date (4th century AD) and accommodated a maximum of c. 2000 men.[194] Fortresses are at the center of a larger communication network of military structures.

Forts

Forts are smaller variants of fortresses and have varying dimensions (c. between 0,1 and 2 ha).[195] They feature defensive walls, which may be equipped with interval and/or corner towers. Their primary function was accommodating a significant number of troops such as auxiliary units or legionary *vexillationes*. Similar to fortresses, structures are also to be found in the interior of forts serving the practical needs of the stationed units. This category corresponds to the Roman *castellum* (Greek οχύρωμα, φρούριον or χάραξ).[196] Forts are situated along major roads/routes and are an integral part of a larger communication network of military structures.

Fortlets

A fortlet is significantly smaller than a fort (c. 0,01 – 0,1 ha), but noticeably larger than a simple watchtower.[197] Its defensive structures are less substantial than

190 For example, cf. Kennedy 2004; al-Khouri 2003; Fiema 1995; Gregory 1997a and Gregory 1997b as well as Gregory 1995; Parker 1995; Kennedy – Riley 1990; Lander 1984. Cf. also Castro 2018.

191 Cf. Findlater 2002, 139–140, who, for example, doubts the purely military function of Jurf al-Darawish.

192 Roman military sites often re-used older Nabataean military structures (e.g. Kennedy 2004, 26).

193 Cf. Ginouvès et al. 1998, 21.

194 Kennedy 2004, 26, 154–159 and 178–179.

195 Cf. Reddé 2015, 137. For examples of structures referred to as small forts in the extended study area that are only slightly larger than 0,1 ha, see the Late Roman *quadriburgia* in the Wadi Arabah: Gharandal measuring c. 0,13 ha (Smith 2010, 33–34; Kennedy 2004, 209–211), Bir Madkhur measuring c. 0,11 ha (Smith 2010, Kennedy 2004, 213) or Yotvata measuring 0,16 ha (Davies – Magness 2015; Smith 2010, 30–32).

196 Ginouvès et al. 1998, 21. The best preserved example of a Roman fort in Jordan (and arguably in the entire Roman Empire) is Qasr Bshir. Additionally, several forts were recently excavated in Jordan including *castella* at Umm al-Jimal, Qasr al-Hallabat, Da 'ajaniya and Humayma revealing more detailed information on the layout of these forts. Other known Roman forts in Jordan are e.g. Umm al-Quttein, Khirbet Khaw, Qaryat al-Hadid, Khirbet Ain, Tell Faysal and Bir Madkhur (cf. Kennedy 2004, 26). Examples of Hasmonaean-Nabataean forts in the Negev can be found at Horvat Ma'agurah of Nessana (Erickson-Gini – Israel 2013, 34 and 39). Note that Roman *burgi*, for example known from En Boqeq, Israel (Gichon 1993), would also be considered as a fort in this study.

197 Cf. e.g. the late 2nd – 4th century AD *centenaria* discussed by Mattingly 1995, 164–166 in *Tripolitania*.

that of a fort. It may have internal divisions for accommodating a small number of auxiliary units that were responsible for surveilling and policing the immediate surroundings. This category corresponds to the Roman *castellum* or *centenarium* (Greek φρούριον or ἐρυμάτιον).[198] Fortlets are often situated along roads and routes, but can also be positioned in more isolated areas. They are an integral part of a larger military communication system.

Watchtowers

This study defines a watchtower as a small structure located in a prominent position in the landscape (e.g. on hilltops, ridges, ledges or slopes) commanding a good, far-reaching view over its surroundings. Watchtowers stood in visual contact with other military and non-military structures as well as roads or routes.[199] Their primary function was therefore surveillance. This category corresponds to the Latin *turris* or *specula* and the Greek πύργος or φρυκτόριον.[200] For identifying a structure as a watchtower, the layout is not decisive, although the majority of the considered watchtowers are rectangular structures. The structural remains of the presumed watchtowers often suggest well-built, once high-standing structures with thick walls to serve potential defensive purposes and to optimize visual communication with other structures. However, there are also examples of simple stone structures that are not substantially built, but also referred to as watchtowers.

Religious Structures

Within the urban limits of Petra, various religious structures have been of major scholarly focus. Starting as early as G. Dalman's seminal work on Petra's rock-cut sanctuaries, Petra's religious 'cityscape' has caught immediate archaeological and historical attention, exemplified by the large excavation projects at the 'Temple of the Winged Lions' or the Qasr al-Bint.[201] The multitudes of Nabataean cultic niches (often with rock-carved *baetyli*) in Petra were also subject to detailed archaeological analysis. Outside the urban limits of Petra, rural religious structures were discussed and set in their cultural context as well. More comprehensive works on Nabataean religion have contributed greatly to the understanding of Nabataean religious behavior in general.[202] It could therefore be expected that a precise terminology of the various religious structures in the environs of Petra has been established. However, there is an inconsistent and variable use of specific terms within scholarly discussions (e.g. the seemingly arbitrary and often synonymous use of the terms 'sanctuary' and 'temple').[203] This is also because there are various structural characteristics of particularly rural Nabataean religious structures, thus making an all-encompassing definition of terms difficult. It is therefore necessary to introduce a structured and consistent categorization of the religious structures that are dealt with here. In order to do so, one must first address the main question concerning the religious nature of sites: What are the indicators for recognizing a site as religious (sacral)? There are various structures and installations that can be set in a religious context. These include major religious/cultic buildings such as temples, churches or mosques, which may or may not be associated with other religious infrastructures. Other religious structures and features are shrines or chapels, installations for ritual banqueting, cultic niches, representations of the venerated deity, *stelae* or cultic inscriptions. Such religious sites, however, are set in varying religious contexts and thus carry different religious meaning. To better grasp the various nature of these religious structures, this study further divides them into three categories regarding their physical appearance, which combines two major aspects: locational context (do the religious structures appear in groups, thus forming a complex or are they isolated?) and construction effort (are religious structures monumental architectures or more modest structures?). On this basis, the recorded religious structures in the Petraean hinterland were classified as 'sanctuaries,' 'significant religious/cultic structures' and 'isolated cultic installations.'

Sanctuaries

A 'sanctuary' is generally defined as a sacred area or complex. Such sacred areas and complexes include at least several structures and/or installations for ritual observances implying the worship of a deity by a large

198 Cf. Ginouvès et al. 1998, 21 with n. 19 and 20.
199 Cf. e.g. Abudanh 2006, 137–138.
200 Ginouvès et al. 1998, 25 with n. 81.
201 On the ,Temple of the Winged Lions', see e.g. Hammond 1986. On the recent excavation results of the Qasr al-Bint, see Augé et al. 2014. Also see Joukowsky 2017, Joukowsky 2007 and Joukowsky 1998 for the excavation results of the so called 'Great Temple' in Petra. The interpretation of this major structure in Petra's city center as a temple has been extensively debated and questioned in the past.
202 Such as the works of J. F. Healey (Healey 2001) and P. Alpass (Alpass 2013).
203 Cf. most recently Wenning 2017, 109–115. Also consider the proceedings of a workshop on the archaeology of rituals in the Nabataean World, held at the Institut français du Proche-Orient in Amman in 2015 and published in Durand – Tholbecq 2017. Particularly in this context: Tholbecq 2017a and 2017b, 41–43.

group of cult practitioners. Sanctuaries are easily accessed by processional ways[204] and may or may not have large cultic architectures as well as other ritual infrastructures such as ritual banqueting installations (*tri-* and *biclinia*, *stibadia*), water installations for cult purposes or associated cultic niches.[205] The 'seat of the deity' in form of an altar (the Nabataean *motab*) are within a sanctuary's precincts.

Nabataean 'high places' in Petra are categorized as sanctuaries: These include an altar (*motab*), a cistern as well as a functioning water system with further channels and basins that was most likely used for ritual practices conducted at the high places as well as installations for enabling the gathering of cult practitioners in form of rock-cut or built *clinai*.[206] Prominent examples of such high places in Petra are e. g. the structures on the Jabal al-Khubtah or, more famously, those on top of the Jabal al-Madhbah referred to as the Zibb Atuf or simply as *the* 'High Place.'[207]

As typical Graeco-Roman *temenoi*, however, the sanctuary as defined here does not necessarily have to be architecturally defined. For example, according to L. Nehmé, Nabataean high place sanctuaries in Petra consist of "[…] *numerous elements of different types, both rock-cut and open-air*."[208] Nehmé further states that the Nabataean term *MHRMH* comes closest to the Graeco-Roman *temenos*, which can be defined as a spatially defined enclosure around sacred installations dedicated to a certain deity. Simply put, the Nabataean *MHRMH* is considered as a loosely defined 'sacred place.'[209] Wenning also highlights the varying structural appearance of Nabataean sanctuaries and finds confirmation of this already by Dalman, who may be quoted in length here as well:[210]

> *Die Bezeichnung 'Heiligtum' habe ich geglaubt nur da anwenden zu dürfen, wo eine ganze Gruppe von sakralen Objekten zusammen zu gehören schien. Als solche Objekte nenne ich heilige Steine, Nischen mit Pfeileridolen, heilige Zellen, Schalenvertiefungen, Lustrationsbassins, Opfermahlstätten* […]. *Allgemein gültige Vorschriften für die Herrichtung der Heiligtümer kann es nicht gegeben haben; denn nicht zwei sind darin gleich* […]. *Das gottesdienstliche Bedürfnis scheint das einzige gewesen zu sein, was feststand. Man bedurfte einer Möglichkeit, vor der heiligen Handlung die notwendige Lustration zu vollziehen, eine Vergegenwärtigung der Gottheit, angesichts deren die Schlachtung statthaben, vor der Spenden ausgegossen werden konnten, eines Ortes für aufzustellende Weihegaben und eines Platzes zum Opfermahl unter freiem Himmel oder auch zum Schutz vor Sonnenglut und Regen in einer gedeckten Felsenkammer* […]. *Eine heilige Cella mit Idol gehört so wenig zum notwendigen Bestand eines Heiligtums, als die Opfermahlstätte bedeckt sein muß. Im Gegenteil dürfte die Anlage unter freiem Himmel das Ursprüngliche und Bevorzugte gewesen sein* […]. *Daß die Grenzen der heiligen Stätten für die Nabatäer von Bedeutung waren, ist anzunehmen; aber nirgends treffen wir eine besondere Bezeichnung derselben* […] *und wenn man ihre besondere Angabe für überflüssig hielt, muß man die durch die natürliche Gestalt der Umgebungen eines Heiligtums dargebotenen Andeutungen für hinreichend gehalten haben.*[211]

Giving a uniform definition for a 'sanctuary' is seemingly extremely difficult, particularly when dealing with rural structures.[212] Highlighting the structural variance of sanctuaries, one may compare, for example, the sanctuary of Isis in the Wadi Abu Olleqah, the small high place sanctuary of ad-Dahunne Slaysil and the Nabataean sanctuary of Jabul Harun. The common denominator of the various appearances of 'sanctuaries' seems to be, particularly for sanctuaries of the high place type, first, their prominent location on higher mountaintops accessed by processional ways and the inclusion of various cultic structures and installations being an integral part of the 'sacred place,' thus offering the possibility of mass-worship of the venerated deity.

Significant Religious / Cultic Structures

Belonging to the category of 'significant religious/cultic structure' are all major religious/sacral structures of a specific architectural form. These structures may be incorporated into a larger sacred area or complex (sanctuary) with further cultic infrastructures and

204 Alpass 2013, 66–68.
205 Specifically on Nabataean *stibadia* in Petra, cf. recently Tholbecq 2018. On Nabataean *tricilinia*, cf. recently Durand 2017 and Charloux et al. 2016.
206 Wenning 2007 and Wenning 1987; Schmid 2001, 377; Nehmé 1997a, 1035–1036.
207 Alpass 2013, 68–73; Schmid 2001, 377.
208 Nehmé 1997a, 1035.
209 Nehmé 1998, 66. However, note that Nabataean sanctuaries do not necessarily always have to be referred to by this term as stated by Tholbecq 2011a, 315.
210 Wenning 2017 and 2007, 257: "*Denkt man bei „Heiligtum" vielleicht zuerst an Tempelbezirke, so überwiegen in Petra bei Weitem die ganz andersartigen Clan-Heiligtümer* […]." Dentzer 2010, 165 also mentions the problematic definiton of a sanctuary in a Nabataean context: *„On appellera ici «sanctuaire» un ensemble regroupant des éléments d'installations cultuelles de nature, de taille et de fonction différentes* […]. *Dans le contexte nabatéen ce terme ne peut être réservé aux formes les plus monumentales, correspondant à de véritables programmes architecturaux*."
211 Dalman 1908, 67–69.
212 Tholbecq 2011a, 314. Cf. also Schmid 2016, 68 stating that parallels among Nabataean sanctuaries or temples "[…] *become less pronounced when instead of 'official' representative temples, tribal shrines, sanctuaries or places of worship are taken into consideration*."

installations.[213] The association with other cultic structures or installations is not necessarily a prerequisite. Significant religious/cultic structures can also be in a more isolated context and may therefore also include smaller temples, village churches or desert mosques. In a Nabataean context, the difference between a temple and a sanctuary is also highlighted by the usage of different terms in Nabataean texts: In contrast to the Nabataean *MHRMH* (cf. above), a temple was always referred to as *BYT* – the "house of the deity."[214] The major difference to a sanctuary is the fact that, for example a temple, is a single substantial building of often monumental dimensions without any necessary association with other cultic structures or installations.[215]

Isolated Cultic Installations

Isolated cultic installations describe all sacral features with minimal infrastructure and which are not part of larger religious complexes. They are often only difficult to access, thus suggesting that they are a restricted place of worship. Such installations include isolated cultic niches, isolated single ritual banqueting installations (*tri-* and *biclinia*, *stibadia*) as well as single cultic inscriptions mentioning the veneration of a deity.[216] This basically corresponds with Alpass' listing of religious 'private monuments,' being *triclinia*, tombs, idol blocks and figurines.[217]

Settlements

The various surveys identified hundreds of rural settlements in the study area. Such settlements include towns, villages, farms and hamlets of various sizes. Although most of the surveys do not provide precise definitions of archaeological categories, uncommented differentiations are nevertheless made between, for example, 'major' and 'agricultural towns,' 'defensive' and 'major agricultural villages,' 'agricultural hamlets' as well as farmsteads, farms and 'farm outbuildings.'[218] This highlights major methodological problems inherent to the core archaeological dataset in terms of site classifications and furthermore underlines the importance of offering rigorous and precise definitions for the various site types.

P. Kouki, who has published the most recent and comprehensive study on rural settlements in the Petraean hinterland thus far, considered archaeological sites only as settlements if the reported building remains were structurally significant and datable by surface pottery. Structures that were interpreted to have had a cultic, funerary or military function were not considered in her analysis.[219] Kouki did not attempt to further classify the discussed settlements in terms of types, but rather grouped them by size (small, medium-sized and large sites). While certainly a valid approach, this study prefers to discuss different settlement types, as defined in the following.

Towns

Expanding on the definition of Ginouvès et al., this study defines a town very generally as a large agglomeration of structures that could have accommodated a significant number of inhabitants.[220] A town may include structures of possible political, commercial and religious functions and may have had an urban street network, large public spaces (e.g. squares). It could also have been fortified.[221] A town is considered to have had an economic importance and thus defined as a place where commercial activity took place.

Villages

A village is smaller than a town and is inhabited by a far smaller population. It is characterized by an agglomeration of structures, possibly oriented along main streets and possible public spaces (e.g. squares). Villages may include public structures, but fewer than

213 See e.g. the Nabataean temple(s) in the larger sanctuary precinct at Sabra (Tholbecq et al. 2016).
214 Tholbecq 2011a, 315.
215 Fiema 2016, 540; Nehmé 1997a, 1033–1036; Tholbecq 1997, 1072–1083. For a recent overview of Nabataean temples, see e.g. Wenning 2017 and 2007, 260–269.
216 Dentzer 2010, 168–171.
217 Alpass 2013, 77–86.
218 For example, cf. the site list of ARNAS provided by MacDonald et al. 2012, 11–21, table 1.2.
219 Kouki 2012, 78–79.
220 Ginouvès et al. 1998, 172–173. Towns are equivalent to Kouki's "large sites" (Kouki 2012, 79).
221 In comparison to this study's definition of a town, a city is generally considered to be larger than a town. However, the main difference between a town and a city is that the latter is characterized by its political and administrative autonomy, the diverse services that are provided by various structures of well-defined functions (political, administrative, commercial or religious) and its political and economic significance to its surroundings. According to the New Pauly, a city should fulfill these characteristics: "[…] *a closed topography and administration, a variety of buildings, pronounced specialization and division of labour, an appropriately numerous, socially differentiated population, and central functions – specifically economic as well as political – for a surrounding area*" (http://referenceworks.brillonline.com/entries/brill-s-new-pauly/town-city-e1120500?s.num=2&s.f.s2_parent=s.f.book.brill-s-new-pauly&s.q=Town (last accessed 06.04.2021). The only site that qualifies as a city in the study area is Petra itself.

a town. Generally, a village's main function is associated with agriculture and it is always rural.[222]

Cluster of Buildings (Hamlets)

This study refers to an ensemble of a small number of structures (including possible farms) without well-defined public structures and features (i. e. streets, squares etc.) as a cluster of buildings. These are rural and mainly with an agricultural function in addition to housing a small number of inhabitants and may thus also be considered as a small village. Such settlement types are often referred to as hamlets.[223] However, this study's more objective 'cluster of buildings' is preferred over this often loosely defined term.

Farms

A farm is smaller than a 'cluster of buildings' and is mainly defined by one primary structure in a rural, agricultural setting. Additional structures that served the production and/or storage of agricultural goods may also be part of a farm.[224]

Rural Mansions

The category 'rural mansion' is difficult to define precisely. Following the definition of a *maison rurale* laid forward by Ginouvès et al, this study very generally defines a rural mansion as a large, often isolated, rural building mainly for habitation purposes.[225] Such structures may also include representative as well as utilitarian features.

Other Structures and/or Features

Many archaeological sites were recorded by the various surveys that are grouped here as 'other structures and/or features.' Among these are sites which cannot be easily defined functionally (i. e. (natural and/or rock-cut) structures and walls of undetermined function) as well as categories that can be better identified functionally, but are difficult to discuss within the frames of the other categories described above (i. e. find clusters and epigraphical sites or locations).

Epigraphical Sites or Locations

Any sort of uncontextualized, written text is considered here as an 'epigraphical site or location.' No distinctions are made in terms of length, content, language/script, date, material or form of the identified graphemes (e. g. stone/rock engravings or painted texts). All forms of uncontextualized rock art are also documented as epigraphical sites or locations. These include the miscellaneous images and signs created by the incision, picking or carving of rock surfaces (*petroglyphs*) as well as those drawn or painted on a rock face (*petrograph*). No further distinctions between size, style, form or date are made.[226]

Find Clusters

Find clusters are defined as significant artifact concentrations relative to the overall density of surface finds in the surrounding area that cannot be associated with other archaeological structures or features. Find clusters do not necessarily have to be *in situ*. No distinctions are made in terms of material or their relative datings. For example, find clusters can describe large concentrations of surface pottery, bones, coins, architectural fragments or lithics of all periods.[227]

Natural and/or Rock-Cut Structures of Undetermined Function

In contrast to the *built* structures of undetermined function, this category describes all natural, largely unaltered sites where the archaeological evidence indicates that these were used by humans. For example, these include natural caves or rock shelters that could have been used for (temporary) habitation or gathering places, storage of agricultural goods and/or equipment as well as for keeping animals. These may be associated with built features such as small walls in front of the caves and/or rock shelters. However, determining an exact function for these natural sites is difficult. This category also encompasses all rock-cut structures and features without clearly definable functions.[228]

222 Cf. also Ginouvès et al. 1998, 172. Villages are also equivalent to Kouki's "large sites" (Kouki 2012, 79).
223 For example, cf. Ginouvès et al. 1998, 172 for a similar definition of a hamlet as this study's cluster of buildings, which fall under Kouki's "medium-sized sites" (Kouki 2012, 79).
224 Cf. Ginouvès et al. 1998, 155. Farms are equivalent to Kouki's "small sites" (Kouki 2012, 79).
225 Ginouvès et al. 1998, 155. Rural mansions are also equivalent to Kouki's "small sites" (Kouki 2012, 79).
226 Cf. also the FJHP's similar definition of "rock carvings" (Kouki – Silvonen 2013a, 342–343).
227 Cf. e. g. also the FJHP's similar definition of "lithics and pottery concentrations" (Kouki – Silvonen 2013a, 341).
228 Cf. the FJHP's similar definitions of "storage caves," "rock shelters," "rock-cut steps" and "other rock-cut features" (Kouki – Silvonen 2013a, 345).

Structures of Undetermined Function

This category describes all (isolated or archaeologically uncontextualized) structures recorded by the various surveys without clearly definable functions. No distinctions in terms of size, layout, material or date are made.

Walls of Undetermined Function

The various surveys have identified isolated or uncontextualized walls that cannot be directly associated with any specific archaeological site. These walls may or may not have served as possible boundary walls, terracing/retaining walls for agricultural and/or hydraulic purposes or simple surface walls. However, as the exact function of these walls cannot be clearly defined, they are grouped here as 'walls of undetermined function.' No distinctions in terms of measurements, material, construction technique or date are made.[229]

Water Structures

This study groups the various water structures into springs, dams/barrages, water conduits, water storage installations and wells.

Springs

A water source is defined as a place where water naturally flows from an aquifer to the surface as a spring. No further distinctions are made. While natural springs cannot strictly be considered as water *structures*, they are nevertheless grouped within this category as they are one of, if not *the* most vital water source in the study area and many natural springs were modified by humans (e.g. 'Ain Braq).[230]

Dams/Barrages

Generally, this study considers a dam as a built barrier that restricts water flow (independent of its source). While the main purpose of a dam is to retain water masses, it may have also been utilized to manage controlled water flow into specific areas. In such a case, the structure may be referred to as a diversion dam or barrage. Such structures divert regular water flow mostly for irrigation purposes. In the study area, a dam or barrage is structurally characterized as a built wall, independent of its measurements, material or construction technique.

Water Conduits

Water conduits describe all installations that distribute water from one place to another including aqueducts, *qanats* as well as all other water channels. Constructional differences are irrelevant. A water conduit may thus describe a ceramic water pipeline, a rock-cut or earthen channel – independent if the conduit is constructed above ground, on the surface or underground. No distinctions in terms of measurements are made. Specifically, although the main water source of a *qanat* is technically a 'mother well' that accesses ground water from an aquifer, the main purpose of a *qanat* is to transport that water source further and is thus considered a water conduit.[231]

Water Storage Installations

Most water conduits transport water into water storage installations. These installations are understood to have stored exclusively run-off water (rain water) or water that was transported by a water conduit. Further constructional distinctions are not made and it is irrelevant whether the installations are situated on the surface or underground, freely built or rock-cut, or whether they are open or closed.[232] Differences in size are also not important. Water storage installations therefore include all types of reservoirs, basins or cisterns.

Wells

A well is defined as an underground excavation that accesses ground water from an aquifer. No distinctions are made in terms of depth. While wells may have been structurally embellished, its material or construction technique is irrelevant. Although a well stores water, the main difference between a well and the above-mentioned water storage installations is that a well derives its water source from a stable aquifer and is thus not supplied with water from any water conduit or run-off water.

Chronology

The re-evaluation of the original survey data in terms of the differing site classifications has also shown that the original dating of archaeological sites do not follow a coherent and standardized chronological system.[233] While there is a general agreement on

229 Cf. Kouki – Silvonen 2013a, 344.
230 See e.g. Farajat et al. 1998 and Lindner – Hübl 1997.
231 Cf. the definition of "water transportation structures" given by Antonelli – Liapi 2015, 309–310.
232 In contrast to many works that distinguish between closed cisterns and large, uncovered reservoirs.
233 The following represents an updated and modified version of Kennedy – Hahn 2017.

culturally defined time periods, the chronological definition of these periods by the different surveys can vary significantly. This is a methodological issue that renders any diachronic archaeological analysis highly problematic if not approached head on from the beginning. The challenge of dealing with varying chronological definitions and classifications is not unique to the archaeological dataset for the Petraean hinterland. Other landscape archaeological studies have suggested various different solutions to the same fundamental methodological problem.[234]

For the Petra area, F. Hahn was particularly concerned with the differing chronological information provided by the original survey data and was able to work out a distressing temporal distortion of sites dating to the same cultural periods.[235] In some cases, the chronological definitions of periods could vary by centuries. It therefore became clear that an uncritical acceptance of such temporal uncertainties would only lead to a methodologically questionable and distorted reconstruction of Petra's rural environment through time. This section therefore assesses the various chronological inconsistencies and temporal uncertainties of the original survey data and presents a more transparent and valid definition of the different cultural periods evidenced within the Petraean hinterland.

Methodological and Analytical Issues

Other archaeological research projects have also recognized the problem of chronological inconsistencies of large datasets.[236] For example, S. Alcock analyzed different chronological shifts as well as chronological continuities within her study on Roman Greece.[237] Considering each evidenced cultural phase separately as well as the various subdivisions of the respective cultural period, Alcock attempted to clarify the different chronological shifts from one cultural period to the next.[238] By meticulously evaluating archaeological sites dating to two or more cultural periods, she also aimed at researching chronological continuities.[239] Hahn also attempted to examine the original survey data of the Petra region in terms of chronological shifts.[240] However, further subdividing these cultural periods appeared to be problematic, as Hahn was able to demonstrate severe methodological problems inherent to the original surveys.[241] Due to the chronological inconsistencies, only an unrepresentative 10 % of the total amount of survey sites could be evaluated in terms of chronological continuities.[242] Another problematic issue for such analyses is the fact that only cultural periods were considered. The differing chronological phasing of the same cultural period as stated by the various surveys of the Petra region is not taken into account, thus inevitably leading to a large chronological distortion of the archaeological dataset. For example, when comparing the various definitions of the Nabataean and Roman periods, it becomes clear that Abudanh, ARNAS and ShamAyl specify that both periods date at least from the mid-1st century BC onwards and end in the 3rd/beginning of the 4th century AD (FIG. 11).

However, other surveys such as the FJHP follow a more conventional historical definition of the Nabataean period covering the 1st centuries BC and AD only. For the FJHP, the Roman period begins no earlier than the early 2nd century AD and ends in the late

234 See Gkiasta 2008, 161–167 on dealing with such issues within her study on ancient Crete. Also Farinetti 2011, 35–39 faced similar challenges within her study on ancient Boeotia. Dewar 1991 provides an insightful methodological contribution on how to tackle problematic issues of site contemporaneity within larger settlement pattern studies, which is then further discussed between Kintigh and Dewar (Kintigh 1994 and Dewar 1994). Studying regional archaeological landscapes in the Middle East, Lawrence et al. 2012 also provide very useful suggestions for dealing with similar chronological inconsistencies within their archaeological dataset.

235 Hahn 2014.

236 See above the cited works of Dewar 1991, Gkiasta 2008, Farinetti 2011 and Lawrence et al. 2012.

237 Alcock 1995, 56–58.

238 Alcock 1995, 56–58. For example, there are ten sites that date to the Byzantine period. However, two of these sites actually date to the Early Byzantine, three to the Middle Byzantine and five sites to the Late Byzantine period.

239 Alcock 1995, 56–58. For example, it is important to know how many Hellenistic sites were also occupied in the (Early) Nabataean period.

240 He was able to demonstrate that 12,27 % of all recorded sites date to the Iron Age II period, 32,64 % to the Nabataean period, 28,36 % to the Roman period, 23,75 % to the Byzantine and only 2 % to the Early Islamic period (Hahn 2014, 29–36). Hahn considered a total number of 1777 sites (although including doublings and multiple entries) recorded by the Edom Survey, the Beidha Ethnoarchaeological Survey, the Southeast Araba Archaeological Survey, the Dana-Showbak-LH2E Survey, the Jabal Shara Survey, the Archaeological Survey of the Wadi Musa, the Bir Madhkur Project, F. Abudanh's survey of the Udruh region, the Finnish Jabal Harun Project (only the sites referred to in P. Kouki's settlement model from 2012) as well as the Ayl to Ras-an-Naqb Archaeological Survey.

241 Hahn 2014, 36: Only 31 % of all Roman sites are further divided into Early and Late Roman. Also, only 17 % of all Byzantine sites could be differentiated into Early and Late Byzantine.

242 Hahn 2014, 36: On this basis he established that only 0,9 % of Iron Age II A–B sites continued to exist in the Iron Age II C period, only 2,2 % from the Iron Age II C to the Hellenistic period, only 3,45 % from the Hellenistic to Nabataean period, 58,19 % from the Nabataean to Roman period, 29,7 % from the Roman to Byzantine period and, finally, only 6,9 % from the Byzantine to the Early Islamic period.

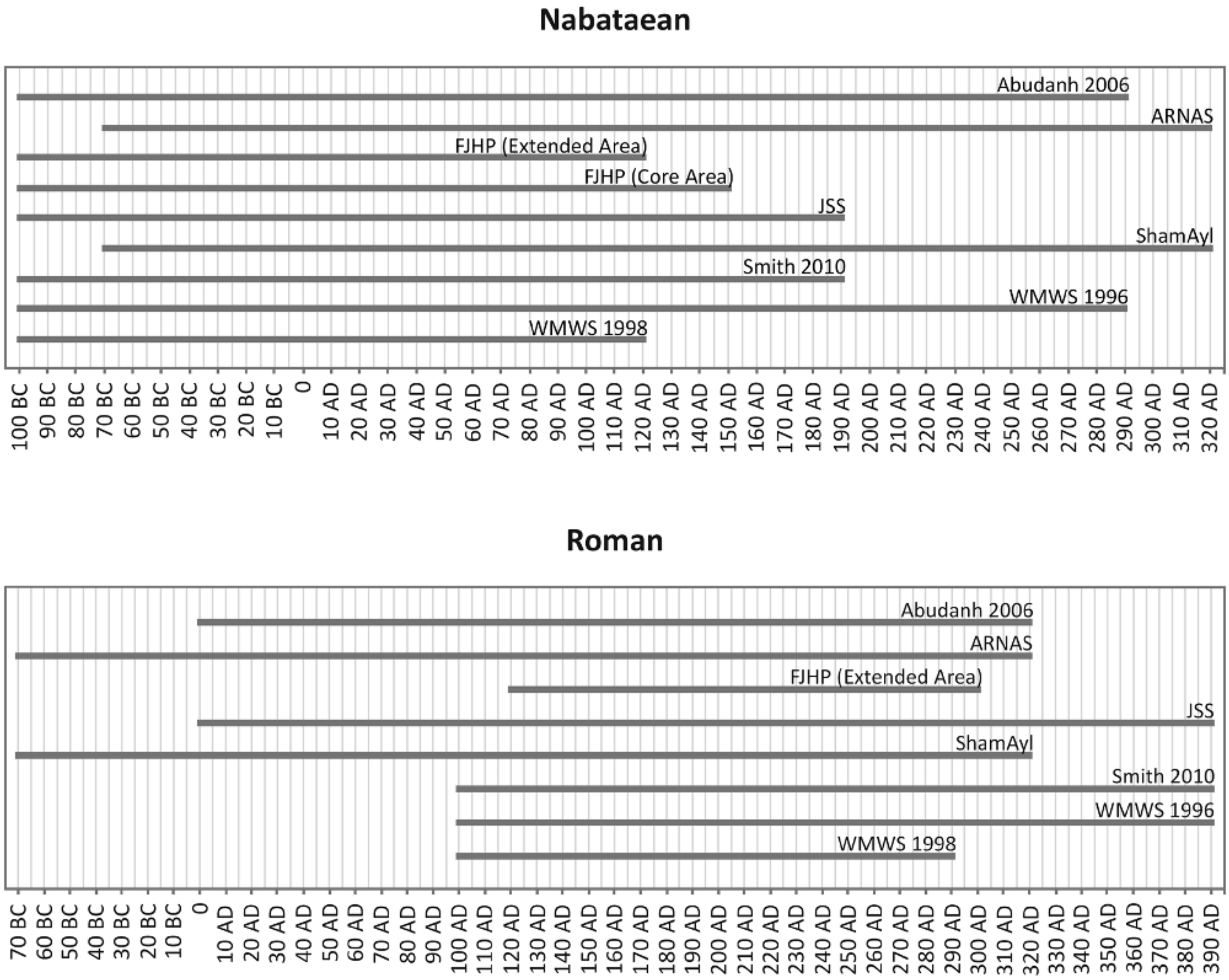


FIG. 11 The Nabataean and Roman periods as defined by the different surveys highlighting the various temporal ranges.

3rd century AD.[243] The chronological definition of the Nabataean and Roman period can vary by centuries depending on which survey to follow. Considering cultural periods alone for diachronic analyses of the archaeological data at hand would therefore only result in a problematic assumption of temporal contemporaneity of archaeological sites.

Recognizing this problem, Kouki's solution was to simply convert culturally defined periods into absolute temporal specifications, if stated by the original surveys.[244] The only reports providing such information were the WMWS, Abudanh's survey as well as the FJHP.[245] Although the approach of associating cultural periods to respective centuries is valid, Kouki's analysis is, first, limited to settlement sites only. A large amount of spatio-temporal data therefore was not considered for her chronological reassessment of the original survey data. Second, this approach can only consider survey data with precise absolute chronological definitions of cultural periods. Reports that date sites by cultural periods without further definitions cannot be included and therefore neglected for any diachronic analysis of the archaeological data. This could result in a misleading or at least incomplete archaeological model of the Petraean hinterland through time.

It was therefore necessary to develop a new and more refined methodology that can quantify the chronological inconsistencies incorporating all data provided by the original surveys. Without such an approach, any archaeological study on spatio-temporal developments of the Petraean hinterland remains methodologically questionable.

243 Silvonen 2013, 129–130. For more conventional historical chronological systems, see Parker 2006, 5–24, 332, Table 2.1; Fiema – Jansson 2002; Homès-Frederique – Hennessy 1986; Sauer 1973, 1–5.

244 Kouki 2012, 80–82.

245 Kouki 2012, 80–82.

Quantifying Chronological Inconsistencies

As archaeological datasets grow larger and more complex, it becomes increasingly difficult to present a coherent chronological system for dating archaeological sites.[246] Archaeological periods are often defined coarsely, which can in part be explained by the low dating accuracy of archaeological sites themselves. Within survey activities, sites are primarily dated based on diagnostic archaeological surface material such as ceramic evidence.[247] Without stratified archaeological material or scientific dating results, any dating based on surface material alone remains suggestive.[248] The dating quality of most of the archaeological sites dealt with in this study is therefore inherently *fuzzy*. Establishing a precise definition for chronological periods is often extremely difficult as they are unsubstantiated or imprecisely classified.[249] Further distinguishing the time spans of cultural periods with exact start and end dates thus poses an even more difficult task, particularly when these time spans correlate to more specific, however loosely defined, archaeological periods such as 'Early Nabataean' or 'Late Roman.'

Attempting to provide more detailed dating information for archaeological sites, such temporally blurred or *fuzzy* cultural periods are still being defined.[250] The limits of such dating methods and the resulting chronological sequencing, however, are only rarely recognized.[251] In order to meet these methodological challenges and to establish a more coherent and standardized chronological system for the diachronic spatial analyses of archaeological sites in this study, it was therefore necessary to reclassify the data into a rigidly structured spatio-temporal system. The original survey data was first categorized into three classes (TABLE 2).

The major issue is that the different *Class A surveys* (with sites dated by cultural periods *with* pre-defined time spans) may define the same cultural periods such as 'Nabataean,' 'Roman' or 'Byzantine,' however, the respective time spans differ sometimes significantly (cf. FIG. 11). Due to the inconsistent definitions of the time spans of cultural periods stated within Class A survey data, it is therefore impossible to fit data from *Class B surveys* (with sites dated by purely culturally defined periods *without* pre-defined time spans) into a respective time span from Class A surveys. Without giving a coherent definition of time spans for Class B survey data, however, these sites cannot be considered for further analyses, resulting in an incomplete spatio-temporal archaeological model of the Petraean hinterland.

In order to include Class B surveys into the base dataset, the far easier option would have been to simply define a new chronological system for this study and to fit all survey data into that greater system. However, the chronological inconsistencies within the survey data would remain and such an approach would have only added to the core problem. In order not to repeat such methodological flaws, the following steps demonstrate not only how to synchronize the varying chronological information within Class A surveys, but also how to incorporate Class B survey data into a valid chronological system.

The first step is concerned with the *acquisition of the base dataset*. At this stage, based on the reports given by the original surveys, all spatial and chronological information is systematically gathered for each site of all survey classes. Chronological information is coded by providing so-called *dating values* for each archaeological site.

After the base dataset is established, all Class A survey data undergoes a *selection process*, where all Class A sites are filtered by each evidenced cultural period and its respective time span. The dating value per archaeological site for each cultural period and time span is also provided. Since every archaeological site received a dating value for each cultural period and its respective time span, the dating values can then be further quantified.

This third step is crucial for *quantifying chronological (un)certainties* for each cultural period. Only then is it possible to define generally valid, quantified time spans of each cultural period evidenced by Class A surveys and to fit the purely culturally defined dating information of Class B survey data into the respective (quantified) time spans, thus finally creating the quantified *spatio-temporal base dataset* for the study area.

Acquiring the Base Dataset

O. Nakoinz presented various solutions on how to code temporal information.[252] In this study, one particular coding method was applied which suits the

246 For other projects dealing with large archaeological datasets and facing similar problems in terms of chronological inconsistencies, see e.g. Crema 2015; Nakoinz 2012, 189–190 as well as the studies referred to above.

247 While the dating of most of the archaeological sites within the Petraean hinterland is based on surface pottery, sites were also dated by numismatic, architectural as well as epigraphical and literary evidence.

248 For a brief overview on the challenges of dating archaeological sites according to surface material, see Crema 2015, 315; Kouki 2012, 28–29; Lyman – O'Brien 2006.

249 Crema 2015, 315.

250 Nakoinz 2012, 190.

251 Crema 2015, 314–315.

252 See Nakoinz 2012, 191–194 for a full discussion on the various coding options of temporal information of

available chronological information and the inherent problem best.

Class A survey data can either be assigned to one cultural period (e.g. 'Roman'), consecutive periods without interrupted temporal intervals (e.g. 'Roman to Byzantine') or various periods with interrupted temporal intervals (e.g. 'Nabataean, Roman, Byzantine'). Particularly for the latter example (sites dating to various periods with interrupted intervals), the best method for coding Class A survey data was Nakoinz' *Stufenbelegung mit unterbrochenem Intervall*.[253] This method dictates to simply assign Boolean values for each evidenced cultural period and its respective time span per archaeological site. A time span is measured in 'time blocks' (**tb**), the unit of each time block being one decade.[254] Following the principles of binary logic, Boolean values only express statements of 'true' or 'false.' The Boolean value '0' signifies 'period not evidenced (false)' and '1' consequently 'period evidenced (true).'[255] The same principle applies for the respective time span of a given cultural period as stated in the Class A survey reports. For example, a site recorded by a Class A survey dates to the Nabataean period. The period N (= Nabataean) consequently receives the Boolean value 1. Additionally, the given Class A survey predefined the Nabataean period to run from 100 BC to 106 AD meaning that the site must date within that time span. Since a time span's time block is measured in decades, in this case the decades 100 BC, 90 BC, 80 BC etc. until 100 AD (or the first decade of the 2nd century AD) would also receive the Boolean value 1.

Another example would be a site recorded by the same Class A survey that is dated to two consecutive cultural periods, e.g. from the Nabataean to the Roman period. The periods N and R (= Roman) would therefore receive the Boolean value 1. Again the Boolean value 1 would be assigned to the entire time span of the Nabataean period as well as the entire time span of the Roman period, which may have been defined to range from 106 to 324 AD. Effectively, this would mean that, since the site dates both to the Nabataean and Roman periods, the decades from 100 BC, 90 BC, 80 BC etc. until 320 AD (in other words the 320s AD) all receive the Boolean value 1.

A last example would be a site recorded by the same Class A survey but is dated to various cultural periods with interrupted temporal intervals, i.e. a site dating to the Iron Age, Nabataean and Byzantine periods. As usual, all evidenced periods – IA (=Iron Age), N (=Nabataean), B (=Byzantine) – receive the Boolean value 1. The same applies to the respective time spans and time blocks of each evidenced period as explained above. However, the cultural periods that are not evidenced (and the respective time spans and time blocks of those periods as well) now receive the Boolean value 0 signifying 'period not evidenced.' In this case the site does not date to the Hellenistic and Roman periods. Thus, the Boolean value 0 must be assigned to both periods. In terms of the respective time spans, the given Class A survey may have defined the Iron Age period to run from 1200 BC to 539 BC, the Nabataean period from 100 BC to 106 AD and the Byzantine period from 324 AD to 630 AD. Each evidenced time block receives the Boolean value 1 and the non-evidenced time spans 0. In this case, these would be the decades from 530 BC to 90 BC as well as from 110 AD to 310 AD.

However, assigning binary Boolean values of 0 and 1 was not always as straightforward. The examples presented above follow absolute Boolean principles of true or false, therefore suggesting a complete certainty of a site (not) dating to a given cultural period. Yet, some sites documented by Class A surveys cannot be dated with absolute certainty. Such chronological

archaeological sites. In addition to the method applied here, Nakoinz presents four alternatives for coding chronological information. By 'Herkömmliche Datierung,' Nakoinz means to structure data that date to one cultural period only, thus being too simplistic for this study. While Nakoinz' 'Stufenbelegung' also defines Boolean values for evidenced cultural periods, they are only assigned to data that are continuously evidenced in consecutive cultural periods. The method applied here ('Stufenbelegung mit unterbrochenem Intervall') is basically the same, but it also takes non-evidenced cultural periods into account. Alternatively, it would be theoretically possible to code chronological information by defining real dating probabilities. Although this would be ideal, the various chronological inconsistencies within the original survey data of the Petraean hinterland do not provide the basis for defining precise probability values of a site dating to a particular period without previous analysis. Finally, since the chronological information at hand firstly follows a Boolean logic of true or false, any further coding options based on dating probabilities, as also proposed by Nakoinz, are not applicable for the data of this study.

253 Nakoinz 2012, 193.

254 It is necessary to define a temporal resolution or scale. Most dating information provided by Class A survey reports has a century-based temporal resolution. For the quantification of the chronological uncertainties, this was broken down to decades in order to receive a better temporal resolution and to better grasp cultural periods such as 'Early Roman' or 'Late Nabataean' as well as temporal overlaps. The issue of temporal resolution is immensely important. The choice of temporal resolution or the scale of the chosen time spans can have a significant impact on the general result of any diachronic quantitative analysis. This issue is highlighted by Wilson 2014, 147–155 and his methodological critique on archaeological studies dealing with Mediterranean ship wrecks.

255 Nakoinz 2012, 192.

uncertainties are signified in the survey reports by expressions such as "probably Iron Age," "possibly Nabataean" or "Roman (?)."[256] The principles of binary logic – of true or false – therefore do not apply in these cases.

As it is crucial to meet these concessions of the dating certainty from the original surveyors, instead of applying the principles of binary logic, aspects of *fuzzy logic* were followed in such cases enabling the quantification of such uncertain or fuzzy information. Fuzzy logic was first developed by L. A. Zadeh who recognized that it is not always possible or necessary to follow binary principles of true or false.[257] In contrast to the absolute Boolean values, fuzzy logic allows us to use uncertain or so-called *fuzzy* values. Since the Boolean values of 0 and 1 cannot be assigned to such sites, the *fuzzy value* '0,5' was defined instead, signifying uncertainties in the dating of sites as stated in the original survey reports.[258] Meeting the uncertain dating information best, the fuzzy dating value 0,5 was chosen since it expresses a 50-50 chance that the respective sites are dated in the stated cultural period.[259] Chronological uncertainties were thus quantifiable and could be assigned to cultural periods and their respective time spans of Class A survey data in the same manner as the Boolean values. Exemplifying this selection process, the Boolean and fuzzy *dating values* '0,' '0,5' and '1' could therefore be assigned to the cultural periods and their respective time spans for *all* archaeological sites recorded by Class A surveys (TABLE 3).

Quantifying Chronological (Un)Certainties

Assigning both the Boolean and fuzzy dating values to each cultural period and its respective time span per archaeological site of Class A surveys, it is possible to establish the temporal range of (un)certainty of the existence of an archaeological site at a particular time block (decade). This goes beyond simply stating the presence or absence of an archaeological site with absolute certainty.[260] The differing chronological information within the original survey data is now further quantifiable and can form the basis for the definition of generally applicable cultural periods.

Based on the assigned Boolean and fuzzy dating values, a given cultural period (p_x) can be further quantified in terms of the existence, or *frequency values* (f), of each evidenced time block ranging between 0 (absolute certainty of non-existence) and 1 (absolute certainty of existence). These existence or frequency values can be considered as *dating probability values* for a given cultural period (p_x).[261] The definition of a cultural period p_x not only follows binary Boolean logic, but is based on the principles of fuzzy logic, thus quantifying the uncertainties of chronological information inherent to the original survey data.[262]

In order to further process these chronological uncertainties, it has been suggested to apply the so-called *aoristic weighting method* or *aoristic analysis*. Underlying similar principles of fuzzy logic, Ratcliffe first developed the method of aoristic analysis for the field of criminology.[263] Johnson later adopted the method for archaeological research purposes in order to quantify uncertainties in the dating of archaeological sites and to get away from the simplistic notion that sites can only be dated according to a linear duration of a given (fuzzy) period.[264] This is particularly applicable when dating archaeological sites not only based on relative chronological systems (such as ceramic typologies etc.), but also on scientific dating methods such as C^{14} dates, which are essentially probability values and thus not absolute.[265] In order to combine all such chronological information, however, the method requires pre-defined time spans of periods with fixed start and end points.[266] In this study, the aoristic method could seem applicable for quantifying the dating values of the cultural periods of Class A surveys. However, working out the dating probability of cultural periods as defined by the individual Class A surveys is of minor interest. Instead, the aim is to achieve a *cumulative* probabilistic dating of cultural periods based on *all* Class A survey data. More importantly, even within Class A surveys there are numerous

256 For example, this goes for Abudanh 2006, 418–419: Abudanh Survey Site No. 042 is "probably Nabataean?" and Abudanh Survey Site No. 043 "Nabataean?."

257 Nakoinz 2012, 197–199; Popa – Knitter 2015, 1287–1288; Crema et al. 2010, 1120; Zadeh 1965.

258 The fuzzy dating value therefore lies between the absolute Boolean values of '0' and '1.'

259 It may be argued that dating information like "Roman?" may suggest a clearer inclination to the Roman period than perhaps the Nabataean or Byzantine period. In order to express such inclinations, further studies on the subject matter could experiment with assigning different fuzzy dating values than 0,5. Since 1 still signifies the absolute certainty of a site being evidenced in a given cultural period, the dating information "Roman?" could, for example, be assigned the more indicative fuzzy dating value of e.g. '0,75.' Whether this would have an effect on the overall results remains to be determined.

260 Bevan et al. 2013b, 40; Crema 2012, 448; Crema et al. 2010, 1120.

261 Nakoinz 2012, 193; Crema et al. 2010, 1120.

262 Nakoinz 2012, 193.

263 Bevan et al. 2013b, 40; Nakoinz 2012, 193; Crema 2012, 448; Crema et al. 2010, 1120; Mischka 2004; Ratcliffe 2000.

264 Johnson 2004.

265 Nakoinz 2012, 193.

266 Nakoinz 2012, 193; Crema 2012, 448; Crema et al. 2010, 1120.

exceptions when sites are dated by cultural periods, but do not correspond to the predefined time spans of those periods. While Class A survey sites can be dated by a predefined cultural period, the absolute dating of the site does not necessarily fit the time span of that cultural period. These inconsistencies do not meet the prerequisites for applying the aoristic method.

Since the aoristic method seems inappropriate for quantifying the archaeological dataset at hand, the cumulative probabilistic dating of each evidenced cultural period was calculated as follows:

Both the Boolean and fuzzy dating values of each cultural period and its respective time span evidenced by Class A surveys were selected and evaluated individually. Subsequently, the sum of all Boolean and fuzzy dating values ($SumDV_{tb}$) for each time block (tb) of each cultural period p_x was then derived. Each time block of each cultural period p_x thus received summed dating values.

The existence or frequency value f per time block (f_{tb}) of a cultural period p_x was then simply defined as the proportion of the summed dating values ($SumDV_{tb}$) from the total amount of sites evidenced for the given cultural phase. In other words, f_{tb} was calculated by dividing the result of $SumDV_{tb}$ multiplied by S_x (the one percent value of the total number of sites evidenced for a phase p_x):

$$f_{tb} = \frac{(SumDV_{tb} * S_x)}{100}$$

The existence or frequency values f_{tb} are basically dating probability values for each time block evidenced for a given cultural period p_x. These values are expressed by decimal numbers ranging between 0 (absolute certainty of non-existence) and 1 (absolute certainty of existence). The length or duration of a cultural period p_x was then simply defined as the maximal temporal range of f_{tb} values evidenced for each given period:

$$length\_p_x = max.temporal\ range\ (f_{tb})$$

Once the maximal temporal range of a given cultural period p_x is defined and the existence or frequency values f_{tb} are calculated for each time block, these values can be adopted as Boolean or fuzzy dating values for Class B survey data, which do not give any temporal information for cultural periods. These dating values must be assigned to each archaeological site evidenced by Class B surveys for each time block within the maximal temporal range of a given cultural period p_x. After this process is completed, all Class B dating values are summed together. The resulting summed dating values per time block of Class B surveys are subsequently added to the summed dating values per time block within the maximal temporal range of a given cultural period p_x of the Class A surveys. In order to receive the new existence or frequency values per time block (f_{tb}), the new summed dating values must then be multiplied by the new one-percent value S_x based on the new total amount of archaeological sites (including Class A and B survey data) evidenced for a given cultural period p_x. The results of each time block are then divided by 100 in order to receive new dating probability values per time block within the maximal temporal range of a given cultural period p_x based on both Class A and B survey data.

The theoretical background on how the chronological uncertainties were quantified and the dating probability values for the cultural periods calculated may appear daunting and immensely complicated at first. It therefore seems best to facilitate the understanding of the entire process by illustrating it with the example of the Nabataean period.[267]

In total, four Class A surveys predefined maximal time spans for the Nabataean period, altogether ranging from 100 BC to 324 AD (TABLE 4). These surveys are F. Abudanh's survey of the Udruh region, the FJHP, ARNAS and ShamAyl. [268] Abudanh defines the Nabataean period to run from 100 BC to 106 AD[269], the FJHP from 100 BC to 125 AD[270] and both ARNAS and ShamAyl from 63 BC to 324 AD (cf. FIG. 11).[271] Since the chronological definitions differ up to two centuries, a simple chronological sorting of the rele-

267 All analyses were mostly conducted with the use of the statistical computing software R. An exemplary script that highlights the workflow of the individual steps described here is included digitally as Appendix IV.

268 The large majority of sites documented by ARNAS are not within the study area. Since the definition of the Nabataean period by ARNAS differs so greatly from the other surveys, only ARNAS sites within the core study area were included into the calculation of the dating probabilities in order to minimize the temporal distortion of the Nabataean period.

269 Abudanh 2006, 201.

270 Silvonen 2013, 129–130. Originally, the Nabataean period was subdivided into "Nabataean B.C." and "Nabataean A.D." by the FJHP. As Silvonen 2013, 130, table 9 states, the latest date of "Nabataean A.D." is roughly set to the "early second century A.D." This, of course, is not a precise definition of an end date for the "Nabataean A.D." period. In contrast to statements such as "mid-2nd century A.D.," which corresponds to 150 AD, "early 2nd century A.D." might as well correspond to 125 AD (first quarter of the 2nd century AD). Realizing that this is an interpretation of the FJHP's original statement, 125 AD is nevertheless taken as the end date of the Nabataean period.

271 MacDonald et al. 2016, xvi; MacDonald et al. 2012, xvi.

vant archaeological sites is impossible. The Boolean and fuzzy dating values '0,' '0,5,' '1' were therefore assigned to each evidenced time block (decade) for all recorded sites of these four Class A surveys.

Taking the FJHP as an example, the decades 100 BC, 90 BC, 80 BC etc. until 120 AD all receive the Boolean dating value 1. In the event that a FJHP site would date to something similar to "*probably early second century AD*," the decades from 100 BC to 90 AD receive the Boolean dating value 0 (not evidenced) and only the decades 100 AD, 110 AD and 120 AD receive the fuzzy dating value 0,5.

After the dating values were assigned to all four Class A survey sites dating to the Nabataean period, the dating probability values for each evidenced time block (tb) within the total temporal range of the Nabataean period can be calculated.

Based on the time spans defined by all four Class A surveys, the maximal temporal range of the Nabataean period (p_N) is set between 100 BC and 324 AD. The sum of all Boolean and fuzzy dating values per time block ($SumDV_{tb}$) within that maximal temporal range can then be calculated (cf. TABLE 4). As 625 Class A survey sites are dated to the Nabataean period (p_N), the one percent value S_N is 0,16. The existence or frequency value for each evidenced time block (f_{tb}) is then calculated by multiplying the summed dating values of each time block by S_N and subsequently divided by 100:

$$f_{tb} = \frac{(SumDV_{tb} * 0,16)}{100}$$

The dating probability values of the four Class A surveys are now established for the Nabataean period for each time block within the maximal temporal range stated by the original survey reports. The values can then be taken as the Boolean of fuzzy dating values for Class B survey data, where sites are dated by non-defined cultural phases only. For the Nabataean period, these include the WMWS 1996 and 1998, the JSS and Smith's survey of the Wadi Arabah. In total, the inclusion of these Class B surveys adds another 107 sites to the total count of archaeological sites dating to the Nabataean period.[272] Following the same procedure as explained above, the sum of the Boolean and fuzzy dating values for the Class B surveys must be derived for all time blocks within the maximal temporal range of the Nabataean period (p_N) (100 BC–324 AD) and subsequently added to the sum of the dating values of the Class A surveys. The new summed dating values of each time block are then multiplied by the new one-percent value S_N being 0,1366 since the new total amount of sites has now risen to 732. Each result is then divided by 100, following the same formula as above. Based on both Class A as well Class B survey data, the existence or frequency value f per time block (f_{tb}) of period p_N is calculated and expressed in decimal numbers ranging from 0 and 1. A simple way of plotting these results, for example may be in form of simple bar charts or histograms (FIG. 12) showing the dating probability values on the y-axis, ranging from 0 to 1 (0% to 100%) and the single time blocks (decades) evidenced within the maximal temporal range of the Nabataean period (100 BC–324 AD) on the x-axis.

In order to create a quantified spatio-temporal dataset for the Petraean hinterland, this entire process was repeated for all evidenced cultural periods mentioned by the original survey reports. These include the following periods: Iron Age, Iron Age I, Iron Age II, Iron Age IIa, Iron Age IIb, Iron Age IIc, Iron Age III, Hellenistic, Early Nabataean, Nabataean, Late Nabataean, Early Roman, Roman, Late Roman Early Byzantine, Byzantine, Middle Byzantine and Late Byzantine.[273] The following presents the results of the dating probabilities calculated for each cultural period by Class A and B survey data. Probability graphs for each evidenced cultural period were created (FIGS. 13–18). These graphs are structured by superordinate cultural periods. Important features of these graphs are the dashed vertical lines that represent the limits of a more accurate definition of the respective periods based on the qualitative evaluation of the results presented below.

The Iron Age Periods

The Iron Age period is defined by Abudanh to run from 1200 BC to 539 BC.[274] Chronologically, the period is not differentiated further, but is equated with the Iron Age II and Edomite periods.[275] In contrast, both ARNAS and ShamAyl differentiate between Iron Age I (1200–1000 BC) and II (1000–539 BC).[276] Only the Edom Survey further subdivides the Iron Age II period into Iron Age II A–C (all three roughly defined between 700 and 500 BC).[277]

272 Tholbecq 2013a; Smith 2010; Tholbecq 2001; 'Amr et al. 1998; 'Amr et al. 1997.

273 Other cultural periods such as the Early Islamic, Middle Islamic, Late Islamic/Ottoman, Umayyad, Abbasid and 'Transitional periods' were also defined and recorded by the surveys. See Abudanh 2006, 222, 225, 229; Silvonen 2013, 130; Sinibaldi 2013, 169–197. However, these periods do not fall within the chronological focus of this study.

274 Abudanh 2006, 196.

275 Abudanh 2006, 196.

276 MacDonald et al. 2016, xvi; MacDonald et al. 2012, xvi.

277 Hart – Faulkner 1985, 256.

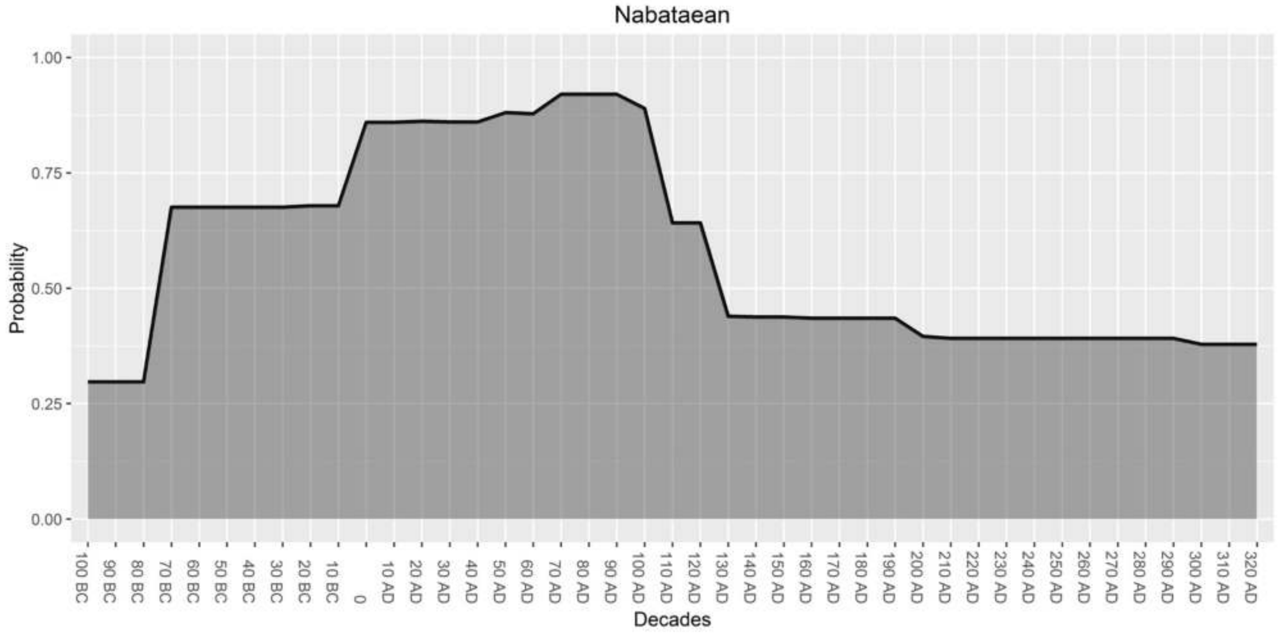


FIG. 12 Dating probability graph for the Nabataean period according to Class A and B survey data.

The Iron Age III period is synonymous with the Persian period for Abudanh (539–332 BC) and both ARNAS and ShamAyl follow the same definition for the Persian period. [278]

Including Class B survey sites, 24 sites date to the Iron Age period in total, without any further specification. The maximal temporal range runs from 1200 BC until the end of the 6th century BC. The high probability values along the entire temporal range as shown in the dating probability graph (FIG. 13) is not surprising as 22 sites are recorded by ShamAyl (Iron Age I and II defined to run from 1200 to 539 BC).

The Iron Age I period is attested by 22 sites. As these are all recorded by ARNAS and ShamAyl, the maximal temporal range from 1200 to 1000 BC as well as the high dating probability values is expected (cf. FIG. 13).

In contrast, 254 sites are evidenced for the Iron Age II period. The maximal temporal range is set between 1200 BC until the end of the 6th century BC. The high dating probability values between 1000 and the 530s BC comes as no surprise (cf. FIG. 13) as almost half of the evidenced sites were recorded by ARNAS or ShamAyl (Iron Age II defined to run from 1000 to 539 BC).

Merely three sites date to the Iron Age II A and B period while the Iron Age II C period is attested by 60 sites. The maximal temporal range of all three periods begins with the 7th century and ends with the beginning of the 5th century BC. All three Iron Age II periods are evidenced by the Edom Survey, explaining the constant dating probability of 100 % (cf. FIG. 13).[279]

Finally, only two sites are dated to the Iron Age III or Persian period, both of which were recorded by Abudanh.[280] This explains the stable probability of 100 % (cf. FIG. 13) throughout the entire maximal temporal range set between 539 and 332 BC.

The Hellenistic Period

The Hellenistic period is evidenced by only one site by both Abudanh and the WMWS 1996. Abudanh sets it to the first three and the WMWS 1996 to the first two centuries BC.[281] As the WMWS 1996, the JSS also sets the period to the first two centuries BC.[282] The FJHP limits it to the 1st century BC and ARNAS as well as ShamAyl set it between 332 and 63 BC.[283]

Including Class B survey sites, 42 sites date to the Hellenistic period. Although the maximal temporal range is defined as the first three centuries BC, the dating probability graph (FIG. 14) shows a very small probability for Hellenistic sites dating to the first half of the 4th century BC as well as the second half of the 1st century BC. The highest probability (between

278 Abudanh 2006, 198; MacDonald et al. 2016, xvi; MacDonald et al. 2012, xvi.
279 Hart 1987a.
280 Abudanh Survey Site No. 047 and 138.
281 Abudanh 2006, 567; ʾAmr et al. 1998, 529.
282 For example JSS Site No. 117: unpublished survey catalog kindly provided by of L. Tholbecq.
283 Silvonen et al. 2013, 373: FJHP Site No. S085 actually states "Late Hellenistic." For the definitions provided by ShamAyl and ARNAS, see MacDonald et al. 2016, xvi; MacDonald et al. 2012, xvi.

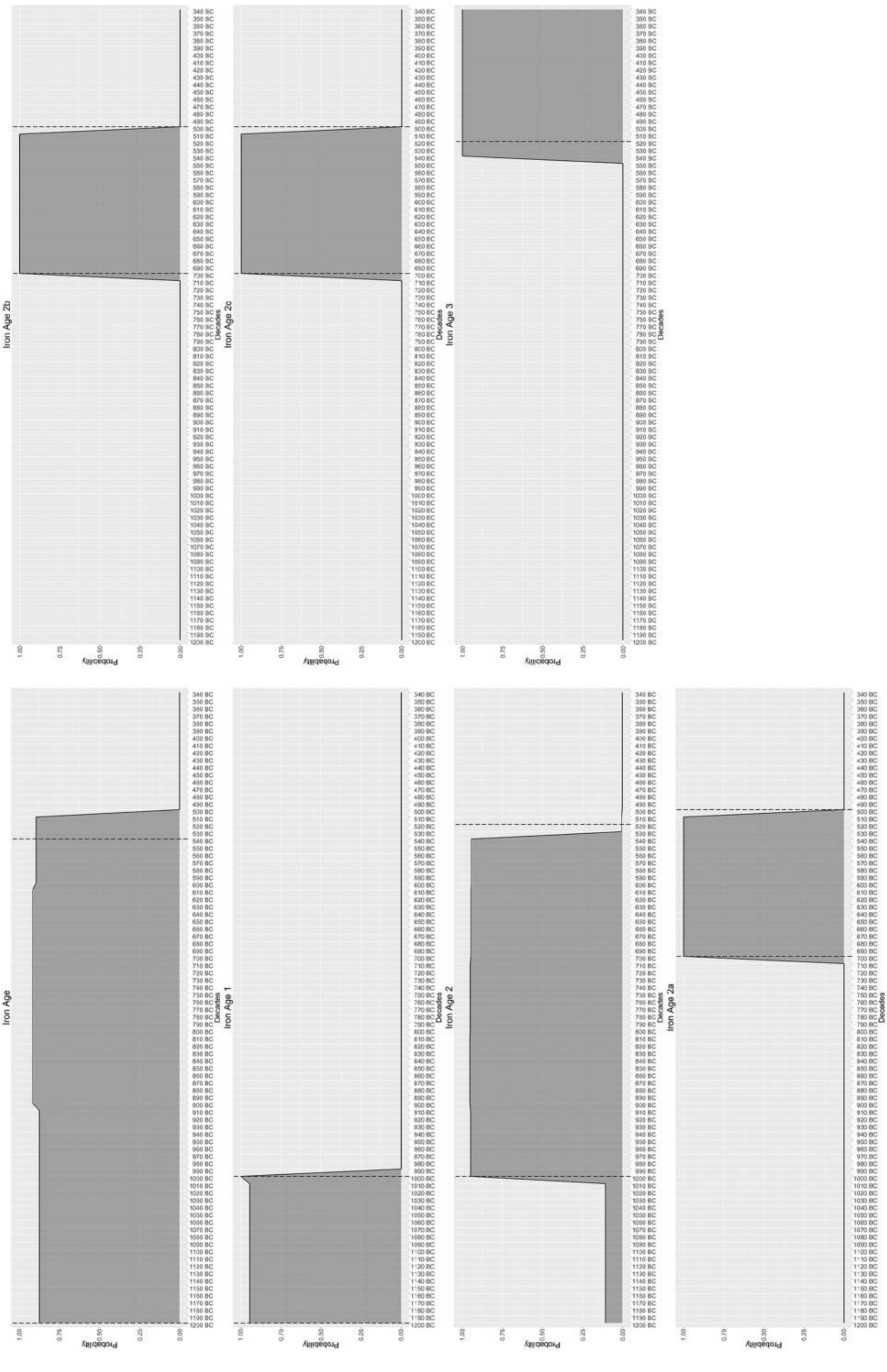


FIG. 13 Dating probability graphs of all Iron Age periods according to Class A and B survey data.

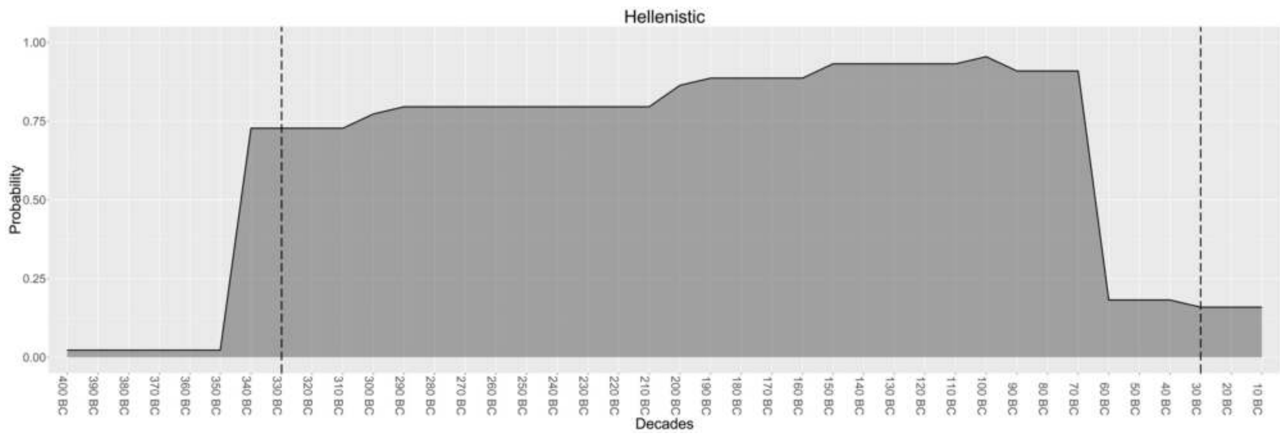


FIG. 14 Dating probability graph of the Hellenistic period according to Class A and B survey data.

approx. 75 and 90 %) falls between 340 and 60 BC. While the starting date of these high probability values corresponds well with the conventional dating of the Hellenistic period beginning with the death of Alexander the Great in 323 BC, the end date is due to the high amount of ARNAS and ShamAyl sites (combined 79 %), where the Hellenistic period is defined to end at 63 BC. Although the authors do not present an argument for this precise date, it may be associated with the military campaigns of Pompey in the Near East.[284]

The Nabataean Periods

Abudanh defines the Nabataean phase to run between 100 BC and 106 AD.[285] The FJHP defines it to run from 100 BC to 125 AD.[286] Without offering any further definitions, Abudanh also dates sites to the Late Nabataean period.[287] It was therefore necessary to artificially define this period in order to incorporate it into the study: Sites dated to the Late Nabataean period by Abudanh were assigned the dating value 1 for the 1st century AD and the fuzzy dating value 0,5 for the 2nd century AD. ARNAS and ShamAyl do not differentiate the Nabataean from the Roman period and set both periods to run from 63 BC to 324 AD.[288] The only recorded site dating to the Early Nabataean period was documented by the WMWS 1996, which set the phase to the first two centuries BC.[289] Since only the one site is evidenced for the Early Nabataean period (the maximal temporal range covering the first two centuries BC), it is not surprising that the dating probability shows a constant 100 % (cf. FIG. 15). However, with only one evidenced site, this period is negligible. As Abudanh, the WMWS 1996 distinguished a Late Nabataean phase as well, which they defined to run from 170 to 320 AD.[290]

With 732 evidenced sites (including Class B survey sites), the Nabataean period represents the most evidenced cultural phase. The maximal temporal range runs between 100 BC and the 320s AD. As shown in FIG. 15, the dating probability is relatively low during the first three decades of the 1st century BC. The dating probability suddenly rises up to almost 70 % during the 70s BC. The probability values continue to climb during the first half of the 1st century AD and peak around 70 AD. With the turn of the century, however, there is a sudden drop, eventually stagnating shortly below 40 % by the 3rd century AD. The observed drop during the beginning of the 2nd century AD correlates with the Roman annexation of the Nabataean realm in 106 AD, but the continuation of the Nabataean period into the 4th century AD seems highly unlikely. This is due to the relatively high number of sites recorded by ARNAS and/or ShamAyl (38 % combined), where the Nabataean period (as well as the Roman period) runs from 63 BC to 324 AD.[291] However, the irregularity of such a dating of the Nabataean period is shown by the expected drop at the beginning of the 2nd century AD marking the more commonly assumed end of the Nabataean period. This is highlighted by the dashed line in the dating graph. The probability values for the Nabataean period after the first quarter of the 2nd century AD must be considered highly critically.

In total, the Late Nabataean period is evidenced by only ten sites. The maximal temporal range runs from the beginning of the 1st century AD and ends in the 320s AD. The relatively high dating probability in the 1st cen-

284 Bowersock 1983.
285 Abudanh 2006, 201.
286 Silvonen 2013, 129–130. On the FJHP's subdivision of the Nabataean period into “Nabataean B.C.” and “Nabataean A.D.,” see n. 270.
287 See e.g. Abudanh Survey Site No. 063.
288 MacDonald et al. 2016, xvi; MacDonald et al. 2012, xvi.
289 ʾAmr et al. 1998, 529: WMWS 1996 Site No. Wadi Musa 23.
290 ʾAmr et al. 1998, 535: WMWS 1996 Site No. Tayyiba 12.
291 MacDonald et al. 2016, xvi; MacDonald et al. 2012, xvi.

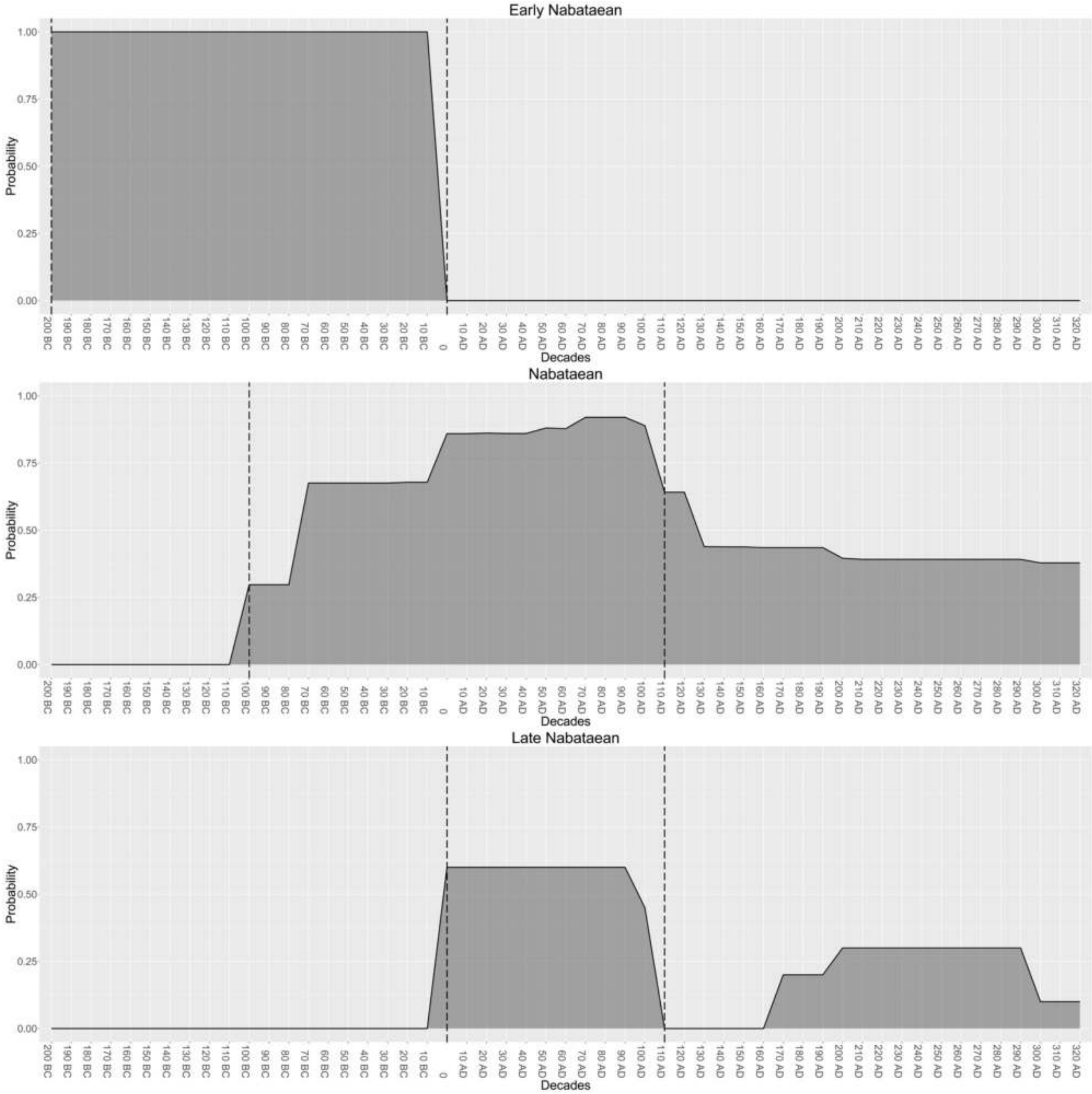


FIG. 15 Dating probability graphs of the Nabataean periods according to Class A and B survey data.

tury AD (approx. 60 %) corresponds well with the decades shortly before the Roman annexation in 106 AD (FIG. 15), but the probability values for the 2nd to early 4th centuries can only be explained by the dating irregularities of the surveys (being Abudanh and WMWS 1996). This assumption is supported by the sudden drop during the end of the 1st century AD, after which no sites are evidenced for half a century. Particularly concerning the Late Nabataean period, it is interesting to note the complete overlap with the Nabataean period. FIG. 16 shows the Nabataean period defined by WMWS 1996 (light grey) and the Late Nabataean period as defined by Abudanh (dark grey). Due to this particularly high degree of temporal overlap, the qualitative value of the Late Nabataean period is limited.

The Roman Periods

Abudanh sets the Roman period between 106 and 324 AD.[292] Without defining them further, he dates sites to the Early and Late Roman periods as well.[293] Again, it was therefore necessary to artificially define these

292 Abudanh 2006, 208.

293 As an example for the Early Roman period, see Abudanh Survey Site No. 026. For the Late Roman period, see Abudanh Survey Site No. 002.

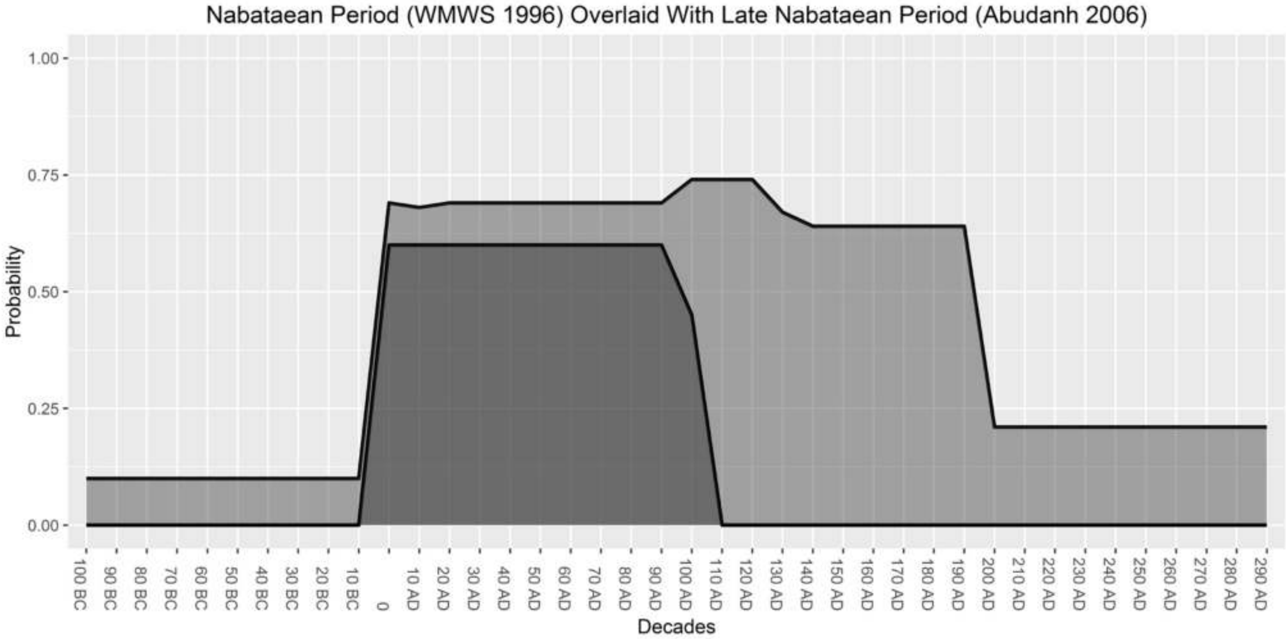


FIG. 16 Temporal overlap between the Nabataean period as defined by WMWS 1996 (light grey) and the Late Nabataean period as defined by Abudanh 2006 (dark grey).

periods in order to incorporate them into the larger study. Abudanh's Early Roman sites were thus assigned the dating value 1 for the 2nd century AD and the fuzzy dating value 0,5 for the 3rd century AD. Sites dated to the Late Roman period were assigned the dating value 1 for the 4th century AD and the fuzzy dating value 0,5 for the 3rd century AD. The FJHP only acknowledges the Late Roman period, which is set between 150 and 300 AD.[294] Although ARNAS and ShamAyl do not differentiate between the Nabataean and Roman periods, they do distinguish between Early and Late Roman. Both surveys set the Early Roman period between 63 BC and 135 AD, and the Late Roman period between 135 and 324 AD.[295]

Including Class B survey sites, only 18 sites date to the Early Roman period. The maximal temporal range is set between 70 BC and the last decade of the 3rd century AD. Due to the unconventional dating of the period by ARNAS (see above) as well as two sites recorded by Smith's survey of the Wadi Arabah, FIG. 17 shows a very small probability for Early Roman sites dating between 70 BC and 100 AD.[296] Corresponding with the Roman annexation of the Nabataean realm in 106 AD, the highest probability (85 %) is set during the 2nd century AD. The relatively high probability for the Early Roman period dating to the 3rd century AD is due to the large amount of sites recorded by Abudanh (89 % of all Early Roman sites).[297] As Abudanh does not give a definition for this period and the dating values were assigned subsequently and artificially, the high probability of the Early Roman period dating to the 3rd century AD must be considered critically.

In total, the Roman period is evidenced by 485 sites. The maximal temporal range runs from 63 BC to the end of the 4th century AD. While dating probabilities for the first centuries BC and AD remain stable around 62 %, a sudden rise up to almost 100 % can be observed with the beginning of the 2nd century AD (cf. FIG. 17). High probability values above 87 % remain until the first quarter of the 4th century AD, when the dating probability reaches almost 0 around 320 AD. Again, the rise in the dating probability can be associated with the Roman annexation of the Nabataean realm and the drop after 320 AD corresponds with the conventional beginning of the Byzantine period at 324 AD. The lower dating probability from 70 BC to 100 AD is explained by the relatively high amount of sites recorded by ARNAS and/or ShamAyl (61 % combined), which defined both the Roman and Nabataean periods to run from 63 BC to 324 AD.[298] However, the irregularity of such a dating of the Roman period is shown by the expected rise at the beginning of the 2nd century AD. Therefore, the probability values for the Roman period before the

294 Silvonen 2013, 129–130. Silvonen 2013, 129 mentions that this period is synonymous with the so-called "Nabataean-Roman" period.
295 MacDonald et al. 2016, xvi; MacDonald et al. 2012, xvi.
296 Smith 2010, 75 and 76: BMP/CAS Site Nos. 016 and 019.
297 In total, Abudanh dates 238 sites to the Early Roman period.
298 MacDonald et al. 2016, xvi; MacDonald et al. 2012, xvi.

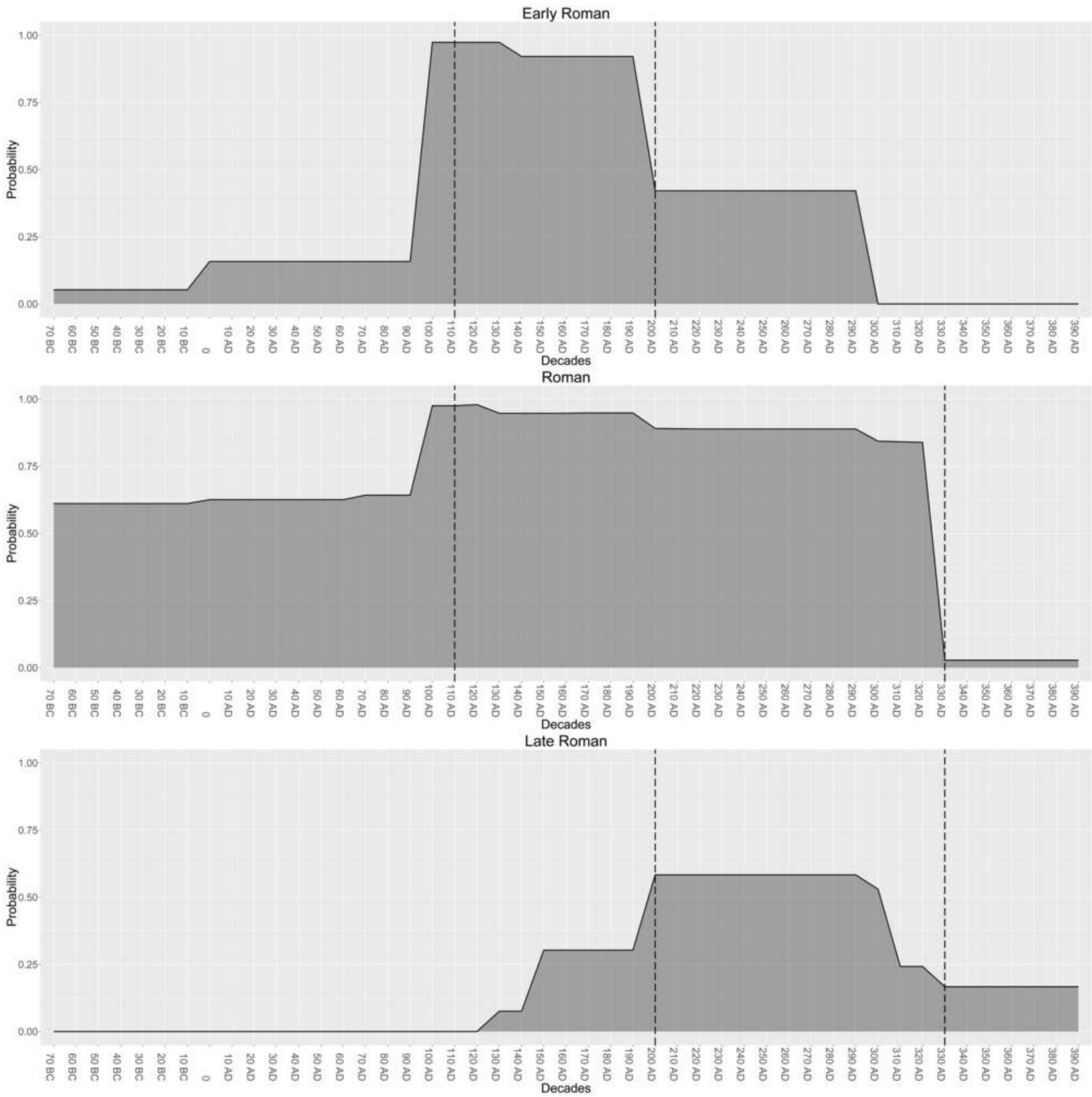


FIG. 17 Dating probability graphs of the Roman periods according to Class A and B survey data.

first quarter of the 2nd century AD must be considered highly critically as indicated by the dashed line in the probability graph.

Overall, 66 sites date to Late Roman period. The maximal temporal range runs from 130 AD to the end of the 4th century AD. The dating probability rises with the beginning of the third century AD and remains stable during the entire course of the century (cf. FIG. 17). The probability values drop again during the first quarter of the 4th century AD. This may correspond to the conventional beginning of the Byzantine period in 324 AD.

The Byzantine Periods

For Abudanh the Byzantine period is set between 324 and 636 AD.[299] Without giving any further definitions, he also dates sites to the Early, Middle and Late Byzantine periods.[300] As for the Late Nabataean, Early and Late Roman periods, it was therefore necessary to artificially distinguish these periods in order to incorporate them into the larger study. For sites dating to the Early Byzantine period, the dating value 1 was assigned for the 4th century AD and the fuzzy dating value 0,5 for the 5th century AD. Abudanh's sites dating

299 Abudanh 2006, 215.

300 See Abudanh Survey Site No. 002 as an example for a site to the Middle Byzantine period were assigned the dating value 1 for the 5th century AD and the fuzzy dating value 0,5 for the 6th century AD. Sites dated to the Late Byzantine period were assigned the dating value 1 for the 7th century AD and the fuzzy dating value 0,5 for the 6th century AD. The FJHP also divides the Byzantine period (generally running from 375 to 525 AD) into 'Early Byzantine' (300–400 AD) and 'Late Byzantine' (525–625 AD).[301] ARNAS and ShamAyl do not further divide the Byzantine period, thus dating the entire phase between 324 and 640 AD.[302]

Including Class B survey sites, 23 sites date to the Early Byzantine period. The maximal temporal range is set between 300 and the last decade of the 5th century AD, although the dating probability graph shows a very small probability for Byzantine sites dating to the 5th century AD and a very high probability (85 %) for sites dating between 300 and 390 AD (FIG. 18).

Only one site is dated by Abudanh to the Middle Byzantine period. Since the Boolean values for this period were artificially assigned, the constantly high dating probability is no surprise (cf. FIG. 18). With only one evidenced site, however, this period is negligible.[303] It appears that the Middle Byzantine period is an individual and unique chronological distinction by Abudanh without any further historical roots, which gives even more reason to neglect this cultural period and rather count the one evidenced site to the general Byzantine period as defined by the probability graph.[304]

With 574 evidenced sites, the Byzantine period is the second most evidenced cultural phase after the Nabataean period. The maximal temporal range is set between 300 and the 640's AD. The dating probability graph shows a very small probability for Byzantine sites dating to the first two decades of the 4th century AD and a very high probability (85 %) for sites dating between 320 and 630 AD.

Including Class B survey sites, only 39 sites date to the Late Byzantine period. The maximal temporal range is set between 400 AD and the 630's AD. The high amount of Late Byzantine sites is recorded by Abudanh (87 %), which most likely explains the sudden rise of the dating probability values towards the end of the 6th century AD. However, as Abudanh does not give a definition for this period and the dating values were assigned subsequently and artificially, the rise of the dating probability in the 7th century AD must be seen critically.

Quantifying Chronological Uncertainties – A Discussion

The seemingly immense effort to quantify the inherent chronological inconsistencies within the original survey data may raise questions on the meaningfulness of the methodology. Particularly in landscape archaeological studies, the application of interdisciplinary and scientific research methods are on the rise. By appropriating such investigative approaches, archaeological research studies are treated as exact sciences – which they are not. Archaeological datasets are always biased by the original surveyors' theoretical background, their understanding of chronological and archaeological site definitions and the provided archaeological information is often prone to problematic site identifications.

With this in mind, by quantifying the chronological inconsistencies inherent to the original survey data, it was possible to develop a rigidly structured spatio-temporal dataset of archaeological sites within the Petra area. Based on the process of calculating the degree of chronological uncertainties for each evidenced cultural period, the differing chronological systems of the various surveys were brought into a uniform format. Each cultural period is now defined by the dating probability values for each decade within the maximal temporal time span of a given cultural period. Alternatively, it would have been possible to simply develop an independent chronological system and attempt to fit the original survey data into that system. However, this would have only added yet

dating to the Early Byzantine period. For a site dating to the Middle Byzantine period, see Abudanh Survey Site No. 089 and for a site dating to the Late Byzantine period, see Abudanh Survey Site No. 017.

301 Silvonen 2013, 130. Similar to the FJHP's definition of "Nabataean A.D" where the latest date is simply defined as the "early 2nd century," the Byzantine period is defined as the "late 4th to early 6th century" (Silvonen 2013, 130, table 9). As the definition of "early 2nd century" was interpreted here as the first quarter of the 2nd century (125 AD), "the late 4th century" was understood as the last quarter of the 4th century (375 AD) and the "early 6th century" as the first quarter of the 6th century (525 AD). According to the FJHP, the Late Byzantine period is defined as "in the course of the 6th century to the early 7th century" (Silvonen 2013, 130, table 9). Presumably, this corresponds with the end of the FJHP's Byzantine period, thus at 525 AD. The "early 7th century" was defined as the first quarter of the 7th century (625 AD).

302 MacDonald et al. 2016, xvi; MacDonald et al. 2012, xvi.

303 In fact, the 'Middle Byzantine period' as a chronological distinction is widely uncommon for the Levant. Dealing with the history of the entire Byzantine Empire (306–1453 AD), T. E. Gregory defines the Middle Byzantine period between 717 and 1204 AD (Gregory 2005, 367). A similar classification is also given by Shepard 2008, 30 for the "Middle Empire," set between c. 700 and 1204 AD. A. Cameron does not distinguish between cultural periods and holds to historical events only (Cameron 2006, 199–206). Specifically dealing with the Byzantine period in the Near East, Kennedy 2006 gives no detailed information on different periodizations.

304 Cf. also the full temporal overlap shown in fig. 18.

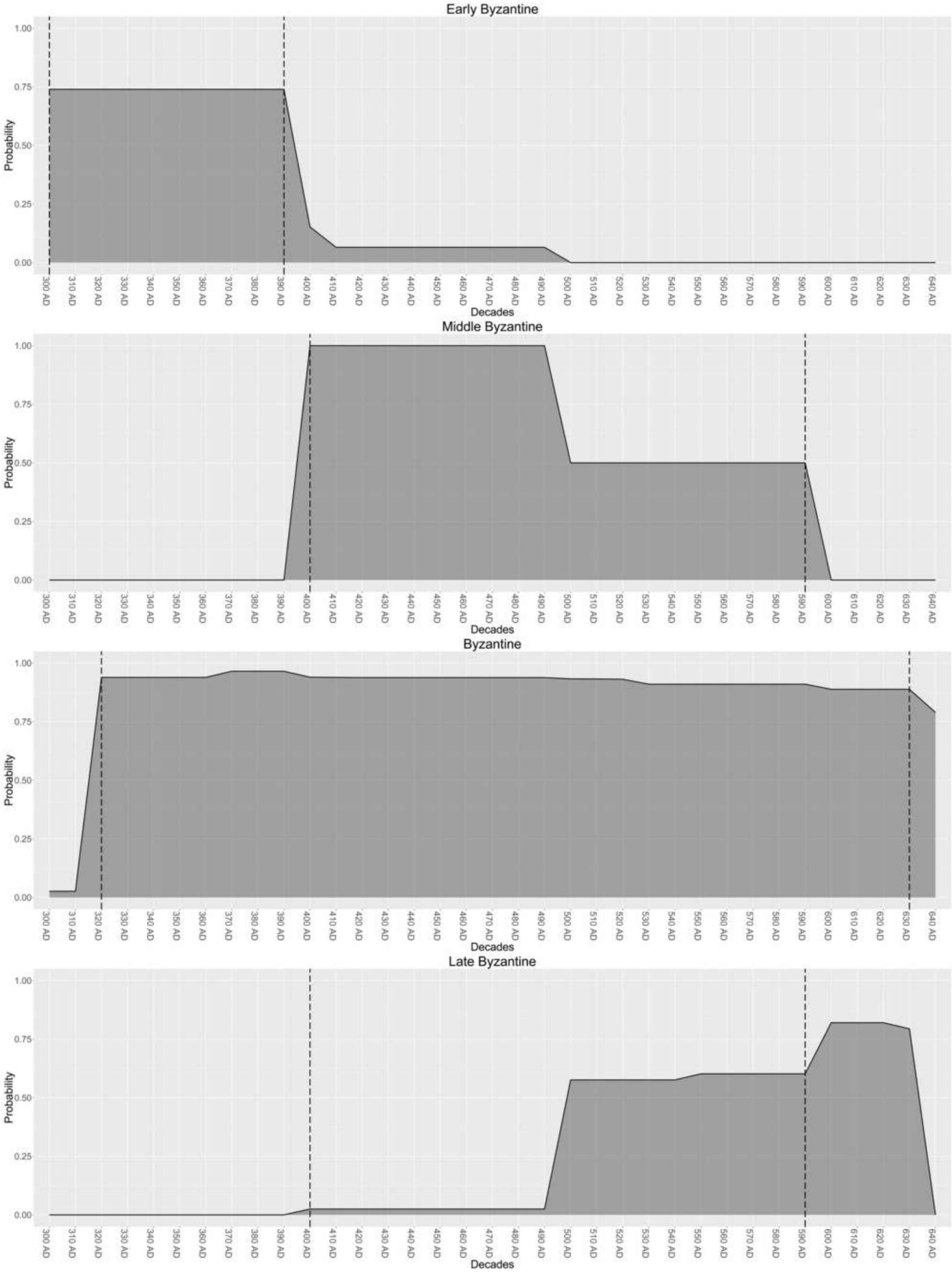


FIG. 18 Dating probability graphs of the Byzantine periods according to Class A and B survey data.

another differing chronology and such an approach would not only fail to solve the issue of chronological inconsistencies within the original data, it would only add to the problem at hand.

While that may be correct, the presented probability graphs shall not be misunderstood as a rectification of unclear chronological definitions, but more as representations of the chronological biases inherent to the base dataset of this study. The dating probability graphs of some cultural periods may even seem historically imprecise or chronologically distorted. A good example is the Nabataean period that ranges from the 1st century BC to the 3rd and early 4th centuries AD, which is, of course, historically false. However, as such outliers were inherent to the original survey data, they are represented in the probability graphs. It is therefore crucial to adopt the dating probability graphs critically and acknowledge the chronological inconsistencies inherent to the original data. Also, the informative value of the graphs varies when considering the differing amount of sites: The maximum amount of dated sites belongs to the Nabataean period (732), while the least evidenced cultural periods are the Early Nabataean and Middle Byzantine periods with only one count each. From all datable sites, 59,90 % date to the Nabataean period, while only 0,08 % to the Early Nabataean and Middle Byzantine periods. This also has to be considered when evaluating the results presented here.[305]

Nevertheless, the dating probability graphs simply define the various periods as they were evidenced by the original survey data. The graphs do not represent an absolute definition of chronological periods, but visualize the chronological inconsistencies and temporal uncertainties inherent to the original surveys. The problematic chronological information is thus made transparent. Furthermore, the dashed lines in the graphs also show the limits of the qualitatively more accurate time spans of each cultural period highlighting the inconsistencies inherent to the original data even more. Any reference to cultural periods in the following chapters are therefore based on the presented probability graphs since these represent the (quantified) chronological information provided by the original base data.

A further advantage of this quantification attempt is that the examined archaeological sites can now be filtered both by cultural periods as well as by absolute time blocks in a methodologically responsible manner. However, sorting by cultural periods is problematic. For example, if one would like to consider all sites evidenced for the Nabataean period, one would receive sites dating from the 1st century BC to the early 4th century AD. Actual temporal contemporaneity of sites is therefore neglected. Also, 'Nabataean' sites dating to the 1st century BC, but not to the 1st century AD could only be filtered with great difficulties. More importantly, the temporal range of cultural periods as defined by the dating probability graphs is not necessarily historically accurate. Sorting sites by cultural periods are therefore likely to result in a historically distorted archaeological model of the Petraean hinterland. This raises the question of what the most appropriate method is to visualize the temporal uncertainties on an archaeological site distribution map.

Several suggestions for visualizing temporal uncertainties of archaeological sites were already made.[306] Following Bevan et al., the most straightforward way for presenting site distributions according to the dating probabilities of a specific cultural period is to classify sites by certain dating percentages.[307] As an example, a site distribution map was created for the Nabataean period showing the different dating probabilities of sites within that cultural phase (FIG. 19).

Based on the probability values shown in the dating probability graph of the Nabataean period (cf. FIG. 12), sites were classified according to percentage cut-offs for dating probabilities between ≥ 25 % and < 50 % (represented in dark grey), ≥ 50 % and < 75 % (represented in grey) and ≥ 75 % (represented in light grey). While this map visualizes the dating uncertainties for the Nabataean period well, it includes sites that are evidenced from the 1st century BC to the 2nd century AD and therefore neither represents chronological continuities, nor actual contemporaneity of sites. It is not possible to map the actual dating of the individual Nabataean sites.

305 One could experiment with different weighting of the percentage values of the various cultural periods in order to account for these variances. However, this goes beyond the scope of this study and the resulting differences are expected to be minimal. Also, when expressing the amount of sites evidenced per cultural period as percentage values from all datable sites, it is possible to define a range of informative value: cultural periods evidenced only between 0,08 and 1,47 % can be deemed informatively negligent. Cultural periods evidenced between 1,80 and 5,40 % may have "little" informative value. Cultural periods evidenced between 20 and 30 % are "acceptable" and periods between 30 and 50 % "good." Periods evidenced by over 50 % can be referred to as "excellent." Hence, the periods Early Nabataean, Middle Byzantine, Iron Age 3, Iron Age 2a and b, Late Nabataean and Early Roman belong to the class "negligent." The cultural periods Iron Age 1, Early Byzantine, Iron Age, Late Byzantine, Hellenistic, Iron Age 2c and Late Roman belong to class "little." Iron Age 2 is "acceptable." The Roman and Byzantine periods are "good" and the Nabataean period "excellent."

306 Bevan et al. 2013b, 45, fig. 9; Bevan et al. 2013a, 318, fig. 2; Nakoinz 2012, 203–205, Abb. 8.

307 Bevan et al. 2013a, 317.

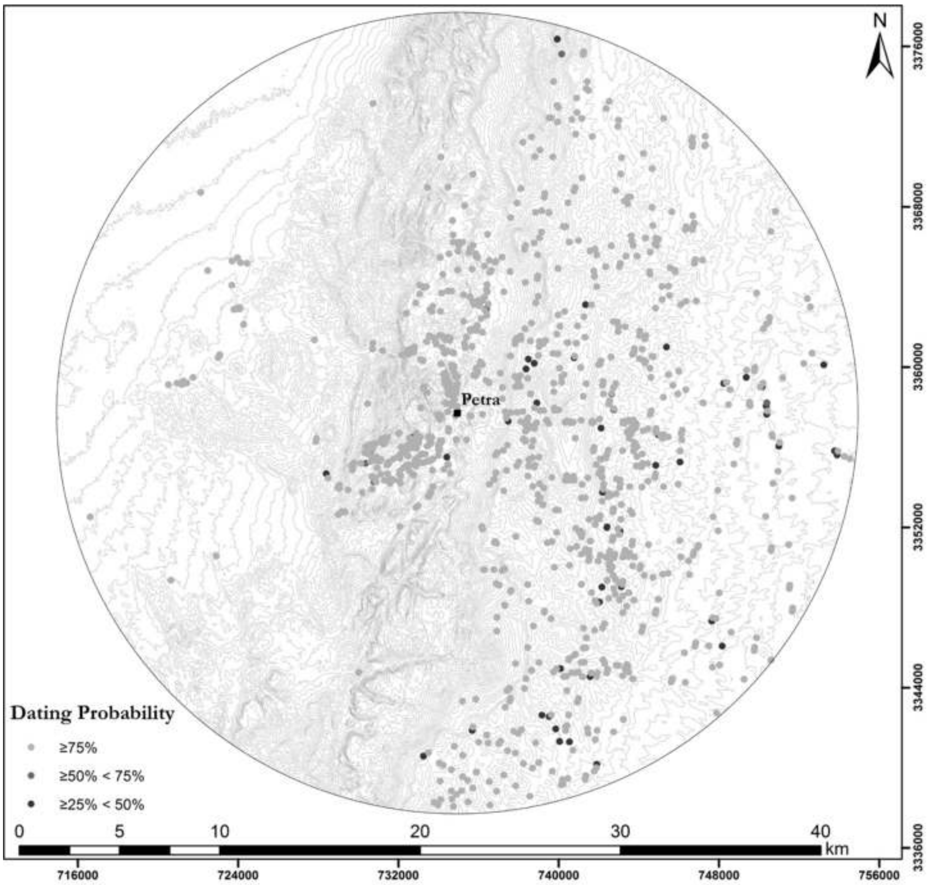


FIG. 19 Distribution map of sites in the Petra area dating to the Nabataean period based on the dating probability values. Sites classified according to percentage cut-offs for their dating probabilities are represented in different shades of grey.

This is a general problem when studying the spatial distribution of sites based on cultural periods.

Sorting archaeological sites by absolute time blocks is therefore far more appropriate. Such an approach is not concerned with historical accuracy of cultural periods, since it simply filters sites according to their actual dating. It is more advantageous to break the chronological information of cultural periods into absolute time blocks. By structuring site distribution maps by centuries for example, contemporaneity and chronological continuities of sites are far easier to visualize. Different site types of the same date can be displayed as well, which is not possible with distribution maps showing the temporal uncertainties of cultural periods. Thus, such century-based visualizations of the spatio-temporal dataset of the Petraean hinterland form the visual basis for conducting further analysis on the spatial patterns of the evidenced sites through time.

However, one issue concerning site contemporaneity still remains: While breaking cultural periods back into smaller time spans (e.g. in centuries), the resulting site distribution maps display all sites that date into the time span of interest. This gives the impression that these sites date into that period with absolute certainty. However, as clearly demonstrated, many sites documented by the original surveys in the Petra area cannot be dated with absolute certainty. In order to represent this dating uncertainty in century-based archaeological site distribution maps, sites that cannot be dated with certainty into a given century (thus 'fuzzy sites') could therefore be represented slightly transparent in the distribution maps. However, this would have required an extraordinary effort in creating the numerous distribution maps, which was not realistic within the scope of this study. The site distribution maps should therefore be considered with some caution. The critical reader further interested in the dating certainty of particular sites may consult the site catalogue (Appendix I), which lists all dating values for each site.

Spatial Analyses – A Methodological Overview

After the critical presentation of the re-evaluation of the archaeological core dataset, this section offers a critical methodological overview of the spatial analyses applied in this study. These landscape archaeological approaches include point pattern analyses, cost-surface analyses and visibility analyses.

Point Pattern Analysis

As G. M. Findlater stated in relation to his study of Roman military sites in southern Jordan, "[…] *the identification of patterning in the archaeological record is fundamental to the analysis of sites in the landscape.*"[308] Indeed, the observed patterns may reveal important insights into the potentially various reasons for past human settlement behavior. The distribution of archaeological sites may have been impacted by cultural factors, environmental constraints and influences, or a combination of both. Alternatively, site distributions do not follow any larger explanatory models and site locations were selected completely randomly.

Numerous studies have attempted to research the various reasons for the particular distribution of archaeological sites in various regions and time periods. As these studies are often dealing with large quantities of (spatial) data, the rise of statistical analyses and GIS-based methods in the 1980s, particularly within the emerging field of landscape archaeology, has provided archaeologists with another valuable toolset for further investigating archaeological site patterns. Despite this development, however, many archaeological studies concerned with the evaluation of site patterns are still often based on very general and simplistic assessments, and thus offer only limited insights into the often complex interaction of cultural and/or environmental factors that impacted the recorded site pattern.[309]

However, a particular method derived from the field of spatial statistics is currently on the rise and is being increasingly applied by modern landscape archaeological studies.[310] This method is known as *point pattern analysis* (PPA) and is dedicated to objectively delineate, characterize and evaluate explicit processes that may have caused particular spatial distributions of archaeological sites (or more generally expressed: *points*). The main principle of the method is fairly straightforward: As with other statistical analyses, PPA determines whether a set of points deviates from a specific distribution pattern. PPA characterizes the simplest possible set of spatial data (e. g. archaeological sites) distributed across a spatial environment or region. The method is a useful tool for describing the spatial processes that caused the patterns of sites within that predefined spatial environment *quantitatively*. It assists in evaluating whether a specific point cluster can be identified or whether points are evenly distributed. Based on the PPA results, it is possible to discuss patterns of archaeological sites on a quantitative and empirical basis. PPA is therefore a valuable tool in further assessing the reasons behind particular site patterns in the Petraean hinterland.

Determining the study area can have a significant effect on the resulting PPA, as an analysis of the same point pattern may lead to completely different results when placed in a different study area. For example, the defined study area in this case is set at a 20 km radius around Petra. While this remains a good delimitation for this study, the 20 km radius cuts the Petra area artificially and documented survey data outside the study area is excluded from the analysis. This well-known challenge, commonly referred to as the *edge effect*, should be considered when interpreting PPA results.[311]

In conducting PPA, the aim is first to determine whether the spatial distribution of points shows a *random point pattern* or a *structured point pattern*. Random point patterns are independent from spatial influences, therefore undergoing non-spatial processes and indicating that the pattern follows an individual distribution process (or none). In such cases, *complete spatial randomness* (CSR) applies and the pattern has undergone an *independent random process* (IRP).[312] If CSR prevails, this means that every point has an equal probability of being placed in any position within the predefined region. CSR thus attests to a complete spatial independence of the points from each other, i. e. the position of any point is completely independent of the position of another point. When the density function of the pattern is constant, this is referred to as a stationary point pattern; an additional indicator for CSR. In the case of a stationary point pattern process being identical in all spatial directions (isotropic), it is referred to as a homogeneous point process. This signifies CSR as well. Therefore, stationary *Poisson* point pattern processes are taken as reference models in order to test for CSR.[313]

308 Findlater 2002, 139.

309 Cf. e. g. Nakoinz – Knitter 2016, 1–3 ; Keron 2015, 2–4; Knitter et al. 2014, 107–108; Amirkhiz et al. 2009, 261 and van Leusen 2002, chapter 1, 2–3.

310 See e. g. Nakoinz – Knitter 2016, 129–147; Keron 2015 or Knitter et al. 2014.

311 O'Sullivan – Unwin 2010, 123, 137–139 state that a very straightforward way to counter edge effects is by including a kind of buffer or guard zone around the edges of the actual study area and, in a second test-run, include sites within that buffer zone as well. However, they also refer to an empirical study that researched how such corrective measures against the edge effect affected the results of the K-function (more below). They conclude that "[…] *if the analysis is largely descriptive, to detect and characterize an observed pattern rather than to estimate parameters of a specific hypothesized point process, there is little point in using any of these corrections*" (O'Sullivan – Unwin 2010, 139). For more on the edge effect, see also Keron 2015, 18.

312 Baddeley et al. 2016, 132–137; Keron 2015, 23; Knitter et al. 2014, 112.

313 Baddeley et al. 2016, 129–139, Baddeley et al. 2016, 299–304; O'Sullivan – Unwin 2010, 105–106. A Poisson distribution is a discrete probability distribution express-

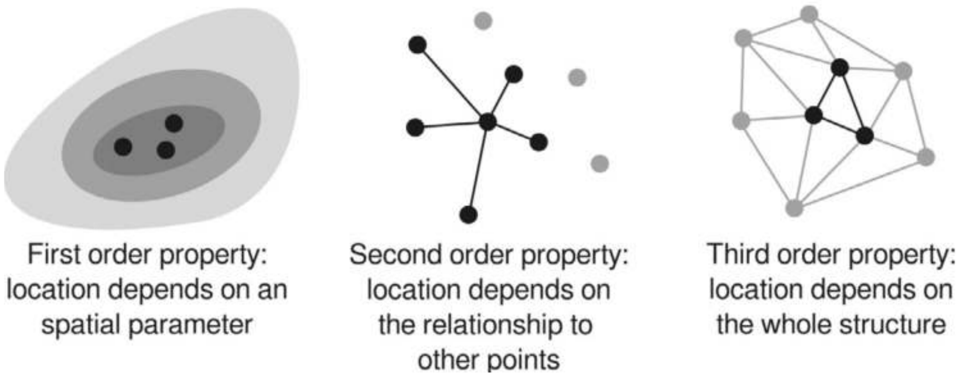


FIG. 20 First-, second- and third-order effects of point patterns after Nakoinz – Knitter 2016, 130, fig. 7.1.

In contrast, *structured point patterns* are influenced by spatial factors, other points or more complex spatial structures. Spatial or natural factors include natural landscape conditions such as topography, geology, water courses etc., which are referred to as *covariates*.[314] Structured point patterns contradict CSR conditions. The dependency of point patterns on spatial or natural factors (or any covariate) is referred to as *first-order effects or properties*, i. e. the probability of a point being influenced by such spatial or natural factors and not by other events in the pattern (FIG. 20). When evaluating such first-order effects, the point *density* (or intensity) is investigated.[315]

If a point pattern is influenced by points, this signifies a *second-order-effect*.[316] If the pattern reflects second-order properties, points within a pattern are dependent on each other and interact spatially. The probability that a point is positioned somewhere in the predefined region and influenced by the position of other points within the same pattern is high. When evaluating such second-order effects, the *distance* between points is investigated.[317]

Conducting Point Patten Analysis

To explain the different steps of how to conduct point pattern analysis, this section takes settlement sites (independent of subcategories) recorded in the Petraean hinterland and dating to the 1st century AD as a test dataset.[318] Prior to beginning the PPA, all settlement sites within the core study area are plotted and simple measures are calculated. These include the mean center of the settlement pattern, the standard distance between the points (measured in meters) and the overall, or global, intensity of the pattern. FIGURE 21 shows the study area with all settlement sites dating to the 1st century AD with the mean center of the point pattern marked by the cross. The radius of the circle around the mean center equals the calculated standard distance between all settlement sites, which is 10146,59 m (10,15 km). These very simple measures belong to the method of *centrography* and can be particularly useful for researching changes in the point pattern over time. However, centrography does not yield any detailed information on the character of the pattern itself. It is not possible to detect potential first- or second-order properties in the pattern.[319] Instead, density-based approaches can help describe first-properties.

First-Order Properties

After conducting simple measures of centrography, the next step involves the further calculation of intensity values, i. e. *global* and *local intensities*.[320] The *global intensity* ($\hat{\lambda}$) assesses the number of points per square kilometer by dividing the total amount of points (n)

ing the probability of a specific number of points (events) occurring in a fixed interval of space assuming that these points are distributed at a known average rate and that they are independent of other points. In PPA, the Poisson distribution evaluates the total *intensity* given by the average number of points within pre-defined quadrats laid over the study area (see below). In contrast to a binominal probability distribution, where the probability values are based on the area of quadrats relative to the location in the study region and the total number of points in the pattern, Poisson distributions correspond to the "[…] *classical law of the frequency of rare events*"(Baddeley et al. 2016, 135).

314 Baddeley et al. 2016, 8–10, 177–188.

315 Keron 2015, 17, 18–19; O'Sullivan – Unwin 2010, 124.

316 See e. g. Keron 2015, 18, 19.

317 Additionally, if a pattern shows a dependency on more complex spatial structures, this is commonly referred to as *third-order effects or properties*. According to Nakoinz – Knitter 2016, 144, by evaluating third-order effects, the spatial interaction between point *triples* is researched (by the so called T-function). As these are not directly evidenced in this study, third-order properties will not be considered.

318 All PPAs were conducted with the use of the statistical computing software R. An exemplary script that highlights the workflow of the individual steps described here is included in Appendix II.

319 O'Sullivan – Unwin 2010, 125–126.

320 Baddeley et al. 2016, 149.

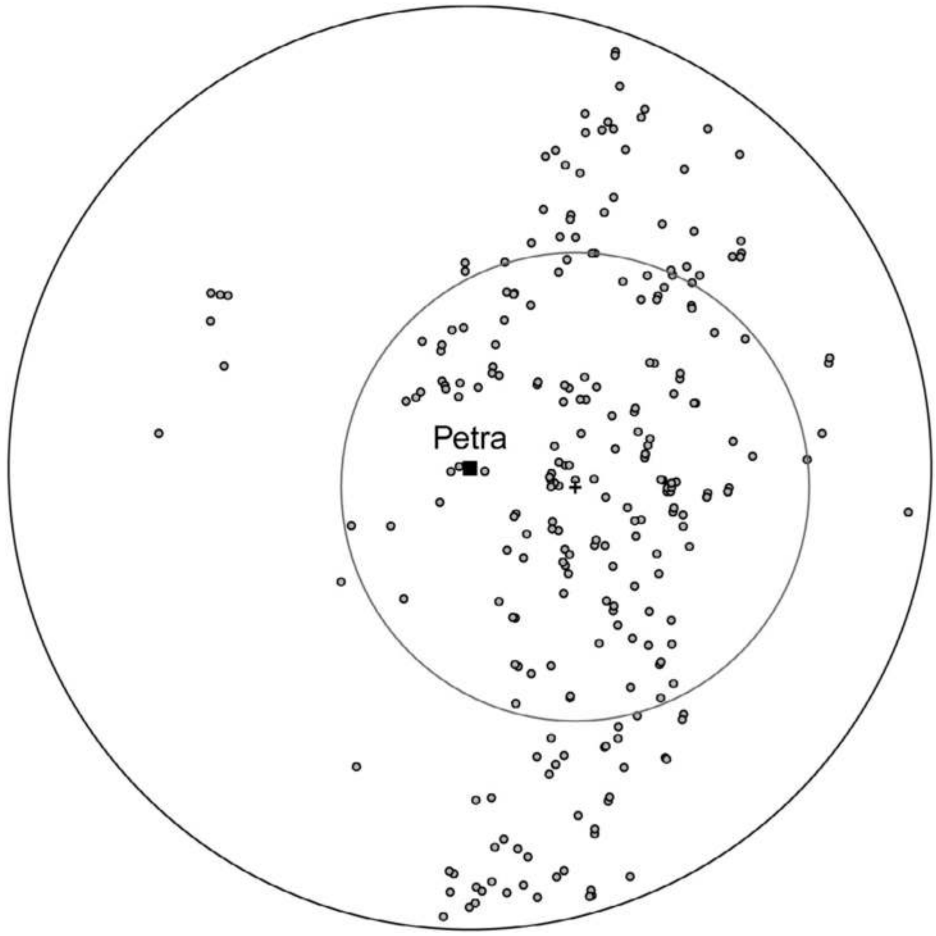


FIG. 21 Settlement sites dating to the 1st century AD. The cross marks the mean center of the point pattern encircled by the standard distance between all settlement sites.

within the pattern (A) by the size of the study area measured in square kilometers (a):[321]

$$\hat{\lambda} = \frac{n}{a} = \frac{\#(S \in A)}{a}$$

In this test case, the global intensity value (GIV) is set at 0,168 settlement sites per square kilometer within the study area (measuring 1599,992 km² in total) (TABLE 5).[322]

The *local intensity* approach divides the study area evenly into artificially defined grids or quadrats based on the total size of the study area and simply counts the amount of points situated within each quadrat (FIG. 22).[323] In this case, the mean of the quadrat count – termed here as mean *local intensity value* (LIV) – lies at 10,76 settlement sites per quadrat.[324] In order to evaluate whether CSR applies to this particular pattern, the 'quadrat test' is conducted using the quadrat count that was just calculated before.[325] The quadrat test is used to compare the quadrat count from the empirically observed evidence and the quadrat count from the expected theoretical (in this case meaning CSR) amount of points within the quadrats based on a variation of the Pearson x^2 statistic.[326]

The results of the quadrat test for 1st AD settlement sites in the Petra area (FIG. 23) show the same quadrats as previously defined, however three counts

321 After O'Sullivan – Unwin 2010, 126: "[…] #($S \in A$) *is the number of events in pattern S found in study area A of area a in appropriate squared distance units such [as] m² or km².*"

322 Note that density-based approaches are particularly sensitive to the definition of the study area (O'Sullivan – Unwin 2010, 126).

323 Baddeley et al. 2016, 163–168; Keron 2015, 16; O'Sullivan – Unwin 2010, 126–127.

324 The quadrat size is determined automatically and is dependent on the size of the study area. Regularly sized quadrats are exhaustively placed with no overlaps within the entire study area and fill it completely (Baddeley et al. 2016, 167). However, randomly placed quadrats are also applied in some studies. For more on the placing of quadrats, see O'Sullivan – Unwin 2010, 127–128.

325 Baddeley et al. 2016, 165–167. Note, however, that the application of the x^2-test is currently considered extremely critically for statistical tests (Nakoinz – Knitter 2016, 135; Hubbard – Lindsay 2008 and Thompson 2006). The method is thus applied only as an initial test for CSR and is complimented by further statistical analyses (more below) in order to verify potentially problematic results of the x^2 -test.

326 See also Baddeley et al. 2016, 165–166 and 278–381.

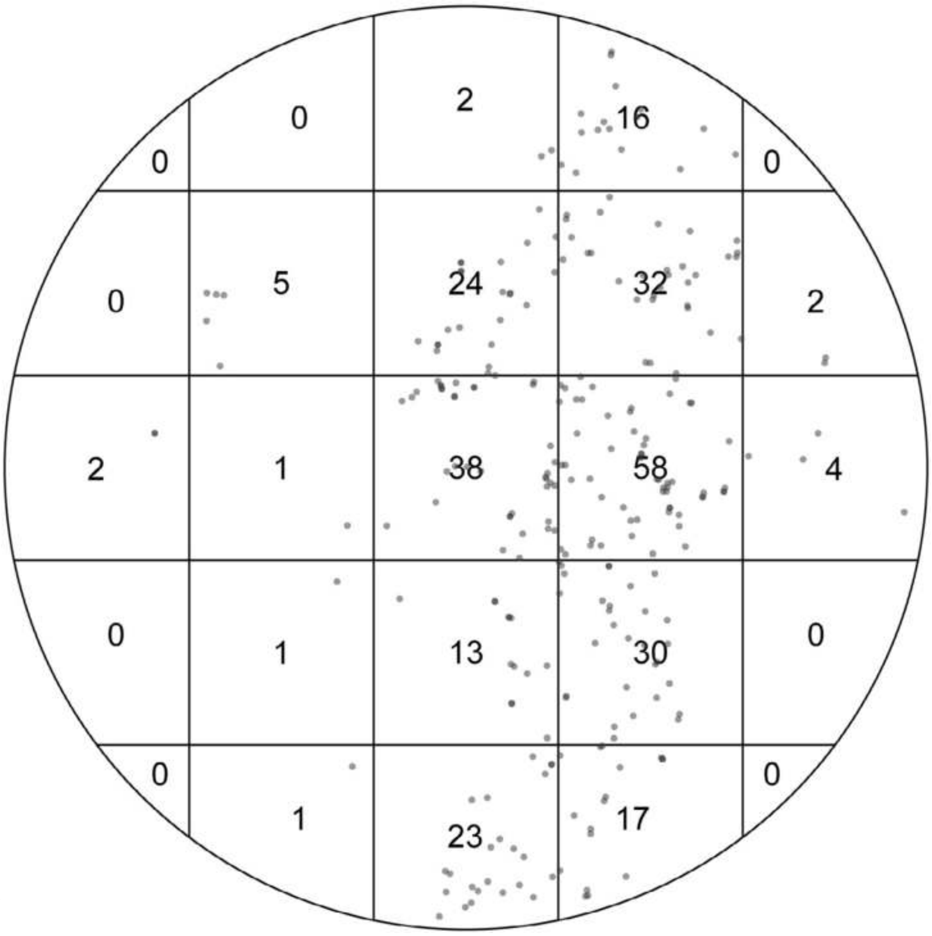


FIG. 22 Quadrat counts of settlement sites dating to the 1st century AD.

are depicted instead of only one. The upper left number represents the empirically observed number of points within the quadrats, the upper right number corresponds to the expected theoretical number of points if CSR would apply and the lower number is the actual result of the quadrat test expressed by the so called *Pearson residual* that indicates the likelihood of accepting the null hypothesis (CSR = 0).[327] Pearson residuals of +/- 2 signify an unusual amount of points within the respective quadrat.[328] In other words, the closer the Pearson residuals are to +/- 2, the more they go against CSR, while the closer they are to 0, the more they would suggest CSR. The larger Pearson residuals are than +/- 2, the greater is the departure from the fitted model of points within a quadrat clearly indicating that there is no CSR.

Tested for 25 quadrats, the quadrat test for 1st AD settlements suggest that the pattern of the sites is not randomly structured, thus going against CSR (except for quadrat D3 where the Pearson residual is -0,19).[329] Interestingly, quadrat C4 with the high Pearson residual of 12 corresponds well with the location of the mean center of the point pattern going against CSR as well.

The section above has concluded the first steps on how to test for CSR. Particularly the quadrat test has shown that the overall point pattern of 1st century AD settlement sites is not randomly spaced and therefore dependent on first- or second-order properties.

In researching whether the pattern of the settlement sites demonstrated CSR, global and local intensities, or densities, were evaluated. Another approach for investigating densities is by applying the *kernel density estimation* (KDE).[330] KDE is a well-known method applied in statistical analyses for scatterplot smoothing. While there are some applications of the method in archae-

327 Generally on the null hypothesis, see Baddeley et al. 2016, 370: "[…] *the researcher formulates two hypotheses, the null hypothesis H_0 and the alternative hypothesis H_1. The null hypothesis is the statement that 'nothing is happening'. The alternative hypothesis effectively specifies what kinds of departures from the null hypothesis we wish to be able to detect efficiently.*"

328 Baddeley et al. 2016, 379.

329 However, only 9 quadrats are of actual regular size. The remaining quadrats are irregularly formed due to the circular shape of the study area.

330 Nakoinz – Knitter 2016; Knitter et al. 2014, 113; O'Sullivan – Unwin 2010, 68–72.

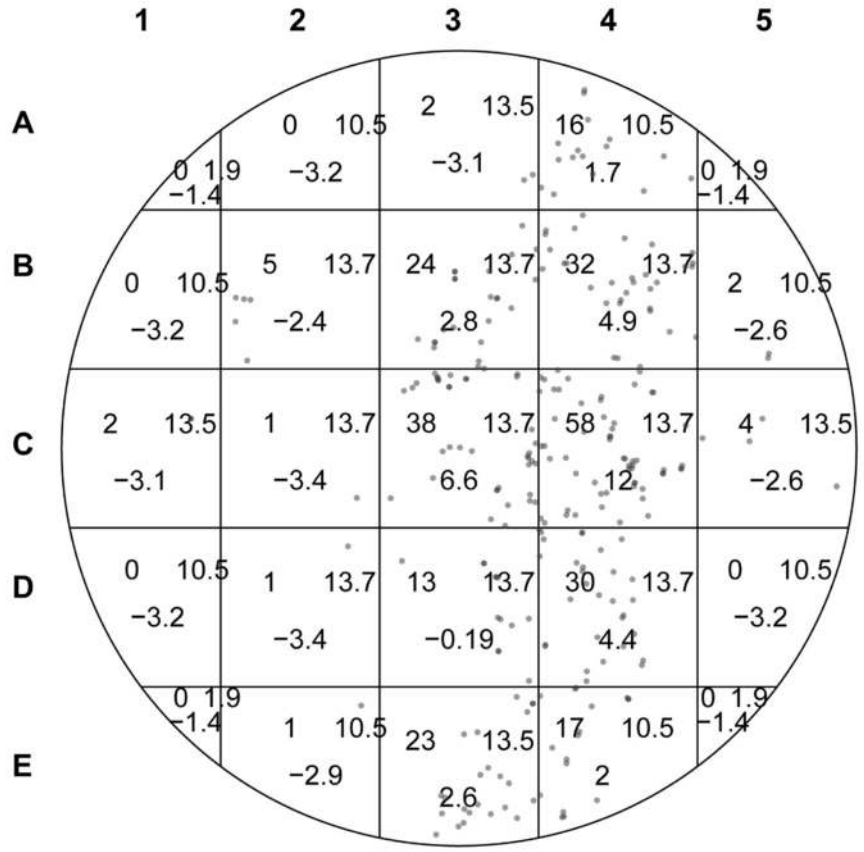


FIG. 23 Quadrat test for CSR for settlement sites dating to the 1st century AD. Upper left: Quadrat counts. Upper right: Expected values for CSR. Bottom: Pearson residual.

ological studies, the proper use of KDE is not particularly widespread.[331] KDEs smooth a known quantity of points in space.[332] The degree of the smoothing is defined by the bandwidth parameter, which can roughly be referred to as the search radius from a point in a landscape.[333] Generally, larger bandwidth values result in a smoother and general density map, while smaller bandwidth values produce more edged and detailed results. Within that predefined bandwidth or search radius, an artificial shape – the *kernel* – is placed over each spatial point. The size of the kernel is determined by the distribution of the researched points, the shape of the kernel and the chosen bandwidth.[334] These kernels are then summed together, to produce the density maps. The more kernels are added together, the higher the density of points is in that area.

Determining the size of the bandwidth is the most crucial factor when applying KDEs.[335] While a smaller bandwidth should be chosen for researching the density of points on a smaller, local scale, larger bandwidths are more appropriate for larger, regional scales.[336] The main question is therefore: how to define the bandwidth? Defining a bandwidth is very much dependent on the research question and always remains somewhat intuitive.[337] However, a general rule of thumb is that the bandwidth "[…] *should be about three times the mean distance to the nearest neighbors* [of the spatial points] *and at least the distance to the*

331 Herzog – Yépez 2013; Herzog 2007; McMahon 2007; Baxter et al. 1997. For a GIS-based application of KDE see most recently Nakoinz – Knitter 2016, 67–85; Bevan – Conolly 2006, 175–177 and Wheatley – Gillings 2002, 186–187.

332 Cf. the illustrative description of KDEs by Baddeley et al. 2016, 168: "*Our favorite analogy is to imagine placing one square of chocoloate on each data point. Using a hair dryer we apply heat to the chocolate so that it melts slightly. The result is an undulating surface of chocolate; the height of the surface represents the estimated intensity function of the point process. The total mass of chocolate is unchanged.*"

333 Baddeley et al. 2016, 170; Herzog – Yépez 2013, 369.

334 For example, the size of a Gaussian kernel is defined by the standard deviation of the distances between the researched points. More elaborate kernel functions experiment with different statistical weighting of the base data. As O'Sullivan – Unwin 2010, 69 state: *"More sophisticated variations on the basic KDE idea make use of kernel functions, which weight nearby events more heavily than distant ones in estimating the local density.* […] *Other functional forms, based on the distance of the point to be estimated from events in the pattern, are possible and are specified with a parameter that is equivalent to the simple bandwidth r."* This study uses the bell-shaped Gaussian kernel (or Gaussian function). Cf. Nakoinz – Knitter 2016, 71; Herzog – Yépez 2013, 369.

335 Nakoinz – Knitter 2016, 79–80; Keron 2015, 31–34; Knitter et al. 2014, 113.

336 Nakoinz – Knitter 2016, 79; Herzog – Yépez 2013, 369.

337 Herzog – Yépez 2013, 369.

nearest neighbors itself."[338] The most important issue regarding the use of KDEs is discussing the definition of the bandwidth for the individual study. Applying a Gaussian kernel on the settlement sites of the Petra region, three different bandwidth sizes – large, empirical and small – were tested to evaluate which size suits this study most appropriately.[339] The large kernel bandwidth was set artificially to 1500 m, while the bandwidth for the so-called 'empirical KDE' was defined as the mean distance to the nearest neighbor value of settlement sites (520,04 m). The bandwidth of the small KDE was set to the median distance to the nearest neighbor value of settlement sites (310,77 m).

While all three definitions fall well within the accepted norms for defining a KDE bandwidth, the resulting density maps of the settlement sites are significantly different (FIG. 24).[340] As the large KDE shows only very general patterns of the site densities, it is not possible to distinctly distinguish any concentration areas of settlements. Important information on the spatial distribution of the sites is therefore lost. In contrast, the small KDE depicts a far more detailed level of information, in some cases even showing individual settlements with high density values. However, individual settlements certainly do not mark a high spatial concentration and therefore the small KDE offers misleading results as well. The empirical KDE shows the general density trends of the large KDE as well as more detailed information pertaining to spatial concentrations of settlement sites. In comparison to the small KDE, however, it represents the actual density proportions more adequately. Based on this test-run of different bandwidths, all KDE calculations are therefore conducted with this bandwidth.

Generally, KDEs are particularly interesting when researching spatial distribution patterns diachron-

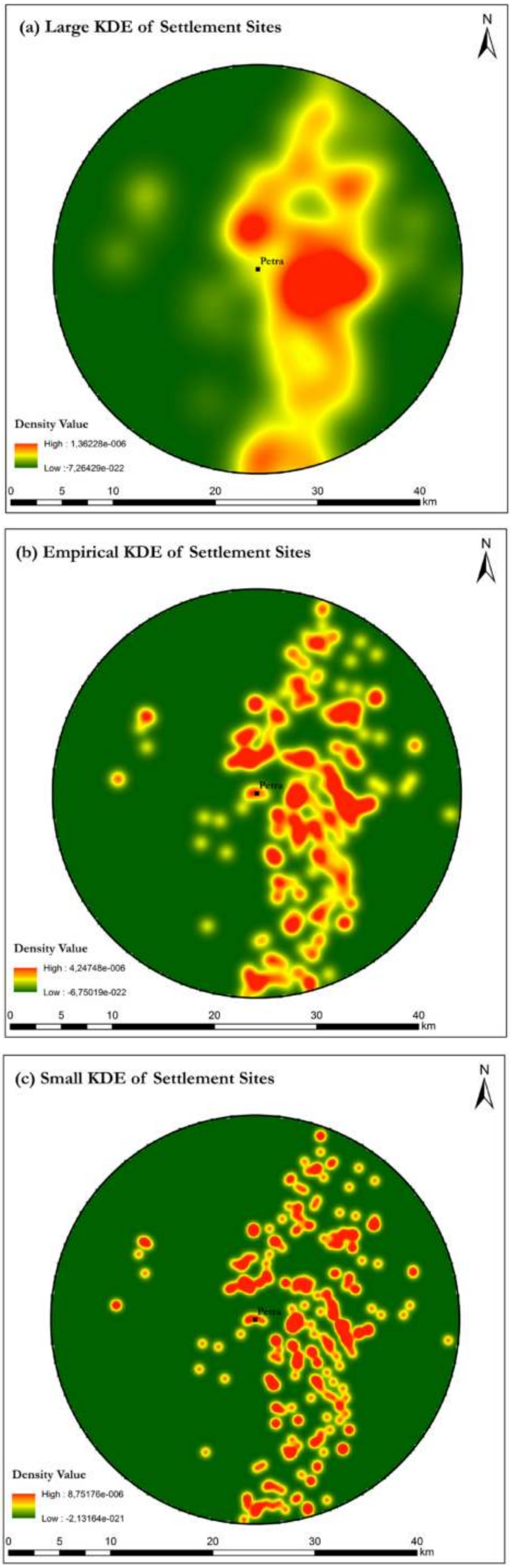


FIG. 24 Different bandwidth sizes for conducting KDEs on 1st century AD settlement sites in the Petra area.

338 Nakoinz – Knitter 2016, 79–80. However, other suggestions concerning the size of the bandwidth have also been made: *"A built-in function is based upon Silverman's suggestion* [1]. *According to the manual, 'it defaults to 0.9 times the minimum of the standard deviation and the interquartile range divided by 1.34 times the sample size to the negative one-fifth power'. Scott* [8] *suggests a factor of 1.06."* (Nakoinz – Knitter 2016, 80). Further proposals for defining a bandwidth are also given by Baddeley et al. 2016, 170–172 as well as Bivand et al. 2008, 165–168.

339 According to Nakoinz – Knitter 2016, 80, a Gaussian kernel is most appropriate in most cases. However, Herzog – Yépez 2013, 369 favor the paraboloid Epanechnikov kernel (see also Herzog 2007). They also recognize, however, that kernel shapes have little influence on the resulting density estimations.

340 In the case of the settlement sites, three times the distance to the nearest neighbor would equal 1560,111 m, thus being virtually the same as the artificially defined bandwidth of the large KDE.

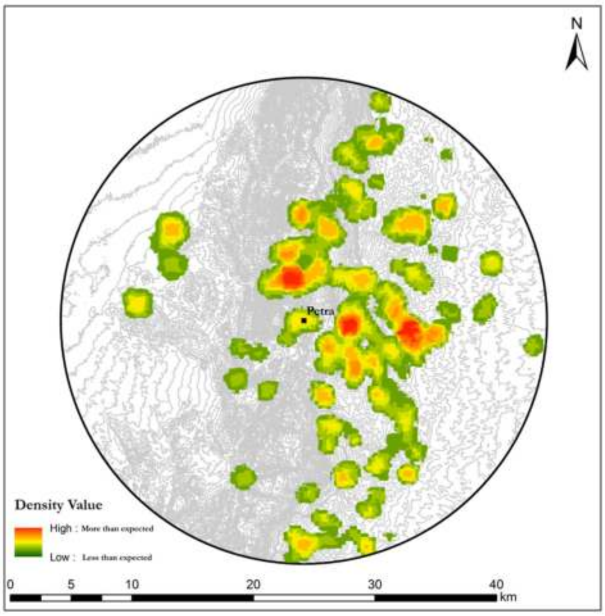


FIG. 25 KDE of settlement sites dependent on elevation values.

ically. Incorporating KDEs into site distribution maps not only helps to visualize spatial shifts of archaeological sites through time, but it is also a great tool for localizing spatial hubs of certain sites types. In terms of investigating first-order effects within point pattern analyses, however, KDEs can be particularly useful for researching the dependencies of the location of archaeological sites on various covariates.

For example, the KDE of settlement sites can be set into relation with elevation values within the study area resulting in a new KDE map highlighting the concentration areas of settlement sites that are spatially dependent on elevation values (FIG. 25). Additionally, a so-called 'intensity function of a covariate' (e.g. elevation values) can be produced to depict the varying spatial density values of the point pattern (in this case the pattern of settlement sites) along the y-axis in dependence on the covariate values along the x-axis (in this case elevation values in meters) (FIG. 26).[341] Corresponding with the rise of the intensity function in black (the grey represents the rate of confidence or *error rate*), the narrow vertical black lines along the x-axis represent the empirical values of the pattern, i.e. in this case the elevation values of the individual settlement sites. The intensity function of settlement sites thus shows that while there are close to no settlements situated below elevation values of 500 m, the density of settlements rises steadily with higher elevations. The function reaches a first peak around 1000 m maintaining similar density values until a sudden and drastic rise occurs the closer elevation values are to 1500 m. This signifies a clear concentration of settlement sites around these elevation values.[342]

Based on KDEs, it is additionally possible to run the *Pearson product-moment correlation test*. This method calculates certain correlation values between two sets of samples or parameters.[343] The test evaluates the degree of linear association between two parameters, which is expressed by the correlation coefficient *r*. The Pearson correlation pulls a straight line of best fit – or trend line – through the two parameters' data and the correlation coefficient *r* simply registers the distance of all data to the trend line ranging from +1 and -1. An *r*-value of 0 signifies that there is no correlation between the two parameters. Thus, the closer the coefficient is to +1 or -1, the stronger is the correlation between the parameters. Positive *r*-values indicate an increase in the values of both parameters. Negative *r*-values signify that while the value of one parameter increases, the value of the other decreases. In more simple terms, r-values between +1 and -1 indicate a variation of the parameters from the trend line and the closer they are to 0 the larger is the variation. This may seem to be a very abstract method, but when dealing with spatial (archaeological) data, it is a very useful tool for evaluating if any spatial correlation between two different sets of archaeological sites exist and is thus extensively applied in this study. Nakoinz and Knitter argue that comparing the location of sites alone might produce a statistical bias in the results of the Pearson correlation test.[344] They therefore propose to include 500 random sampling points in addition to the evidenced pattern. To account for a possible bias with these sampling points, however, the example of 1st century AD settlements provide Pearson correlation values with and without the sampling points. TABLE 6 shows the calculated Pearson correlation coefficients between the density of the archaeological evidence type 'settlement' (with its respective

341 Cf. Baddeley et al. 2016, 152.

342 As described in chapter 5, they correspond geographically to the Jabal Shara region where the maximum annual precipitation rates in the study area occur. The KDE of the settlements that are dependent on elevation values not only confirms this interpretation, but also allows a more exact location of these concentration areas. Obviously there appears to be three noticeable hubs of elevation-dependent settlements: The first is concentrated in the Beidha area, just north of Petra. The second lies near the modern village of Wadi Musa (ancient Gaia) and the last, immediately east of Wadi Musa along the course of Wadi Malghan, just north of al-Bitar.

343 Nakoinz – Knitter 2016, 87–88, 132. For an easily explained and quick introduction to the Pearson product-moment correlation, see also Lane 2016, 170–175. For an online-version: http://onlinestatbook.com/2/index.html (last accessed: 06.04.2021).

344 Nakoinz – Knitter 2016, 132.

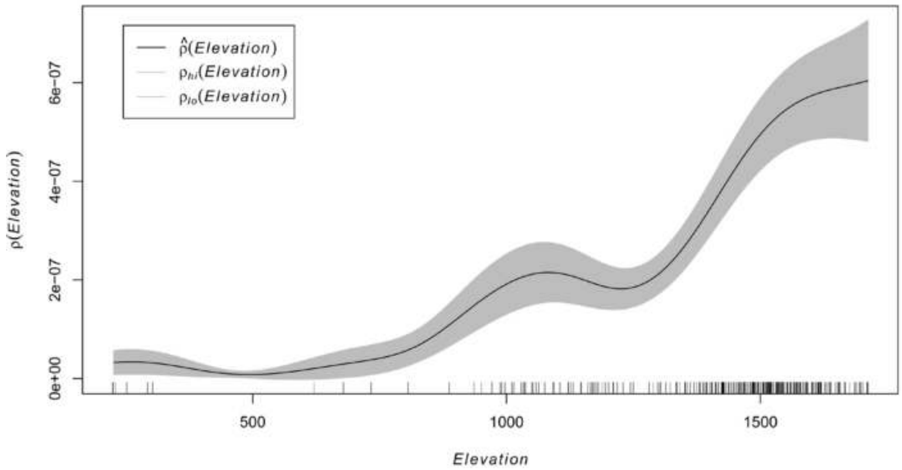


FIG. 26 Intensity function of terrain elevation for 1st century AD settlement sites in the Petraean hinterland.

subcategories) and the density of other archaeological site categories dating to the 1st century AD. Without going into too much detail here, the coefficient values on the archaeological evidence level show that there is a general spatial correlation between settlement sites and other types of archaeological evidence.[345] However, with a mean coefficient value of 0,27, the degree of spatial correlation is generally weak, with the exception of the spatial correlation between rural mansions and industrial/exploitation installations (*r*-value of 0,62) as well as between farms and water storage installations (*r*-value of 0,65). TABLE 6 also shows only little variance between the calculation of the Pearson correlation coefficients with the 500 sample points and those without.[346] Only little variance between the correlation values calculated on the basis of the observed point pattern and the pattern including 500 sample points was observed with other types of archaeological categories as well. Thus, following Nakoinz and Knitter's statistically more correct approach, Pearson correlation values are given only with the sample points for all archaeological categories discussed in this study.

However, evaluating Pearson correlation values by such numerical coefficients may seem too abstract to handle for a qualitative archaeological assessment. The numeric Pearson correlation coefficients were therefore transformed into qualitative expressions. Based on Evans' guide for describing the strength of the correlation values, the ranges of coefficients were reclassified into qualitative statements expressing the different levels of spatial correlation between the various parameters (TABLE 7).[347] Rather than referring to abstract numbers, such a reclassification of the Pearson correlation coefficients makes a qualitative evaluation of the spatial dependencies between archaeological sites far easier to comprehend for archaeological research purposes. TABLE 8 shows that the qualitatively expressed Pearson correlation test demonstrates only very weak and weak spatial correlations between settlement sites and other types of archaeological evidence. Some moderate correlations are also evidenced.[348]

In this test case, strong spatial correlations between rural mansions and industrial/exploitation installations as well as between farms and water storage installations can be noted.

Finally, the potential dependencies of settlement sites on elevations were evaluated. Other environmental constraints, such as slope values (given in %); slope directions (percentage of direction); geographical distances to streams (wadis) and the various covered geological zones (%), were also analyzed for this test case as shown in TABLE 9. It can be shown that settlements were preferably established at locations with comparatively flat slopes (average

345 Note that the reason why there are no coefficients for cities and road markers is that only one site of those categories is evidenced for the 1st century AD. It is not possible to calculate Pearson correlation coefficients with one parameter consisting of only one point.

346 The exception being the resulting *r*-values between settlements and communication infrastructures. As Nakoinz – Knitter 2016, 133 point out, it is also important to note that *r*-values, including the sample points, can vary when repeating the test as the sample points are randomly chosen.

347 Cf. Beldjazia – Alatou 2016, 26–27 referring to Evans 1996. Note that different qualitative classifications of the Pearson correlation values may lead to different statistical inferences. For example, cf. the 'rule of thumb' for interpreting the size of a correlation coefficient presented by Mukaka 2012, 71. However, Mukaka makes use of Spearman's correlation coefficient instead of Pearson's.

348 This study will generally not discuss such very weak, weak and moderate spatial correlations as the scientific value of such information is relatively limited. Instead, only 'strong' and 'very strong' spatial correlations will be discussed explicitly as it may be assumed that such correlation classes signify truly noteworthy and conspicuous spatial correlations between different archaeological sites.

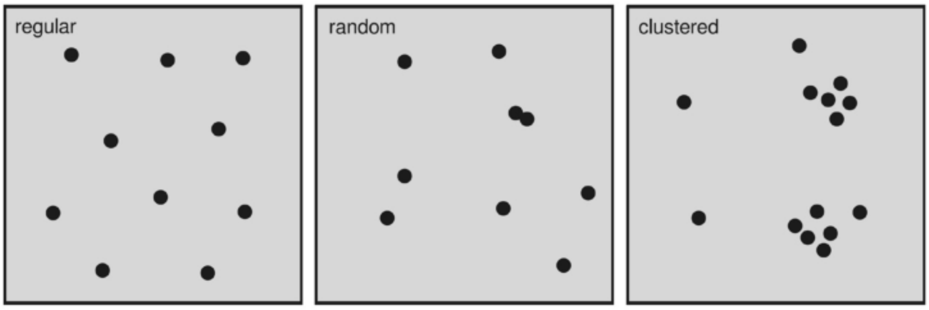


FIG. 27 The three types of point patterns after Nakoinz – Knitter 2016, 135, fig. 7.2.

slope value of 16,21 %) without clear preference for specific slope directions.[349] The average elevation value lies at 1388,27 m a.s.l., corresponding well with the values given in FIG. 26. The average distance to streams (wadis), lies just under 700 m, which indicates a preference to settle near potential water sources.[350] It could also be established that over half of all evidenced settlements (58,36 %) are situated on limestone[351], followed by 13,79 % of all settlements situated on alluvium and 13,38 % on sandstone. Presumably, settlements were thus founded on comfortable geological formations.

Second-Order Properties

Thus far, the density-based evaluations of first-order properties for 1st century AD settlement sites has shown that the pattern demonstrates no signs of CSR and that there is a significantly high density of settlements situated at elevation levels around 1500 m a.s.l.. The Pearson correlation test has demonstrated that there is a predominately weak and very weak spatial correlation to other types of archaeological evidence in the study area. A strong correlation between rural mansions and industrial/exploitation installations as well as between farms and water storage installations was demonstrated.

In addition to such first-order effects, distance-based dependencies, or the degree of spatial interaction, between settlements and other sites can be examined.[352] Further tests for CSR can yield more information on the point pattern than simply stating whether complete spatial randomness applies to the pattern or not. Generally, three types of point patterns can be distinguished: regularly spaced (a negative interaction between points), randomly spaced (no interaction between points), or clustered point patterns (positive interaction/attraction between points) (FIG. 27).[353]

For researching these types of point patterns (and testing for CSR), three main functions can be calculated that further describe the pattern: the so-called G-, F- and K-functions (FIG. 28).[354]

Both the G- and F-functions evaluate nearest-neighbor distances between points.[355] The simplest nearest-neighbor approach is described by the *G-function* ($G(d)$) (also referred to as the 'refined nearest neighbor' function). This simply assesses the cumulative frequency distribution of the nearest-neighbor distances of the points and calculates which fraction of all nearest-neighbor distances ($d_{min}(s_i)$) is then in a particular distance within the pattern, as stated by the formula below:[356]

$$G(d) = \frac{\#\{d_{min}(s_i) \leq d\}}{n}$$

As the resulting G-function for 1st century AD settlement sites shows, the general distance *d* between points increases (FIG. 29). So does the fraction of nearest-neighbor-distances that are less then *d*. The

349 This can be seen by the relatively even percentage of geographical directions ranging between a min. value of 8,92 % of settlements situated on slopes oriented to the NW and a max. value of 15,24 % of settlements situated on slopes oriented to the southwest.

350 Although wadis are often only seasonally flooded.

351 This covers most of the Jabal Shara region and eastern high plateau, thus confirming the results of the elevation values presented above.

352 Cf. Baddeley et al. 2016, 149; Keron 2015, 17.

353 Nakoinz – Knitter 2016, 136.

354 Baddeley et al. 2016, 149–150. The second-order G-, F- and K-functions generally test for CSR. In this test example, however, the quadrat tests and the KDEs have already shown that there is no CSR for this pattern. Therefore, strictly speaking, testing for CSR by evaluating second-order properties of the pattern is statistically redundant. Nevertheless, as is shown by the description and interpretation of the G-, F- and K-functions, distance-based insights can be gained into the nature of the pattern that was not possible by researching first-order properties alone. The calculations of the G-, F- and K-functions are therefore to be considered independently of and in addition to the first-order properties.

355 Baddeley et al. 2016, 261–267; O'Sullivan – Unwin 2010, 130–135.

356 Baddeley et al. 2016, 264; Nakoinz – Knitter 2016, 136; Knitter et al. 2014, 112; O'Sullivan – Unwin 2010, 133.

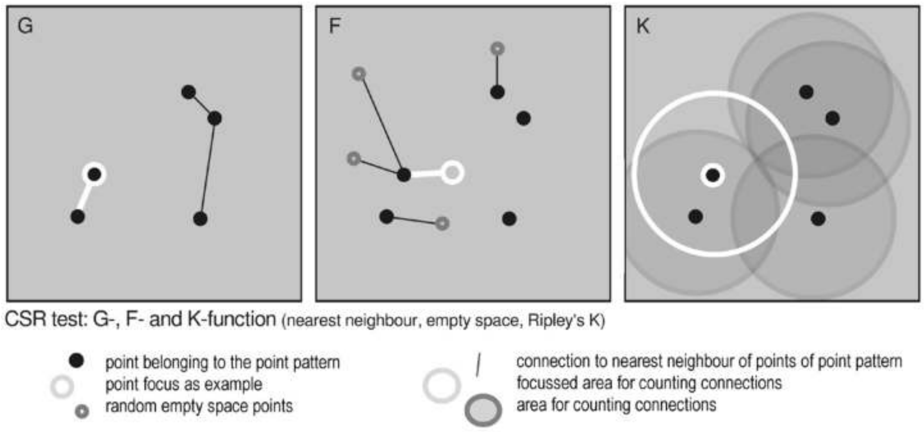


FIG. 28 G-, F- and K-functions after Nakoinz – Knitter 2016, 137, fig. 7.4.

theoretical G-function (dashed line) is drawn automatically signifying the result of the function if spatial randomness would apply. The grey 'envelope' is also depicted showing the presumed variance when calculating the function for the spatially random model.[357] How can we then deduce any types of point patterns from this function?

The obvious difference between the theoretical (spatially random) curve and the actual function of settlement sites is striking. It can generally be assumed that when the empirical G-curve runs above the CSR-function, a clustering of the pattern is suggested. When the G-curve runs below the CSR-function, a more regular distribution can be assumed.[358] Thus, as the G-function of the settlements runs above the theoretical CSR-curve, the assumption that no spatial randomness applies to this pattern is not only confirmed, but it also suggests a clear clustering of the sites.[359] When points are clustered, the function generally rises quickly within short distances. The slower the function rises, the more evenly spaced the pattern is.[360] Although the rise is not particularly dramatic in this example, the function shows that there seems to be a clustering of points at smaller distances (between c. 160 m and 220 m). At further distances, the function rises more slowly signifying that the settlements are more regularly distributed.

However, the results of the G-function can be biased by the overall number of points in a specific pattern (e.g. resulting from differing survey intensities). To account for this possible bias, the *F-function* is applied, which basically follows the same principle as the G-function. It differs however, as it does not assess the cumulative fraction of nearest-neighbor distances between the actual points within the pattern. Instead, completely random points are artificially added to the evidenced pattern and the minimum distances from these random points to any point within the evidenced pattern are evaluated.[361] The F-function ($F(d)$) is therefore also referred to as the 'empty-space function.'[362] The function cumulates the frequency distribution of the distances between the random points and the actual points in the pattern. Formally, it is described as follows:

$$F(d) = \frac{\#\{d_{min}(p_i, S) \leq d\}}{m}$$

According to O'Sullivan and Unwin, the advantage of the F-function over the G-function is the insertion of random points (and thus the overall sample size m), with the resulting graph of the F-function being far smoother and potentially representing the pattern's properties more adequately (FIG. 30).[363] However,

357 This inclusion of the theoretical model and the variance 'envelope' is based on a Monte Carlo simulation and is automatically set into the graph when applying the 'spatstat' package in the statistical program R. See more in Baddeley et al. 2016, 268–271, 396–403; Nakoinz – Knitter 2016, 136; O'Sullivan – Unwin 2010, 148–151 or Baddeley 2008.

358 Cf. Bivand et al. 2008, 161. For a more founded explanation, see also Nakoinz – Knitter 2016, 136: *"If the point pattern in clustered, it is more likely to have another point nearby than in a random point pattern. There are more short distances to the nearest neighbor and the cumulative curve rapidly increases at short distances."* This explains why the empirical curve, when signifying a clustered pattern, runs higher than the CSR-function.

359 Cf. Baddeley et al. 2016, 266–267.

360 O'Sullivan – Unwin 2010, 133.

361 Knitter et al. 2014, 112; O'Sullivan – Unwin 2010, 133.

362 Baddeley et al. 2016, 261–264; Nakoinz – Knitter 2016, 136; Knitter et al. 2014, 112.

363 O'Sullivan – Unwin 2010, 133: *"The F function is the cumulative frequency distribution for this new set of distances. If* $\{p_1 \dots p_i \dots p_m\}$ *is a set of m randomly selected locations used to determine the F function* […] *where* $d_{min}(p_i, S)$ *is the minimum distance from location* p_i *in the randomly selected set to any event in the point pattern S."*

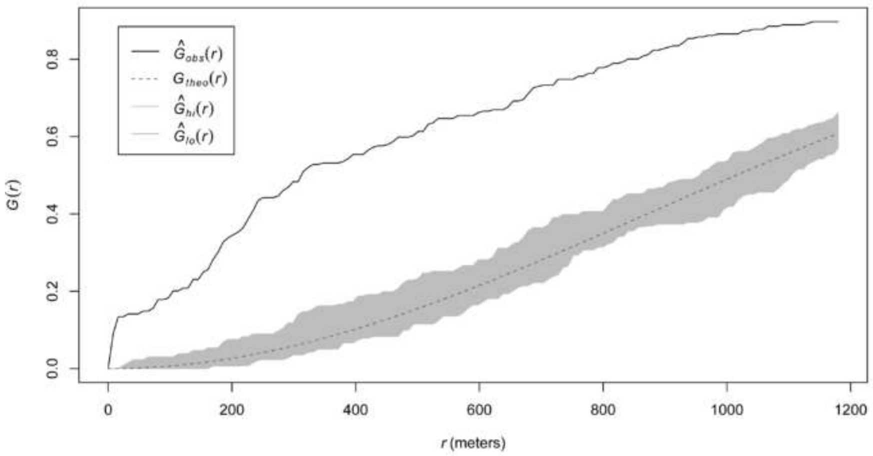


FIG. 29 G-function for 1st century AD settlements in the Petraean hinterland.

the F-function has to be read differently than the G-function. Simply put, the difference between the F- and G-function is that the former evaluates how far the pattern's actual points are from the arbitrary random points, while the latter examines how close the pattern's points are to each other. This explains why the theoretical CSR-curve is larger than the modeled curve when no CSR applies and the pattern is clustered. The pattern is regularly spaced when the empirical F-curve runs above the CSR-function.[364] In contrast to the G-function, the F-function first rises slowly at smaller distances when a point pattern is clustered as the probability is high that actual points are near random points. At larger distances, the function rises faster (steeper) as the distances between random points and actual points are growing larger, thus signifying a more regularly spaced pattern.[365] In the case of the 1st century AD settlements, the F-function first highlights the striking difference between the theoretical CSR-curve and the actual function. Seemingly, there is no CSR to be assumed in this pattern. As the modeled curve runs distinctly lower than the CSR-function, it is clearly clustered. The modeled function immediately rises steeply to approx. 800 m, before rising more slowly. After c. 1500 m, the function continues more steeply again. Although the curve is not particularly distinctive, it suggests a cluster of settlements at a distance between 1000 m and 1200 m.

While both the distance-based analyses of the G- and F-functions are able to provide important information for characterizing the nature of a point pattern, there are some methodological drawbacks, particularly when researching potential clustered patterns.[366] Both functions can potentially lead to questionable results as they deal exclusively with nearest-neighbor distances. However, these are very short distances relative to other distances in the pattern and therefore do not necessarily show other structures in the pattern.[367]

To account for these potentially problematic methodological issues, the *K-function* was introduced into PPAs. In contrast to the G- and F-functions, the K-function assesses *all* distances between all points within a specific 'threshold.'[368] As O'Sullivan and Unwin state, the most straightforward way to understand the K-function ($K(d)$), is to imagine circles placed around each point within the pattern that radiate at various distances (cf. FIG. 28). The amount of points within the various radii of these circles is simply counted and the mean count calculated which is then divided by the size of the overall density of points ($n\lambda$) within the study area:[369]

$$K(d) = \frac{\sum_{i=1}^{n} \#[S \in C(s_i, D)]}{n\lambda}$$

Observing the calculated K-function for 1st century AD settlements of the Petra area (FIG. 31), the function goes against CSR and demonstrates that the pattern is clustered as the empirical curve runs significantly higher than the CSR-function (cf. the reading of the G-function above). Generally, the curve rises gradually at regular intervals towards larger distances. How-

364 Cf. Bivand et al. 2008, 162.
365 Baddeley et al. 2016, 266; Nakoinz – Knitter 2016, 136–137; O'Sullivan – Unwin 2010, 134.
366 Nakoinz – Knitter 2016, 137; O'Sullivan – Unwin 2010, 134.
367 Knitter et al. 2014, 112–113; O'Sullivan – Unwin 2010, 134–135.
368 Baddeley et al. 2016, 203–208; Nakoinz – Knitter 2016, 138; Keron 2015, 46–47; O'Sullivan – Unwin 2010, 135.
369 O'Sullivan – Unwin 2010, 135: "[…] $C(s_i, d)$ *is a circle of radius d centered at [a point]* s_i."

ever, the curve seems to rise slightly steeper until c. 2000 m. This indicates that a larger number of points were counted in comparison to larger distances where the curve rises more gradually. Although the empirical curve of the K-function is not distinctive enough to assume this for certain, one could tentatively argue that the K-function confirms the results of the F-function, where a clustering of settlements was assumed between 1000 m and 1200 m.

The results of the presented functions have clearly shown that the pattern of 1st century AD settlements is not randomly spaced, but that there are distinct indications for a clear clustering of sites. The G-function suggests a clustering of settlements at very short distances (between c. 160 m and 220 m). In addition, particularly the F-function (and to some degree the K-function as well) indicates that settlements also cluster at larger distances (roughly between 1000 m and 1200 m).[370]

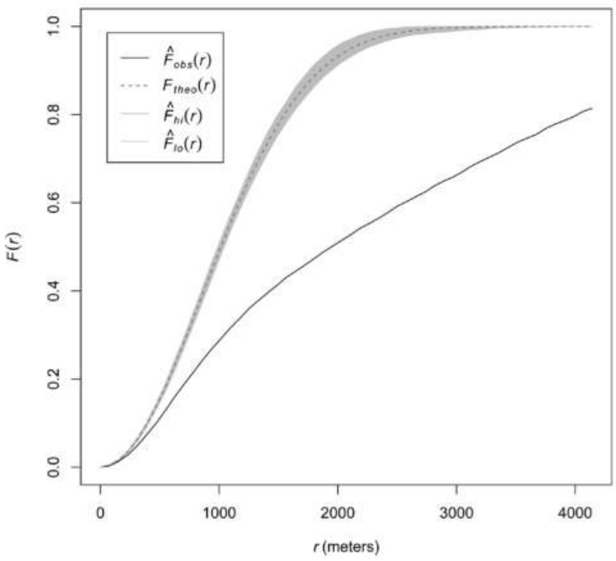


FIG. 30 F-function for 1st century AD settlements in the Petraean hinterland.

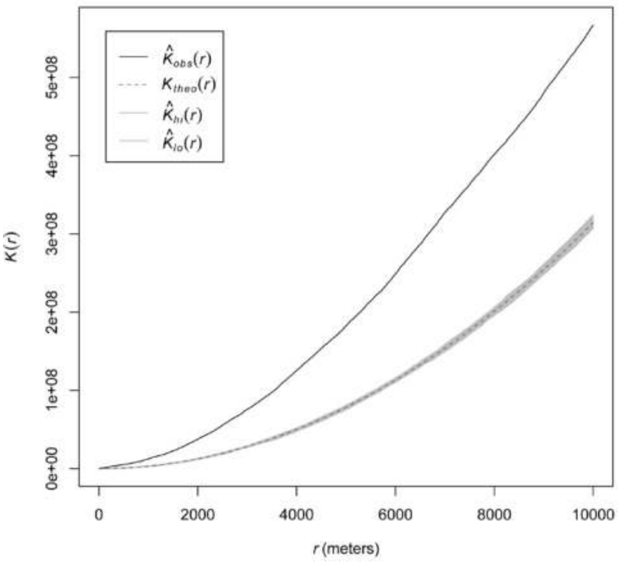


FIG. 31 K-function for 1st century AD settlements in the Petraean hinterland.

Cost-Surface Analyses – Site Catchment and Least-Cost Path Analysis

This section addresses two GIS-based analytical methods applied in this study: *Site-catchment analysis* and *least-cost path analysis*. While site-catchment analyses aim at defining potential territories of archaeological sites, the analysis of least-cost paths attempts to model optimal routes between two points. While these two different methods are applied to achieve two very different objectives, they are both based on the idea of modelling most cost-efficient movement across a landscape (surface), explaining why they are included here under the generic term *cost-surface analysis*.

Site Catchment Analysis

An attempt to model environmentally determined territories of archaeological sites can be made by applying the method of *site-catchment analysis*. The method is used to investigate archaeological sites as isolated complexes, incorporate them in their immediate surroundings, and assess the availability of natural resources in their area of influence (catchments). When studying human land-use strategies, the potential – as well as the constraints – on moving through a land-

370 The fact that the settlements appear to be clustered seems to go against the calculated (non-nearest-neighbor) Euclidean distances between settlement sites and other types of archaeological evidence as shown in TABLE 10. The mean standard Euclidean distance between settlements is at approx. 12,5 km. This deviation can be explained by the potential inclusion of outliers when calculating mean values for standard Euclidean distances.
Also, note that there are some methodological improvements on the K-function (the so-called L-function) as well as another function that basically combines the G- and F-function (the so-called J-function). The L-function is a square root transformation of the K-function "[i]*n order to stabilize the variance and make visual comparisons easier* […]" (Nakoinz – Knitter 2016, 138). For more on the L-function, see Baddeley et al. 2016, 207 and 275–277 on the J-function. However, Nakoinz – Knitter 2016, 139 reject the J-function for point pattern characterizations as it does not "[…] *distinguish different phenomena that have a different effect on both* [the G- and F-] *functions*." It is generally been recognized however, that the G-, F- and K-function functions form a solid basis for attempting to comprehensively characterize second-order properties in point patterns. It is therefore valid not to consider the L- and J-functions here.

scape must be understood and set into context with archaeological sites.[371] The site-catchment approach thus attempts to model environmentally determined territories of archaeological sites, which can be defined as the most cost-efficient area when traversing through the landscape from a specific archaeological site.

The advantage of applying the site-catchment approach in order to model possible territories over other, particularly distance-based methods such as Thiessen/Voronoi polygons, is that the latter only considers two-dimensional distances between points.[372] The resulting tessellation of the surface is then often taken as a modeled definition of territories of the researched archaeological sites. While this remains a valid approach for at least preliminary attempts at modeling territories, the tessellation of the Thiessen/Voronoi polygons do not reflect the realities of the natural environment and are based on Euclidean distances between points that are not necessarily spatially dependent on each other. While some studies have calculated Thiessen/Voronoi polygons that respect the geographical constraints of the natural landscape, the problem of assuming a spatial dependence between sites remains.[373]

The first to have developed the term, site-catchment analysis, were Vita-Finzi and Higgs in 1970, having described a relationship between technological and economic possibilities of past societies and the natural resources of their immediate landscape.[374] Vita-Finzi and Higgs were interested in analyzing the relationship between archaeological sites and their catchments by means of methods taken from geography and other disciplines. In short, site-catchment analyses calculate cost-benefit ratios in relation to archaeological sites and establish a "*hierarchy of importance of resources.*"[375]

With the growing popularity of GIS applications in archaeology since the late 1980s, site-catchment analyses have undergone a vital methodological development. While early catchment analyses demonstrated that the

> [...] *size, shape, and location of an individual site's catchment are* [...] *largely a function of the zonation, spacing, and seasonal differentials of resource zones exploited from the site,*[376]

with catchments correlating with the function and size of the site itself, they tended to over-simplify the large amount of physiographic data necessary for the analysis.[377] Hunt also criticized a certain lack of accuracy in standard site-catchment analyses depending on the available data.[378] Geographical data often could not be mapped accurately leading to the common circular shape of the catchment areas.[379] This was considered to be environmentally too simplistic for accurately modeling a site's procurement area. GIS applications improved these limitations by first organizing all physiographic data by layers and presenting all data on a commonly scaled map. GIS also abandoned the simple circular catchment shape as GIS-based models are able to more accurately follow the natural course of the various environmental datasets that are considered for the analysis (e.g. following the natural topography or the specific geological zones etc.).

The first step in conducting site-catchment analyses is to define the various factors deemed important. These factors can include a wide range of data, such as simple topography (elevation and slope values), land cover and soil, water courses, visibility, cultural 'taboo zones,' trade routes and more.[380] Depending on the availability of the various data as well as the preference of the specific study, these datasets are then combined in a GIS environment to form the so-called *accumulated cost surface* (ACS). Based on the ACS, the cost of traversing from one specific point of origin to a particular (or multiple) destination(s) within a given landscape is then calculated (accumulated cost

371 Conolly – Lake 2006, 214.
372 For a very basic overview on Thiessen/Voroinoi polygons, see Conolly – Lake 2006, 214 with further references.
373 Cf. e.g. Nakoinz 2013, 251, Abb. 9 and 2011. Recent landscape archaeological studies have made use of more complex, quantitative analytical approaches in order to better model territories. In particular, consider the calculation of 'cultural distances' and the modeling of 'culturally dominant units' conducted by O. Nakoinz. See Nakoinz – Knitter 2016, 149–168 as well as Nakoinz 2013 and Nakoinz 2011. However, as this is not central for this study, such complex methods are not further explored here. Instead, the more traditional approach of site-catchment analysis is preferred.
374 Vita-Finzi – Higgs 1970, 5. In Jordan, site catchment analyses were also conducted for Neolithic sites by I. Ullah in the Wadi Ziqlab (Ullah 2011), by N. G. Smith (Smith 2009, 279–284) researching Iron Age (Edomite) sites immediately north of the Petra area and, most recently, Castro 2018, 49–50; 58–65 also applied cost distance analyses on Roman military sites in southern Jordan. For other archaeological studies applying site-catchment analyses, see K.-P. Wechler's research on the surroundings of early Neolithic settlements in eastern Germany (Wechler 1997) as well as A. Posluschny's work on the so called 'Celtic Princely Seats' in southwestern Germany and eastern France (Posluschny et al. 2012, Posluschny 2010a and Posluschny 2010b).
375 Roper 1979, 121.
376 Roper 1979, 121.
377 Hunt 1992, 284.
378 Hunt 1992, 285–286.
379 Cf. e.g. Vita-Finzi – Higgs 1970.
380 Herzog 2014, chapter 3 with further references (http://intarch.ac.uk/journal/issue36/5/3.html, last accessed 21.05.2020) as well as chapter 5, table 1 (http://intarch.ac.uk/journal/issue36/5/5.html, last accessed 06.04.2021).

of movement) by means of a spreading function.[381] Before creating the ACS however, it is vital to understand the underlying base data as these are crucial for assessing the quality of the resulting cost surface model.

As topography is one of the most determining factors for movement through a landscape, many studies applying cost surface analyses simply use slope values (measured in percent or degree) as their cost surfaces.[382] Some studies produce isotropic, other anisotropic slope maps for their cost surfaces.[383] As very severe slopes and mountain ranges characterize the topography of the Petra region, topographical constraints are the most dominating and striking natural landscape feature of the study area. This study therefore includes anisotropic slope values for the cost surface. As explained above, the slope values (measured in percent) are based on the SRTM-1 digital elevation model and were subsequently reclassified according to E. Farinetti's slope classifications for mountain ranges.[384] Were this study to consider slope values as the only component of the cost surface, the respective percent values could easily be taken as calculable *cost values* necessary for assessing the costs of traversing through the study area. However, as the geological setting of the Petraean hinterland is included in the accumulated cost surface here as well (see below), these non-conformable datasets must be converted into new, common cost values. Within a GIS environment, this is not a difficult technical process. As both the slope and the geological data come in a raster format, each grid of the respective raster contains the relevant spatial information. Exemplified with the slope data, each slope raster grid that originally contained the relevant slope values in percent can simply be reclassified according to pre-defined *cost classes* (cf. FIG. 32). The process of defining cost classes is arbitrary and strongly based on individual assessments of the studied landscapes. Nevertheless, at least for defining different cost classes for different slope values, the process is relatively straightforward as it can be assumed that the energy expenditure is higher for larger slope values and lower for smaller slope values. As this study proposes five slope classes (cf. above), these correspond to five cost classes accordingly. Cost classes for traversing along the reclassified slope values were defined as ranging from 1–5 (cost class 1 being the most cost-efficient class) (TABLE 11).

In addition to topographical features, the Petra region is also very much characterized by its unique and complex geological setting. These geological formations, particularly in combination with extreme slope values, affect movement across the study area enormously. It was therefore necessary to first distinguish all geological formations within the study area based on 1:50,000 geological maps provided by the Royal Jordanian Geographic Center and to digitize them in order to further process the data within a GIS environment. Cost classes then needed to be defined for each geological formation. Although several studies provide cost classes or *multipliers* for different soil or geological data, in most cases these test studies define cost classes for physiological features that are not necessarily typical for the Petra region such as grassy fields, brushes, swamps or bogs.[385] However, some studies did define multipliers for traversing across sands.[386] Nevertheless, it seemed more realistic to define simple cost classes for each geological feature based on the author's personal walking experiences in the study area as well as reports from local Bedouins. These classes range from 1–10 (cost class 1 being the most cost-efficient class) according to the different geological formations of the study area as listed in TABLE 12.[387]

In order to calculate an appropriate *accumulated* cost surface for the study area, both landscape components – slope and geology – were combined.[388] While Fiz and Orengo created combined cost surface models by means of addition based on a function originally

381 See Herzog 2014, chapter 3.1 (http://intarch.ac.uk/journal/issue36/5/3.html, last accessed 06.04.2021) for an overview of the various approaches to the spreading process. This study applies cost surface analyses for pedestrian movement only as most studies do. However, empirical data also exists for walking behaviors of animals, which can theoretically be processed by GIS applications as well. As cost surface analyses do not form a central part of this study however, these options were not explored.

382 I. Herzog listed the various cost components used for creating cost surfaces by different archaeological studies until 2009 showing that most studies only use slope values (Herzog 2014, chapter 5: (http://intarch.ac.uk/journal/issue36/5/5.html, last accessed 06.07.2020).

383 Isotropic slope maps model cost surfaces independent of the travel direction, while anisotropic models consider travel direction because the energy expenditure and time needed for traversing across a landscape can significantly vary when travelling up- or downslope (Conolly – Lake 2006, 215; van Leusen 2002, chapter 6, 5–6).

384 The author already experimented with the most cost-effective area based on Farinetti's slope values (Farinetti 2011) derived from the freely accessible ASTER-DEM in Kennedy 2016a.

385 Herzog 2014, chapter 5.3 (http://intarch.ac.uk/journal/issue36/5/5-3.html, last accessed 06.04.2021) with further references.

386 Herzog 2014, chapter 5.3 (http://intarch.ac.uk/journal/issue36/5/5-3.html, last accessed 06.04.2021).

387 Cost class 1 was also assigned to "undifferentiated" and "land slip" although both geological formations are too vaguely defined and yield no information on the ease of moving through the study area.

388 Other environmental data such as soil properties and wadi courses should have also been considered for the creation of the ACS. However, either the relevant data was simply not

Slope (%): ≥ 45 [very severe slope]	Slope (%): ≥ 10 < 25 [moderate slope]	Slope (%): < 10 [gentle slope]	Slope (%): ≥ 10 < 25 [moderate slope]	Slope (%): ≥ 45 [very severe slope]
Slope (%): ≥ 45 [very severe slope]	Slope (%): ≥ 10 < 25 [moderate slope]	Slope (%): < 10 [gentle slope]	Slope (%): ≥ 10 < 25 [moderate slope]	Slope (%): ≥ 45 [very severe slope]
Slope (%): ≥ 45 [very severe slope]	Slope (%): ≥ 10 < 25 [moderate slope]	Slope (%): < 5 [plateau]	Slope (%): ≥ 10 < 25 [moderate slope]	Slope (%): ≥ 45 [very severe slope]
Slope (%): ≥ 45 [very severe slope]	Slope (%): ≥ 10 < 25 [moderate slope]	Slope (%): < 10 [gentle slope]	Slope (%): ≥ 10 < 25 [moderate slope]	Slope (%): ≥ 45 [very severe slope]
Slope (%): ≥ 45 [very severe slope]	Slope (%): ≥ 10 < 25 [moderate slope]	Slope (%): < 10 [gentle slope]	Slope (%): ≥ 10 < 25 [moderate slope]	Slope (%): ≥ 45 [very severe slope]

5	3	2	3	5
5	3	2	3	5
5	3	1	3	5
5	3	2	3	5
5	3	2	3	5

FIG. 32 Schematic raster grid structure of classified slope values (left) and after the conversion of the slope values into the respective cost classes.

proposed by de Silva and Pizziolo, Herzog claims that adding cost components is statistically problematic and may result in misleading cost values.[389] She suggests to multiply cost components as carried out by Zakšek et al. for their study in Languedoc, France.[390] Herzog also proposes following the simple formula for calculating a cost surface map from A. Nelson, originally developed for accessibility studies in modern-day Honduras, as it is a good method for multiplying cost components.[391] Based on Nelson's function, the accumulated cost surface map for this study was thus calculated by multiplying the anisotropic slope values derived from the DEM with the cost classes of the geological features.

All most cost-efficient site catchment areas could then be calculated with the *cost distance* tool available for ArcGIS 10.3 on the basis of the calculated ACS.

Although this is a valid approach, it is important to realize that while this study's ACS represents the most differentiated basis for conducting cost surface analyses, it is only one option among several possible cost surfaces. There are great discrepancies when basing the analysis on different cost surfaces. For example, most cost-efficient areas were calculated for Petra on the basis of (a) slope values based on the freely accessible ASTER-DEM with a raster resolution of 30 m, (b) slope values based on the freely accessible SRTM-1-DEM as well as (c) the accumulated cost-surface raster based on slope values and geological formation (FIG. 33).[392] Based on slope values derived from the ASTER-DEM, the catchment area for Petra is far more extensive, particularly towards the north including the area of Ras Slaysil, Beidha and Baja. In contrast, the catchment area based on slope values derived from the SRTM-1-DEM is significantly smaller as it barely exceeds the immediate Petra valley. Results based on the accumulated cost surface on the other hand, are again more extensive as it extends more to the south and east than the other options do.

As the different cost surfaces clearly result in very different catchment areas, an arguably crucial methodological weakness of site-catchment analyses is exposed (which also applies for least-cost paths described below). With such divergent results, it is difficult to convincingly prefer one cost surface option over the other. While this touches a larger methodological issue, for this study it was deemed best to dismiss all presented cost surfaces and instead propose only the largest overlapping area of all cost surface options as potential catchment areas of archaeological sites (cf. FIG. 33D). While this may be a responsible solution, a 100 m wide buffer zone was nevertheless added along the border of the catchment area in order to highlight the uncertainties inherent to the method.

accessible to this study or the data is only available at such a large and thus useless scale for incorporating it into the ACS.

389 Herzog 2014, chapter 5.8 (http://intarch.ac.uk/journal/issue36/5/5-8.html last accessed 06.04.2021); Herzog 2013, 378; Fiz – Orengo 2008, 316–317; De Silva – Pizziolo 2001, 281–282.

390 Herzog 2013, 378; Zakšek et al. 2008, 311.

391 Herzog 2014, chapter 5; Nelson 2000, 8: Friction = Slope × [Precedence (Barriers, Roads, Rivers, Urban, Land Cover)].

392 All catchment areas were calculated under the same circumstances and with the same *cost distance* tool of ArcGIS 10.3.

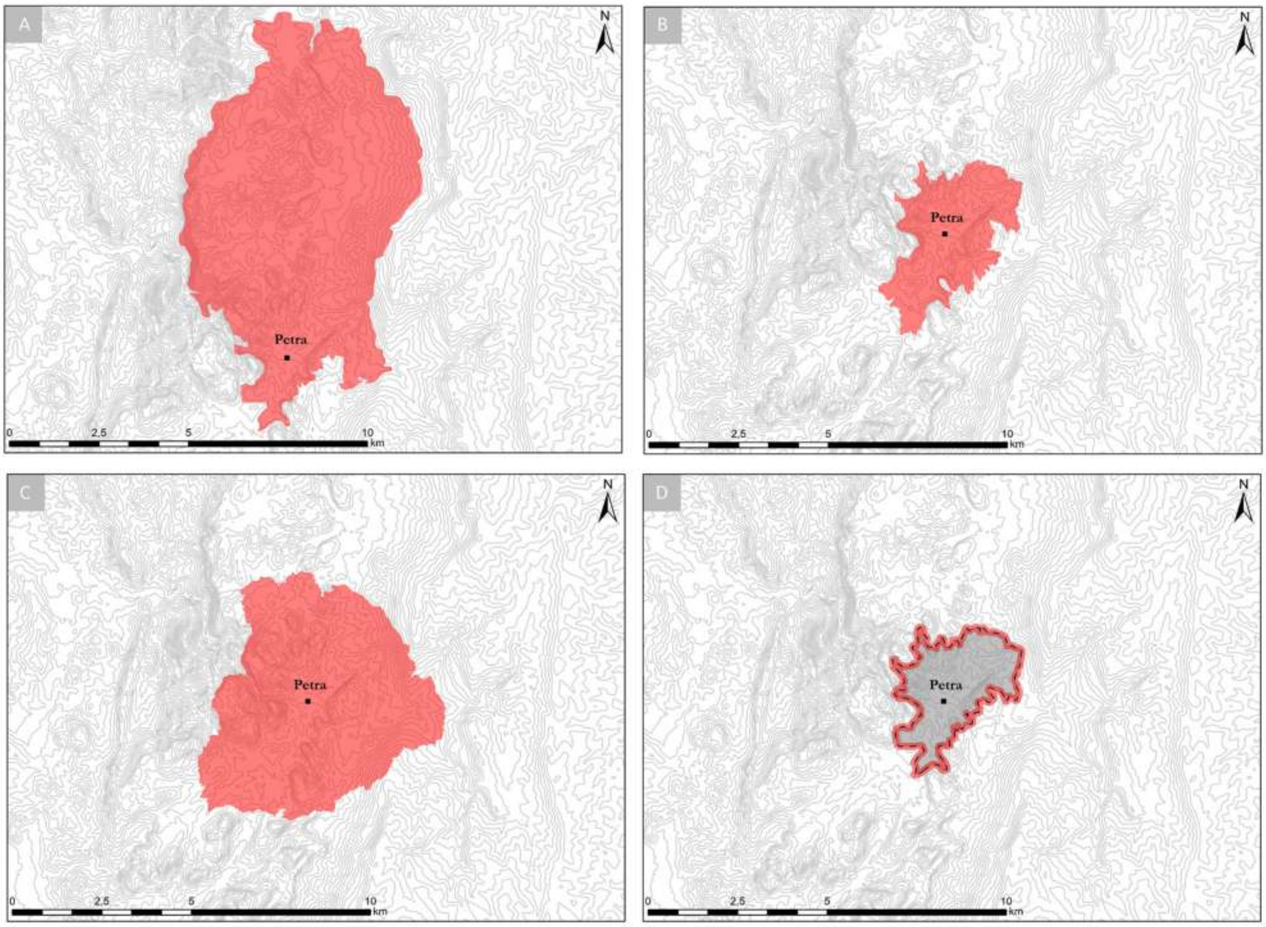


FIG. 33 Most cost-effective catchment areas for Petra based on (A) slope values derived from a ASTER-DEM, (B) slope values derived from a SRTM-1 DEM, and (C) the accumulated cost surface derived from SRTM-1 slope values as well as geological formations. D: Largest overlapping area of all catchment options (grey) with a 100m buffer along the catchment's borders.

Least-Cost Path Analysis

As the calculation of least-cost paths (LCPs) is based on the same cost surface raster as for site catchment analyses, the same methodological concerns apply to LCPs as well. Nevertheless, with the introduction of GIS, the calculation of least-cost paths has grown increasingly popular.[393] The aim of the method is not only to model the possible course of ancient paths, it can also provide information on ancient land use and how the natural environment affected movement through a landscape. When the archaeological evidence is missing, LCPs can offer further insights into the infrastructure and spatial organization of ancient landscapes in terms of transportation velocity, security and the connectivity of different sites.[394] Without highly complex modeling approaches, however, the method does not take certain social factors such as territorial claims, taboo zones or personal preferences into account. LCPs are therefore no substitute for missing archaeological and historical data.[395]

While most archaeological studies base LCPs on slope values derived from digital elevation models, additional environmental factors can also be considered for the calculation of LCPs. This study thus bases all LCPs on the accumulated cost surface, which includes slope values and the geological formations of the study area.

Based on the cost surface, the course of the calculated LCPs is either measured by energy expenditure (i.e. calories) or by time.[396] When the amount of time is measured that is needed to traverse through a landscape, the LCP suggests the shortest (= quickest) path – regardless of the energy spent to travel along the proposed path. When LCPs are measured by the amount of energy needed to travel from one point to

393 It is impossible to offer a complete list of all archaeological studies that conduct LCPs. For a most recent methodological overview on LCPs, see e.g. Herzog 2014 and Polla – Verhagen 2014 with further references.

394 Posluschny 2012, 115; Herzog – Posluschny 2011, 236–237.

395 Posluschny 2012, 115; Herzog – Posluschny 2011, 237.

396 Posluschny 2012, 115.

another, the LCP represents the least-cost path as the name suggests. It also considers "[...] *the actual surface distance that must be traveled and* [...] *the horizontal and vertical factors influencing the total cost of moving from one location to another.*"[397] The "horizontal and vertical factors" are also referred to as friction values, or factors defined by the underlying cost surface for the LCP calculation.

GIS software packages can be based on different algorithms that calculate optimal paths from two pre-defined points in a landscape. Most packages employ Dijkstra's algorithm (e.g. ArcGIS), although Tobler's hiking function is preferred by other studies as it is based on empirically observed data on pedestrian walking pace relevant to different slope values.[398]

Depending on the algorithm used for LCP calculations, the results can vary significantly. While this study follows Tobler's hiking function for LCP calculations, the diverging results are highlighted here when contrasting LCPs calculated between Rujm Ruba'i and Khirbet as-Faysif (Naqb ar-Ruba'i) in the Petra area (FIG. 34). The LCPs were based on Dijkstra's algorithm as well as Tobler's hiking function. While the two LCPs follow the same general course (with the exception of a diverging southwestern turn of the LCP based on Tobler's function), it is striking that both LCPs strongly deviate from the course of Naqb ar-Ruba'i as it was walked and mapped in the field. Rather than following Wadi Jawf Ahmar, the LCPs suggest that the optimal path leads through a parallel wadi to the south of Wadi Jawf Ahmar. However, not only was Wadi Jawf Ahmar pointed out to the author by local Bedouins, the course is further corroborated by several archaeological sites and features observed along the way (cf. chapter 6). At least for this part of the study area, the presented LCPs must be considered critically, as they may not correspond to routes evidenced and mapped in the field.

Arguably, this is less problematic for this study, as from the nearly 50 roads and routes presented and discussed in chapter 6, only six are LCPs. Moreover, these were calculated mainly for reconstructing optimal paths in the wide and flat alluvial plain of the Wadi Arabah where topographical and geological conditions had only a limited impact on the course of routes. The great majority of the presented roads and routes were either archaeologically assessed by the author or are based on other archaeological reports and maps provided by previous studies. The calculation and assessment of LCPs are therefore not central to this study.

Visibility Analysis

Visibility analyses can offer insights into the cultural context of archaeological sites within visual range from a particular observer standpoint and thus allow to deduce information on the observer site as well.[399] There is considerable archaeological research on the aspect of visibility particularly concerning military sites as it is claimed that these were often part of a visual communication network and visually controlled specific territories of their immediate surroundings.[400] With the introduction of GIS, computational approaches to further investigate aspects of visibility have grown increasingly popular and developed into useful quantitative tools particularly within landscape archaeology. As aspects of (inter)visibility form an important analytical role in assessing the functions of the evidenced military structures in the Petraean hinterland as well (cf. chapter 7), the following presents a brief, but critical methodological overview on how GIS-based visibility analyses are used in this study.

GIS-based visibility analyses are based on a digital elevation model (DEM). Binary visibility analyses calculate visible and non-visible areas within a landscape from a pre-defined observer point. In their seminal paper on GIS-based visibility analyses, Wheatley and Gillings define four factors which should be considered when conducting visibility analyses: the local and regional natural landscape conditions (if possible also including climatic and weather conditions), aspects of mobility, the degree and range of visibility from and to the researched observer points as well as the consideration of diachronic landscapes and contemporaneity of archaeological sites.[401] However, information on the elevation of the observer as well as the target points is most important.[402]

Wheatley and Gillings also introduce the concept of the landscape architect, Tadahiko Higuchi, who offered a more differentiated approach on how best to conduct visibility analyses.[403] Following Higuchi, it was recognized that there are additional factors to consider when researching more comprehensive aspects of visibility that go beyond simple analyses of visible and non-visible areas.[404] These include visual

397 http://help.arcgis.com/en/arcgisdesktop/10.0/help/index.html#//009z00000022000000.html (last accessed 06.04.2021).

398 Herzog reports that over 220 LCP algorithms have been developed since the late 1950s: Herzog 2014, chapter 5.3 (http://intarch.ac.uk/journal/issue36/5/3.html last accessed 06.04.2021).

399 Cf. Posluschny 2008, 371; Ogburn 2006, 405.

400 For Jordan, cf. e.g. most recently Driessen – Abudanh 2019 and Castro 2018, 46–57.

401 Wheatley – Gillings 2000, 5–14.

402 Posluschny 2008, 367.

403 Wheatley – Gillings 2000, 5–14; Higuchi 1983.

404 Wheatley – Gillings 2000, 15.

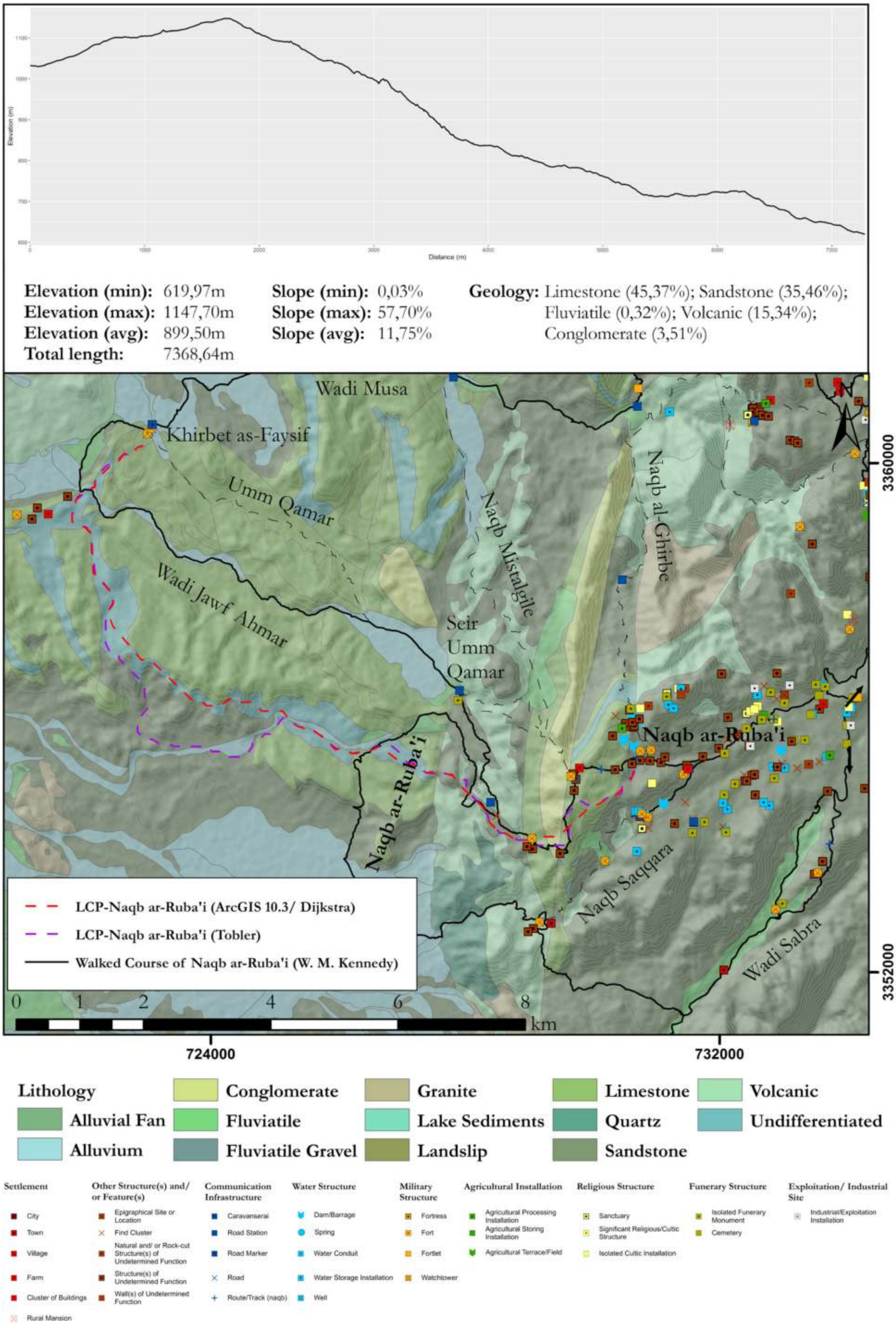


FIG. 34 Map of Naqb ar-Ruba'i leading from Rujm ar-Ruba'i to Khirbet as-Faysif in the Wadi Arabah as walked by the author (black line). Contrasted by the LCPs based on both Tobler's hiking function as well as Dikstra's algorithm used in ArcGIS 10.3.

ranges, horizontal and vertical angles, three-dimensionality and lighting, as well as distance values. Particularly concerning distances, Higuchi realized that landscapes are perceived as complex constructs that become increasingly blurred at greater distances. Therefore, distances have a great impact on the quality of landscape perception. This led Higuchi to define a standardized object height relatable for the observer when viewing the objects within a landscape at various distances. This was tested by Higuchi in a well-forested area using 6 m tall trees as a standardized object height.[405] He recorded the visual quality of the trees at different distances and, on this basis, defined three visibility ranges:

Objects within the immediate visual surroundings of the observer are within a *short-distance view*. When viewed across a wide terrain however, where topographical features are generally perceivable but objects are more difficult to distinguish (mainly due to larger distances and the impact of weather conditions), Higuchi claims these are within a *middle-distance view*. At this range, aspects of visibility are most significant.

Everything within Higuchi's *long-distance view* may be generally visible, but have no immediate impact on the observer as the objects are simply too far away. For example, colors are no longer perceivable and topographical features are blurred on a distant horizon.

Acknowledging Higuchi's distance values, this study conducts GIS-based visibility analyses in consideration of the following aspects and methodologies: Natural landscape; climatic and weather conditions of the study area; observer and target heights; Higuchi's distance-based visibility ranges, as well as an archaeological discussion of the structures for which visibility analyses are conducted.

The visibility analyses are based on the freely accessible SRTM-1 DEM with a raster resolution of 30 m. The analyses were calculated with a horizontal angle of 360° and a vertical angle of 90° above and below the horizontal viewing line of the observer. All visibility fields were calculated using the *r.viewshed* command of Grass GIS 7, which was incorporated into an R-script to better handle the large amount of archaeological sites.[406]

To define observer and target heights and establish a realistic distance within which structures of a specific height remain clearly visible, the author already proposed visual parameters for conducting visibility analyses. These are followed here as well.[407] Based on excavation results of a presumed Nabataean-Roman watchtower on top of Umm al-Biyara immediately southwest of Petra, the structural remains of the tower did not permit the reconstruction of a large structure height. A first visibility field was therefore calculated with an observer height of 1,70 m corresponding to the presumed average height of a local male in antiquity. While the resulting visibility field included vast areas south-southeast from the tower on Umm al-Biyara, it did not reach other preselected towers in the Petra area, which were considered to further research their visual relation to each other.[408] Due to this negative result, different observer heights were arbitrarily defined to test the potential impact of different observer heights on the resulting visibility fields. Experiments with observer heights of 3 m, 4 m, 6 m as well as 8 m were carried out. While the various visibility fields generally did not show any significant differences, the results with larger observer heights (6 m and 8 m) unrealistically included areas 40 km away from the structure on Umm al-Biyara (the radius of the visibility analyses were set as indefinite) which fall into Higuchi's long-distance visual range. Moreover, the small wall width and overall poor structural remains of the Umm al-Biyara tower could not suggest a reconstructed height of 6 m or 8 m. A more realistic observer height of 4 m was thus defined as the sum of the average height of a local male (1,70 m) and a proposed maximum structure height of 2,30 m, which is more appropriate considering the structural remains of the tower on Umm al-Biyara.

Adopting the proposed maximum observer height of 4 m for all other towers in the Petra region, the maximum distance within which structures of such height would have had to be within to be clearly visible remained undefined. Based on the proposed standardized height of 4 m, the visibility fields of the discussed towers were divided into Higuchi's short-distance, middle-distance and long-distance visual ranges: Following the Hi-

405 Higuchi 1983, 11–16. Also cf. van Leusen 2004, 11–12 who applied the Higuchi method for his visibility analyses on Archaic and Early Roman settlements in the Pontine region (Latium) in Italy. Llobera 2007 also discusses Higuchi viewsheds in his study on aspects of 'co-visibility' between round barrows in northern England. Also consider the application of the Higuchi method by Murrieta-Flores 2014 on her study on the role of megalithic monuments as potential waypoints along routes in prehistoric Andalucia, Spain.

406 See Appendix III for the full R-script.

407 Kennedy 2016b and 2013b. Driessen – Abudanh 2019 now follow these parameters as well.

408 In Kennedy 2013b, these included contemporary Nabataean-Roman structures at Qasr Umm Rattam, ar-Rajif as well as Jabal Qarun (which is now dismissed as a tower in this study). Kennedy 2016b also adds a presumed Nabataean-Roman tower situated along the lower Jabal Shara escarpment.

409 Higuchi 1983, 14–16. Also see Wheatley – Gillings 2000, 16: *"In quantitative terms the maximum distance at which*

guchi method, the standardized height of 4 m was multiplied with 60 for a short-distance range and 1100 for a large-distance range.[409] Accordingly, a short-distance radius of 240 m was defined, with everything beyond 4400 m falling within the long-distance range. Therefore, the middle-distance range includes everything between 240 m and 4400 m from the observer standpoint. As aspects of visibility are most important within the middle-distance range, all visibility analyses were conducted for an observer height of 4 m and a maximum middle-distance radius of 4400 m. [410]

In order to confirm these proposed visual parameters, they were positively tested with other examples of presumed Nabataean-Roman watchtowers in the Wadi al-Hasa area c. 75 km north of Petra where other scholars assumed that the structures were intervisible.[411] It was shown that all of the tested structures from the Wadi al-Hasa were well within the middle-distance radius of 4400 m and thus formed an intervisible unit.[412]

As part of the *Limes Arabicus Project* concerning the Roman defensive system in Jordan, Parker also researched visual means of communication around the *castrum* of al-Lejjun c. 160 km northeast of Petra using an experimental archaeological approach.[413] Manning 14 contemporary watchtowers and other military structures located on hilltops around the *castrum* and placed between 1,5 and 2,5 km from each other, Parker observed the degree of visibility between the structures using fire, smoke and mirror signals in the morning, mid-day and after nightfall. The experiment concluded that fire signals were the best option, particularly at night. Based on the good visibility of night fire signals, a visual communication network was reconstructed reaching three manned posts at 15 km and ten manned posts at 20 km. This implies an average distance between posts of two to five kilometers, and corresponds with the proposed maximum middle-distance radius of 4400 m.

As the examples from the Wadi al-Hasa and al-Lejjun areas confirm, the presented visual parameters previously proposed by the author make it reasonable to accept the parameters for the present study as well. All visibility analyses conducted in this study are therefore based on a predefined observer height of 4 m and only consider areas within the maximum middle-distance range of 4400 m.[414]

The Applied Landscape Archaeological Analyses – A Methodological Appraisal

This study's landscape archaeological approach demonstrates certain advantages and disadvantages. These are reviewed in this section, which serves as a critical methodological appraisal and should be kept in mind when considering the results of the different methods and analyses applied here.

For this study's specific aims, it has proven useful to follow the landscape archaeological approach as defined at the beginning of this chapter. Understanding landscape archaeology as the study of past cultural landscape changes (*Kulturlandschaftsgenese*) that clearly focuses on the material remains of past cultures in a landscape, offers unique opportunities to further investigate a wide range of archaeological research questions pertaining to the relationship between the natural environment and the cultural landscape. Landscape archaeological studies follow a multi- and interdisciplinary approach applying useful methodologies and analyses from related fields, particularly from the geosciences. These offer farther-reaching insights in addition to more 'traditional' archaeological and historical approaches.

However, a common weakness in some landscape archaeological approaches is that the focus sometimes relies too strongly on the development and discussion of the various multi- and interdisciplinary analytical methods. Dependent on the academic background and skillset of the individual researcher, to apply the various landscape archaeological analyses in a methodologically correct fashion, a large learning barrier must sometimes be overcome, with the conduct of the different methods potentially resulting in an unbalanced time and work effort.[415]

visibility can be regarded as short-distance is equivalent to a horizontal angle of steady gaze of 1 degree, or approximately 60 times the size of the dominant tree species for the area. At a horizontal angle of gaze of 3 minutes, equal to a distance of 1.100 times the size of the tree, we move into the long distance range." Obviously "the size of the dominant tree species" is to be replaced with the standardized height of structures for which visibility analyses were conducted.

410 For more on how these visual parameters were defined, see Kennedy 2016b, 165–169 and 2013b, 286–287.

411 MacDonald 1984, 219–230.

412 Kennedy 2016b, 171–173 and 2013b, 287–288.

413 Parker 1986, 60, 84. See also Kennedy 2016b, 173–174 and 2013b, 288.

414 This may appease skeptics who criticize archaeological studies that claim visual communication networks over great distances, but who "[…] *concede that communication networks can function over short distances of 1 to 5 km*" (Fachard 2016, 230). For some critical views on visual communication networks between military structures, see Fachard 2016, 229, n. 89 referring to Lohmann 1995, 159–160 and Fachard 2012, 271–273.

415 For example, without any extensive prior knowledge in programming, it took the author more than one month

Indeed, the correct application of landscape archaeological methodologies can significantly challenge the core skillsets of any archaeologist. There is a great risk that landscape archaeologists gradually mutate into geoscientists, environmental researchers, surveyors and cartographers, statisticians and mathematicians or computer programmers. As a downside of an overly interdisciplinary approach, some landscape archaeological studies draw so strongly from other methodologies – particularly from non-archaeological fields of the natural sciences – that a more in-depth archaeological and culture-historical contextualization and discussion is often reduced to a mere side note. Many landscape archaeological analyses can be methodologically so overwhelming that it is easy to fall into a deep methodological trap. The development and application of complicated analytical methods is sometimes so disproportionately prioritized that the capacity to offer meaningful archaeological and culture-historical discussions seem to be exhausted. In some studies, 'landscape' is clearly in central focus while 'archaeology' is pushed into the peripheral. Complex archaeological sites are reduced to simple points on the map and intricate archaeological and historical discussions are disregarded for the sake of dominating quantitative analytical models.

In other examples, some studies apply various landscape archaeological analyses without clearly discussing their inherent methodological setbacks and shortcomings. The advantages and potential of landscape archaeological methodologies are realized, but such studies often follow a dangerous 'push-the-button principle.' As landscape archaeological analyses produce calculated, quantitative research results, such studies run the risk of being blinded by impressive, 'scientific-looking' distribution maps, graphs and charts etc. but fail to grasp the full complexity and potentially problematic premises inherent to the applied methods.

Keeping these two viewpoints in mind is crucial when following a strong landscape archaeological approach such as this study. It is important to be critically aware of the technical particularities of the applied methods and to make their strengths and weakness, as well as inherent methodological premises transparent to assess their value for farther-reaching archaeological and culture-historical discussions.[416] The following therefore serves as a critical methodological appraisal of the different landscape archaeological analyses applied in this study.

First, this study established a quantifiable chronological system respecting the differing datings of sites documented by the original surveys conducted in the Petra region. By means of complex statistical calculations, this study not only filters the various chronological inconsistencies within the original surveys and makes them transparent for further research, it also lays the groundwork for reconstructing a more differentiated and methodologically coherent archaeological model of the Petraean hinterland throughout the periods considered for this study. However, the resulting probability graphs for the maximum time spans of the various cultural periods remain unclear and can be considered only as a visualization of the inconsistent chronological periodization of archaeological sites surveyed within the Petraean hinterland. The graphs should not be taken as factually absolute definitions of chronological periods, but rather as transparent representations of dating (un-)certainties. While this approach has allowed the incorporation of otherwise useless survey data with chronological information providing undefined cultural periods only, sorting the relevant data into the respective time spans was nevertheless based on *fuzzy dating values*. Although this approach minimized the margin of error and produced a statistically reliable dating system for the study, the root of the problem lies in the initial data collection and chronological precision of the various surveys. Even by means of such analytical methods, it will never be possible to account for the subjective and unilateral decision making process during archaeological survey work – i. e. particularly in this case the dating of surface pottery and different definitions of chronological periods. While the only possible solution is to subject all base data to the same examination method and to assess the data by the same criteria (as was attempted in this study), the resulting new dataset will never be completely uniform as this would require all dating material to be analyzed by only one person or team. Therefore, a degree of uncertainty naturally remains in the subsequent breakdown of the entire archaeological dataset by centuries.[417]

Second, by applying the highly complex spatial statistical method of *point pattern analysis* (PPA), this study has gone far beyond general assessments of the spatial distribution of the various archaeological site categories evidenced in the Petraean hinterland. The method has proven to be a useful tool for describing the spatial processes that caused the patterns of the

alone to write the relevant R-scripts for the applied point pattern and visibility analyses.

416 Cf. also Knitter et al. 2018, 196–198 who also underline the importance of developing a critical awareness of the pitfalls inherent to interdisciplinary landscape archaeological approaches.

417 The specific dating values of all sites discussed in this study are listed in the site catalogue (Appendix I).

various sites quantitatively, thus serving as a solid methodological basis for dealing with a vast archaeological dataset. PPA can be considered as a good toolset that offers valuable quantitative data for subsequent qualitative, archaeological and historical interpretation of the potentially various reasons for past human settlement behaviors. However, as exemplified for 1st century AD settlement sites, PPAs produce a vast amount of spatial and environmental information, but not all necessarily provide meaningful productive results for a farther-reaching archaeological and historical discussion. It is thus justified to question the value of such detailed and exhaustive quantitative analyses. Admittedly, some patterns may be easily noticed on a distribution map. Keron rightly critiques PPAs as sometimes simply confirming obvious site clusters by overly complicated quantitative means.[418]

Moreover, the acquired archaeological dataset is so diverse and covers such a wide time span that it is impossible to provide comprehensive PPA results for each type of archaeological evidence and its respective subcategory. Specifically concerning the PPAs, this study therefore follows a more pragmatic approach discussing them specifically for site categories only when the analysis may yield more promising and useful results. For example, it would overreach the limits of this study to discuss all density-based first- and second-order properties demonstrated above for the 1st century AD settlements. Particularly quadrat counts and the evaluation of global and local intensity values are too abstract for a meaningful archaeological discussion of the various archaeological site patterns. However, the calculated *kernel density estimations* (KDEs) have proven to be a useful tool for discussing specific site densities and clusters of the various archaeological categories – despite Keron's criticism that, in some cases, KDEs and other density-based analyses mathematically demonstrate the obvious. The statistical method is particularly meaningful as it nicely visualizes site concentrations and can thus be well understood without any deeper understanding of more abstract and complicated distance-based functions such as the presented G-, F-, and K-functions (which are therefore only analyzed and discussed in singular cases here). However, as the calculated KDE results are heavily influenced by the bandwidth definition, it is important to keep in mind that alternating bandwidths may lead to slightly different results.

This study also makes substantial use of the *Pearson correlation test*, which is based on the KDEs. This method statistically calculates certain spatial correlation values between the various archaeological sites through time, and is thus a powerful analytical tool. As the originally numeric values of the correlation test are too abstract for a meaningful archaeological discussion, they were reclassified into qualitative expressions following statistically recognized classes. However, there are different qualitative classifications of the Pearson correlation values which, when applied, may lead to different statistical inferences. This should be kept in mind when assessing the results of the Pearson correlation values. It should also be noted that this study will not discuss 'very weak,' 'weak' and 'moderate' spatial correlations as the scientific value of such information is relatively limited.[419] Only 'strong' and 'very strong' spatial correlations will be discussed explicitly as such correlation classes signify noteworthy and conspicuous spatial correlations between different archaeological sites.

All density- and distance-based approaches conducted within PPAs (including KDEs as well as the Pearson correlation test) are strongly influenced by the underlying archaeological dataset. For example, the discussed site densities evidenced by the KDEs are impacted by the varying survey intensities. The spatial correlations between the archaeological sites discussed on the basis of the Pearson correlation test is also highly sensible to the various spatial distributions and patterns of the different archaeological site categories. Any minuscule change in the pattern of any archaeological site category may potentially result in different correlation values. Therefore, the potential bias of the underlying dataset must always be taken into consideration when assessing the Pearson correlation tests.

PPAs also allow to discuss general distribution characteristics for sites, e.g. standard Euclidean distances between 1st century AD settlement sites and the distances to other archaeological sites (cf. TABLE 10). General natural landscape characteristics such as slope values, slope direction, elevation values (in addition to intensity functions of terrain elevation), distances to streams (wadis) as well as the different geological zones can also be extracted. While such information may have value for highlighting the spatial characteristics of particular sites, providing such information for each archaeological site category for all time periods would be a perfect example of an unbalanced

418 Keron 2015, 30: "[…] *we are almost invariably dealing with something that is most definitely a cluster on the landscape and we are frequently looking at the entire cluster, so trying to prove it is a cluster is just mathematically demonstrating the obvious.*"

419 The relevant information will be listed mainly in the relevant tables uncommented.

time and work effort as mentioned above. The informative value is purely descriptive and arguably of only limited use for a more in-depth archaeological and culture-historical discussion. Such general landscape characteristics are therefore only rarely presented in the following chapters.

While PPA is a particularly useful approach for describing detailed spatial patterns in a scientific and methodologically reliable manner offering well-grounded evidence for further archaeological and historical discussions on ancient settlement behaviors, the analysis clearly has its methodological shortcomings.

Other landscape archaeological analyses applied in this study include *cost surface analyses*. These result in good GIS-based models allowing insights into how natural landscape factors impacted movement across the Petraean hinterland. Specifically, the *site catchment analysis* was conducted in order to model environmentally determined territories of preselected archaeological sites. However, the resulting site-catchments are defined as the most cost-efficient area when traversing through the landscape and are thus based entirely on environmental factors. The calculated catchment areas are also heavily dependent on the underlying cost surface model. For example, entirely different models were presented when basing the analysis on different DEMS or the accumulated cost surface (ACS). As it is difficult to prefer one cost surface model over the other, a major methodological problem inherent to the site-catchment analysis was exposed. It was therefore deemed best to propose the largest overlapping area of all cost surface options as potential catchment areas of archaeological sites. Despite these methodological shortcomings, the calculated catchments are nevertheless adequate suggestive models.

This study also calculated GIS-based *least-cost paths* (LCPs) in order to model the possible course of ancient routes, particularly when there was no positive archaeological evidence for specific routes in the study area. As the modelled site-catchments, LCP results are extremely dependent on the underlying cost surface model and the applied algorithms as well. The LCP results based on the commonly used algorithm of Dijkstra as well as Tobler's hiking function were thus compared with the course of a route in the Petra area that was walked and mapped by the author. While there were similarities in the modelled paths, significant differences exist as well. Although LCPs are not explored extensively in this study, such methodological issues must nevertheless be acknowledged.

Finally, GIS-based *visibility analyses* were calculated in order to gain further insights into the cultural context of specific archaeological sites within visual range from a particular observer standpoint. Visibility analyses were specifically calculated for the evidenced military sites in order to evaluate whether they were part of a visual communication network and/or visually controlled particular territories of their immediate surroundings. While visibility analyses are generally useful for deducing further information on specific functions of archaeological sites, the results are impacted by the defined observer height and radius of maximum visibility. This study therefore follows the Higuchi method and all visibility analyses are based on a predefined observer height of 4 m and only consider areas within the maximum range of 4400 m. These parameters should be considered when evaluating the discussed visibility analyses.

As this methodological appraisal of the applied landscape archaeological analyses has shown, the results of all discussed methods can only be considered as analytical *models*. All analyses are either based on problematic methodological premises and assumptions, or show certain inherent methodological weaknesses. Quantitative and computational approaches in archaeological research are clearly limited and often not made transparent in landscape archaeological studies. This chapter shall therefore make the reader critically aware of the methodological shortcomings of the applied landscape archaeological analyses. These must be acknowledged when assessing the reliability and value of the methods. This study therefore avoids the above-mentioned 'methodological trap' and strongly argues the viewpoint that the application of such quantitative spatial analyses are only one part of landscape archaeological approaches. Quantitative analytical approaches can only offer additional lines of evidence to a more in-depth archaeological and culture-historical discussion of archaeological datasets. They should serve as an extension of our observational abilities, and not form the basis for it.[420] Particularly concerning spatial statistics, but also applying to quantitative spatial methods in archaeology in general, Keron brings it nicely to the point:

> [Landscape archaeological analyses] *are just another widget in the archaeologist's tool kit, much like a microscope or a Munsell soil colour chart. The job of interpreting the implications of all of our archaeological observations, statistical and otherwise, is and always will be the responsibility of the archaeologist.*[421]

420 Keron 2015, 210 after Wheatley – Gillings 2002.
421 Keron 2015, 211.

Chapter 3
The Petraean Hinterland in the Iron Age Periods. An Overview

Human activities in the Petra area date as far back as the Palaeolithic periods. The region was also settled during the Early Bronze Age as well as the Iron Age periods (12th – 6th centuries BC) when the chronological scope of this study begins.

With the rise of the Edomite kingdom (8th – 7th century BC), the Petra region experiences the most extensive pre-Nabataean settlement activities. These are mainly characterized by almost inaccessible isolated mountaintop settlements distributed along the sandstone outcrops of Petra itself as well as along the limestone formations of the Jabal Shara region and the eastern high plateau with no access to fresh water, thus necessitating carving cisterns into the bedrock surface.[422] These mountaintop sites are all located within the study area and include Umm al-Biyara, as-Sadeh, Baja III, Khirbet al-Mu'allaq, Jabal al-Qseir, Jabal al-Khubtah, Jabal as-Suffaha, Mansur, Tawilan, al-Muzayr'a, Jabal Shara as well as two sites in the at-Tayyiba and Ayl areas.[423] They are all situated near terraces and fields, which were most likely used as pasturages and small-scale agricultural activities. The most prominent Iron Age hilltop settlement in the Petra region is undoubtedly Umm al-Biyara where a stamped seal was discovered mentioning "Qos-Gabr, King of Edom" who is probably also referred to in the annals of the Assyrian kings Asarhaddon (673 BC) and Assurbanipal (667 BC), offering a more precise date for the settlement on Umm al-Biyara.[424]

Scholarly debates on these Iron Age mountaintop settlements are mainly concerned with the question why they were situated on such inaccessible hilltops with no access to spring water although this was widely available along the Jabal Shara escarpment. It is assumed that the inhabitants (most likely belonging to various tribes) acquired cereals and other agricultural goods from nearby settlements in the plains below by means of trade.[425] The ceramic assemblages of these settlements only include coarse wares. Fine wares are generally absent. This has led to the suggestion that settlements may have been occupied only seasonally. However, the absence of fine wares is probably better explained by varying (tribal) traditions and dietary habits. It seems more likely that the sites were permanently settled and that the different 'tribes' were involved in caravan trade along the Darb ar-Rasif (King's Highway) or other routes in the Petra area.

During the Iron Age, large parts of rural Petra's population were probably pastoral nomads living in tents. However, the increase of rural agricultural settlements along cultivable lands (predominantly on the eastern high plateau; cf. below) during the 8th and 6th centuries BC may have pushed pastoral nomads further into the more arid and peripheral areas of the Petra region where the environmental conditions did not allow the cultivation of crops. As this development continued, scholars hypothesize that some of these pastoral nomadic tribes retreated on top of isolated mountains that became characteristic for Edom.[426] Whether the settlement mountaintops can truly be associated with retreating pastoral nomads or not, the hilltop sites certainly served as 'central places' of different Iron Age peoples local to the Petra area.

With the end of the Edomite kingdom in the 6th century BC, recent research concludes an abrupt abandonment of virtually all Iron Age settlements throughout the entire Edomite realm. As there is little to no archaeological evidence for continuity of Iron Age settlements into the Nabataean period, it is assumed that the Petra region was inhabited mainly by pastoral nomads until the 1st century BC.[427]

This sets the very general context of the Petraean hinterland during the Iron Age periods. While the following presents the various Iron Age findings in the study area, this chapter does not aim to provide an exhaustive discussion of the Petraean hinterland during the Iron Age. The period constitutes merely the chronological 'preview' to the main Nabataean and Roman periods, thus serving only as an overview of the Petra area during the Iron Age. While the

422 Generally on the Petra area during the Iron Age, see e.g. Bienkowski 2013; 2012; 1992b as well as Bartlett 1989.

423 For an overview with further references, see Bienkowski 2013, 23–28.

424 Cf. the final report of C. M. Bennet's excavations on Umm al-Biyara: Bienkowski 2011.

425 On the tribal structure of the study area during the Iron Age, see e.g. Bienkowski 2007.

426 Cf. e.g. Bienkowski 2013.

427 There are only few indications for settlement activities in the area during the Hellenistic period (cf. chapter 9).

archaeological data recorded by the various surveys was analyzed as for the later periods, an in-depth culture-historical discussion of the Iron Age periods was not possible within the limits of this study. This chapter may nevertheless serve as an adequate basis for future research aiming at further investigating the Petraean hinterland during the Iron Age.[428] The following sections are structured by the same superordinate topics as the next chapters, in which the relevant archaeological evidence is presented and discussed.

Subsistence Strategies

This section deals with the subsistence strategies in the Petraean hinterland during the Iron Age periods. As in chapter 4, the following presents all relevant 'agricultural installations,' 'water structures,' 'other structures and/or features' related to alternative subsistence strategies as well as 'exploitation/industrial sites.' The definitions of these site categories are given in chapter 2.

Agricultural Installations

While the various surveys have documented no agricultural terraces or agricultural storing installations for the Iron Age periods (cf. FIGS. 35–37), there are only two agricultural processing installations that date to the 12th and 11th centuries BC: The threshing floor of ShamAyl Site No. 308 and the winepress of WMWS 1996 Site No. Bayda 21. By the 10th century BC two additional threshing floors are evidenced, but these remain the only four agricultural processing installations until the 6th century BC (cf. FIG. 36).[429] No agricultural installations are documented for the 5th century BC.

Water Structures

There are only six water structures recorded for the Iron Age. Two water conduits presumably dating to the 12th and 11th centuries BC are situated southeast of Udruh (FIGS. 38 and 39). According to MacDonald et al., Iron Age surface material was recorded at ShamAyl Site No. 142 (Wadi al-Fiqai) which is described as an above-ground aqueduct that still stands up to 1,50 m high.[430] However, an Iron Age date for this aqueduct is doubtful. Abudanh and Twaissi are certainly correct in assuming that the aqueduct is part of the Byzantine *qanat* system in the Udruh area (cf. chapter 4) and associated with the contemporary village of Khirbet al-Fiqai in the immediate vicinity of the aqueduct.[431] The other water conduit where surface pottery material may suggest an Iron Age date is ShamAyl Site No. 366. According to the original surveyors, this conduit is also part of the Udruh *qanat* system. The site is described as an underground channeling system with *qanat* shafts. As for the latter site, an Iron Age date should be rejected as the extremely limited amount of surface material may have been washed in from anywhere.

Supposedly dating from the 10th century BC onwards, ShamAyl Site Nos. 195 and 365 also belong to the Udruh *qanat* system.[432] An Iron Age date for these two sites is also very unlikely.

Only two water storage installations were documented for the 10th – 6th centuries BC. MacDonald et al. identified a small, 4 × 4 m reservoir south of Saddaqa near Khirbet Juwayza as well as a cave along the eastern high plateau that was further developed into a cistern. Presumably, these date to the Iron Age.[433]

Other Structures and/or Features Presumably Related to Alternative Subsistence Strategies

As for later periods, the various surveys have identified a large number of sites dating to the Iron Age periods that are difficult to define functionally. Among such sites, there are also structures and/or features that may be related to alternative, possibly pastoral, subsistence strategies. While only 25 structures of un-

428 E. g. McGlone 2018 recently initiated similar landscape archaeological investigations of Iron Age sites surveyed in areas between Ras en-Naqb and Busayra.

429 The only possible agricultural storing installation may be the large enclosure of D. Kennedy's 'Circle 5' (cf. MacDonald et al. 2016, 307–308). However, this is problematic as discussed below.

430 MacDonald et al. 2016, 254–255.

431 Abudanh – Twaissi 2010, 69–70, 72, 83.

432 MacDonald et al. 2016, 306–307, 449–450.

433 MacDonald et al. 2012, 54.

434 In total, the various surveys have documented 71 find clusters dating from the 10th – 6th centuries BC (cf. FIG. 40). No pottery concentrations are documented for the 12th – 11th centuries or for the 5th – 2nd centuries BC. Epigraphical sites or locations are evidenced from the 10th – 6th centuries BC. No rock drawings (petroglyphs), wusūm or inscriptions were documented for the Iron Age. The surveys documented 20 walls of undetermined function. These are constructed by a number of techniques, have various dimensions and are built of different stone material. Surface material suggest a date between the 10th and 6th centuries BC (as well as from the 1st century BC until the 7th century AD). Findlater (2003, 200–201) discusses the possibility that the important Khatt Shebib wall dates to the Iron Age, but this is convincingly dismissed by Kennedy and Banks (2015, 151) as further discussed in chapter 4.

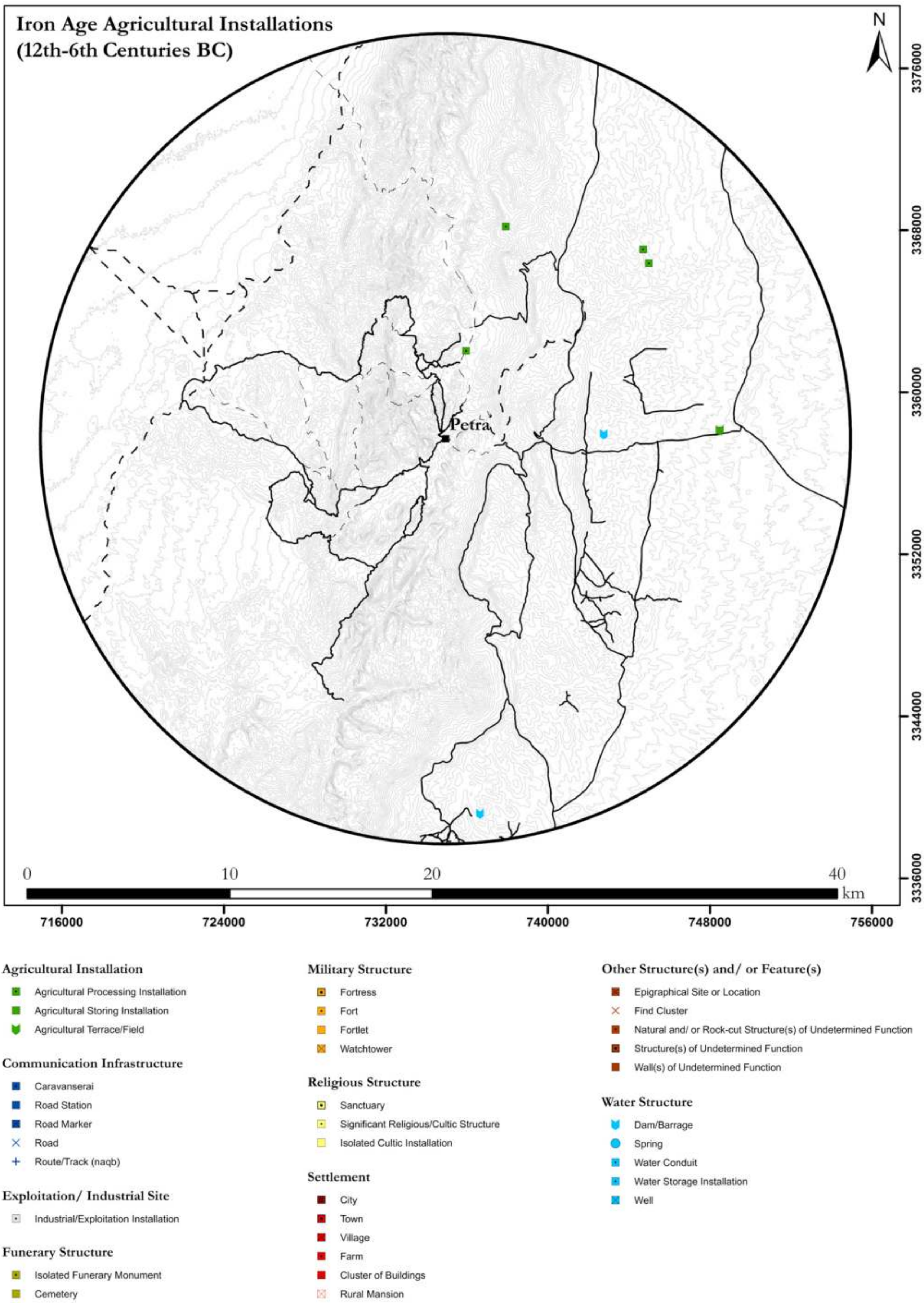


FIG. 35 Distribution map of all agricultural installations dating to the Iron Age period (12th – 6th centuries BC) in the Petraean hinterland.

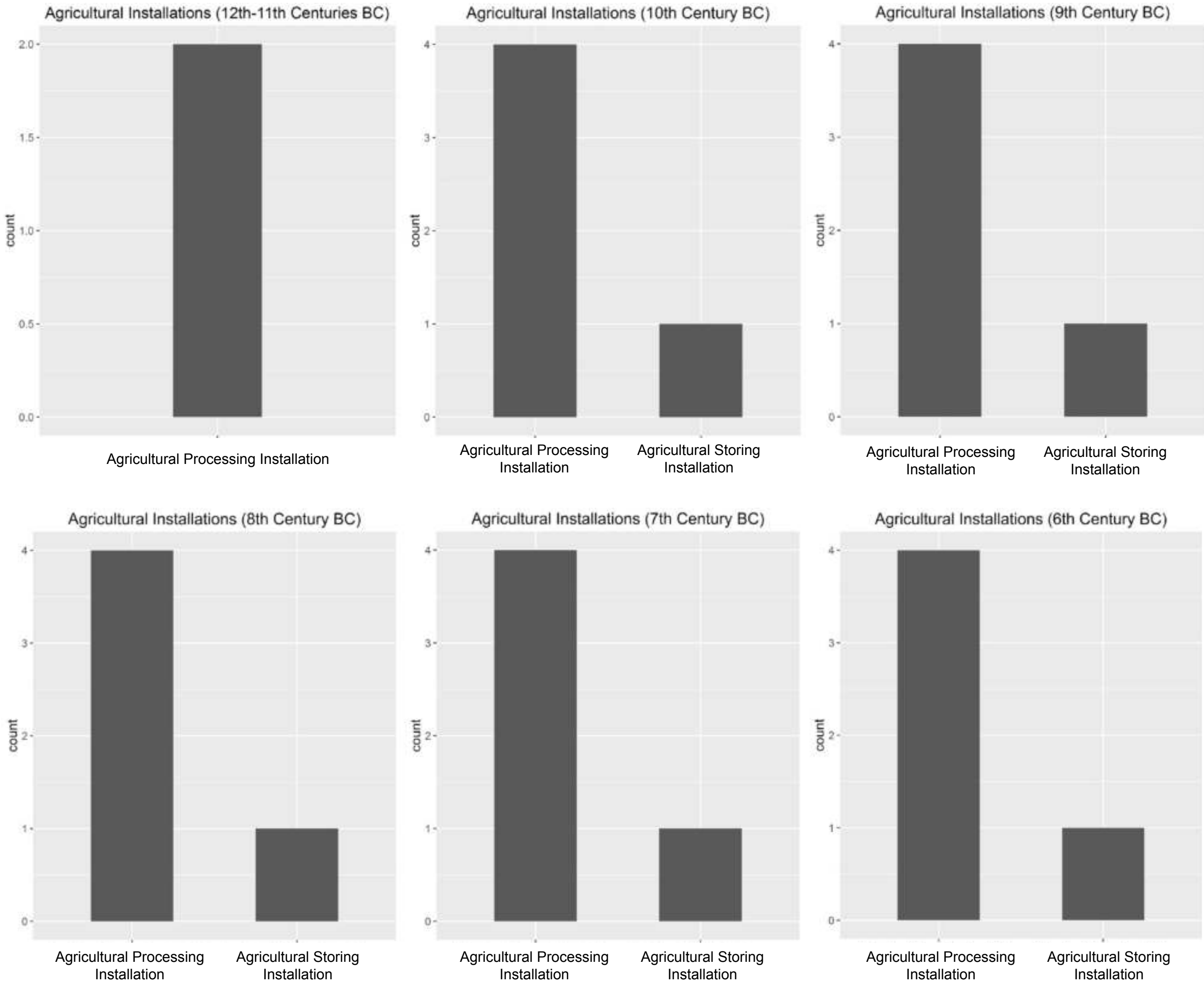


FIG. 36 Number of all agricultural installations dating to the Iron Age period (12th – 6th centuries BC) in the Petraean hinterland.

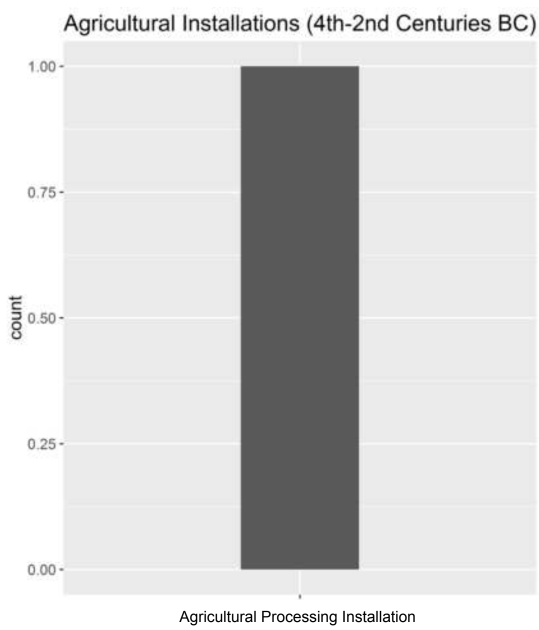


FIG. 37 Number of all agricultural installations dating to the Hellenistic period (4th – 2nd centuries BC) in the Petraean hinterland.

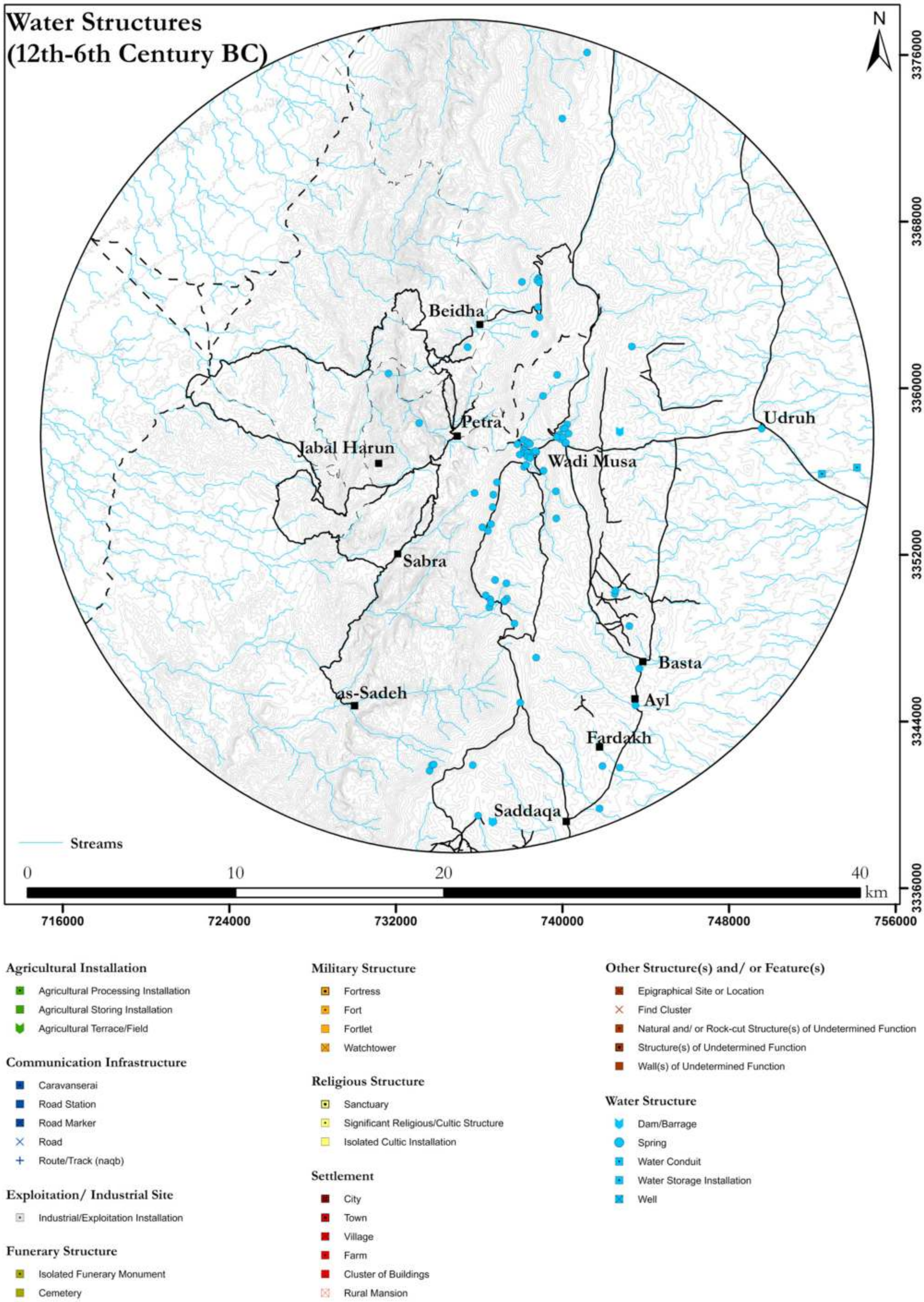


FIG. 38 Distribution map of all water structures dating to the Iron Age period (12th – 6th century BC) in the Petraean hinterland.

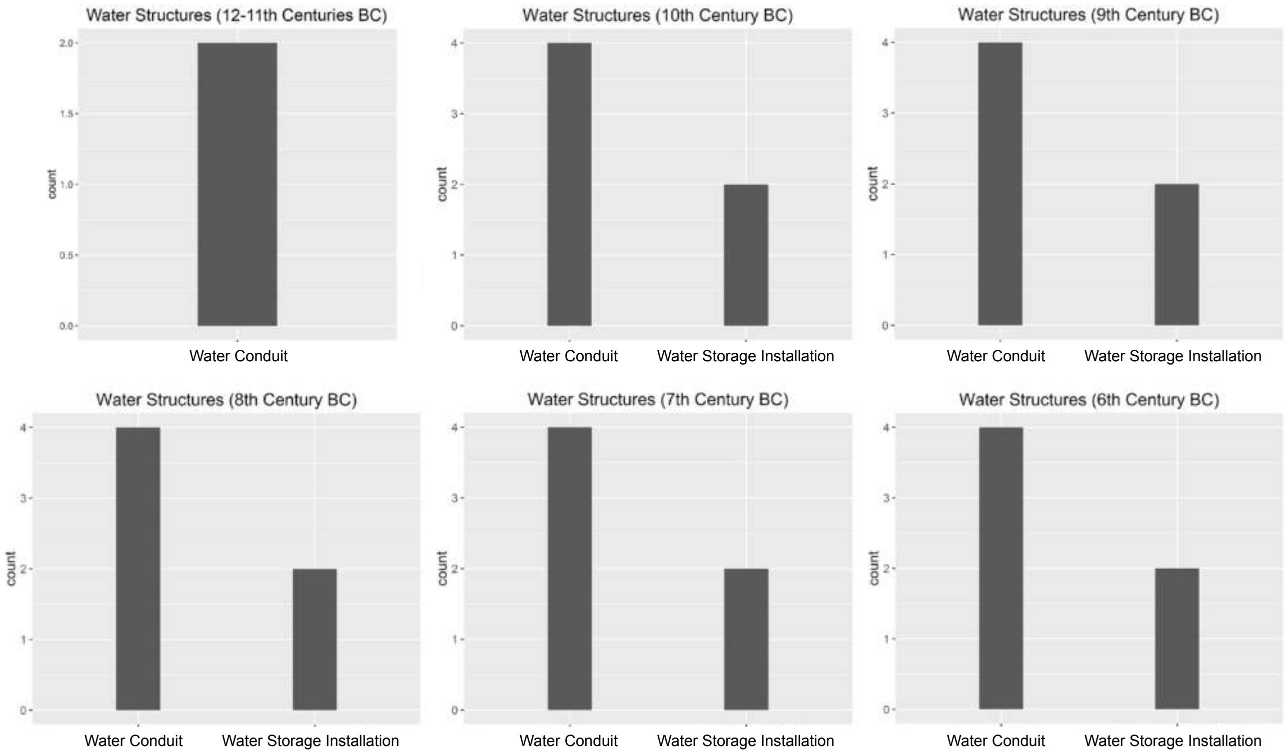


FIG. 39 Number of all water structures dating to the Iron Age period (12th – 6th centuries BC) in the Petraean hinterland.

determined function (in addition to the few find clusters and walls of undetermined function)[434] date to the 12th and 11th centuries BC, the 10th century BC marks a significant increase with over 50 documented structures of undetermined function (FIG. 40).[435] These include possible Iron Age camp sites that may have been used by pastoralists. While there are no corrals recorded for the Iron Age, ShamAyl collected Iron Age surface pottery from the two large stone circles at Khirbet Jarba and Udruh (Kennedy Circles J5 and J6) at the opening of the Khatt Shebib wall, which are discussed as possible 'open market areas' for pastoralists coming from the desert areas east of Udruh (cf. chapters 4 and 9).[436]

Surface material suggests that natural and/or rock-cut structures of undetermined function (95 sites) were in use between the 10th and 6th centuries BC as well.[437] These include natural caves or rock shelters, which could have been used for (temporary) habitation, storage of agricultural goods and/or equipment as well as for keeping animals. While this remains speculative, it is likely that such natural and/or rock-cut structures were used by mobile people travelling through the Petraean hinterland.

A dramatic decrease of all subcategories of 'other structures and/or features' can be observed during the 5th century BC. This reflects similar observations made for other archaeological site types.[438]

Exploitation/Industrial Sites

As further discussed in chapter 4, the copper mine of Umm al-'Amad near Abu Khusheiba was apparently already worked in the Early Iron Age (12th – 9th century BC).[439] The only other industrial/exploitation site evidenced for the Iron Age period (10th – 6th century BC) is the small chert quarry of ShamAyl Site No. 315 situated along the eastern high plateau (cf. FIGS. 145 and 146).[440] The site measures c. 11 × 11 m and rock-cut blocks of c. 1 m length were observed at the site. The (little) surface pottery ranges from the Iron Age II to the Byzantine and Islamic periods, indicating the longevity of the quarry. No other industrial/exploitation installations are recorded between the 5th and 2nd centuries BC.

435 The dating quality of such ephemeral sites must be considered critically (cf. chapter 4).
436 MacDonald et al. 2016, 307, 328.
437 See the site catalogue (Appendix I) for a complete list of these sites.
438 There is only one structure of undetermined function dating to the 5th century BC.
439 Hauptmann 1986, 33, 43, n. 27; Lindner 1986a, 188; Kind 1965, 71–73.
440 MacDonald et al. 2016, 409.

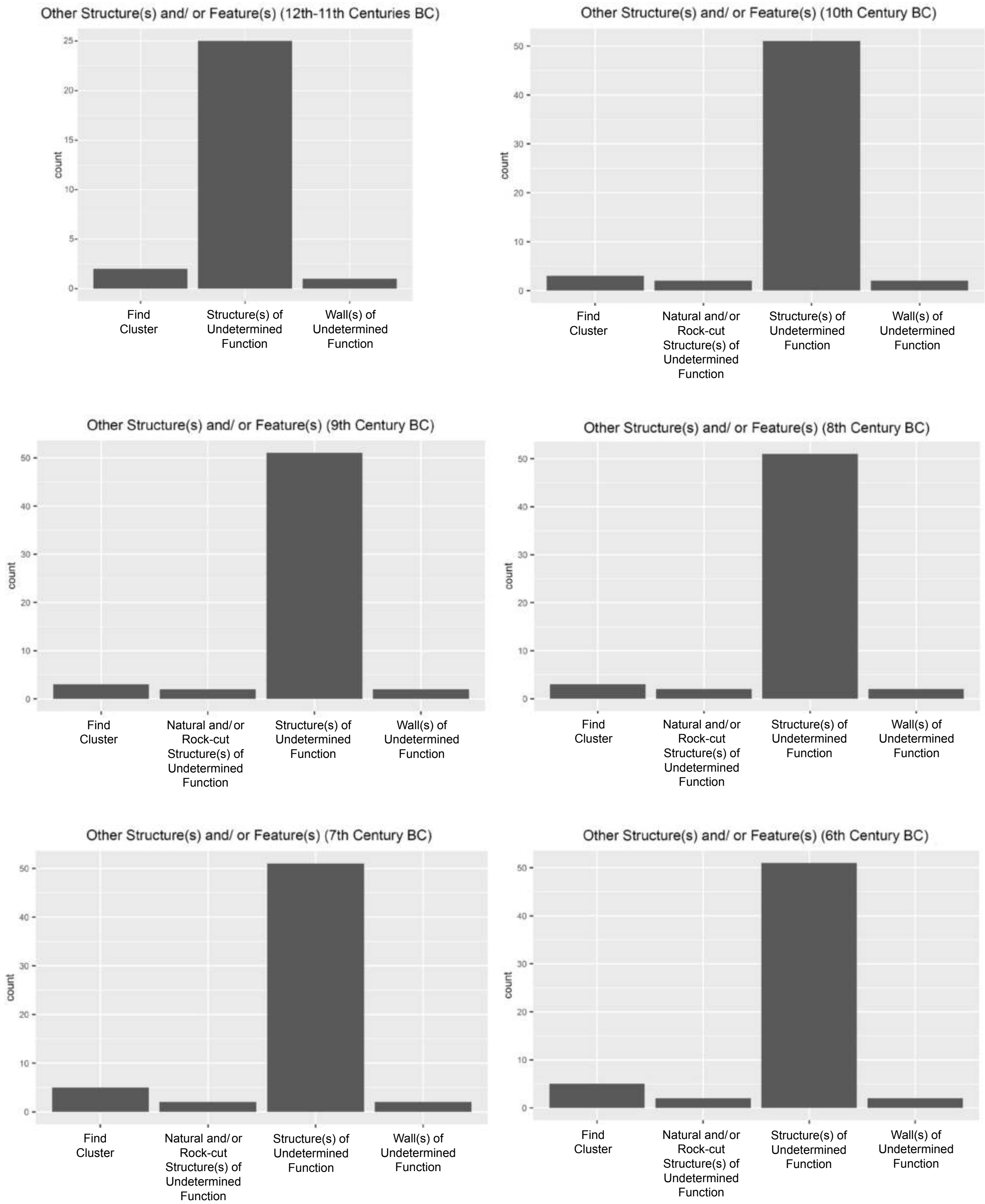


FIG. 40-1 Number of subcategories of other structure(s) and/or feature(s) dating to the Iron Age and Hellenistic periods (12th – 2nd centuries BC).

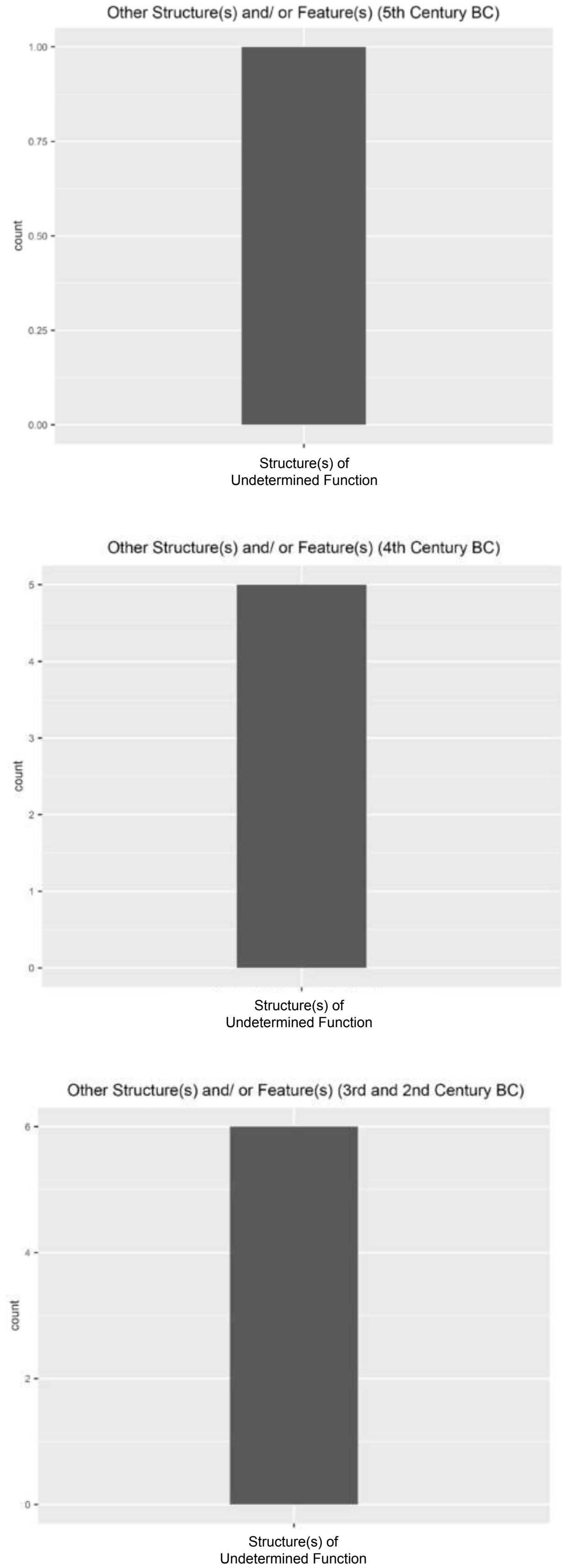


FIG. 40-2 Number of subcategories of other structure(s) and/ or feature(s) dating to the Iron Age and Hellenistic periods (12th – 2nd centuries BC).

The Settlement Pattern

This section deals with the settlement pattern in the Petraean hinterland during the Iron Age periods. Chapter 5 discusses the topic for the main chronological periods of this study. Similarly, all relevant rural settlement types are presented. These include 'towns,' 'villages,' 'cluster of buildings (hamlets),' 'farms,' as well as 'rural mansions.' The definitions of these site categories are given in chapter 2.

Towns

For the 12th and 11th century BC, this study tentatively lists Saddaqa as the only major settlement in the Petraean hinterland.[441] However, this should be considered critically as Saddaqa's identification as a town is based entirely on the 4th century AD Roman fort with its extensive civilian settlement (FIGS. 41 and 42) (cf. chapter 7). Apart from the few Iron Age surface material observed by both Abudanh and ARNAS, the main archaeological evidence for an Iron Age date of Saddaqa is the Bronze and Iron Age material revealed during Graf's sondages at the site in 1989.[442] As no major architectural remains were revealed, and due to the extensive reuse of the site in the later periods, the exact nature of Saddaqa during the Iron Age period remains unknown.[443] While Saddaqa may be referred to as a town during the Late Roman/Byzantine periods, the limited archaeological evidence for the pre-Roman periods does not permit to clearly characterize the nature of Saddaqa adequately.

By the 10th century, Khirbet Tal' at 'Umar as well as ancient Gaia (Wadi Musa), also appear on the archaeological map as potential larger 'urban' centers (FIGS. 43 and 44). Similar to Saddaqa, there is only little evidence for settlement activities during these early periods. Situated along the southern Jabal Shara escarpment, the c. 2 ha large site of Khirbet Tal' at 'Umar is described by MacDonald et al. as a possible "administrative center for a district," and is characterized by numerous structures of various dimensions, some of which are "much larger and impressive."[444] While the presented archaeological evidence is unsatisfactory to confidently consider Khirbet Tal' at 'Umar

441 See e.g. MacDonald et al. 2012, 35–36 (ARNAS Site No. 007) or Abudanh 2006, 545 (Abudanh Site No. 282) who identify the site as a large village or town claiming an Iron Age date.
442 Graf 1995a, 254 and more recently Graf 2015.
443 This is also the case for the site's undoubted major Nabataean phase as evidenced by vast amounts of surface pottery material and is confirmed by Graf's sondages as well.
444 MacDonald et al. 2016, 218.

as an 'administrative center,' it is nevertheless possible that the site was a major civilian settlement.

Although extensive settlement activities at ancient Gaia did not peak until the 1st century BC, there is archaeological evidence that Gaia was already occupied by the Middle Bronze Age and Iron Age periods.[445] However, the exact nature of ancient Gaia cannot be determined for the Iron Age.

The site of as-Sadeh was presumably settled at least since the Early Bronze Age period. An Iron Age (possibly fortified) settlement was also documented on the high plateau of Umm al-ʾAla. The limited evidence, however, does not allow to further determine the extent of as-Sadeh during these early periods.[446]

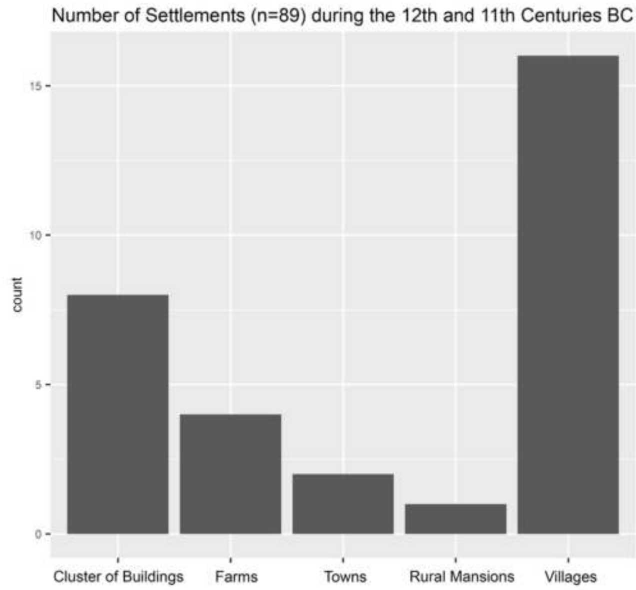


FIG. 41 Number of all settlements dating to the 12th and 11th centuries BC.

Villages

For the 12th and 11th centuries BC, 16 villages are recorded, making them the largest category of all evidenced settlements (in total 31) for that period (cf. FIGS. 41 and 42).[447] Kernel density estimation maps (KDEs) suggest that the recorded villages cluster in the far northern part of the study area along the Jabal Shara escarpment as well as the areas immediately northeast of Wadi Musa along the eastern high plateau (FIGS. 45 and 46).[448] The Pearson correlation test (TABLES 13 and 14) suggests a strong spatial correlation between villages, fortlets and cluster of buildings and a very strong correlation between villages and structures of undetermined function. This is not surprising as the latter category constitutes the largest category of archaeological sites.

In the 10th century BC, the number of villages increases, corresponding to the generally rapid growth of settlements for this period (cf. FIG. 43). This can possibly be associated with the formation of the Edomite kingdom that necessitated more agricultural goods. Villages remain by far the largest category of all evidenced settlements as during the two previous centuries (42/89 settlements in total). The KDE for the 10th century BC suggests a more differentiated clustering of villages, particularly in the northern study area along the Jabal Shara escarpment and, most notably, areas immediately east of Wadi Musa (FIG. 47). There is also a slight clustering of villages northwest of Udruh as well as around the Ayl/Basta area. The Pearson correlation test indicates that villages now have strong spatial correlations with clusters of buildings and farms (TABLE 15). It thus seems that smaller settlement types begin to nucleate around larger settlements by the 10th century. This may indicate the formation of more differentiated agriculture-based communities that concentrated around the villages.

The situation remains unchanged during the 9th and 8th centuries BC as the overall number of villages, the KDE and the Pearson correlation test show the same results as for the 10th century BC (cf. FIGS. 43–44, 47–51; TABLES 16 and 17). This also applies to the 7th and 6th centuries BC, although the total count of settlements rises by one and the KDE now indicates that the area northwest of Udruh is not as clustered as before (cf. FIGS. 48–49, 52–55; TABLES 18 and 19). However, these fluctuations are meaningless to the overall settlement pattern.

By the 5th century BC the pattern changes dramatically which may be associated with the collapse of the Edomite kingdom (cf. FIGS. 52 and 53). All rural settlements in the Petraean hinterland are abandoned. According to the survey reports, the only exceptions are Tawilan and a presumed farm at Abu Danna.[449]

445 On Wadi Musa, see most recently ʾAmr 2012 as well as ʾAmr – al-Momani 2001, 264–268 and ʾAmr et al. 1998, 522–529.

446 Lindner 2005 and 2003a, 29–54; Lindner et al.1990 and 1988.

447 All evidenced villages are listed in the site catalogue (Appendix I).

448 As only 16 villages are considered for the KDE, the results are relatively coarse.

449 Abudanh 2006, 472; ʾAmr – al-Momani 2001, 264; ʾAmr et al. 1998, 520. Due to the extremely small number of settlements evidenced for the 5th to 1st century BC, it is pointless to present KDEs, Pearson correlation tests or point pattern analyses.

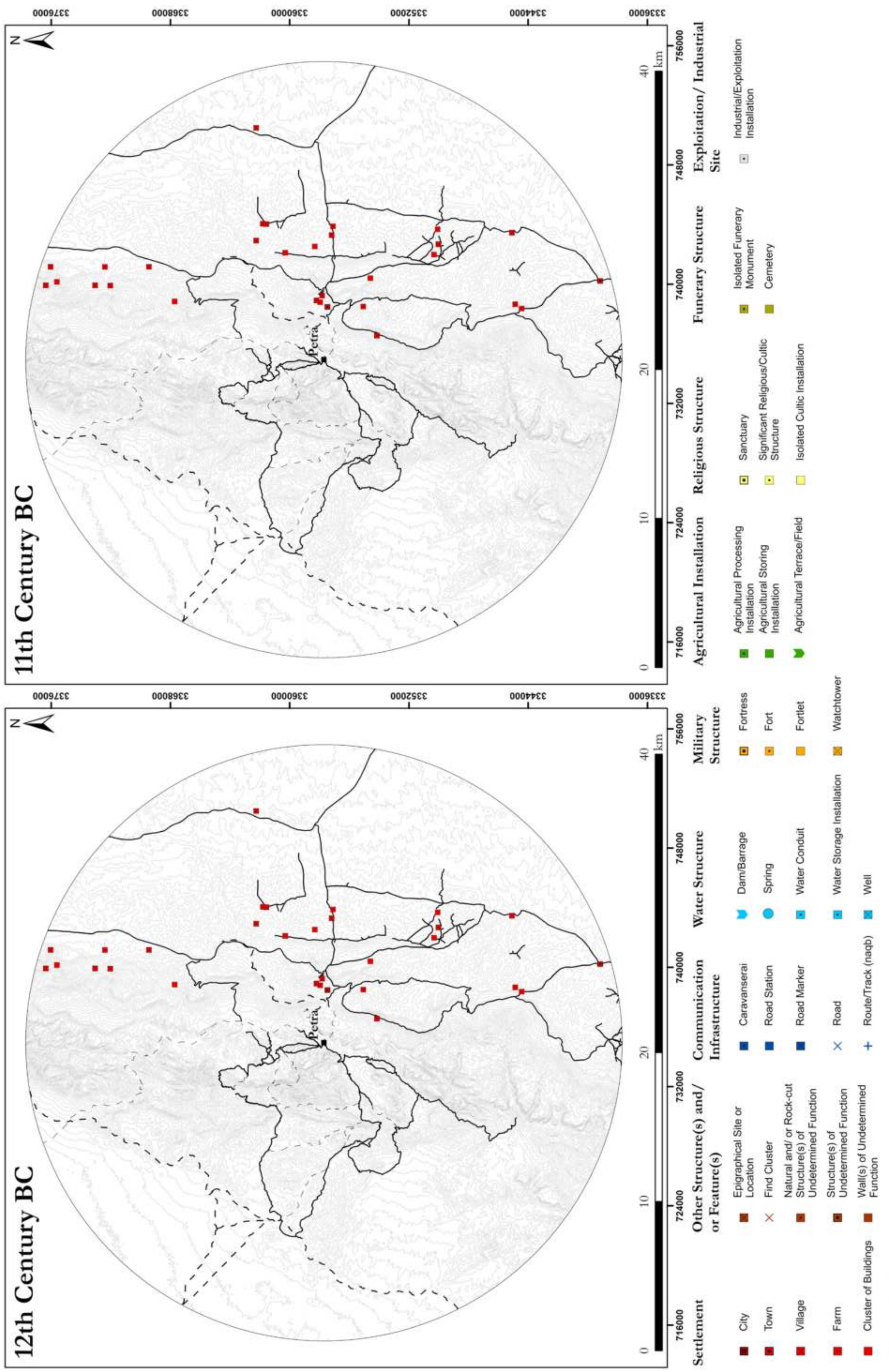


FIG. 42 Distribution map of all settlements dating to the 12th and 11th century BC.

Cluster of Buildings (Hamlets)

During the 12th and 11th centuries BC, clusters of buildings are the second largest category of all evidenced settlements in the Petraean hinterland (8/31) (cf. FIGS. 41 and 42). They are mostly situated east of Wadi Musa as suggested by the distribution map and the KDE (cf. FIGS. 45 and 46).[450] The Pearson correlation test suggests a strong spatial correlation to farms, villages and wells, further indicating a cluster of larger settlements in this period.[451]

Corresponding with the overall rise of settlements in the 10th century BC, the count of clusters of buildings increases as well (cf. FIG. 43), remaining the second largest category behind villages (28/89). The distribution map shows a strong concentration along the Jabal Shara escarpment, although clusters of buildings generally spread further east along the eastern high plateau and even reach as far as the Udruh area (cf. FIG. 47). However, denser clusters also appear in areas northeast of Wadi Musa, the northern part of the Jabal Shara escarpment as well as in the Saddaqa-Fardakh area. The Pearson correlation test still indicates strong spatial correlations to farms and villages, and now to structures of undetermined function as well (TABLE 15).

The same observations are made for the 9th century BC (cf. FIGS. 43–44 and 50), although the Pearson correlation test now suggests a strong spatial correlation to villages and structures of undetermined function only (TABLE 16).

For the 8th century BC, the count of clusters of buildings remains the same as for the previous two centuries, but – as for the contemporary pattern of farms presented below – the KDE indicates a slightly coarser clustering (cf. FIG. 51). This is a curious observation, as there are no indications for a shift in the pattern as postulated for the contemporary farms.[452]

The results for the 7th century BC, suggest the same patterning already observed for clusters of buildings since the 10th century BC. The overall count, the results of the KDE as well as the Pearson correlation test remain unchanged (cf. FIGS. 48, 54 and TABLE 18). This also applies to the pattern for the 6th century BC, although one additional site is evidenced (cf. FIGS. 52–53, 55 and TABLE 19). There are no cluster of buildings recorded for the 5th century BC.

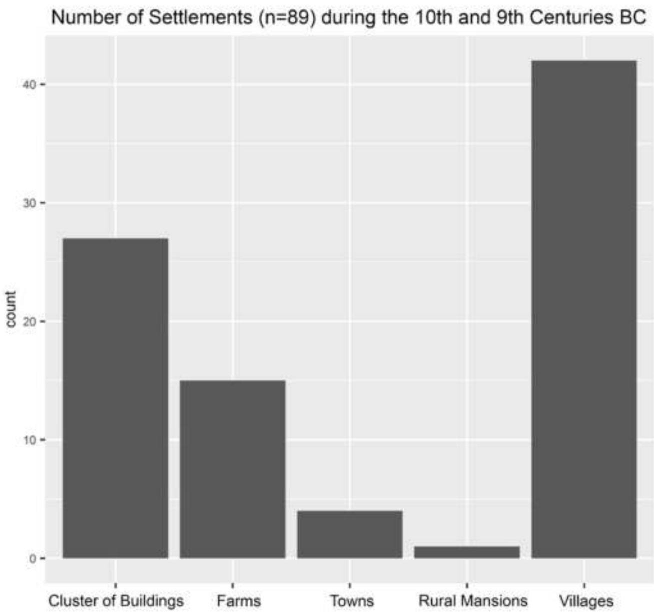


FIG. 43 Number of all settlements dating to the 10th and 9th century BC.

Farms

Situated along the eastern high plateau, there are only four farms dating to the 12th and 11th centuries BC (cf. FIGS. 48 and 49).[453] The Pearson correlation test suggests a very strong spatial correlation between farms and agricultural storing installations as well as a strong correlation to forts, watchtowers, clusters of buildings, towns and rural mansions (TABLES 13 and 14). Despite the small number of evidenced farms, it thus seems that they were concentrated around larger settlements. The strong correlation to forts and watchtowers suggests that farms were potentially protected by such military structures.

By the 10th century BC the count of farms increases to a total number of 15, corresponding to the general rise of settlements in the study area (cf. FIGS. 43–44). The KDE suggests a strong cluster in the al-Bitar area as well as areas along the northern Jabal Shara escarpment (cf. FIG. 47). The Pearson correlation test shows strong spatial correlations to clusters of buildings, villages as well as structures of undetermined function, indicating that farms continue to nucleate around larger settlements (TABLE 15). While the same observations can generally be made for the 9th and 8th centuries BC (cf. FIGS. 43–44, 48–49, 50–51), the

450 Due to the limited amount of data, the KDE results are relatively coarse.

451 The Pearson correlation test for clusters of buildings dating to the 11th century BC does not show strong spatial correlations to wells any longer (TABLE 14).

452 The Pearson correlation test (TABLE 17) shows the same spatial correlations as for the 9th century BC.

453 ShamAyl Site Nos. 009, 043, 075, 291 (MacDonald et al. 2016, 120, 162, 194 and 390). Due to the limited amount of data, the KDE for farms dating to the 12th and 11th centuries BC (FIGS. 45 and 46) is too coarse to provide additional information on the distribution pattern.

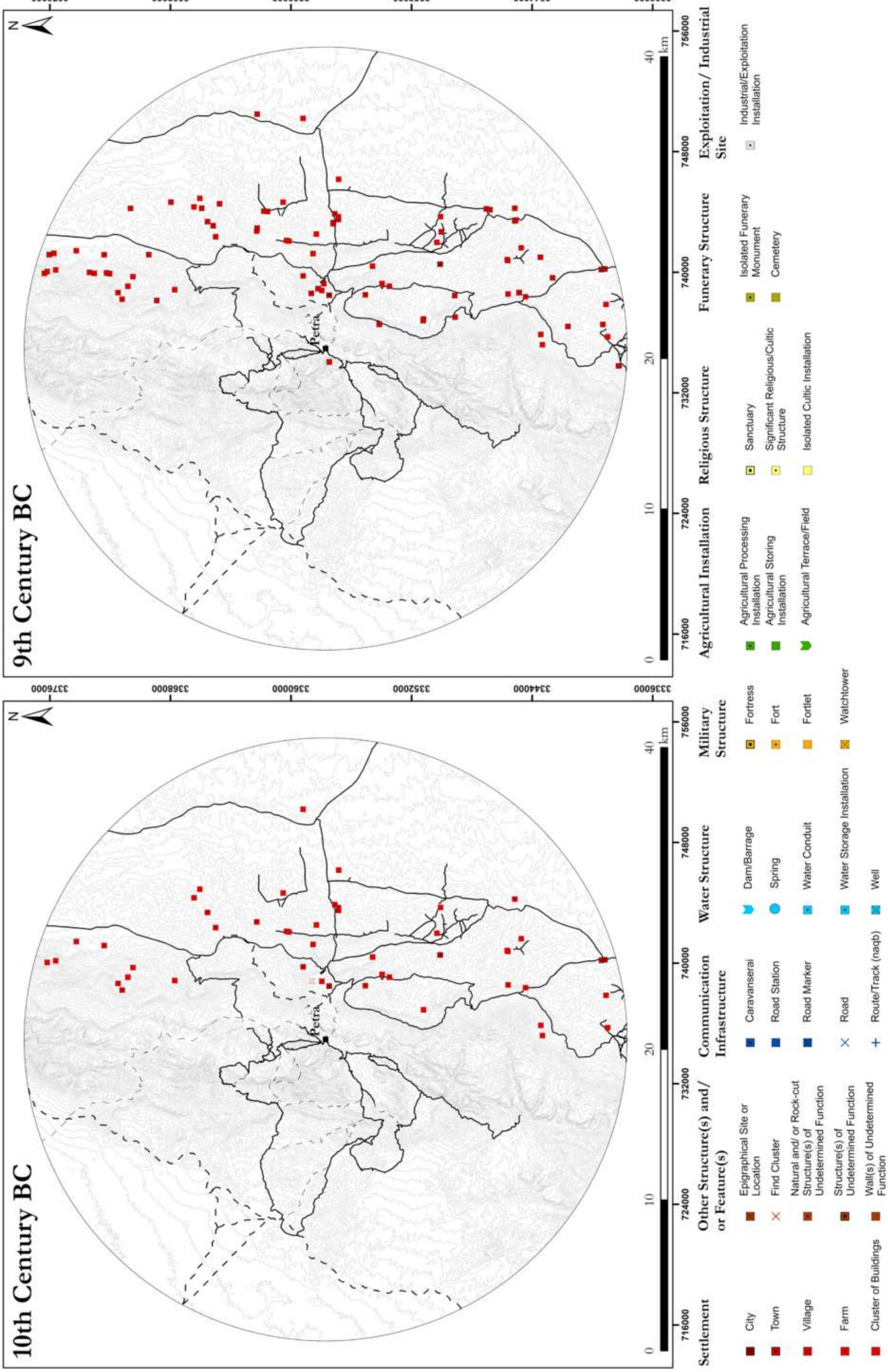


FIG. 44 Distribution map of all settlements dating to the 10th and 9th century BC.

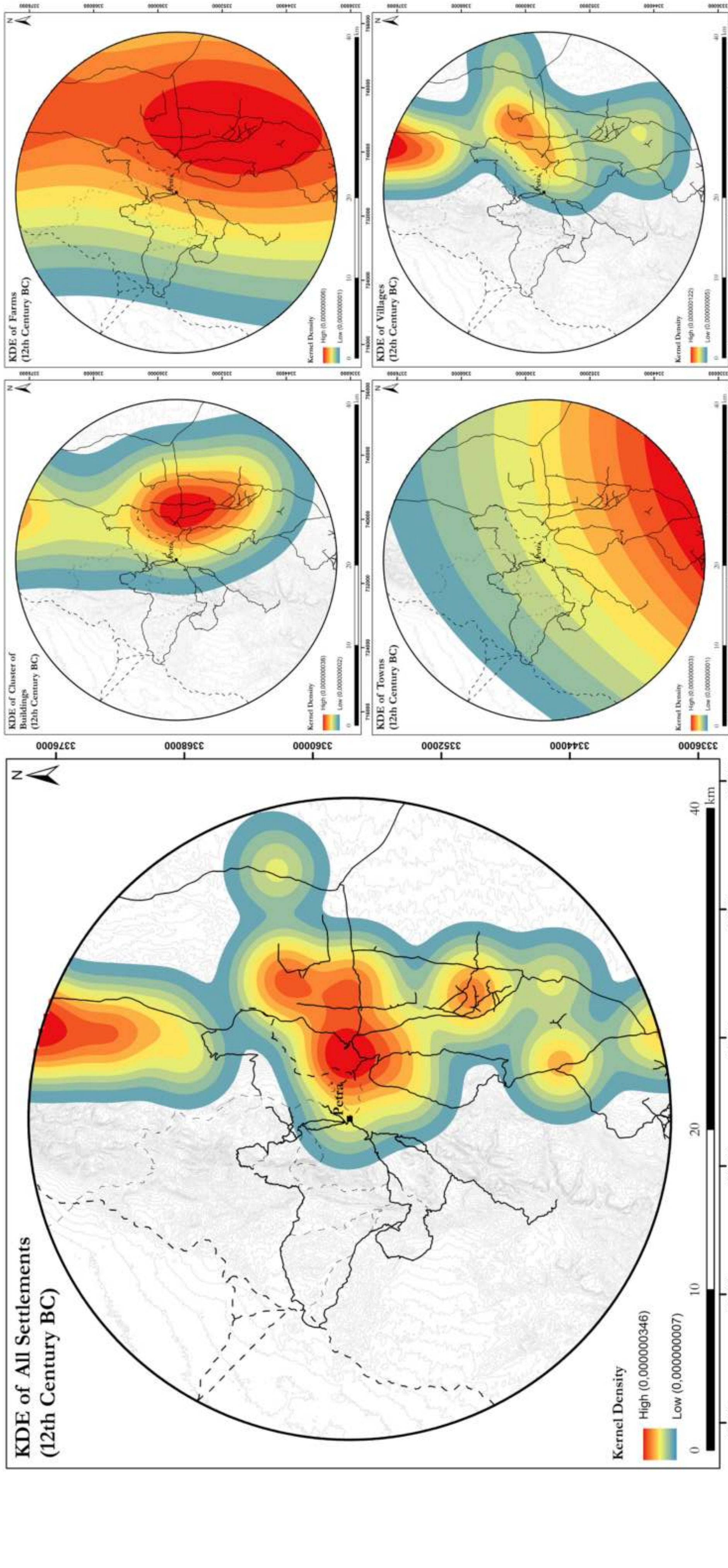


FIG. 45 Kernel density estimations of all settlements (left) and the individual subcategories of settlements dating to the 12[th] century BC.

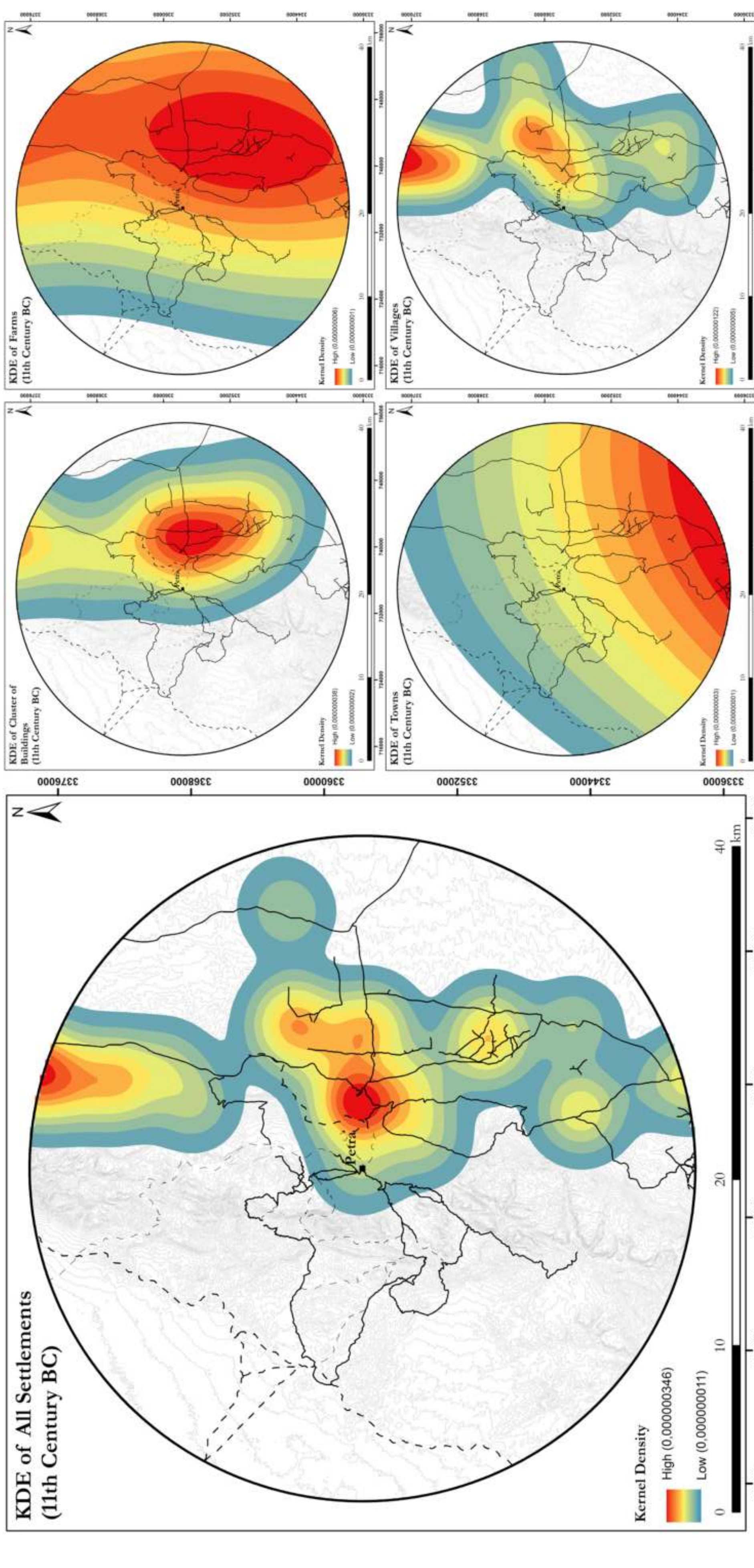


FIG. 46 Kernel density estimations of all settlements (left) and the individual subcategories of settlements dating to the 11th century BC.

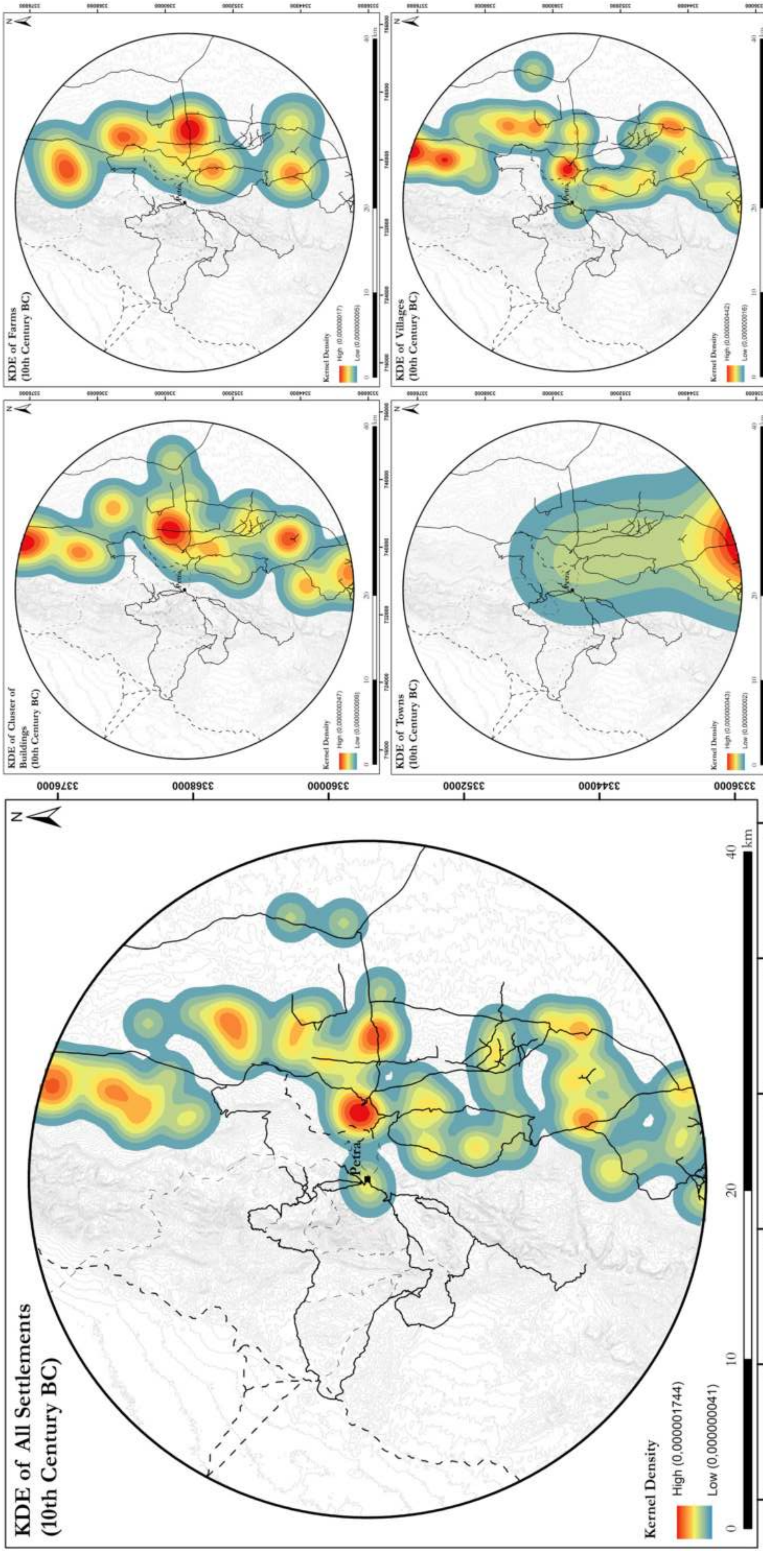


FIG. 47 Kernel density estimations of all settlements (left) and the individual subcategories of settlements dating to the 10th century BC.

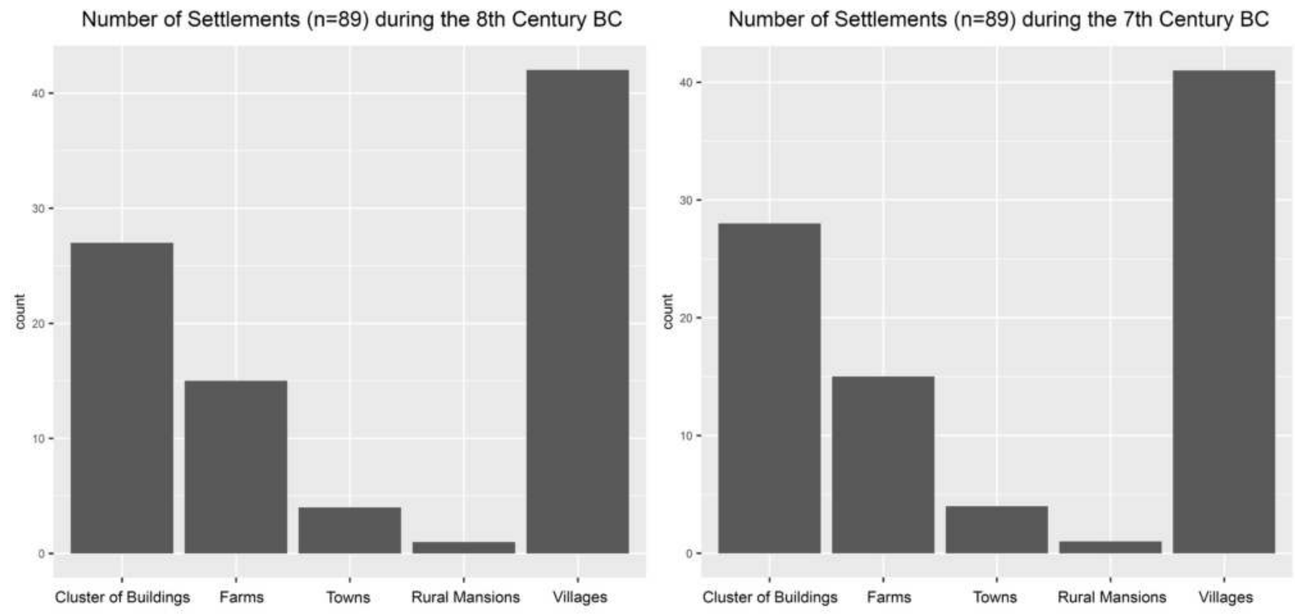


FIG. 48 Number of all settlements dating to the 8th and 7th centuries BC.

Pearson correlation test for the 9th century BC does not indicate any significant correlation between farms and other archaeological sites (TABLE 16). This suggests a slight, but insignificant shift in the pattern of farms during that period, which seems confirmed when considering the KDE of farms dating to the 8th century BC (cf. FIG. 51): Although the overall count as well as the general pattern of farms remains unchanged since the 10th century, the KDE becomes slightly coarser. The Pearson correlation test for the 8th century BC indicates a strong spatial correlation to cluster of buildings again (TABLE 17). Although insignificant, there are thus some indicators for a slight shift in the pattern of farms between the 9th and 8th centuries BC.

By the 7th century BC, this presumed shift is reversed as indicated by the KDE showing that the observed clustering of farms is again denser without any change in the pattern observed already for the 10th century BC (cf. FIG. 54). This is also supported by the Pearson correlation test that once more indicates strong spatial correlations between farms and villages as well as clusters of buildings as already observed for the previous century (TABLE 18). The overall count of farms dating to the 7th century BC remained unchanged since the 10th century BC (cf. FIG. 48).

One additional farm is recorded for the 6th century BC (cf. FIG. 52–53), which only had an extremely limited (if at all any) effect on the pattern.[454] Apart from Abu Danna (Abudanh Survey No. 136), all farms are abandoned by the 5th century BC (cf. FIG. 52–53). Next to the village of Tawilan, this farm is the only settlement evidenced for this period.[455]

Rural Mansions

The only possible rural mansion documented as early as the 12th BC is al-Muzayr'a (WMWS 1998 Site No. 30), which is arguably the first and only rural mansion evidenced in the Petra area until the 1st century BC (cf. FIGS. 48–53).[456] Situated along the Jabal Shara escarpment just north of Wadi Musa on the eastern side of Wadi Yasala, al-Muzayr'a is described as a substantial structure built of large, roughly hewn ashlars with walls still standing up to 4 m high.[457] It is postulated that a boundary wall along its northern and western side enclosed the site, while its eastern border is defined by a natural cliff. Most of the ancient walls are currently used as agricultural terrace walls. Although the total count of surface material was scarce, predominantly Iron Age II sherds were recorded in addition to Late Roman and Early Islamic material.

454 The KDE (FIG. 55) shows a slightly denser cluster of farms in the al-Bitar area and the Pearson correlation test indicates only a strong spatial correlation to structures of undetermined function (TABLE 19).

455 Abudanh 2006, 472.

456 MacDonald et al. 2016, 445–446; ʾAmr – al-Momani 2001, 269; Tholbecq 2001, 402; ʾAmr et al. 1998, 519.

457 See ʾAmr – al-Momani 2001, 269, fig. 23 and Tholbecq 2001, 402, fig. 3 for illustrations.

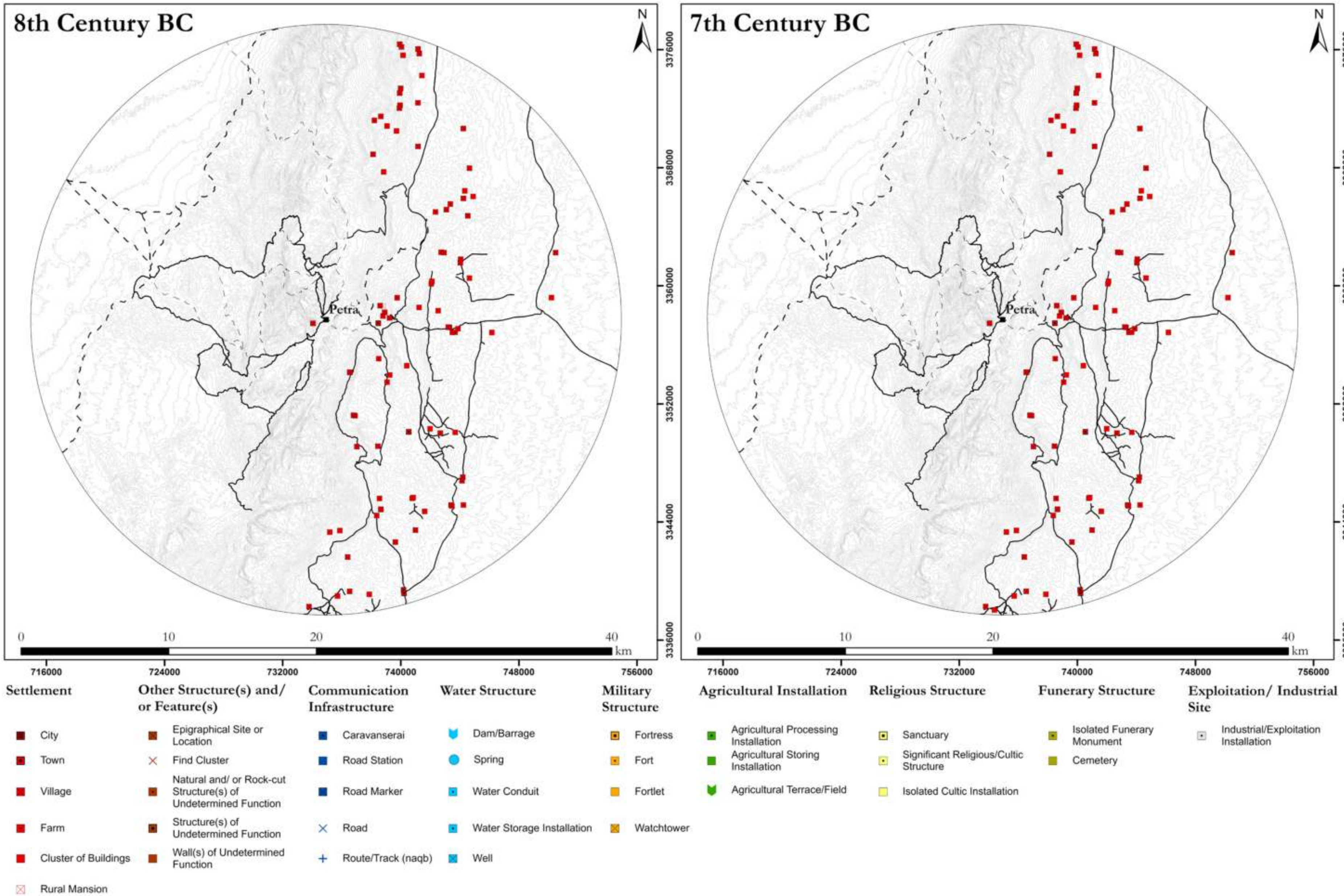


FIG. 49 Distribution map of all settlements dating to the 8th and 7th century BC.

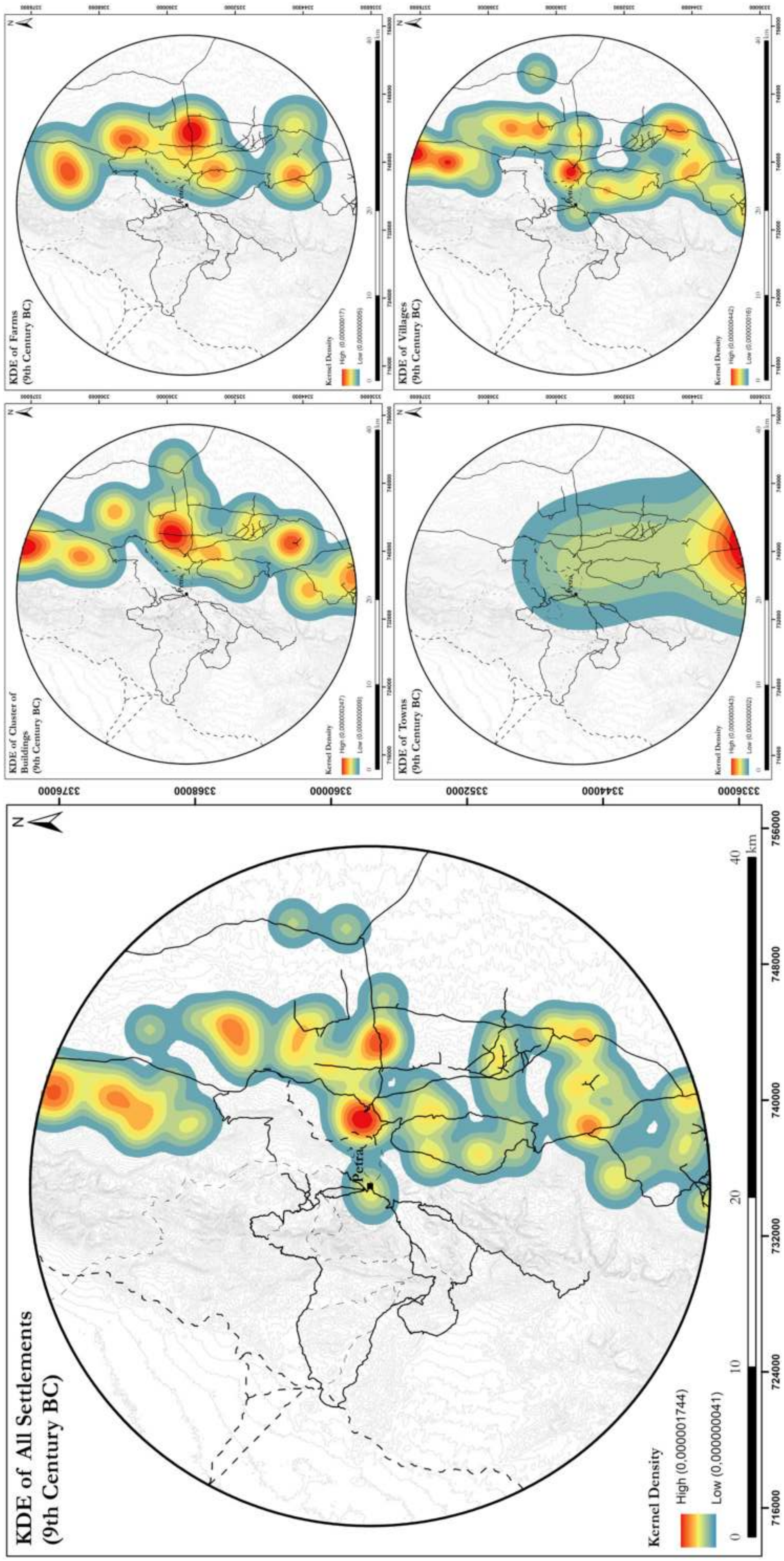


FIG. 50 Kernel density estimations of all settlements (left) and the individual subcategories of settlements dating to the 9th century BC.

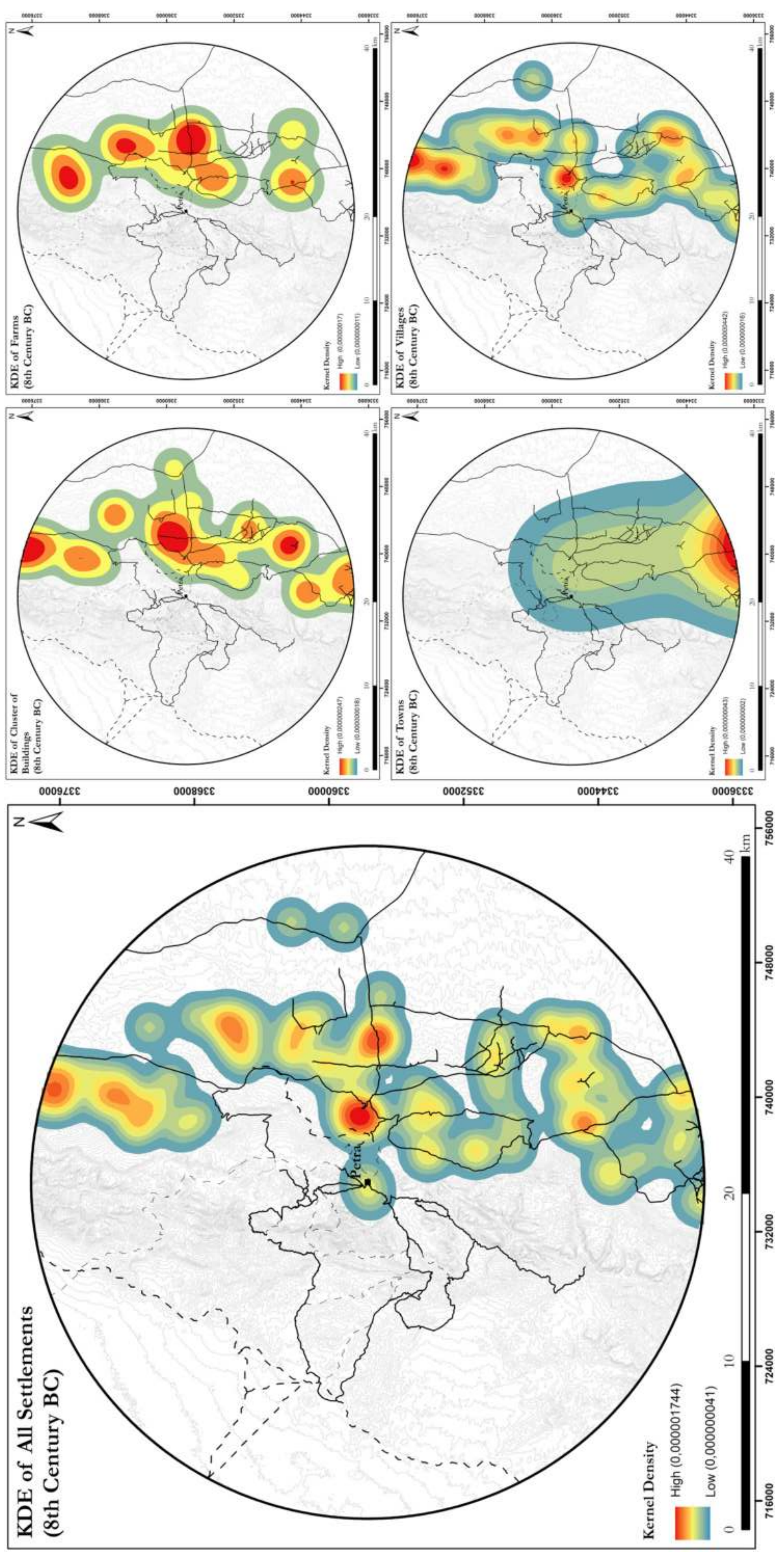


FIG. 51 Kernel density estimations of all settlements (left) and the individual subcategories of settlements dating to the 8th century BC.

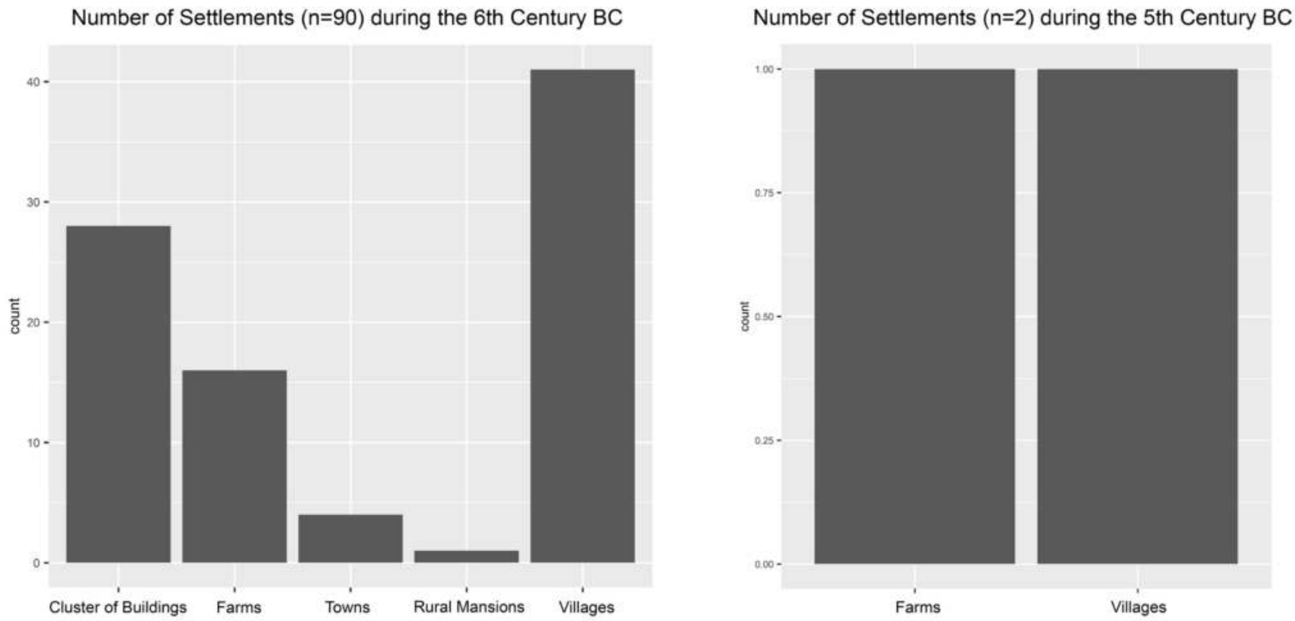


FIG. 52 Number of all settlements dating to the 6th and 5th centuries BC.

Communication Infrastructures

This section deals with the communication infrastructure in the Petraean hinterland during the Iron Age periods. Unlike in chapter 6, the paucity of secure archaeological evidence for Iron Age communication infrastructures does not allow a differentiated presentation of the evidence by the separate subcategories (cf. chapter 2). The findings are thus summarized as follows:

It is argued that one of the main roads in the Petra area, the *Darb ar-Rasif* or 'King's Highway,' dates to the Iron Age period. It runs along the western escarpment of the Jabal Shara mountains between Petra and Qana (cf. FIG. 191), and most likely served as an important supraregional trade route for the Edomite kingdom.[458] As the course of the Darb ar-Rasif is largely overbuilt by the Roman *via nova Traiana*, and many of the road-related sites featuring Iron Age surface material date predominantly to the Nabataean-Byzantine periods, the details of this road will be presented in chapter 6.

It is assumed that the original road connecting the Petra area with the Negev before the Nabataeans erected various forts and road stations along the Petra–Gaza road was the *Darb es-Sultan* ("The King's Way"). This road supposedly circumvented the Ramon Crater in the Negev and connected the copper mines of Wadi Faynan with the lower Negev highlands via the Nahal Zin Basin.[459] Additionally, Ben David notes that the later Nabataean course of the Petra–Gaza road may also have been used in earlier periods, as evidenced by sites dating to the Chalcolithic, Early Bronze Age, Middle Bronze Age I as well as Iron Age II periods between Moyat ʾAwad and Oboda.[460] Whether the Darb es-Sultan is associated with the Darb ar-Rasif in the Petra area is not discussed. However, assuming an Iron Age date for both roads seems possible.

The only structure dating to the Iron Age periods (12th – 6th century BC) that may tentatively be identified as a possible road station is ShamAyl Site No. 33 (cf. FIG. 183). It is situated below the modern Wadi Musa–at-Tayyiba road (most likely the ancient Darb ar-Rasif and later *via nova Traiana*) and measures c. 12,5 × 5 m.[461] There are no road/route stations that date between the 5th and 2nd century BC.

The Military Disposition

This section deals with the military disposition in the Petraean hinterland during the Iron Age periods. Chapter 7 discusses the topic for the main chrono-

458 Abudanh et al. 2015b, 159; Graf 1992, 258. The course of the Darb ar-Rasif was re-mapped by the author on the basis of Graf 1995a, 249, fig. 2 and 251–253 as well as satellite imagery.

459 Zohar – Erickson-Gini 2019, 2 and 12; Erickson-Gini – Israel 2013, 25. Ynnilä 2013, 264 also claims that the necessity for establishing a functioning road network in the western Petraean hinterland was originally driven by the exploitation of the copper mines west of the Wadi Arabah (presumably meaning Timnah). If this assumption is correct, this would date the western routes as early as the Iron Age.

460 Ben David 2012, 21.

461 MacDonald et al. 2016, 153. "Classical period" surface pottery was recorded at the site as well.

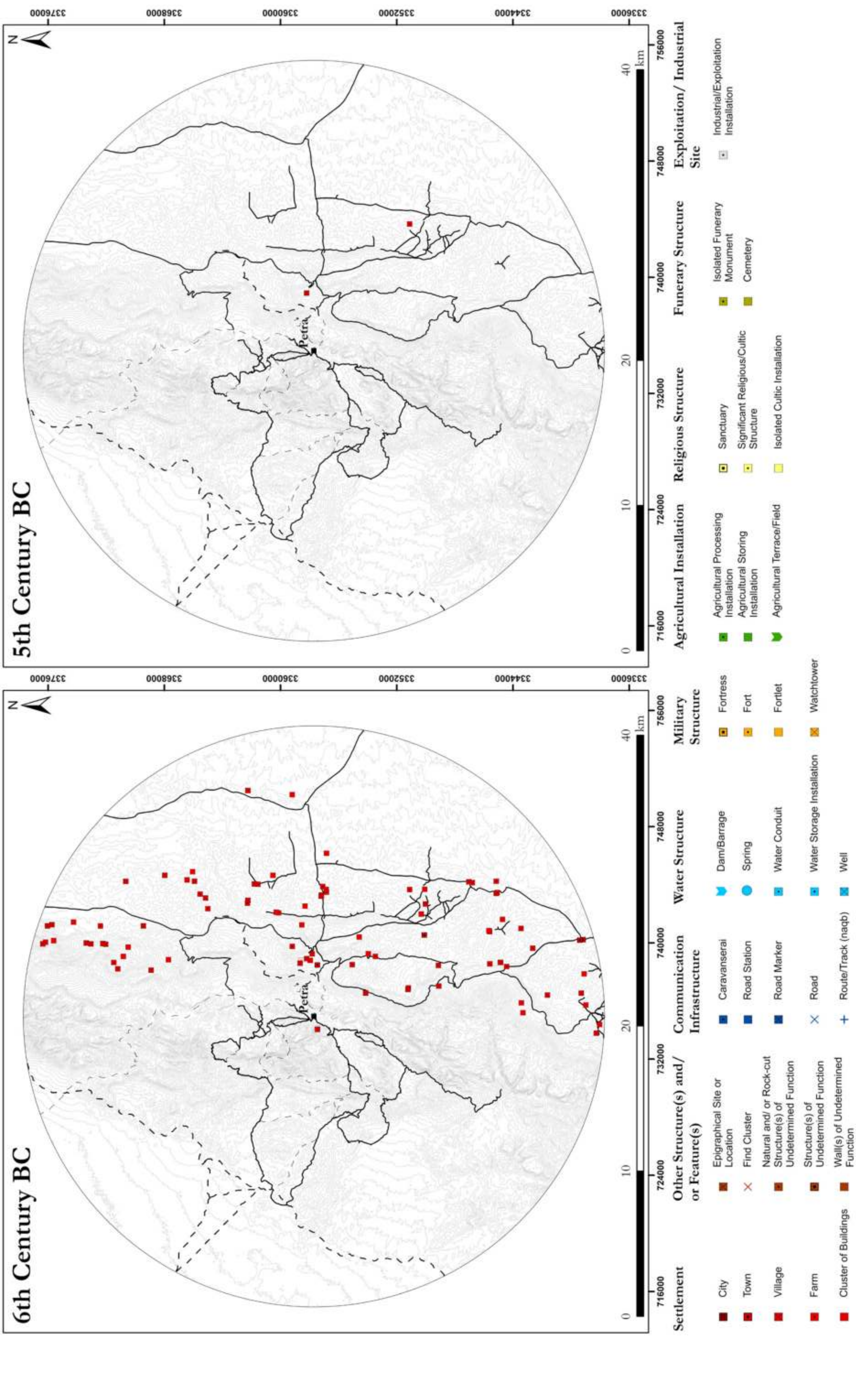


FIG. 53 Distribution map of all settlements dating to the 6th and 5th century BC.

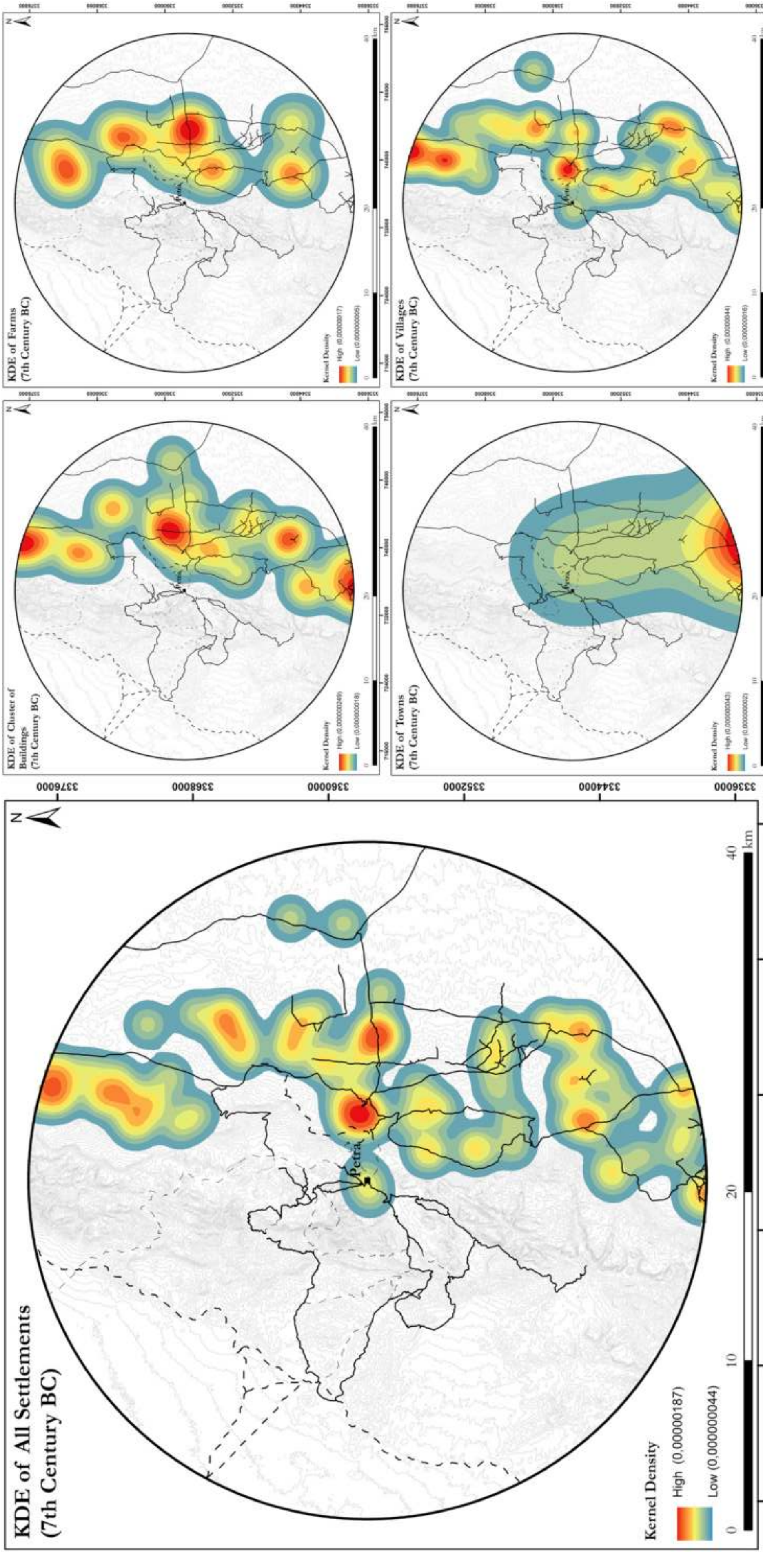


FIG. 54 Kernel density estimations of all settlements (left) and the individual subcategories of settlements dating to the 7th century BC.

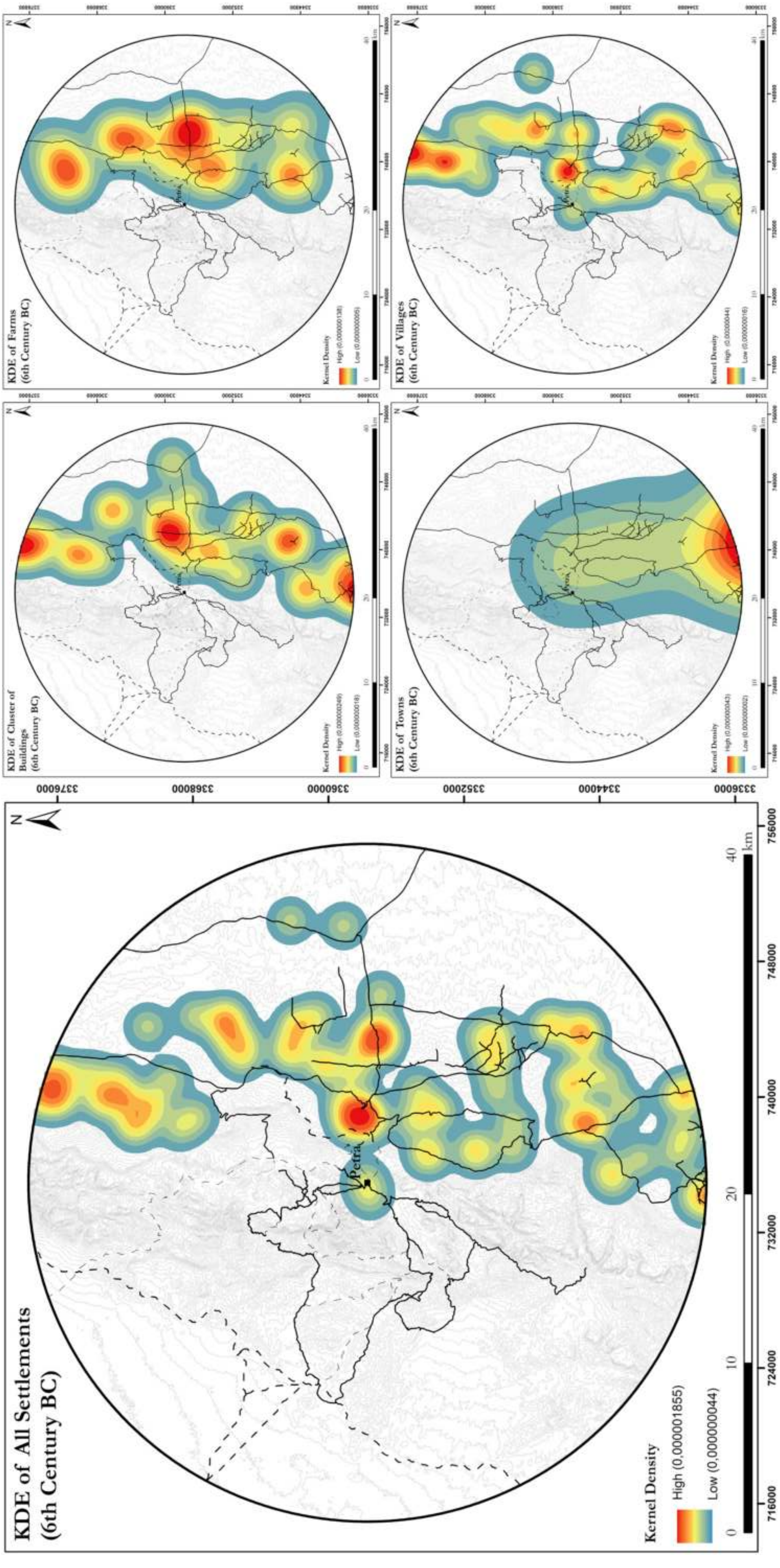


FIG. 55 Kernel density estimations of all settlements (left) and the individual subcategories of settlements dating to the 6th century BC.

logical periods.[462] The following presents all relevant 'forts,' 'fortlets/road stations,' 'watchtowers' as well as 'other structures of possible military/communication function.' The definitions of these site categories are given in chapter 2. No fortresses were identified for the Iron Age.

Forts

The largest category of possible Iron Age military structures are forts. Based on surface pottery, the arguably earliest forts in the Petra area are Khirbet ar-Ruways (ShamAyl Site No. 024) and Khirbet Ayl (Abudanh Survey Site No. 192) that date from the 12th century BC onwards. Situated on a hilltop near at-Tayyiba, the original surveyors refer to Khirbet ar-Ruways as a fortress.[463] However, its small measurements (c. 0,23 ha) correspond to this study's definition of a fort. The hilltop structure consists of a thick perimeter wall and shows further internal divisions. A possible tower was constructed within the fort at a high point in the east of the structure to offer better visual control of the landscape.

Measuring c. 0,4 ha, Khirbet Ayl (cf. FIG. 265) is almost twice the size of Khirbet ar-Ruways. Situated on a hilltop and commanding a far-reaching view over the nearby *via nova Traiana* (and therefore possibly the Iron Age Darb ar-Rasif) as well as the (modern) settlement of Ayl and its spring, the rectangular structure is built of thick walls enclosing a c. 8 m² large corner tower.[464] Surface pottery suggests that the site was in continuous use from the 12th century BC through to the Late Ottoman period, although Kennedy notes that, based on "slim architectural grounds," the fort dates mainly to the Roman period.[465] The predominantly Roman date of the site is probably also emphasized by the fort's vicinity to the *via nova Traiana* and the discovery of a painted milestone dating to the first half of the 3rd century AD.[466] While this certainly highlights the importance of the site during the (Late) Roman period, the earlier surface pottery suggests that the site may have functioned as a fort in earlier periods as well. Without further investigations confirming the exclusive dating of the fort to the Roman period, this study respects the dating of the documented surface material as well.[467]

The above-mentioned sites are the only evidenced forts until the 10th century BC when a fort was also erected at Khirbet Dubayl (ShamAyl Site No. 34).[468] Khirbet Dubayl measures c. 0,28 ha and is situated on the western edge of the Jabal Shara escarpment along the Darb ar-Rasif, overlooking the Wadi Araba to the west. It is characterized by a thick perimeter wall (c. 1–1,5 m wide) and has a possible watchtower located at the fort's high point. The original surveyors noticed further internal divisions.

Generally, GIS-based viewshed analyses show that Iron Age forts exerted only limited visual control (FIGS. 56–57).[469]

Surface pottery suggests that all forts were abandoned by the 5th century BC. No forts were occupied in the Petraean hinterland until the 1st centuries BC.

Fortlets, Watchtowers and Other Structures of Possible Military Function

Specifically structures smaller than 0,1 ha that the original surveys documented as possible military sites, are difficult to define functionally as there is only limited archaeological information. Therefore, this study exercises particular caution when assigning military functions to fortified structures smaller than 0,1 ha (cf. chapter 7). With this in mind, the following presents possible Iron Age 'fortlets/road stations,' 'watchtowers' and 'other structures of possible military/communication function.'

Fortlets/Road Stations

The only fortlets/road stations of possible Iron Age date are the structures of at-Tiyir and ShamAyl Site No. 114.[470] They are situated near villages along the eastern high plateau and possibly served to monitor activities around the villages, and potentially to provide security for local communities.

462 In which the general difficulties of positively identifying sites as military structures are discussed as well.

463 MacDonald et al. 2016, 145. Also see ʾAmr – al-Momani 2001, 270.

464 Abudanh 2006, 505; Kennedy 2004, 180; Gregory 1995, 390–391; Killick 1986a, 438; Parker 1986, 98–99, Gregory – Kennedy 1985, 434–435; Glueck 1935, 74–75; Brünnow – von Domaszewski 1904, 467–468.

465 Kennedy 2004, 180.

466 Graf 1995a, 249; Glueck 1935, 75 (No. 7). For more on the milestone, see chapter 7.

467 This view seems to be shared by Abudanh 2006, 505.

468 MacDonald et al. 2016, 154; ʾAmr – al-Momani 2001, 270; ʾAmr et al. 1998, 532; Glueck 1935, 79 (Site 122); Musil 1907, 128, 283. Also note that dating to the Iron Age IIc period (7th – 6th centuries BC), Edom Survey Site No. 076 is listed as a 'fortress.' However, no further explanation is offered and the exact nature of this site remains undetermined (Hart 1885, 271). 'Classical period' surface pottery was also observed at the site.

469 FIG. 56 depicts the 12th and 11th centuries BC together because there is no significant change in the overall site pattern between these two centuries.

470 MacDonald et al. 2016, 230–231; MacDonald et al. 2012, 192. More on these structures in chapter 7.

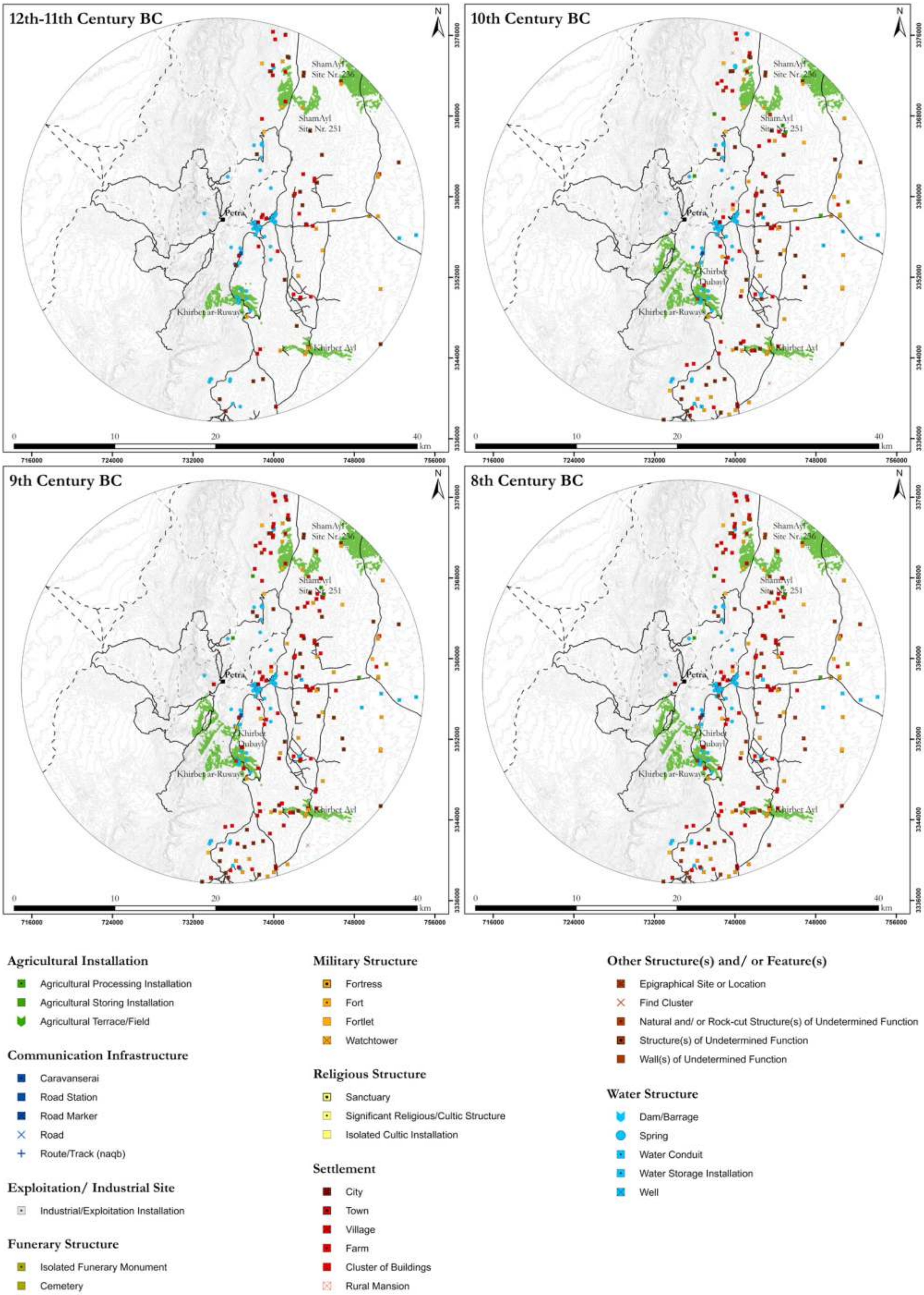


FIG. 56 GIS-based viewshed analyses calculated for 12^{th} – 8^{th} century BC forts in the Petra area with the evidenced road network. Visibility radius of 4400m.

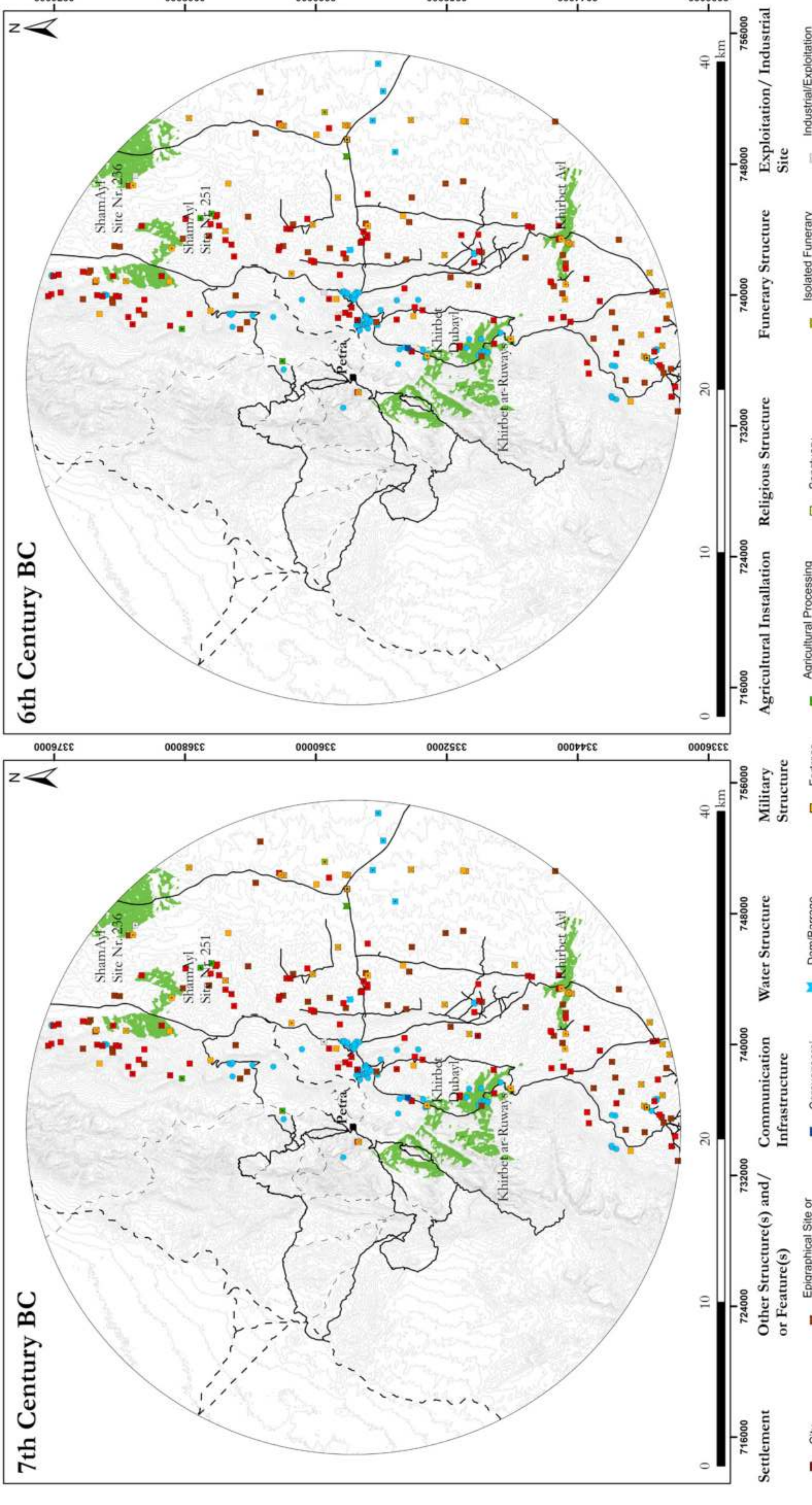


FIG. 57 GIS-based viewshed analyses calculated for 7th – 6th century BC forts in the Petra area with the evidenced road network. Visibility radius of 4400m.

Watchtowers

The only possible towers that date to the 12th and 11th centuries BC are Tell Qrah and ARNAS Site No. 002/Abudanh Survey No. 260 (Ayl).[471] There are only eight towers recorded for the 10th to 8th centuries BC. They are distributed across the eastern high plateau.[472] The GIS-based cumulative viewshed analyses calculated for these towers show that their visibility fields concentrate along the eastern limits of the study area and visually control mostly civilian settlements, the local road network as well as water structures (FIG. 58). The most visible area (from a maximum of three towers) is that around Saddaqa. Whether this implies that the area around Saddaqa was of particular interest during these periods is difficult to determine in light of the overall paucity of archaeological evidence for this period. The resulting high cumulative visible area may also be due to the limited number of known towers and should therefore be considered critically.

For the 7th and 6th century BC, the situation remains unchanged. However, with the construction of the tower on Umm al-Biyara during the 7th century BC, the beginning of a westward shift can be observed, with the Petra valley now under visual control for the first time (FIGS. 58 and 59). No towers are recorded for the 5th – 2nd centuries BC.

Other Structures of Possible Military/Communication Function

Particularly for the Iron Age periods, the various surveys documented a number of structures that they interpreted as possible military sites, but do not fit the criteria for any category of military sites defined here (cf. TABLE 34). Many of these structures were commonly referred to as 'watchtowers,' but their inconclusive nature and the limited archaeological information does not allow such a precise categorization. While these structures most likely had a surveillance function, they are significantly larger than the structures discussed as proper watchtowers here (cf. chapter 7). Their structural layout also suggests additional defensive functions that have not been discussed before. Referring to these structures as plain watchtowers thus seems to overly simplify their function. After presenting the archaeological evidence, this study therefore tentatively proposes an alternative term for these structures: hilltop refuges.

The first structure is Tell Udruh (Dubais) (cf. FIG. 298, No. 1), situated on a hilltop immediately east of the later fortress at Udruh. The site was partly excavated by Killick, who identified it as a watchtower.[473] This interpretation is followed by Abudanh, who also considered the site for his survey.[474] Measuring c. 368 m², the rectangular structure is characterized by thick external walls around a natural cave and the southwestern part of the structure is slightly elevated from the rest, which Abudanh presumes to be the mentioned tower. Based mostly on surface material, the structure is dated between the 12th and 4th centuries BC. Abudanh claims it was occupied in the 2nd century AD as well. Additionally, the structure features an earthen ditch circling around it and dug into the upper part of the hill. Aerial photographs show this clearly (FIG. 60). To refer to this structure simply as a watchtower is then an understatement. While an exact function of the site is difficult to determine, the presence of the ditch and the substantial architecture of the site (if contemporary) certainly highlights a defensive character. The site may have had a surveillance function, but could have also served as some sort of defendable refuge in time of need.

The Iron Age site of Rujm al-Jarba (cf. FIG. 298, No. 2) is also a rectangular structure with possible internal divisions and thick external walls situated on a hilltop south of Khirbet al-Jarba commanding a clear view over the surrounding landscape. Abudanh thus refers to the site as a watchtower.[475] Although it is only about half the size of Tell Udruh, it seems quite large compared to the other discussed watchtowers. The site certainly served observation purposes, but may have also functioned as a small refuge.

The c. 400 m² large rectangular structure of ShamAyl Site No. 200 (Rujm Abu al-Alaq) (cf. FIG. 298, No. 5) dates from the 10th through 6th centuries BC and then again from the 1st century BC onwards. It is situated on a hilltop with good visibility around its surrounding landscape and was identified by the original surveyors as a probable watchtower.[476] However, the structure is far too large to be referred to as a simple tower. As there is no further archaeological information for the site, any other interpretation concerning its possible function can also only be hypothetical, but it may have served defensive purposes in addition to its surveillance function.

Dating between the 10th and 6th centuries BC, the original surveyors describe the site of Rujm 'Utayq (cf.

471 MacDonald et al. 2012, 30; Abudanh 2006, 405, 535.
472 ARNAS Site Nos. 002, 017, 018, 020 and 022; ShamAyl Site Nos. 116, 208, 269.
473 Cf. Driessen – Abudanh 2019, 458–460.
474 Abudanh 2006, 422.
475 Abudanh 2006, 413.
476 MacDonald et al. 2016, 309–310.

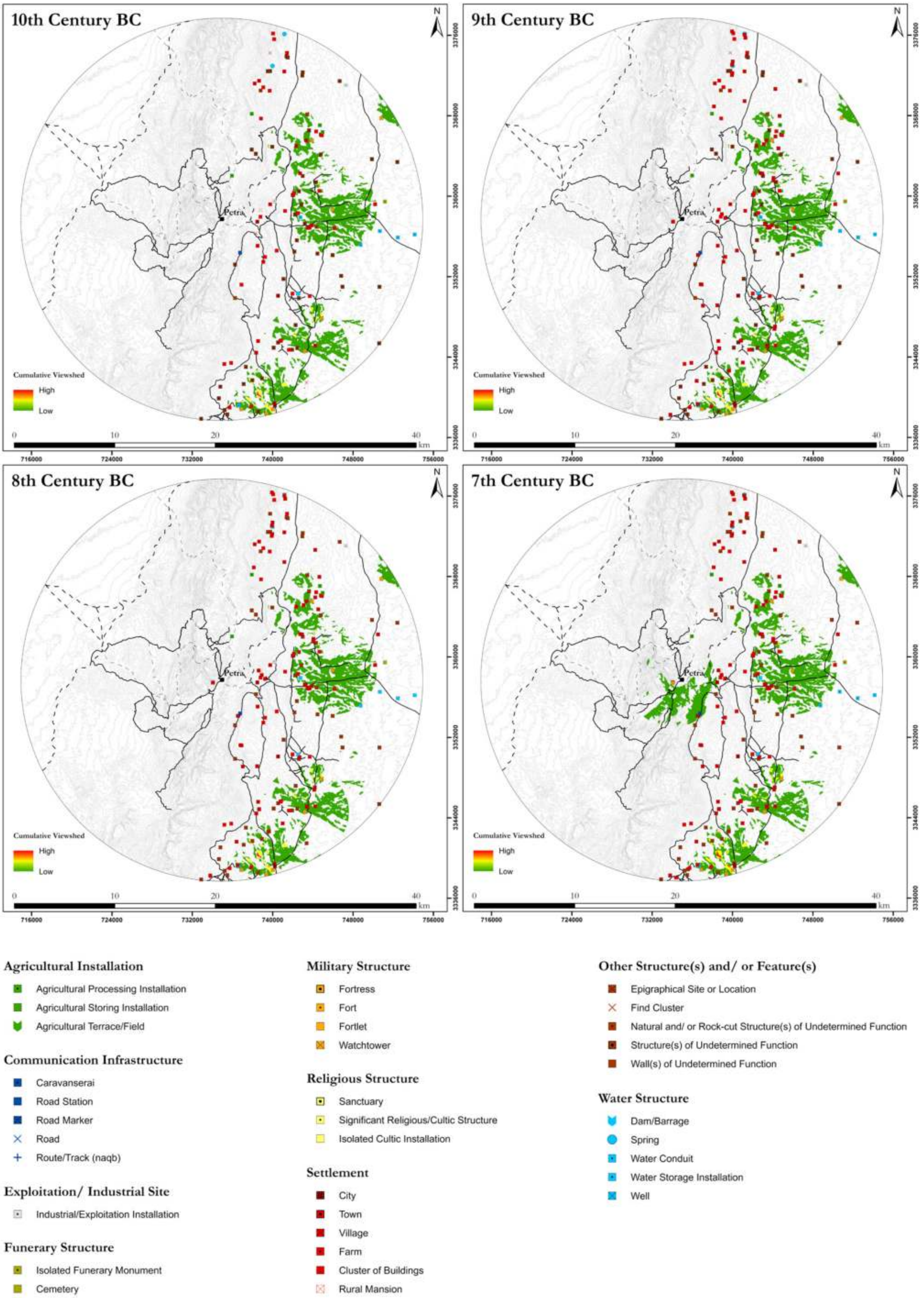


FIG. 58 Cumulative viewsheds of all presumed watchtowers in the Petraean hinterland dating to the 10th – 7th century BC. Maximum cumulative visibility from 3 towers. Visibility radius of 4400m.

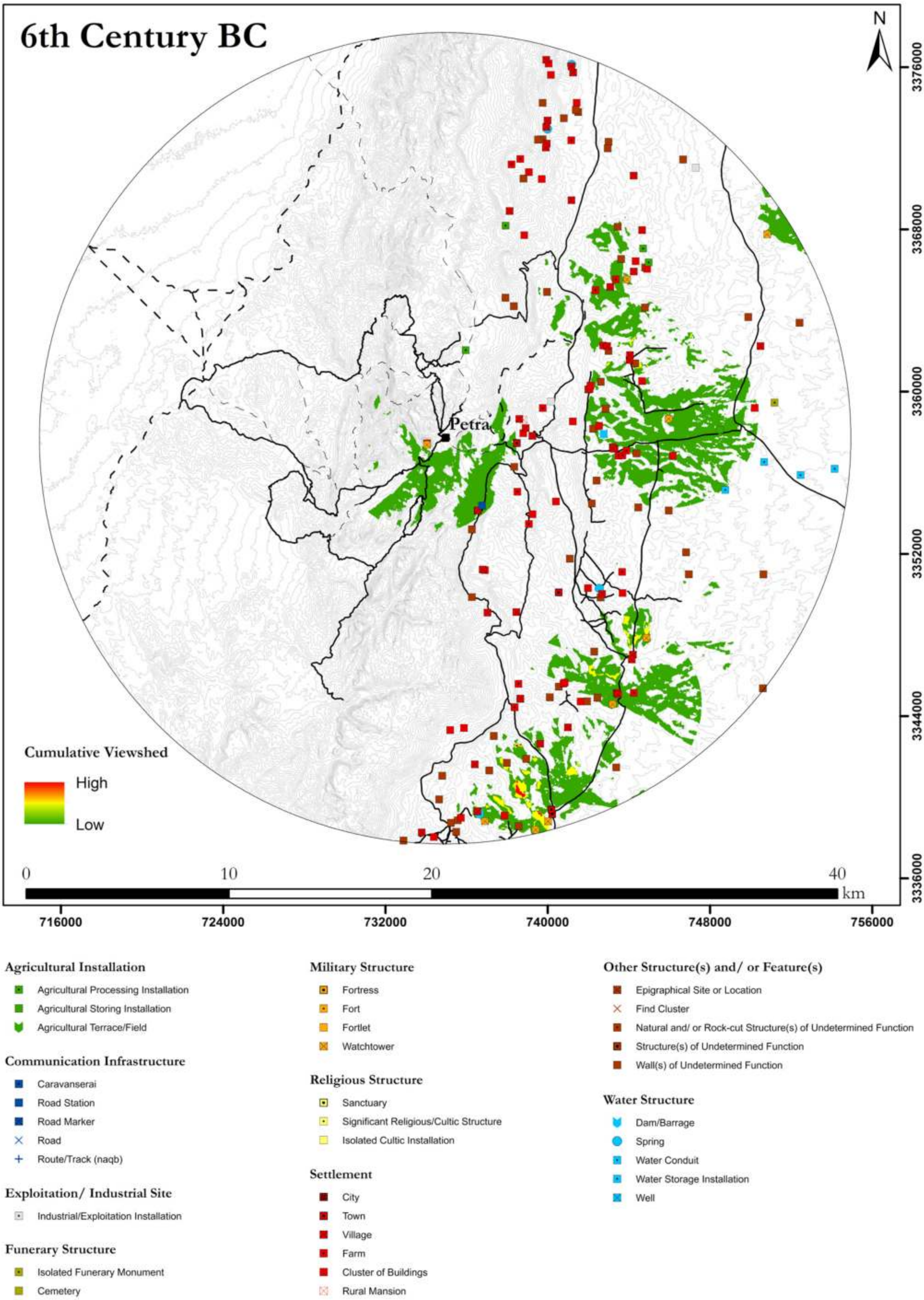


FIG. 59 Cumulative viewsheds of all presumed watchtowers in the Petraean hinterland dating to the 6th century BC. Maximum cumulative visibility from 3 towers. Visibility radius of 4400m.

FIG. 60 Aerial view of Tell Udruh (Dubais) with an earthen ditch around the structure. Photo: APAAME.

FIG. 61 Aerial view of Rujm Saddaqa. Photo: APAAME.

FIG. 62 Aerial view of ARNAS Site No. 020. Photo: APAAME.

FIG. 298, No. 6) as a watchtower because the hilltop structure commands a good view over its surroundings including stretches of the Darb ar-Rasif, Rujm Saddaqa and Ain Juwayza.[477] While this interpretation is likely, the 15 × 15 m structure appears quite large compared to the other structures discussed as watchtowers. The structure may have thus served functions other than just surveillance.

The well-known structure of Rujm Saddaqa (cf. FIG. 298, No. 7 and FIG. 61) also dates between the 10th and 6th centuries BC and then supposedly again from the 1st century BC onward. Situated on a prominent hilltop about one kilometer east of Saddaqa, scholars have commonly referred to the structure as a watchtower.[478] The rectangular structure measures c. 19,5 × 17,75 m, and is characterized by c. 1,25 m thick exterior walls with internal divisions built of well-dressed limestone ashlars. The plan suggests that the structure was possibly open along its eastern side and Abudanh noticed a "vault" near this presumed entrance.[479] Graf's survey of the site revealed a Nabataean "necropolis" on the hilltop, including the monumental *hypogeum* (cf. chapter 8).[480] Despite this important discovery, Rujm Saddaqa continues to be uncritically referred to as a watchtower, except for Kennedy, who proposes to interpret the structure as a shrine that was possibly reused in a later phase as a watchtower.[481] Although this proposal is also speculative, Rujm Saddaqa is definitely far too large and structurally complex to be considered as a simple watchtower. This is further supported by the fact that aerial images clearly show that the structure was incorporated into a larger rectangular enclosure, which has not been discussed previously (cf. FIG. 61). Due to its prominent position, Rujm Saddaqa was then reused in the Nabataean period as a burial site, which causes serious doubt of any strategic function, at least for that period. After the abandonment of the *hypogeum*, it is possible that the site then served surveillance purposes once more, but further excavations are necessary to clarify the function of Rujm Saddaqa.

The c. 225 m² square structure of ARNAS Site No. 020 (cf. FIG. 298, No. 8) is situated on a low hill commanding a good view over its surrounding landscape.

477 MacDonald et al. 2012, 52.
478 MacDonald et al. 2012, 37; Abudanh 2006, 547; Graf 1995a, 248; Parker 1986, 100; Glueck 1935, 72; Musil 1907, 232; Brünnow – von Domaszewski 1904, 468.
479 Abudanh 2006, 547; Gregory – Kennedy 1985, 334.
480 Graf 1995a, 254; Kurdi 1972.
481 Kennedy 2004, 187 *contra* e.g. al-Khouri 2003, 46.

The original surveyors interpret the site as a watchtower.[482] Although this is possible, aerial images of the site suggest that it is too large in comparison to other watchtowers (FIG. 62). It is thus possible that the site served more functions than just surveillance; perhaps a small refuge. Surface pottery evidence suggests that the site was occupied between the 10th and 6th centuries BC and then again from the 4th century AD onward.

Dating between the 10th and 6th centuries BC and then again from the 1st century BC onwards, the unique site of Jabal al-Tahkeem (al-'Ashari) is located on a prominent hilltop just north of Udruh and characterized by two separate structures arranged in an L-shaped fashion (cf. FIG. 298, No. 4 and FIG. 63).[483] The conspicuously thick (c. 1,2 m) walls still stand relatively high. Due to its excellent view over the surroundings and its thick walls, Abudanh considers the site to have played a defensive role. MacDonald et al. explicitly refer to it as a "fort and/or watchtower."[484] While the site's prominent hilltop location and its solid exterior walls may indicate a defensive purpose, the layout is completely unique and not comparable to any other presumed military structures known in the Petraean hinterland to date. It may be considered as a fortified civilian site, but its location along a possible road leading further north from Udruh (cf. FIG. 299) may also indicate a function related to the road. However, this can only remain speculative as well.

Due to the inconclusive nature of these sites, they cannot be referred to as simple watchtowers. They are all rectangular structures with thick perimeter walls and are located on prominent hilltops either along and/or with good visibility over important roads. Particularly Tell Udruh (Dubais), Rujm al-Jarba and Rujm Saddaqa are significantly larger than the other structures discussed as simple watchtowers, and often show internal divisions suggesting additional functions other than surveillance. The structures' solid exterior walls and large ashlars as well as other features such as the earthen ditch around Tell Udruh or the presumed rectangular enclosure of Rujm Saddaqa clearly highlight their defensive character as well.

As a tentative proposal, this study therefore introduces the term 'hilltop refuge,' which may match the function of these structures more accurately. Although this term remains imprecise as it is understood in a purely functional sense and can relate to any military structure that is situated on a hilltop, it may nevertheless suffice for the sake of this study's argument as it is not defined on the basis of more specific structural or functional characteristics. However, future studies on these military structures should critically re-evaluate the appropriateness of the term. It is nevertheless tempting to consider these structures as possible pre-Nabataean military sites that were – at least in some cases – also used in later periods. Whether this hypothesis can be confirmed or not, these structures certainly cannot be considered as simple watchtowers as they clearly served various purposes.

In addition to these presumed hilltop refuges, there are other, larger structures that the various surveys identified as possible defensive structures, but which cannot be securely classified to any of the pre-defined military sites as well:

The first structure is a presumably Iron Age site situated in the northern part of the study area originally identified by Glueck, who refers to it as Khirbet al-Iraq (LH2E Site No. 045) (cf. TABLE 34). Glueck noticed some structural remains on a hilltop that he interpreted to have been of a possible defensive nature. This interpretation was tentatively followed by Hart as well.[485] However, as no more information is available on the site, it cannot be confidently considered here as a military structure.

Ras 'Urayta is another rectangular structure situated on a hilltop (cf. FIG. 298, No. 3).[486] Surface material suggests that the site was occupied between the 10th and 6th centuries BC and then again from the 1st century BC onwards. The original surveyors interpret the site as a "small fort," although they also claim it may have been a farm. With no further information on the structure itself, the latter interpretation seems more likely; particularly as the site description mentions (modern) agricultural activities in the immediate environment of Ras 'Urayta as well as corrals.

Dating from the 10th to 6thcenturies BC and then again from the 1st century BC onwards, ShamAyl Site No. 085 (Rujm 'Ayn al-Hajim) consists of several structures with one central structure measuring c. 15 × 8 m with a possible dividing wall overlooking a nearby spring (cf. FIG. 298, No. 20).[487] The surveyors assumed that the site had a defensive function in relation to the spring, but the provided information is too inconclusive to support this proposition.

The assignment of a defensive function for most of all 'other structures with possible military/com-

482 MacDonald et al. 2012, 48.
483 Driessen – Abudanh 2019, 461–462. Killick (1983a) refers to the site as 'Qasr al-Temei'ah.'
484 MacDonald et al. 2016, 270; Abudanh 2006, 420.
485 Hart – Faulkner 1985, 270; Glueck 1935, 88.
486 MacDonald et al. 2012, 75.
487 MacDonald et al. 2016, 205.

FIG. 63 Aerial views of the structure of Jabal al-Tahkeem (al-ʾAshari). A: Jabal al-Tahkeem and surroundings. B: Detailed view. Photos: APAAME.

munication function' is seemingly questionable. The archaeological information for these sites is either inconclusive or the site descriptions do not convincingly suggest them to have had any defensive function. Although these sites should not be dismissed as possible military/communication structures entirely, they must be considered critically.

The Religious and Funerary Landscape

Unlike in chapter 8, the paucity of secure archaeological evidence for the Petra area's religious and funerary landscape during the Iron Age does not allow a differentiated presentation of the evidence by the separate subcategories (cf. chapter 2).

No funerary structures were recorded for the Iron Age periods and the only religious structure is a presumed temple on a hilltop at as-Sadeh identified by Lindner (cf. chapter 8 and FIG. 345).[488] During small-scale excavations, Lindner revealed a possible small altar. Pottery material also included some Iron Age fragments.[489] No further information is provided for this presumed temple.

Terra Petraea in the Iron Age Periods. A Synthesis

The following critically discusses all relevant archaeological data and assesses the Petraean hinterland in the Iron Age periods. Similar to the synthesis of the later periods (chapter 9), the following is structured by the same superordinate topics 'subsistence strategies and communication' and 'the military disposition.' The paucity of archaeological evidence does not offer meaningful insights into the socio-cultural background of the Petraean hinterland during the Iron Age. Specific aspects that may be relevant for the Iron Age periods, but are important for the later periods, are discussed in the subsequent chapters.

Subsistence Strategies and Communication

The rural agricultural settlement pattern of Petra during the 12th and 11th centuries BC is characterized by comparatively few settlements. The total count does not exceed 31 sites. The largest category is villages, followed by cluster of buildings and few individual farms. All evidenced settlements are situated along the Jabal Shara escarpment and eastern high plateau, thus in areas with the highest rainfall and best lands for agricultural cultivation. While the settlements may suggest that agriculture was already practiced as early as the 12th century BC, it was nonetheless extremely limited and arguably focused strongly around larger settlements such as villages, clusters of buildings and the only town-like settlements at Saddaqa, Khirbet Tal'at-Umar and to some extent also Gaia (Wadi Musa).

By the 10th century BC, an overall increase of rural settlements was observed that may correspond to the gradually rising Edomite kingdom. The total count rises to 89 settlements with villages remaining the largest category, followed by clusters of buildings and eventually a small number of individual farms. Despite the increase of settlements, the general pattern observed already for the 12th and 11th centuries remains the same: All settlements concentrate along the Jabal Shara escarpment and eastern high plateau and nucleate around larger settlements. This is supported by the intensity function of terrain elevations calculated for all settlements and the G-, F- and K-functions suggest an overall clustering of sites (FIGS. 64–66). While the mean center of all settlements is just northeast of Wadi Musa during the 12th and 11th centuries BC, by the 10th century BC it moves slightly towards the south indicating a shift in the concentration of settlements in the study area. The same observations can be made for the 9th – 6th centuries BC, suggesting that the overall settlement pattern remained largely unchanged since the 10th century BC (FIGS. 67–70). By the 5th century BC, an extremely dramatic decrease of settlements is noted that is arguably associated with the collapse of the Edomite kingdom. Apart from the village of Tawilan and the presumed farm at Abu Danna, all settlements are abandoned.

In addition to rural settlements, the few agricultural installations indicate that the Petraean hinterland was, at least in part, based on agriculture during the Iron Age periods. Although the surveys did not record any Iron Age agricultural terraces or dams/barrages, the four agricultural processing installations may point to limited agricultural activities during the Iron Age. Apart from a wine press in the Beidha area where

488 Lindner 2003a, 47; Lindner et al. 1990, 211–213, pl. X.1; Lindner et al. 1988, 85, fig. 6. Only ShamAyl (MacDonald et al. 2016, 272) mention a 10th century BC to 7th century AD sherd scatter that may be related to a 'tomb.' No further description of this presumed tomb is provided.

489 Lindner 2003a, 47; Nehmé 1997a, 1042; Lindner et al. 1990, 213.

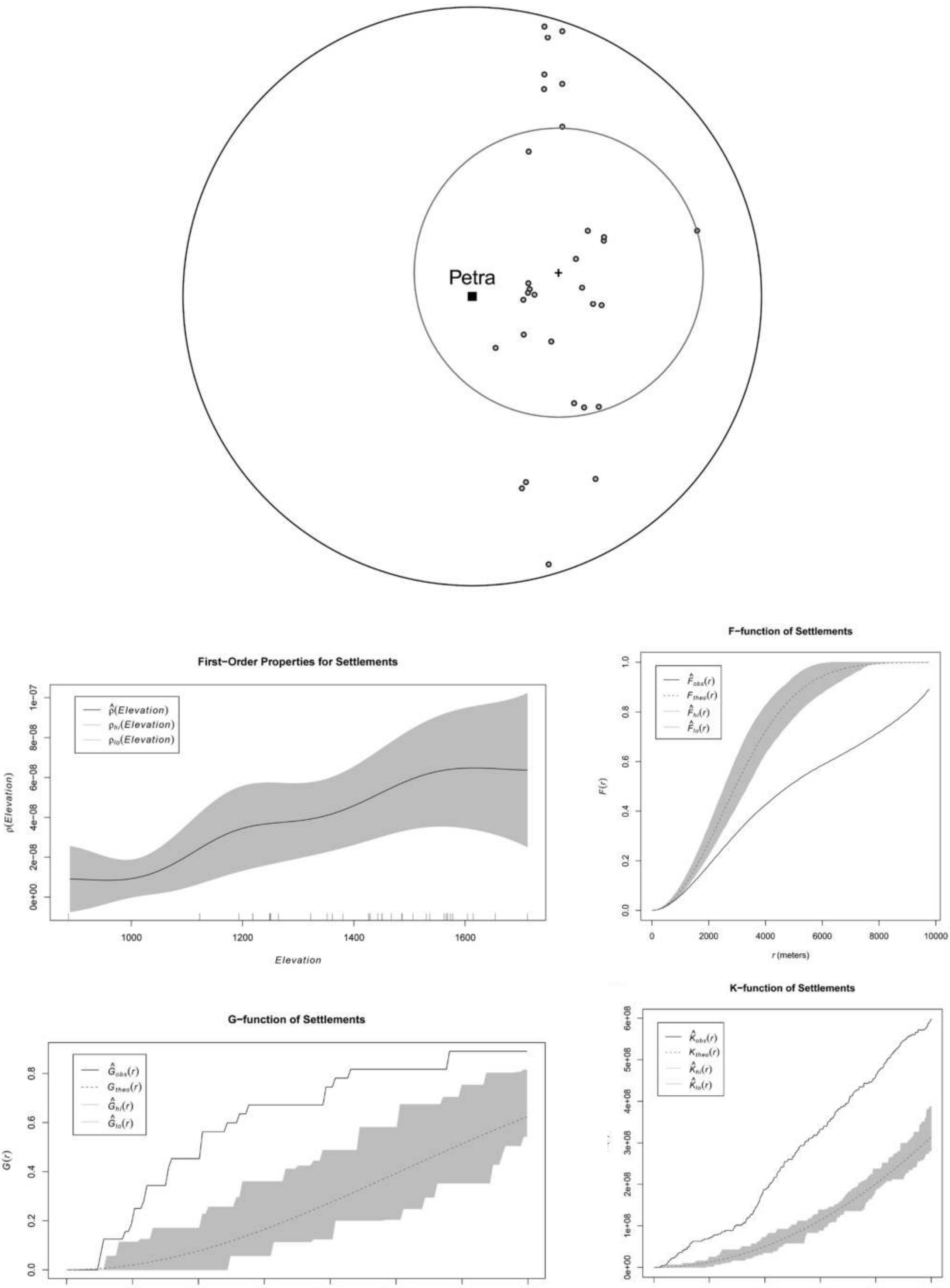


FIG. 64 Point pattern analyses of settlements dating to the 12th century BC. Above: All evidenced settlements in the study area with mean center of the pattern (cross) encircled by the standard distance between all settlements. Upper left: Intensity function of terrain elevation for all settlements. Lower left: G-function. Right: F- and K-functions.

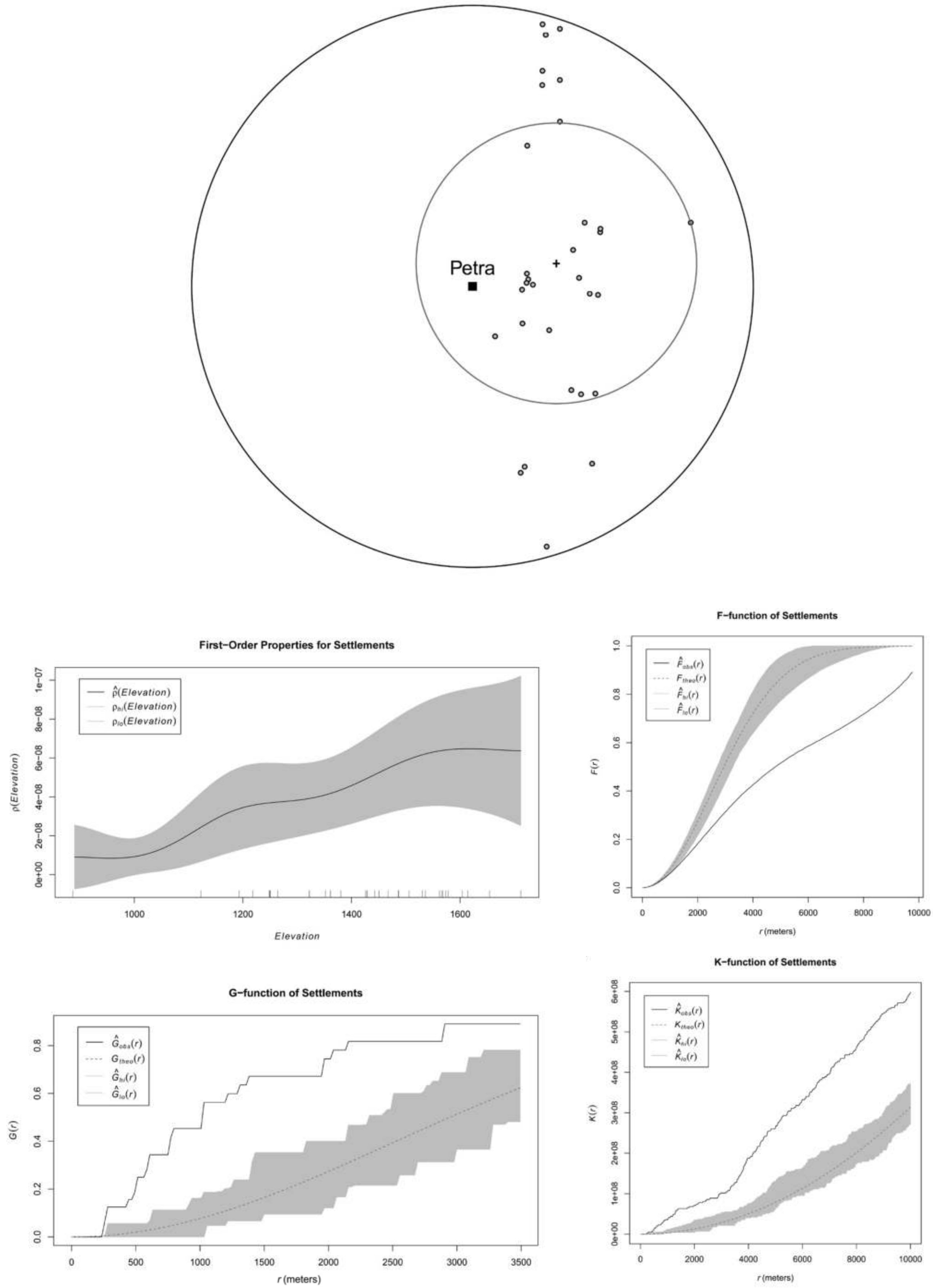


FIG. 65 Point pattern analyses of settlements dating to the 11th century BC. Above: All evidenced settlements in the study area with mean center of the pattern (cross) encircled by the standard distance between all settlements. Upper left: Intensity function of terrain elevation for all settlements. Lower left: G-function. Right: F- and K-functions.

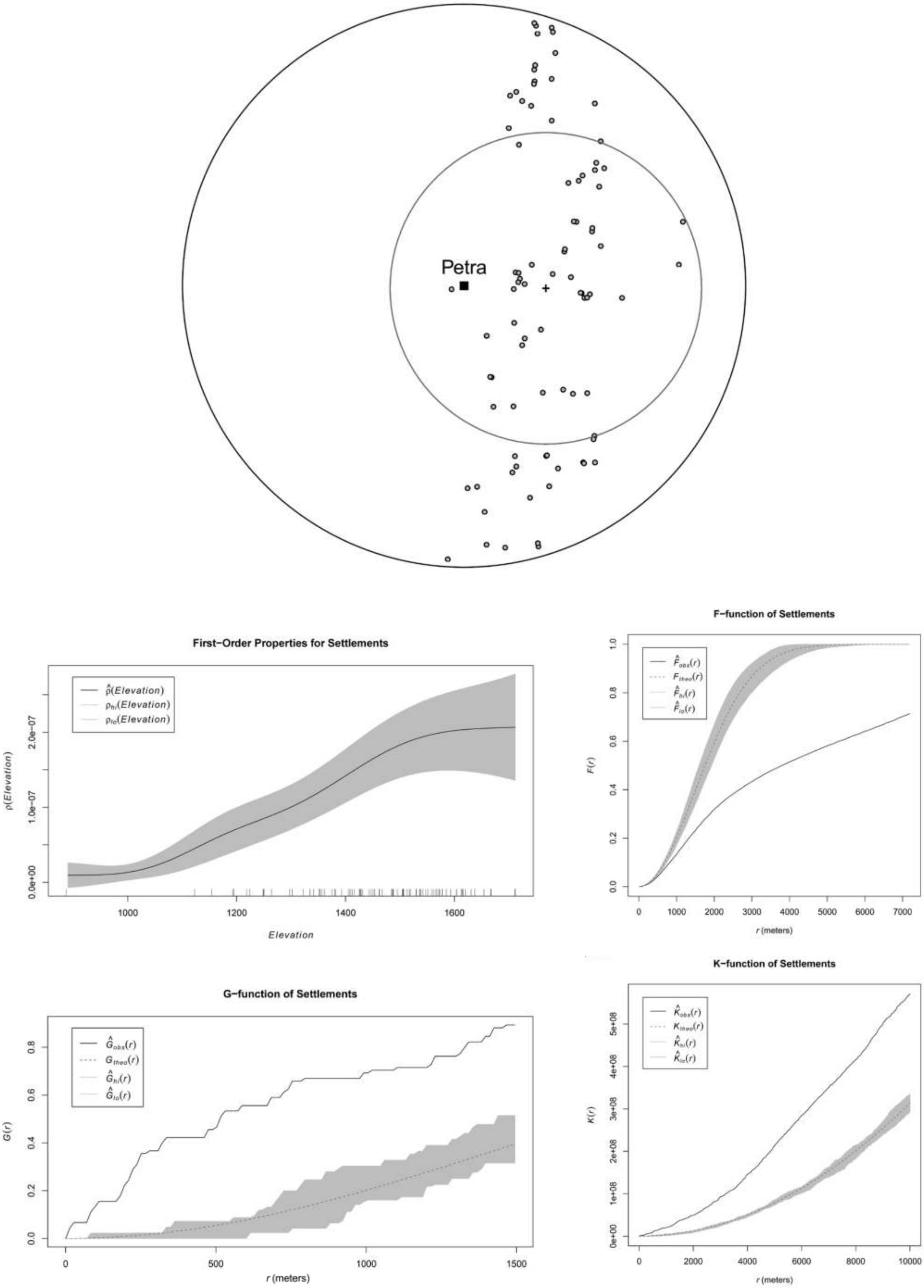


FIG. 66 Point pattern analyses of settlements dating to the 10th century BC. Above: All evidenced settlements in the study area with mean center of the pattern (cross) encircled by the standard distance between all settlements. Upper left: Intensity function of terrain elevation for all settlements. Lower left: G-function. Right: F- and K-functions.

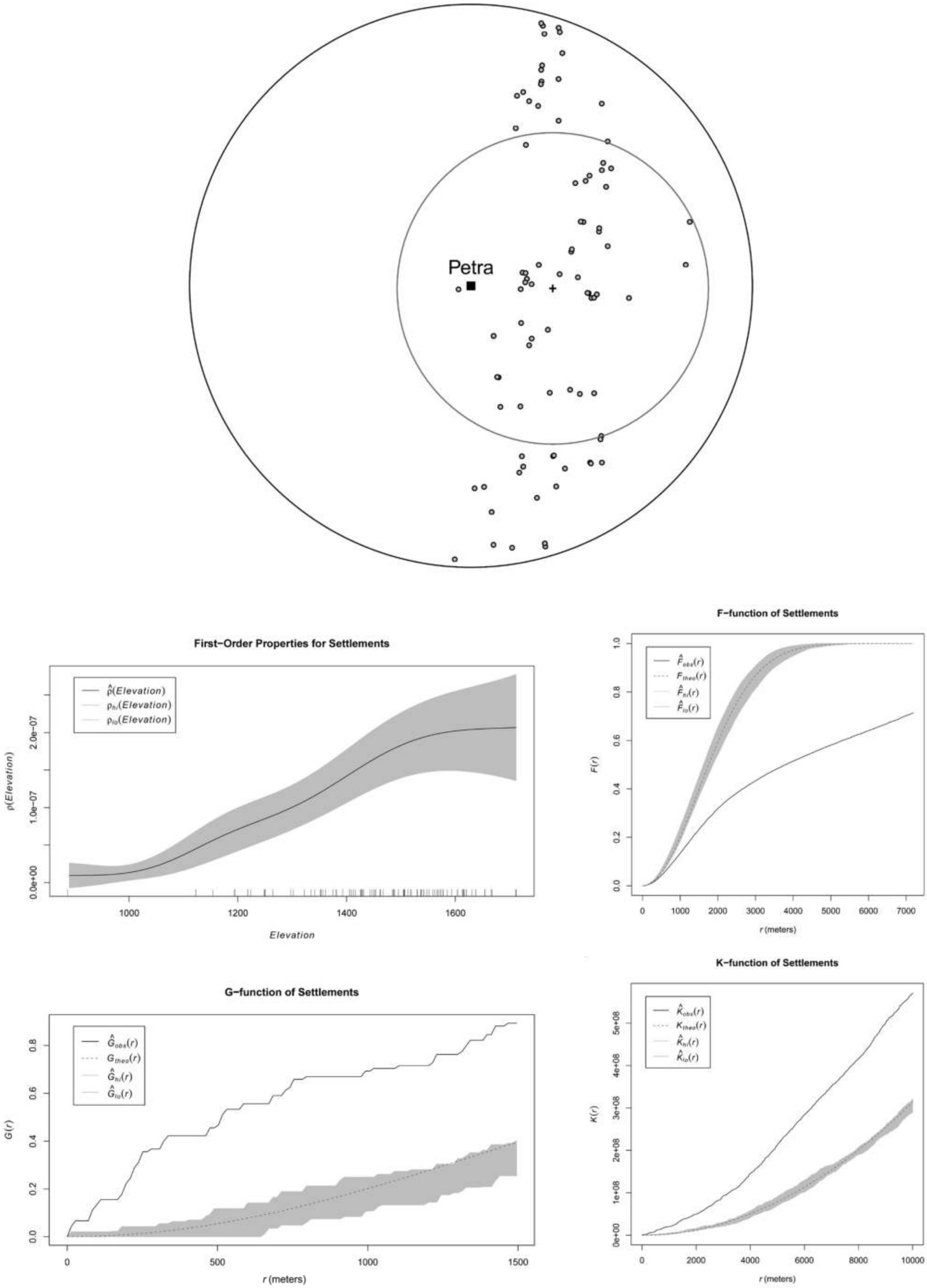


FIG. 67 Point pattern analyses of settlements dating to the 9th century BC. Above: All evidenced settlements in the study area with mean center of the pattern (cross) encircled by the standard distance between all settlements. Upper left: Intensity function of terrain elevation for all settlements. Lower left: G-function. Right: F- and K-functions.

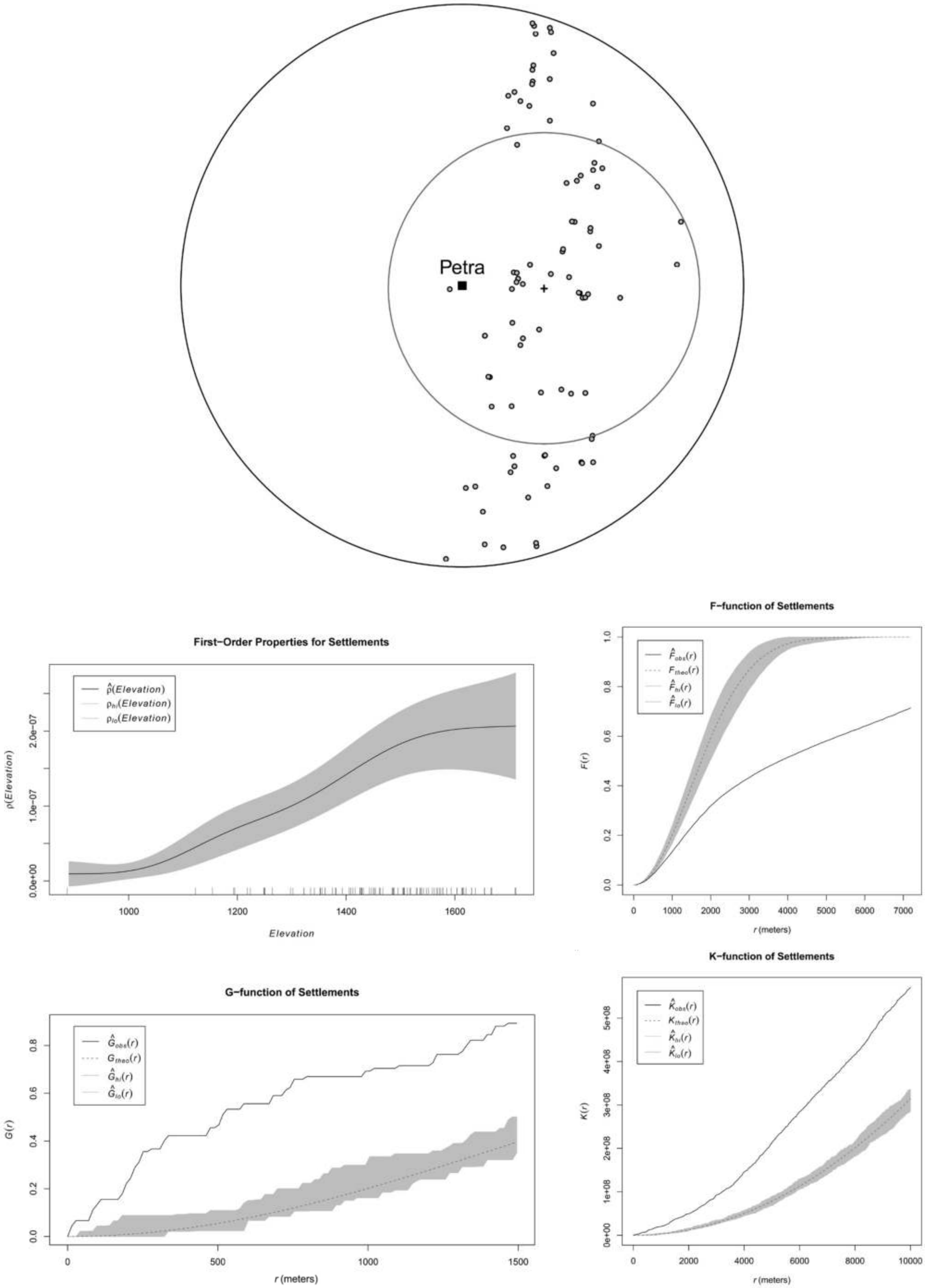


FIG. 68 Point pattern analyses of settlements dating to the 8th century BC. Above: All evidenced settlements in the study area with mean center of the pattern (cross) encircled by the standard distance between all settlements. Upper left: Intensity function of terrain elevation for all settlements. Lower left: G-function. Right: F- and K-functions.

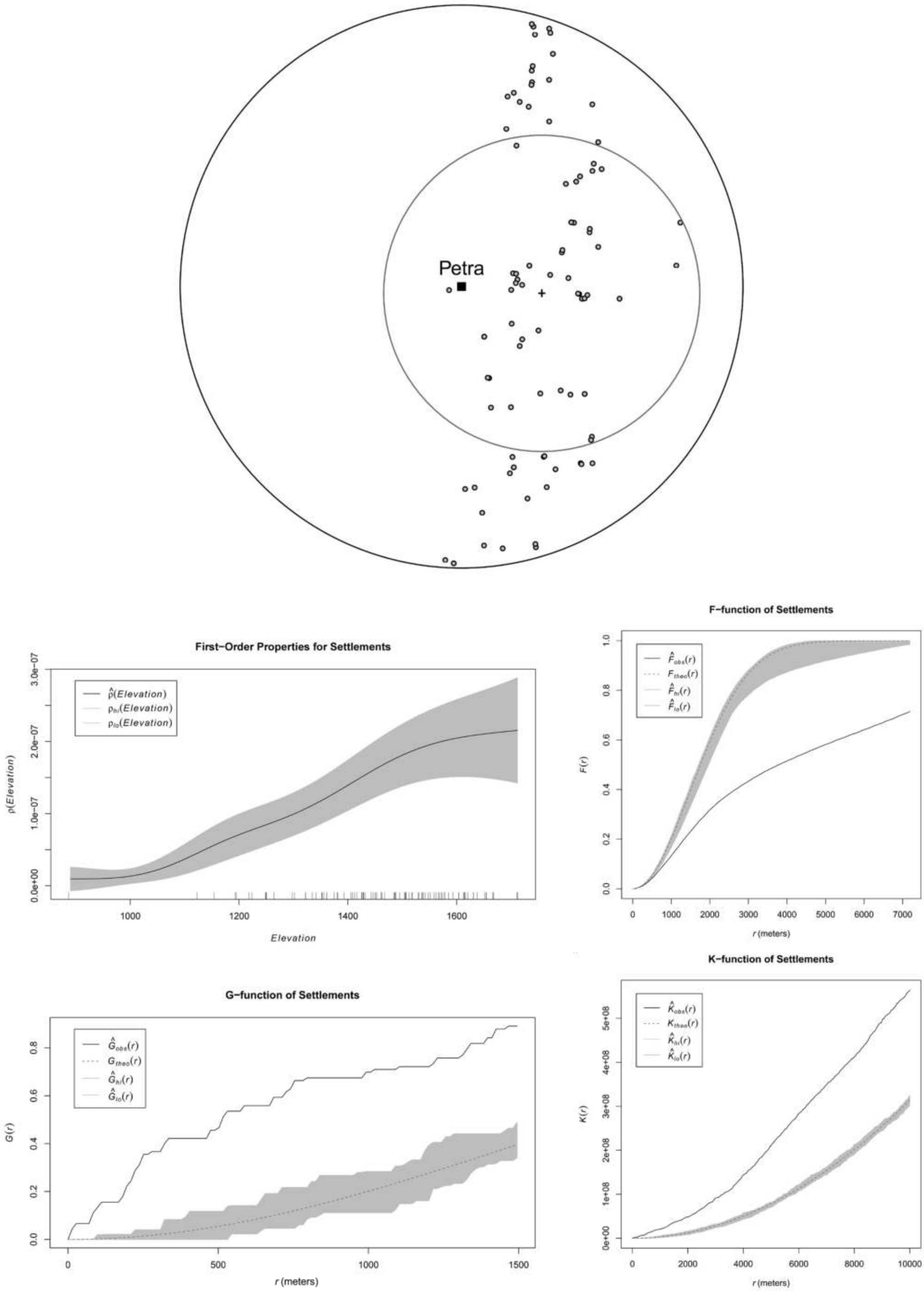


FIG. 69 Point pattern analyses of settlements dating to the 7th century BC. Above: All evidenced settlements in the study area with mean center of the pattern (cross) encircled by the standard distance between all settlements. Upper left: Intensity function of terrain elevation for all settlements. Lower left: G-function. Right: F- and K-functions.

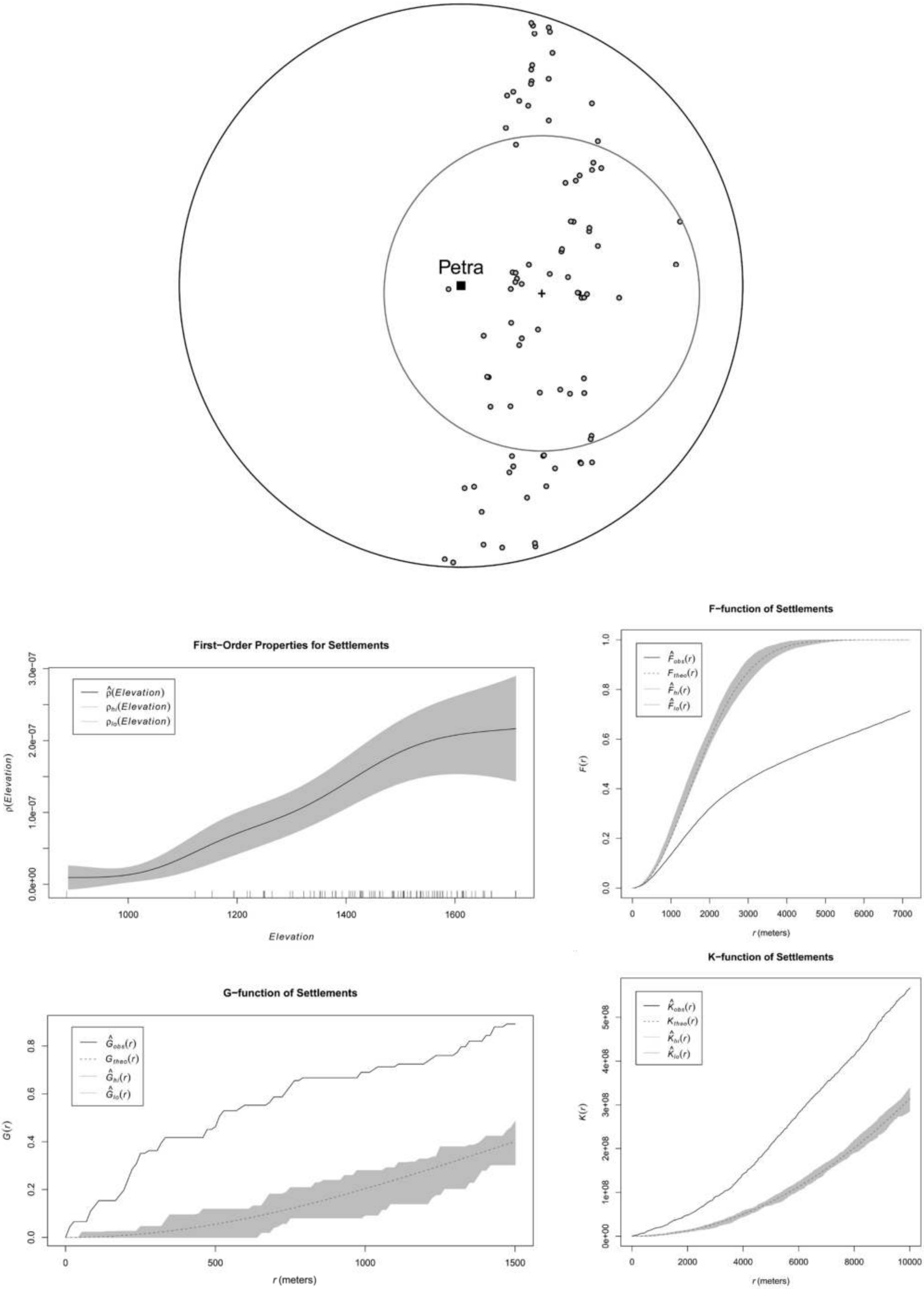


FIG. 70 Point pattern analyses of settlements dating to the 6th century BC. Above: All evidenced settlements in the study area with mean center of the pattern (cross) encircled by the standard distance between all settlements. Upper left: Intensity function of terrain elevation for all settlements. Lower left: G-function. Right: F- and K-functions.

the original surveyors documented Iron Age II surface material, the only further archaeological evidence for agricultural activities are three threshing floors and one simple enclosure distributed along the eastern high plateau.[490] However, the documented wine press in the Beidha area is most likely a later (Nabataean) addition. Nevertheless, the limited amount of threshing floors as well as the comparatively few evidenced farms indicate that agriculture (particularly cereal cultivation) was practiced on a small and local scale during the Iron Age periods.

The presented water structures give no indications that run-off cultivation was practiced. Instead, the water management system was most likely largely based on the collection and storage of run-off water in cisterns as was the common practice during that time in Transjordan.[491]

Possible camp sites were discussed as direct archaeological indicators that pastoralism formed an important subsistence strategy in the study area in addition to limited farming (cf. FIGS. 124 and 128).[492] Although dating these structures is highly problematic, there were nevertheless a few possible camp sites where surface pottery material suggests an Iron Age date. Moreover, the major site of Tawilan continued to be settled in the Persian period and a cuneiform tablet was discovered that gives details on the sale of livestock by a group referred to as 'Nabataeans.'[493] It may thus be assumed that pastoralism played a major economic role in the Petraean hinterland during the Iron Age periods.

The industrial activities in the study area during the Iron Age were seemingly limited to a small and local scale as suggested by only two small chert quarries on the eastern high plateau (cf. FIGS. 145 and 146).[494] Although no dating material was observed, Abudanh documented the c. 10,000 m² large quarry at Muhaidhrat, which was most likely exploited for the construction of the Iron Age-Roman hilltop structure of Khirbet Muhaidhrat.[495] Additionally, the copper mines of Umm al-ʾAmad were presumably exploited as early as the Early Iron Age (12th – 9th century BC). Although these small-scale copper mining activities were certainly no competition to the larger mines at Timnah or Faynan, the extraction of copper from the Umm al-ʾAmad area indicates that it was already attempted to exploit the region's resources.[496]

In terms of rural Petra's communication infrastructure in the Iron Age, the domestication of the dromedary in late second millennium BC opened new trade-related avenues. Camels were able to carry far heavier loads over much longer distances and with less water sources than donkeys, which were the traditional beasts of burden (cf. chapter 6).[497] This is confirmed by the (admittedly rare) Assyrian textual evidence (9th – 8th century BC) as well as biblical sources referring to regular caravan trade between South Arabia and the Mediterranean Sea, dating camel-based caravan traffic as early as the 10th century BC.[498]

In the Petra area, the introduction of the camel as the 'ship of the desert' facilitated transportation and traffic along the main Iron Age camel caravan road, the *Darb ar-Rasif*, that connected the Petra area with northern Transjordan and eventually Mesopotamia (cf. e.g. FIG. 191 for the stretches of the Darb ar-Rasif in the study area).[499] In the Iron Age, the Darb ar-Rasif directly connected to transregional caravan trade and was thus the major economic artery of the Edomite kingdom, and thus the Petra area as well. In addition to the main north-south direction of the Darb ar-Rasif, recent investigations of Abudanh et al. revealed that additional, smaller roads branched off the main course of the Darb ar-Rasif connecting the road with settlements farther away, thus highlighting the significant infrastructural organization of the Petraean hinterland during the Iron Age.[500] Also, in addition to the Darb ar-Rasif, the east-west running *Darb es-Sultan* presumably also crossed through the Petra region during the Iron Age. This is indicated by sites along the Petra–Gaza road between Moyat ʾAwad and Oboda dating to the Chalcolithic-Iron Age II periods.[501] Possibly, the

490 ʾAmr et al. 1998, 512.
491 al-Muheisen 2009, 83–89; Oleson 1997, 176; Oleson 1995, 709; Evenari et al. 1982, 14–17, 159, 171. For example, consider the numerous cisterns on Umm al-Biyara associated with both the Iron Age and Nabataean structures on the mountaintop (cf. e.g. Schmid et al. 2012, 75–85 and Bienkowski 2011).
492 Cf. also the parallels from the Negev (more in chapter 4).
493 Studer 2007, 252.
494 MacDonald et al. 2016, 346, 409.
495 Abudanh 2006, 484–485, 503, 518, 539.
496 Hauptmann 1986, 33; Kind 1965, 71–73.
497 Magee 2015; Meerpohl 2013, 168; Riemer – Förster 2013; Rosen – Saidel 2010, 74–76; Uerpmann – Uerpmann 2002 and Köhler-Rollefson 1993, 182–184. See Köpp 2013, 110 on the continuing importance of the donkey in transregional trade.
498 On the biblical reference, see Köhler-Rollefson 1993, 184: 1 Kings, 10. Also note the historically perhaps questionable accounts of the Midianites and Ishmaelites attacking rural settlements on camel-back (Rosen – Saidel 2010, 74). On the Assyrian sources: Rosen – Saidel 2010, 72; Köhler-Rollefson 1993, 184; Ephal 1982. Also cf. Hdt. 7, 69, 86.
499 Abudanh et al. 2015b, 159; Graf 1992, 258.
500 Abudanh et al. 2015b, 186. Borstad 2008, 59–61; Zayadine 1992, 227–228.
501 Ben David 2012, 21. Also compare Erickson-Gini – Israel 2013, 25.

(limited) exploitation of the copper mines at Umm al-ʾAmad necessitated a functioning route system in Petra's western hinterland as early as the Early Iron Age.[502] However, this remains speculative.

The Military Disposition

Only a limited number of presumed military sites date to the Iron Age periods (cf. FIG. 366). Merely four forts, one presumed fortlet and two possible watchtowers are evidenced for the 12th – 11th centuries BC. While a slight increase can be observed during the 10th – 6th centuries BC, all are abandoned in the 5th century BC.[503] This abandonment of military sites mirrors the general absence of archaeological sites in the study area during this period.

The GIS-based visibility analyses attempted to further investigate the general relationship between military structures and other archaeological sites in the study area (FIGS. 71–77). During the 12th – 11th centuries BC there are areas visible from a maximum of only two military structures that concentrate around the area immediately north of Udruh (cf. FIGS. 71–72). Other areas of the Petraean hinterland are under very little visual control. Areas west of the eastern high plateau and the Jabal Shara escarpment, including Petra, are not controlled as there are no military structures evidenced in these parts of the study area. The most structures visible from military structures dating to the 12th – 11th centuries BC are other military structures, which are then followed by civilian rural settlements, other structures and/or features as well as water structures.

The situation changes during the 10th century BC (cf. FIG. 73), when areas become visible from a maximum of six military structures. This is due to the general increase of sites during this period, which is possibly associated with Edomite settlement activities in the immediate Petra region, and explains the slightly more comprehensive visual control exerted by the evidenced military structures.[504] Three areas are now under particularly good visual control. These include the immediate surroundings of Udruh (as before), the area around Basta and Ayl and, most importantly, the surroundings of Saddaqa. While the most visible structures were military sites in the previous two centuries, the number of non-military sites within the cumulative visibility fields of military structures dating to the 10th century BC (particularly settlements and other structures and/or features) has now increased, amounting to approximately the same number as visible military structures.

The same observations can be made for the 9th – 6th centuries BC (cf. FIGS. 74–77), although during the 7th and 6th centuries BC previously non-visible areas immediately south of Petra were under visual control as well. Presumably, the visibility analyses indicate that military structures mainly served the surveillance of civilian settlements and important roads such as the Darb ar-Rasif.

Finally, it was proposed to reinterpret the function of several structures identified by previous scholars as simple watchtowers. Those dating to the Iron Age periods include Tell Udruh (Dubais), Rujm al-Jarba, Jabal al-Tahkeem (al-ʾAshari), Rujm as-Saddaqa as well as ARNAS Site No. 020 (cf. TABLE 34).[505] These sites were referred to here as possible 'hilltop refuges' as they are situated on prominent hilltops on the eastern high plateau along important roads such as the Udruh–Saddaqa or the Udruh–Shawbak roads (cf. FIG. 299). They are all described as rectangular structures with thick perimeter walls and are significantly larger than other structures discussed as watchtowers. They also often show internal divisions indicating that they served functions additional to surveillance. Their solid perimeter walls and large ashlars, as well as other features such as the earthen ditch around Tell Udruh or the observed rectangular enclosure of Rujm Saddaqa highlight the structures' clear defensive character. The proposed term 'hilltop refuge' may therefore be more appropriate. However, farther-reaching research is required to investigate whether these 'hilltop refuges' may be considered as possible pre-Nabataean military structures in the Petraean hinterland.

502 Cf. Ynnilä 2013, 264.

503 The only exception is apparently the possible fortlet/road station of at-Tiyir (ARNAS Site No. 192) which seems to have been occupied in the 4th – 2nd centuries BC as well.

504 However, the western part of the Petraean hinterland is still not included.

505 Additionally, Rujm al-Bitar, possibly Rujm ʾUtayq, Rujm al-Mattwi and Rujm al-Khatabiyya were also discussed as other (non-Iron Age) 'hilltop refuges' (cf. chapter 7).

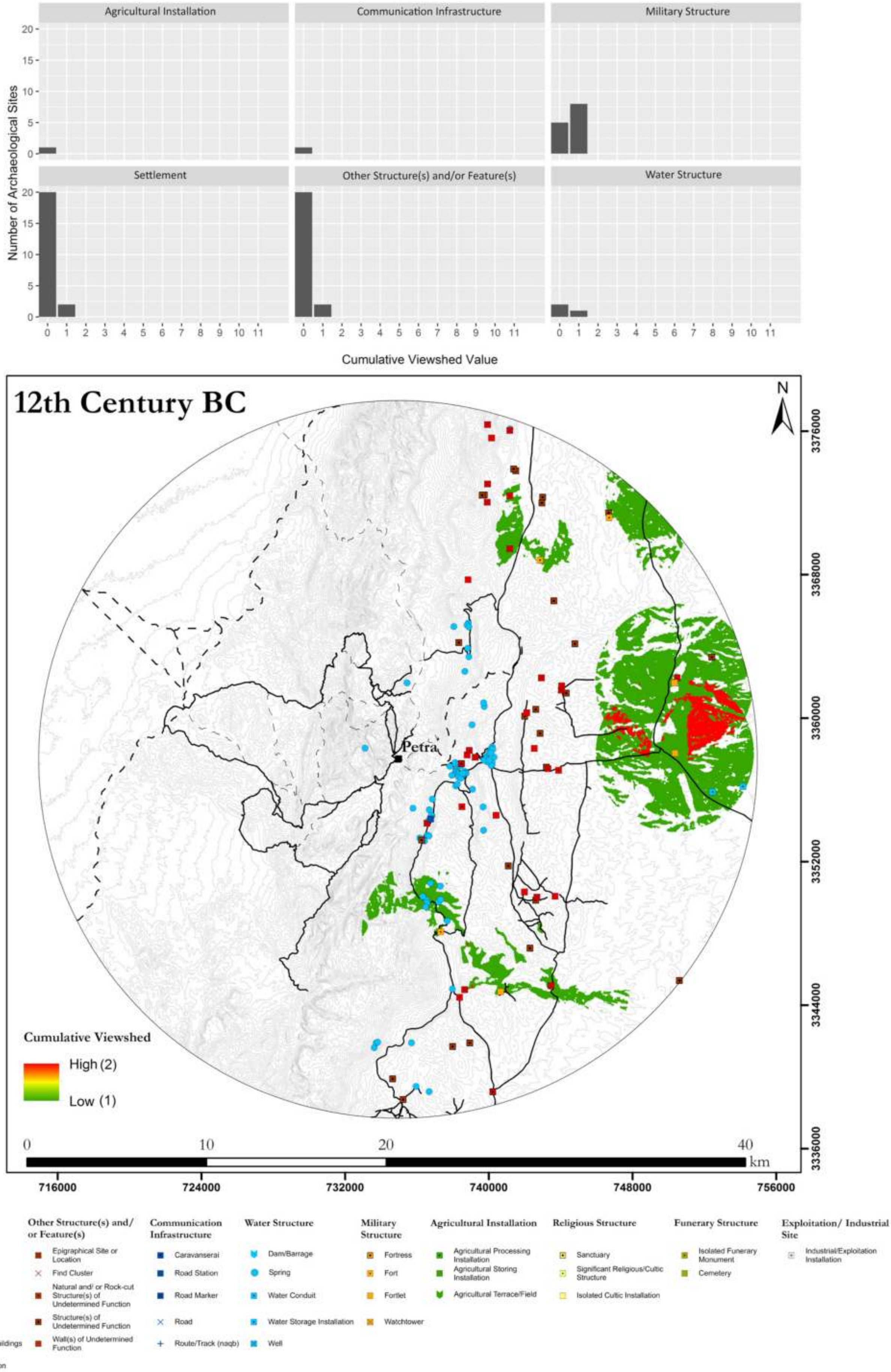


FIG. 71 Cumulative visibility analysis of all military sites dating to the 12th century BC with number of other contemporary sites within visibility fields.

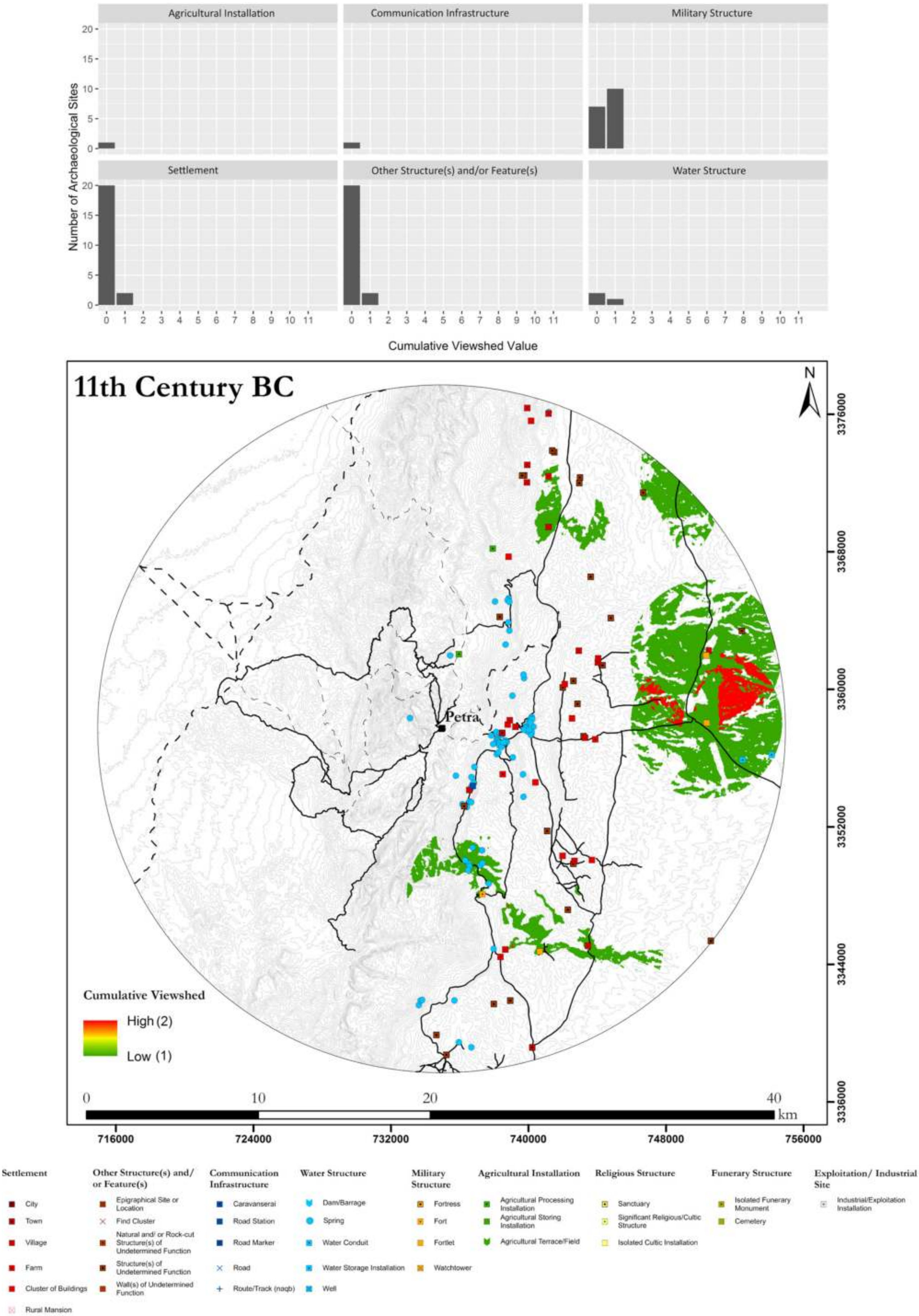


FIG. 72 Cumulative visibility analysis of all military sites dating to the 11th century BC with number of other contemporary sites within visibility fields.

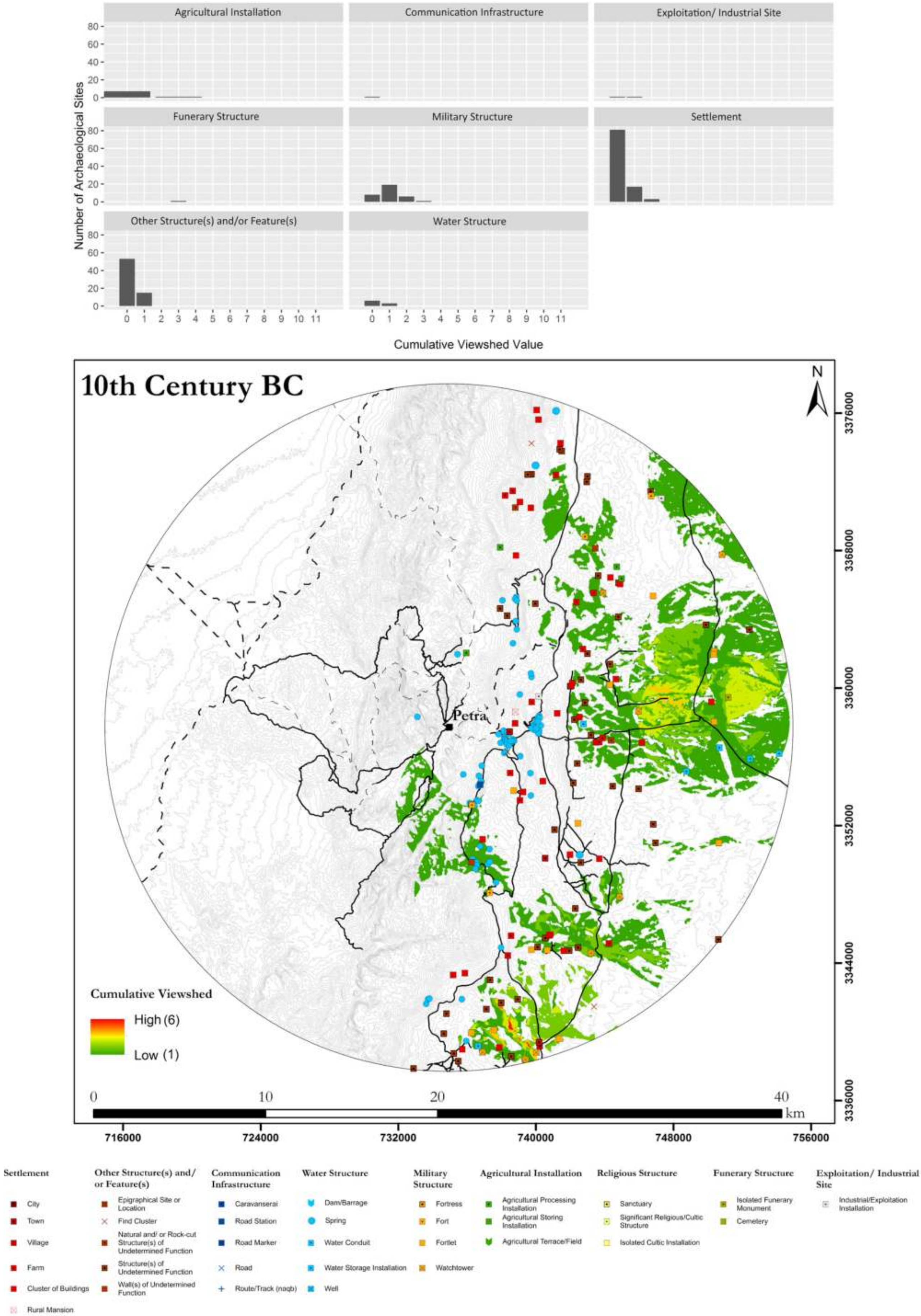


FIG. 73 Cumulative visibility analysis of all military sites dating to the 10th century BC with number of other contemporary sites within visibility fields.

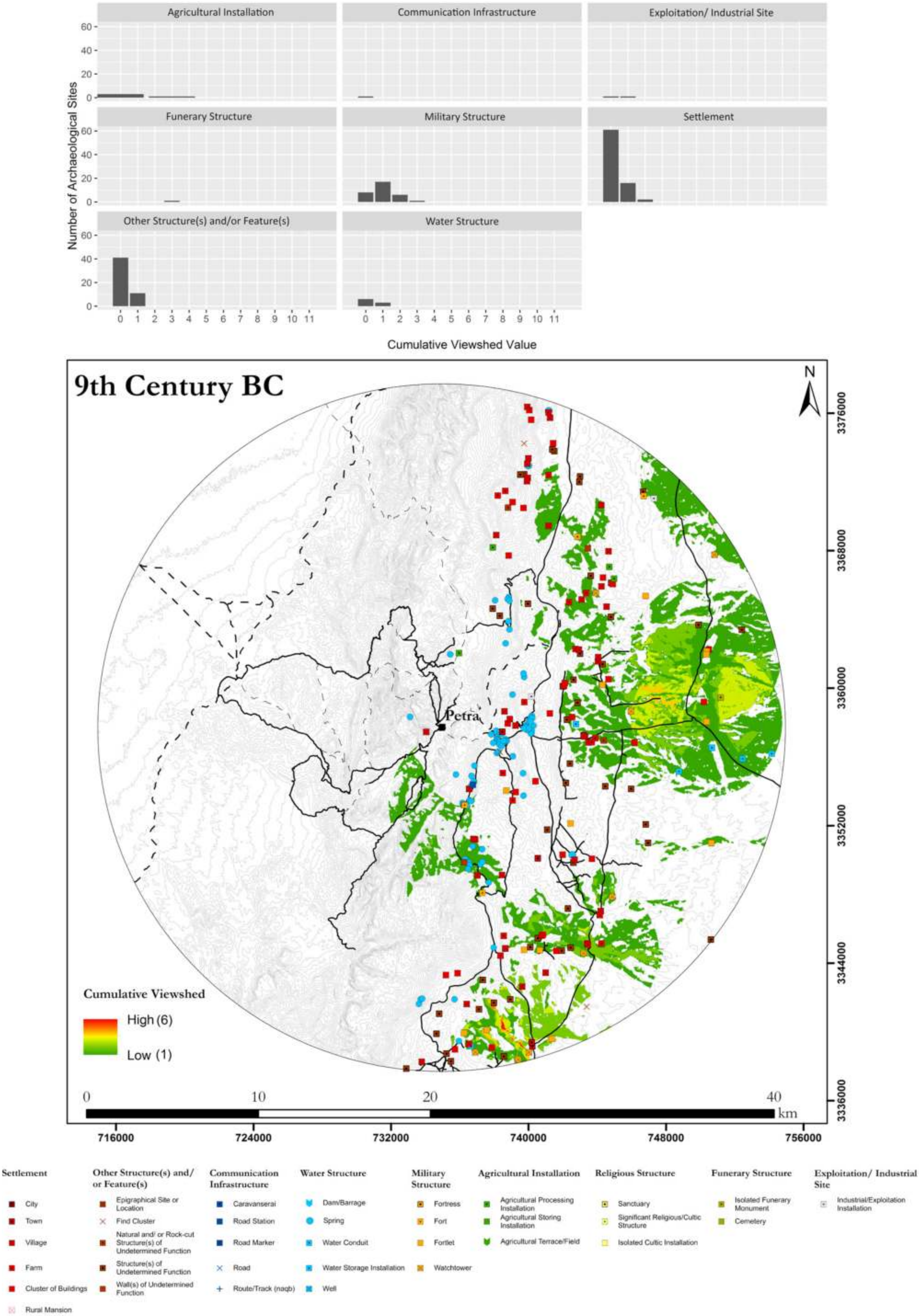


FIG. 74 Cumulative visibility analysis of all military sites dating to the 9th century BC with number of other contemporary sites within visibility fields.

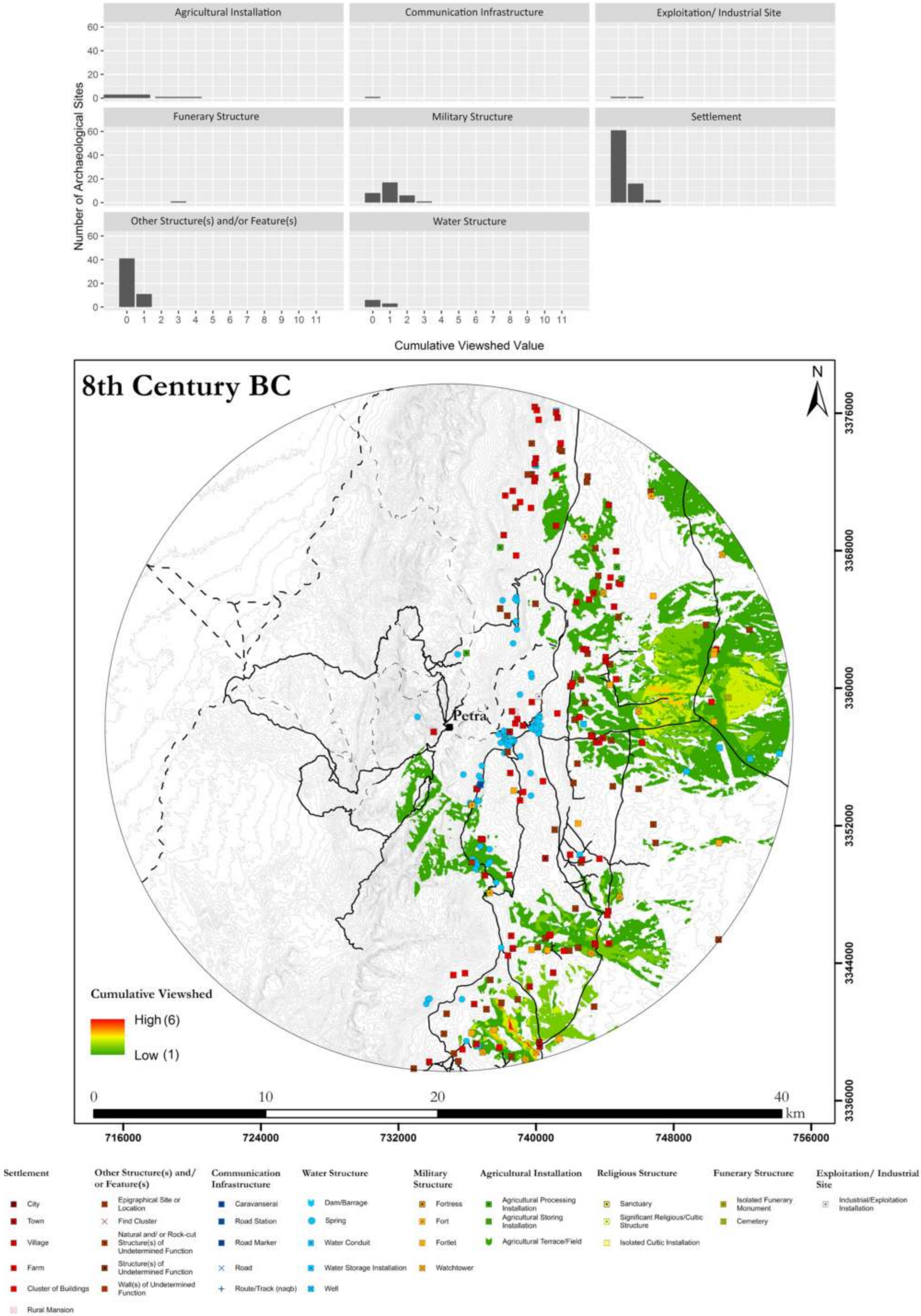


FIG. 75 Cumulative visibility analysis of all military sites dating to the 8th century BC with number of other contemporary sites within visibility fields.

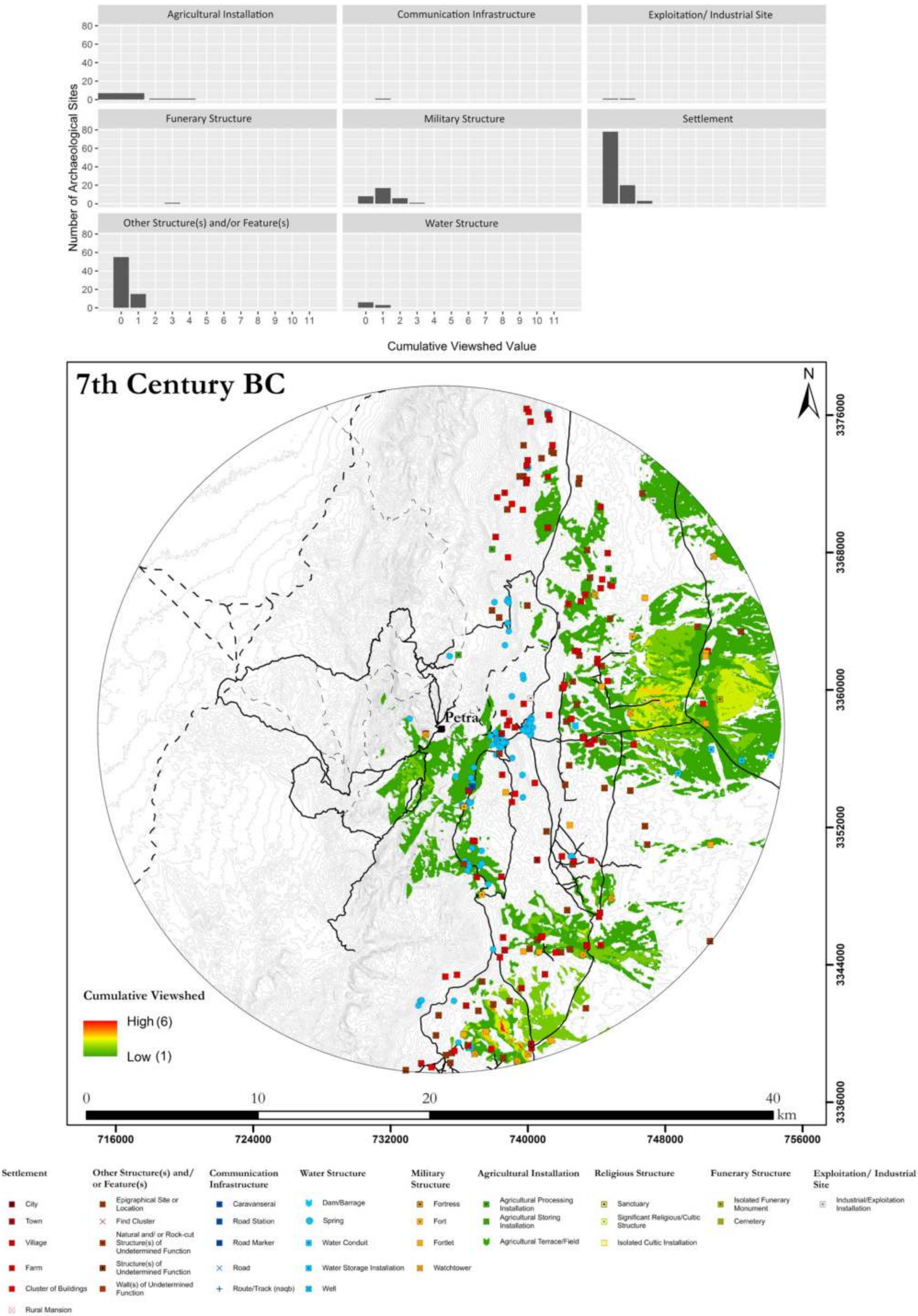


FIG. 76 Cumulative visibility analysis of all military sites dating to the 7th century BC with number of other contemporary sites within visibility fields.

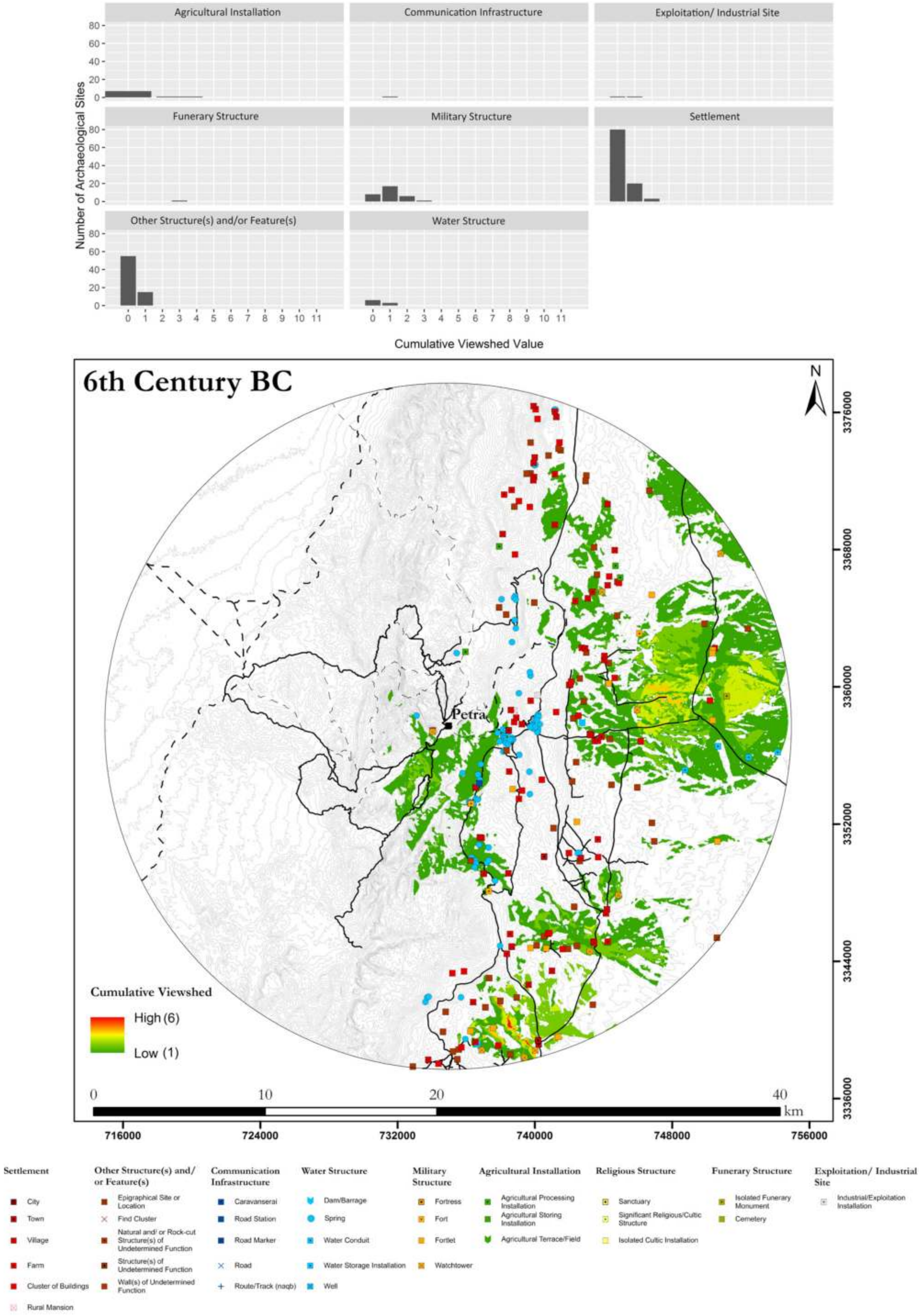


FIG. 77 Cumulative visibility analysis of all military sites dating to the 6th century BC with number of other contemporary sites within visibility fields.

Chapter 4
Subsistence Strategies

As chapter 3 concluded the overview of the Petraean hinterland during the Iron Age periods, the following chapters critically present the archaeological evidence provided by the various surveys for the main periods of this study ranging from the Hellenistic to Nabataean and Roman periods as well as the Byzantine period as the chronological 'outlook.'

Structured according to superordinate topics, this chapter begins with the different subsistence strategies in Petraean hinterland. This is followed by a discussion of the rural settlement pattern (chapter 5), the communication infrastructure (chapter 6), the military disposition (chapter 7) as well as the funerary and religious landscape (chapter 8). Chapter 9 critically synthesizes the findings. Adhering to the definitions of the individual site classes described in chapter 2, this chapter specifically discusses 'agricultural installations,' 'water structures,' 'exploitation/industrial sites' as well as 'other structures and/or features' presumably related to alternative subsistence strategies.

Agricultural Installations

The following sections provide a critical overview of the evidenced isolated agricultural installations that are not immediately associated with any specific rural settlements. These are further classified into 'agricultural terraces/fields,' 'agricultural processing installations' and 'agricultural storing installations' (cf. chapter 2 for definitions). Whether these installations can be related to the settlement pattern or not, will be discussed in chapter 9.

Agricultural Terraces/Fields

This section deals with the archaeological evidence for run-off cultivation. Archaeologically, run-off cultivation is discernible by systems of small dams/barrages or terrace walls along slopes that collected rain water from above in order to irrigate the terraces and/or to divert water further into fields below.[506] Dating such structures on the basis of surface finds is particularly difficult as it is assumed that much of the material (if there is any at all) is washed away. The dating quality is thus often unreliable and only suggestive at best. Traditionally however, run-off cultivation in the Petra area and in Transjordan in general has been largely associated with the Nabataeans as proposed by other archaeological studies e.g. in the Wadi Faynan and particularly in the Negev, although more recent studies argue that run-off cultivation (especially in the Negev) mainly emerged in the Late Roman/Byzantine periods.[507] Nevertheless, numerous agricultural terraces in the Petra region could be associated with various settlements where surface material often suggested a Nabataean date and other comparative studies in Jordan have highlighted the multi-period use of many terraces.[508] As Beckers et al. demonstrated, both optically stimulated luminescence (OSL) and radiocarbon dates taken for sample terraces in the extended Beidha area as well as along the Wadi Musa west of Qasr Umm Rattam indicate that run-off cultivation was practiced in the Petra area from the 1st century AD at least until around 800 AD.[509] The fact that agricultural terraces in the study area were used continuously throughout a long period of time is further supported by excavation results of a barrage system in the Jabal Harun area.[510] It is thus assumed that run-off cultivation was an important part of the agricultural economy of the Petra region at least since the 1st century AD. However, the analysis of surface pottery from terraces and barrages as well as associated building structures in the Jabal Harun area further indicate that the most active periods were between the 1st century BC and

506 Technically, the category 'dam/barrage' belongs to the larger archaeological category of 'water structures,' but as they were undoubtedly used for agricultural purposes, they are discussed already in this section.
507 For the Wadi Faynan, see recently Friedmann 2013, but more importantly Newson et al. 2007. For the traditional claim that run-off cultivation in the Negev was particularly practiced by the Nabataeans, see Negev 1961, 133–136 and Negev 1963, 112–124 as well as Evenari 1989, Evenari et al. 1982 and Evenari et al. 1958. *Contra* Evenari and Negev however, see Erickson-Gini 2012 with further references.
508 Cf. Kouki 2012, 106–107 with further references. Also note al-Salameen 2004, 137–139 for an earlier assessment of Nabataean agricultural terraces.
509 Beckers et al. 2013.
510 Lavento et al. 2013, 224–225 also noting that run-off cultivation is still practiced in the area today.
511 Lavento et al. 2013, 225.

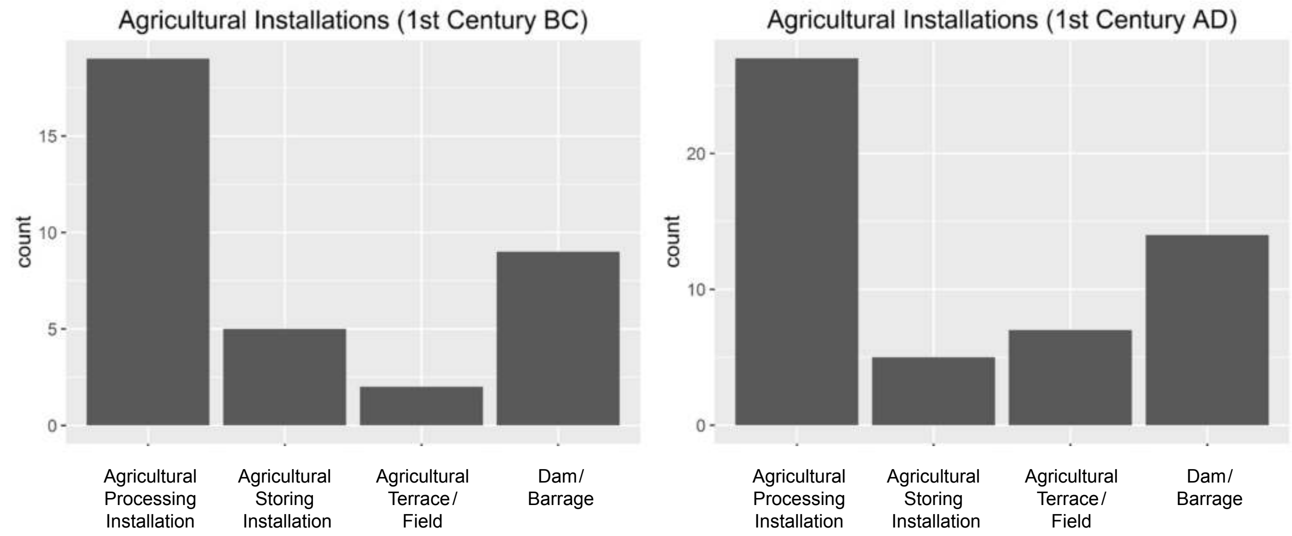


FIG. 78 Number of all agricultural installations dating to the 1st centuries BC and AD.

2nd century AD.[511] Keeping the particular dating problems and longevity of the agricultural terraces and dams/barrages in mind, the following discussion of the archaeological evidence for ancient run-off cultivation must be considered critically.

As no terraces or dams/barrages were documented for the Iron Age and Hellenistic periods, a significant increase of terraces and barrages is noted as ten barrages and two terraces are evidenced for the 1st century BC (FIGS. 78 and 79).[512] This development continues in the 1st century AD as now 14 barrages and seven terraces were documented (FIGS. 78 and 79). Although apparently one terrace was abandoned in the 2nd century AD, the overall situation remained unchanged (FIGS. 80 and 81). By the 3rd century AD, the total count of terraces and barrages decreases greatly (only four terraces and two barrages evidenced) (FIGS. 80 and 81). While for the 4th century AD the count stagnates, the observed decline continues in the 5th century AD (two more terraces abandoned) (FIGS. 82 and 83). It is the same for the 6th and 7th centuries AD (FIGS. 84 and 85). However, current explorations in the Udruh area are investigating extensive field systems which are most likely associated with the Byzantine *qanat* system (see below). The Petra Papyri also mention a cultivable land plot (*patrimonium*) around Udruh, which highlights the agricultural significance of the Udruh region at least for the Byzantine periods.[513]

The above-mentioned results claiming that the main period of run-off cultivation was between the 1st century BC and 2nd century AD (and particularly during the 1st century AD) is supported by this study. As the overall count of terraces and barrages declines during the 3rd century AD, but subsequently stagnates (the observed decline in the 5th century AD is comparatively minor), the observations made the FJHP that run-off cultivation was practiced increasingly less intensely towards the Byzantine period are also mirrored here.[514] However, while this may be the general case for the Petraean hinterland during the Late Roman/Byzantine periods, smaller communities arguably continued to practice intensive run-off cultivation as, for example, was recently demonstrated for the area around Bir Madkhur.[515]

The longevity of terraces and barrages is further confirmed by considering the natural landscape characteristics of the run-off systems: For example, the intensity functions of terrain elevation for the evidenced terraces dating from between the 1st century BC and 3rd century AD clearly indicates that terraces remain in similar elevation ranges between 960 and 1080 m

512 While this statistical evaluation may be representative, it does not mirror the actual count of all terraces and barrages in the study area as there are simply too many to be have been recorded systematically by the surveys. The only exception is the FJHP which devoted more than ten years to investigate the run-off systems in the Jabal Harun area (cf. Lavento et al. 2013 and Kouki 2013a). For more intensive work on agricultural terraces in the Petraean hinterland, cf. e.g. Lucke et al. 2019 and al-Qudah et al. 2016.

513 Driessen – Abudanh 2015, 302–303. As there is no spatial data available for the extensive field systems in the Udruh area, these field systems cannot be further analyzed statistically.

514 The available data on agricultural terraces and barrages used in this study derives mostly from the FJHP, which may explain the correlation.

515 Kinzel 2018, 215; Smith – Kay 2018, 134; Ramsay – Smith 2013.

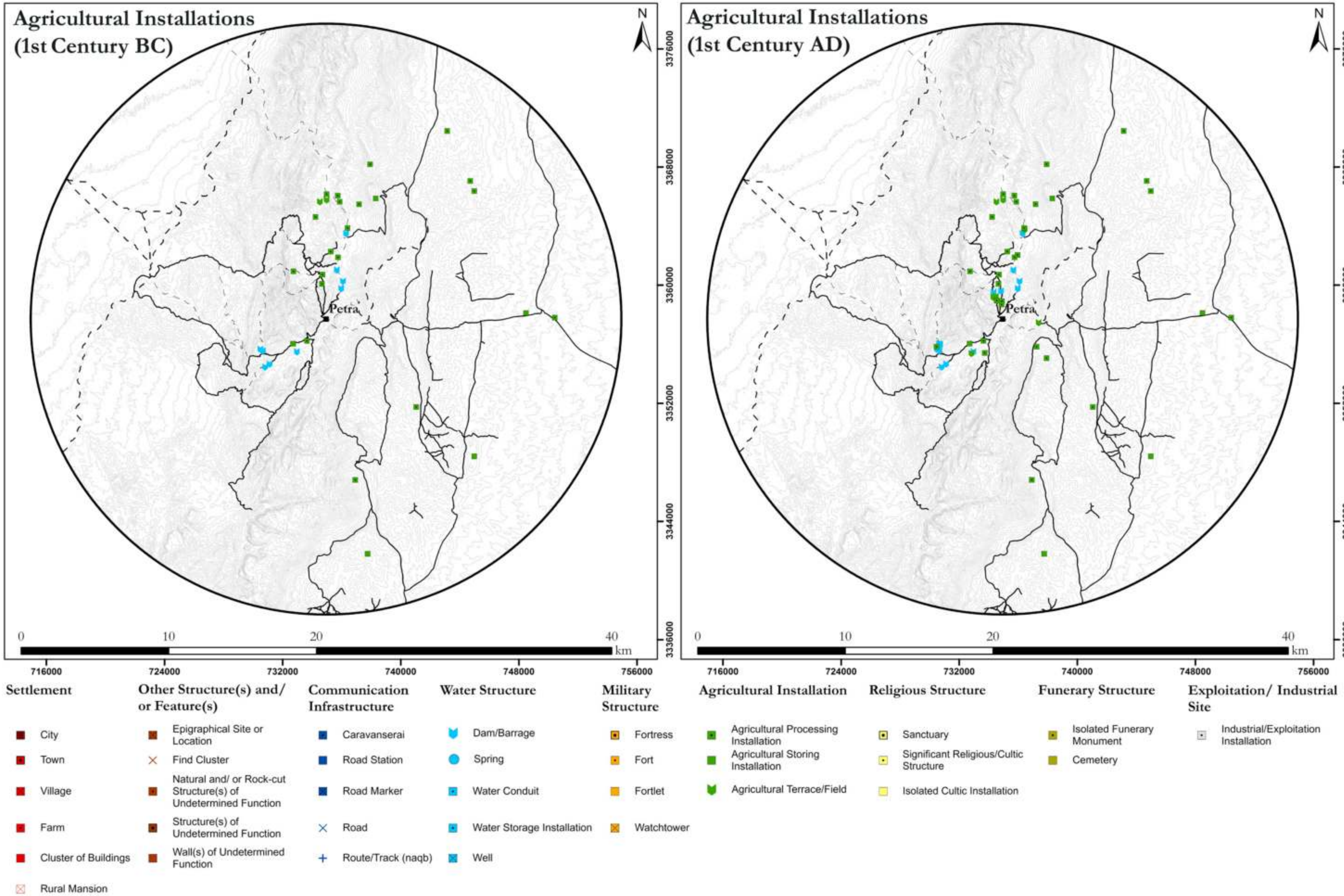


FIG. 79 Distribution map of all agricultural installations dating to the 1st centuries BC and AD.

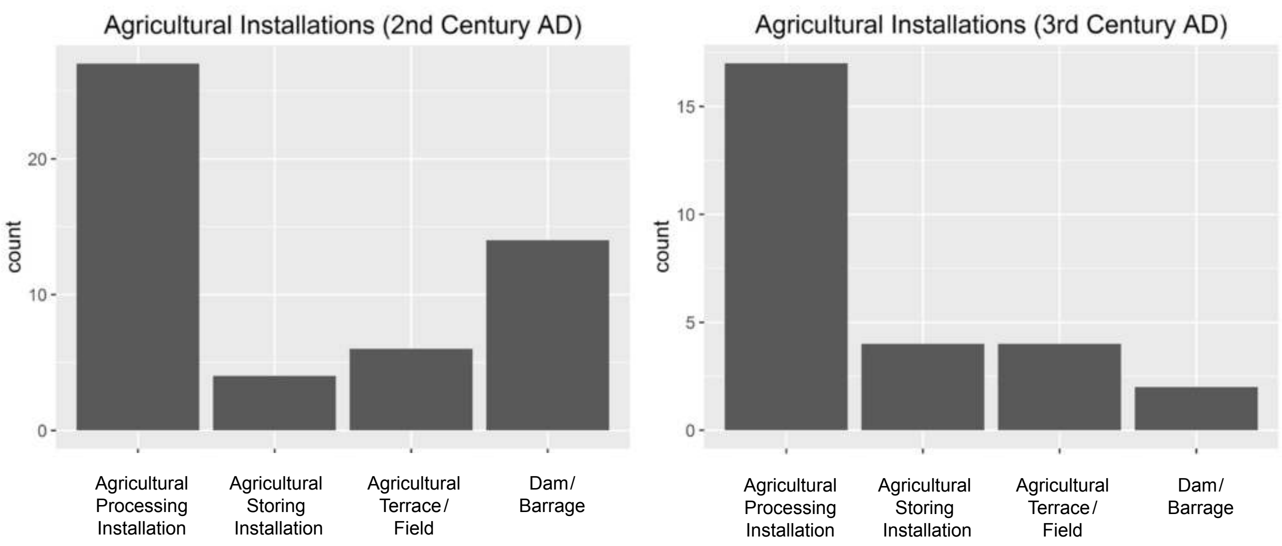


FIG. 80 Number of all agricultural installations dating to the 2nd and 3rd century AD.

a. s. l. (FIG. 86).[516] However, the mean slope values of run-off systems grow increasingly steeper (TABLE 20): While the mean slope value of the evidenced run-off systems lies just over 9 % during the 1st century BC, it almost doubles during the 1st and 2nd centuries AD (just over 16 %) and continues to rise in the 3rd century AD (nearly 26 %). Possibly, this reflects the changing settlement pattern which shifts more towards the east up the Jabal Shara escarpment from the 3rd century AD onwards (cf. chapter 5). This finds further support when considering that the Pearson correlation tests for agricultural terraces indicate no significant spatial correlations to settlements between the 1st century BC and 2nd century AD (cf. TABLES 22–24), but a strong spatial correlation between agricultural terraces and rural mansions for the 3rd century AD (cf. TABLE 25).

Additionally, the kernel density estimations (KDE) highlighted three distinct clusters of agricultural terraces and barrages at least between the 1st century BC and 2nd century AD (FIG. 87).[517] For all three centuries, a clear clustering of agricultural terraces and barrages can be observed in the ad-Thankia region north of Baja, the extended Beidha region (particularly the al-Begh'ah plain) as well as the as-Sto'e and al-Farasha plains in the extended Jabal Harun area.[518] The latter appears particularly densely clustered during the 1st century BC, while a shift towards the Beidha and ad-Thankia regions can be observed by the 1st century AD. While this largely remains the same during the 2nd century AD, the Wadi Musa area becomes more clustered with agricultural terraces and barrages than during the two previous centuries. With the overall decrease of evidenced terraces and barrages by the 3rd century AD, the respective KDE grows noticeably coarser although the majority of the evidenced run-off systems are still located in the extended Beidha area. This pattern remains largely the same for the later periods as well.

Based on this landscape archaeological approach, it can thus be suggested that agricultural products derived from run-off cultivation came mostly from the extended ad-Thankia, Beidha and Jabal Harun regions during the Nabataean and Early Roman periods and mainly in the extended Beidha area in later periods. As these regions were connected to Petra via various roads and routes (cf. FIG. 87), it is likely that they supplied the capital with agricultural goods in addition to offering supplies for local needs. However, numerous agricultural field systems are associated with the many settlements along the eastern high plateau. As no spatial data is available specifically for these fields, the KDE results naturally omit a large amount of agricultural data. It must therefore be kept in mind that the eastern high plateau was a major area for

516 The landscape characteristics were only considered until the 3rd century AD as the overall situation for later periods generally remained the same. Thus, although the resulting KDEs are only presented until the 3rd century AD, they are representative for the 4th – 7th centuries AD as well.

517 The KDEs may be biased by the limited archaeological data provided by the various survey reports. For example, there are extensive agricultural terraces studied in the vicinity of Bir Madhkur (Kinzel 2018, 215, 230, fig. 6; Smith – Kay 2018, 134; Ramsay – Smith 2013) and many terraces were also observed near Qasr Umm Rattam (Lindner et al. 2007, 247 and Lindner et al. 2000, 535) and Abu Khusheiba (Lindner 2003b, 72).

518 Cf. Gentelle 2009, 138–140.

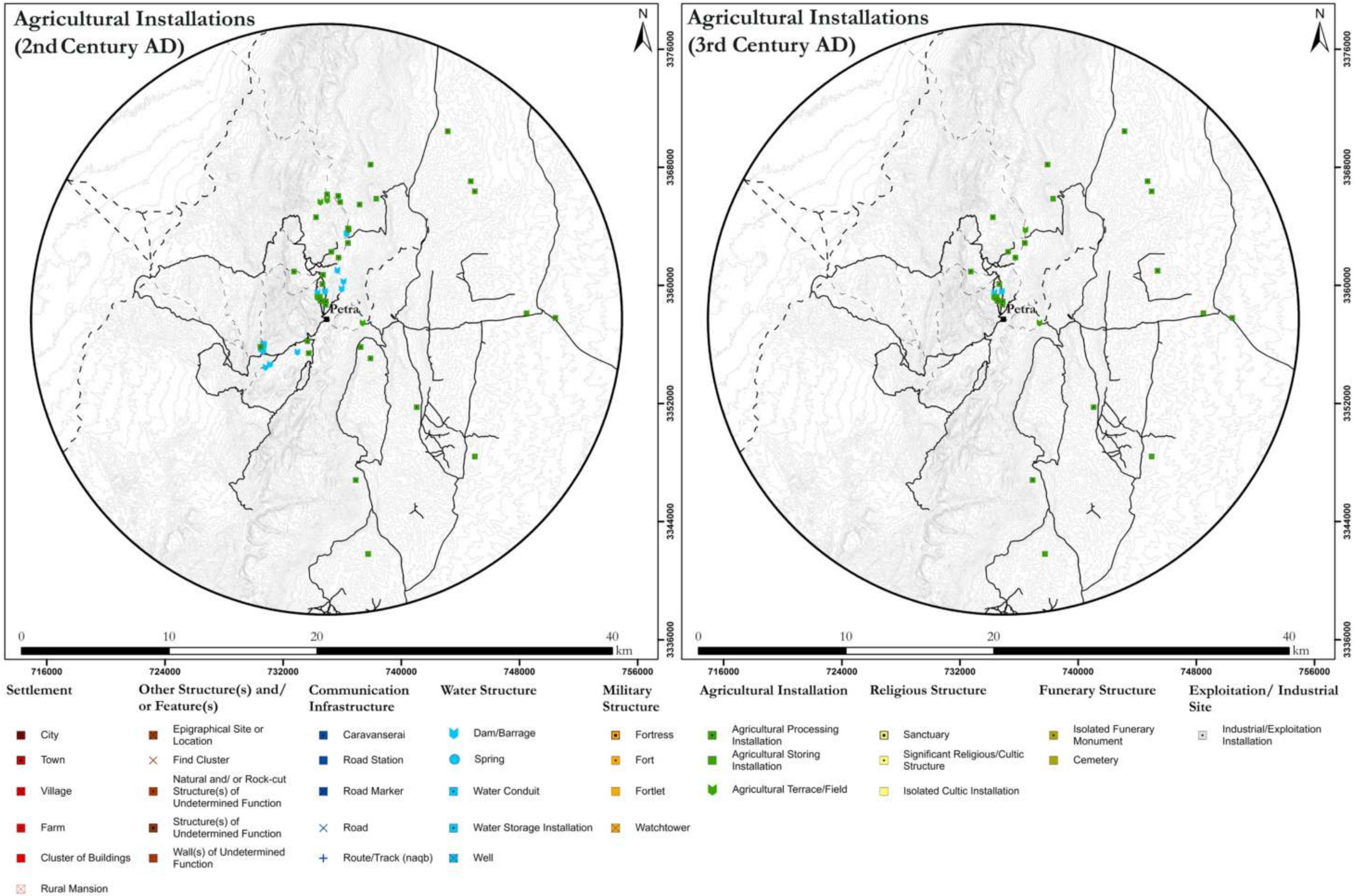


FIG. 81 Distribution map of all agricultural installations dating to the 2nd and 3rd century AD.

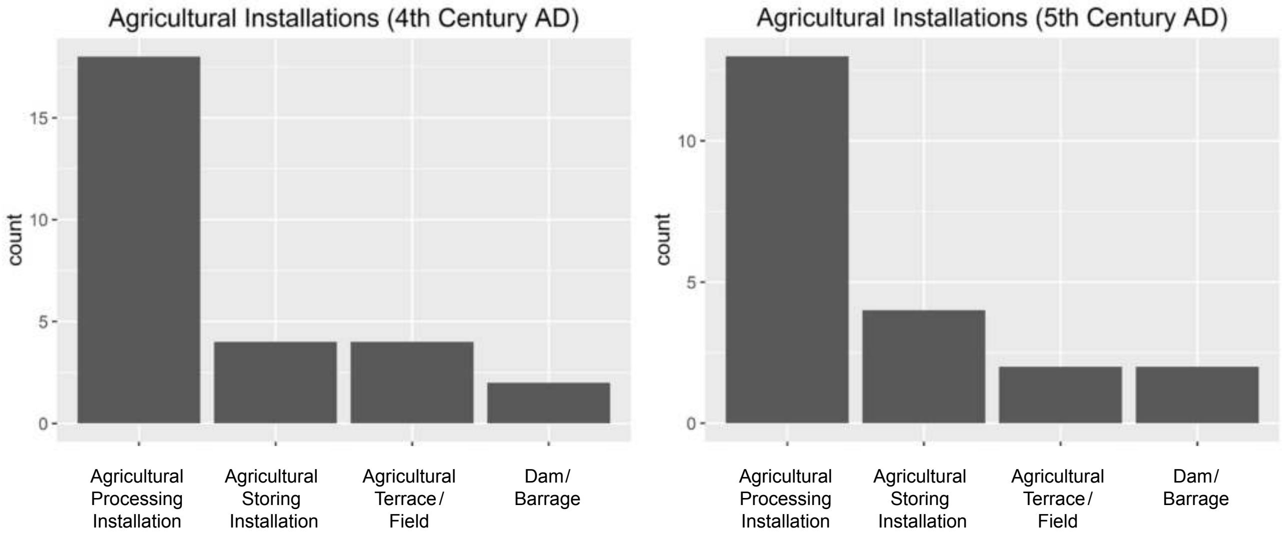


FIG. 82 Number of all agricultural installations dating to the 4th and 5th century AD.

the production of agricultural goods in the Petraean hinterland – in addition to the ad-Thankia, Beidha and Jabal Harun areas where run-off cultivation was mainly practiced (cf. chapter 5). This observed clustering of major areas of run-off systems as well as the eastern high plateau with its numerous agricultural fields is further supported by the distribution of the evidenced agricultural processing installations, which are presented in the following.

Agricultural Processing Installations

As only singular agricultural processing installations were documented for the Iron Age periods (cf. chapter 3), the only agricultural site dating to the Hellenistic period (4th – 2nd centuries BC) is supposedly the threshing floor of ShamAyl Site No. 89 (cf. FIG. 37). By the 1st century BC however, a dramatic increase of agricultural processing installations can be observed which constitute by far the largest category of all evidenced agricultural installations for this time period (cf. FIG. 78). From these processing installations, there are eleven wine presses, six threshing floors as well as one olive press.[519] This trend continues in the 1st and 2nd centuries AD when four additional wine presses as well as two more threshing floors are recorded (cf. FIGS. 79–81). Corresponding to the general decrease of agricultural installations by the 3rd century AD only six wine presses, seven threshing floors and one olive press are evidenced. This remains the same during the 4th century AD (cf. FIGS. 81–83). The observed decline continues in the 5th and 6th centuries AD when there are only three wine presses and seven threshing floors (cf. FIGS. 82–84). By the 7th century AD, only six threshing floors and one wine press are documented (cf. FIG. 85). While the archaeological evidence clearly suggests a decline of agricultural processing installations in the later periods, the 6th century AD Petra Papyri indicate the persisting olive and wine production in the Petra area at that time.[520]

As shown by the KDEs calculated for the 1st century BC to 3rd century AD, there is a clear cluster of agricultural processing installations in the extended ad-Thankia and Beidha regions north of Petra although the KDE grows increasingly coarse in the 3rd century AD as there are significantly less processing installations evidenced for that period (FIG. 88).[521] Although the observed main clusters vary slightly through time, the results are clear (FIG. 89): the great majority of the evidenced agricultural processing installations in the Beidha/ad-Thankia region are exclusively wine presses (although one olive press is documented as well) (FIG. 90). All processing installations outside the main cluster of the KDEs are threshing floors. These are evidenced mostly along the eastern high plateau, although there is also one in the as-Sto'e region to the

519 Note that MacDonald et al. 2016, 266 reported "Classical" surface pottery (1st century BC – 7th century AD) at the site of Tahuna near Udruh, which is described as a windmill. However, as Late Islamic material was also recorded and no ancient windmills are known in the area, the mill is most likely modern.

520 Cf. e.g. Nasarat et al. 2012.

521 As for the discussed agricultural terraces and barrages above, the KDE for the 3rd century AD is largely representative for the later periods as well, although the overall count of the processing installations declines and there are generally more threshing floors than wine presses.

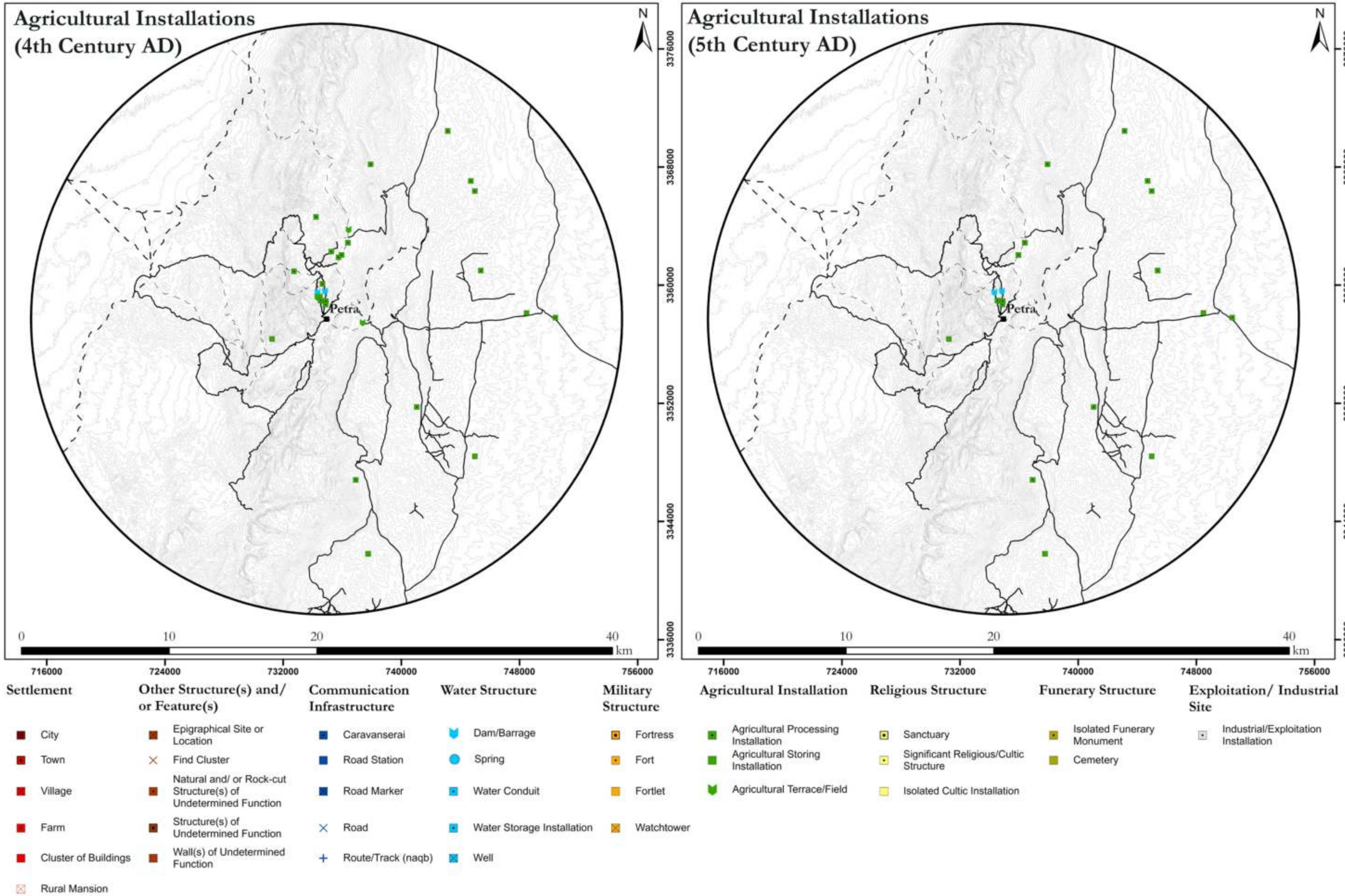


FIG. 83 Distribution map of all agricultural installations dating to the 4th and 5th century AD.

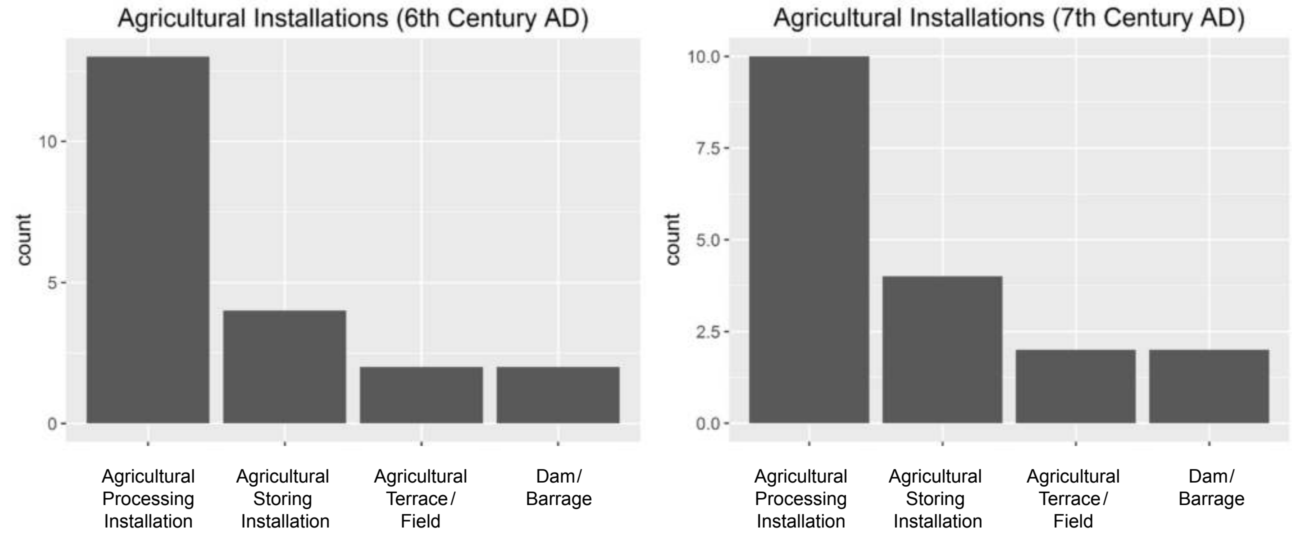


FIG. 84 Number of all agricultural installations dating to the 6th and 7th century AD.

southwest of Petra dating to the 1st and 2nd centuries AD. Additional, possibly ancient, threshing floors are also reported in the al-Farasha area southwest of Jabal Harun.[522] However, the distinct cluster of wine presses in the Beidha region is only representative for the 37, presumably Nabataean, rock-cut wine presses documented by al-Salameen.[523] No spatial data is available for most of these presses, explaining why they are not included in the KDEs. The cluster of wine presses in the Beidha region should therefore be far denser than presented here.[524] This observed cluster of wine presses confirms previous claims that the Beidha area was particularly important for viticulture. Archaeobotanical evidence from sites in urban Petra also yielded large quantities of grape pips, which further supports the significance of grape cultivation and their further processing into wine.[525]

A possible olive press was discovered at the village of Ras Slaysil southwest of the main cluster of wine presses (FIG. 91). As for the round olive crusher discovered in the substructures of the luxurious Nabataean mansion of ez-Zantur IV dating to the 2nd/early 1st century BC, the find from Ras Slaysil probably reflects local farming activities there, although it seems unlikely that olives were grown locally in the Ras Slaysil area.[526] Generally, the main archaeological evidence for the processing of olives is documented in the Wadi Musa area, most notably the several Nabataean/Early Roman olive presses discovered at Khirbet an-Nawafla as well as the press recorded at al-Bidd.[527] It is thus assumed that the main region for olive cultivation were the western slopes of the Jabal Shara escarpment in the immediate Wadi Musa area.

Based on the distribution of the wine and olive presses, it therefore seems safe to assume that the Wadi Musa area specialized in the cultivation of olives and the extended ad-Thankia and Beidha regions were mainly used for viticulture. While the elevated position of Wadi Musa and its surroundings has good access to water sources for the cultivation of olives, the extensive run-off irrigation systems in the ad-Thankia and Beidha regions were arguably sufficient for successfully practicing viticulture.

Although extensive agricultural terraces and barrages were documented by the FJHP in the as-Sto'e and al-Farasha plains (extended Jabal Harun area), this region was probably used mainly for the cultivation of grain.[528] This is not only evidenced by the several threshing floors that were recorded by the FJHP, but also by macrofossil samples taken from

522 Kouki 2013b, 247–248.
523 al-Salameen 2005 and 2004, 169–195. Also cf. MacDonald 2015, 62. Al-Salameen was able to distinguish between small and simple as well as large and more sophisticated presses.
524 In addition to those documented by al-Salameen, note the ongoing research by U. Bellwald on a presumed 'winery' in the Wadi Aglat in the Beidha-Ba'ja area (presentation held at the 14th International Conference on the History and Archaeology of Jordan in Florence, 21 January 2019). Also, note that Abudanh reportedly identified more wine presses along the eastern high plateau as well (Rawashdeh 2018). While these new findings could not be included in this study's statistical analysis, the general trends presented here nevertheless remain representative.
525 Kouki 2012, 110.
526 On the olive crusher from ez-Zantur, see e.g. Kolb – Keller 2001.
527 'Amr et al. 2000, 233–234. Cf. also al-Salameen 2004, 197–202 on Nabataean olive presses.
528 Although one Nabataean wine press was identified in the extended Jabal Harun area by the FJHP (Kouki 2013b, 248).

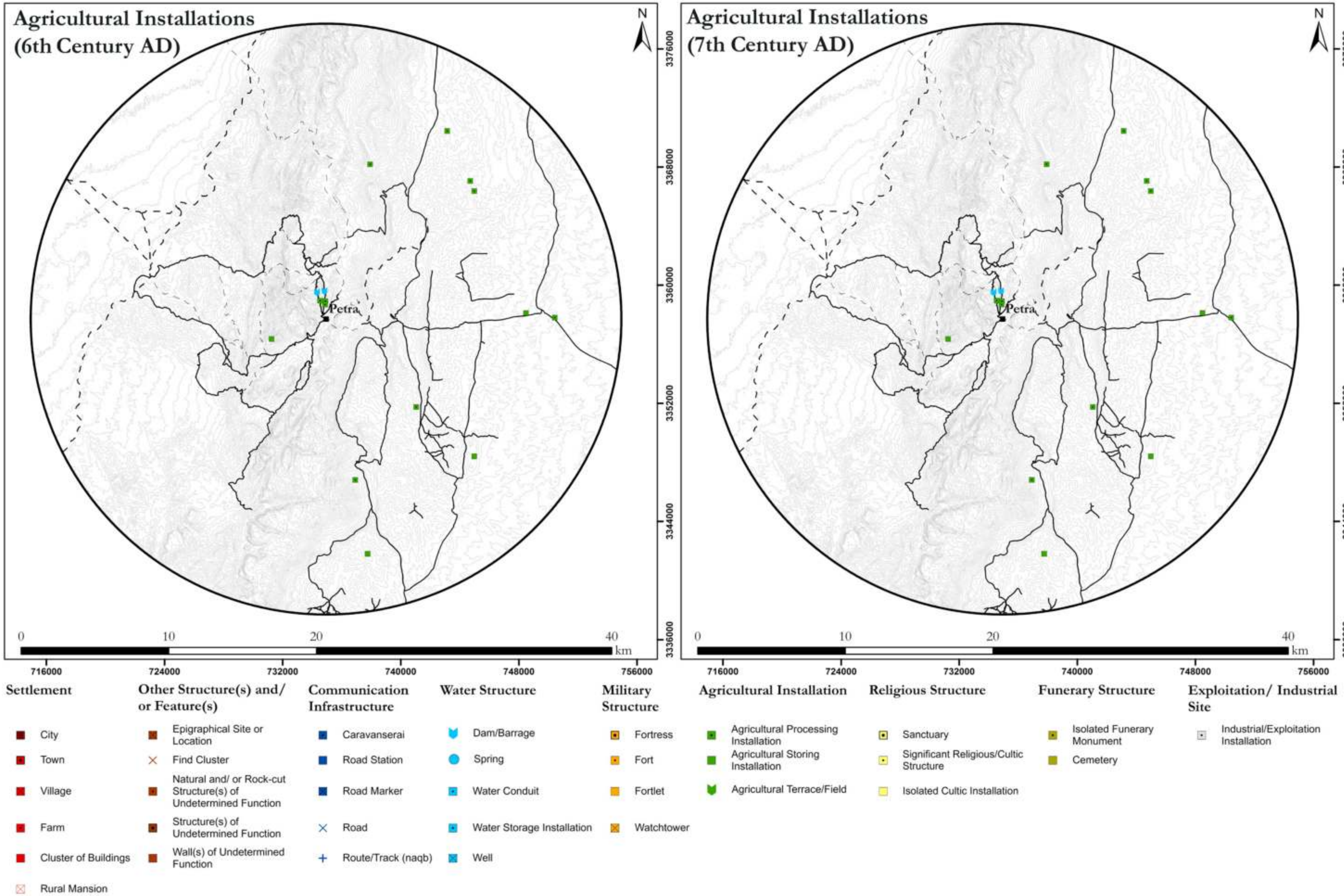


FIG. 85 Distribution map of all agricultural installations dating to the 6th and 7th century AD in the Petraean hinterland.

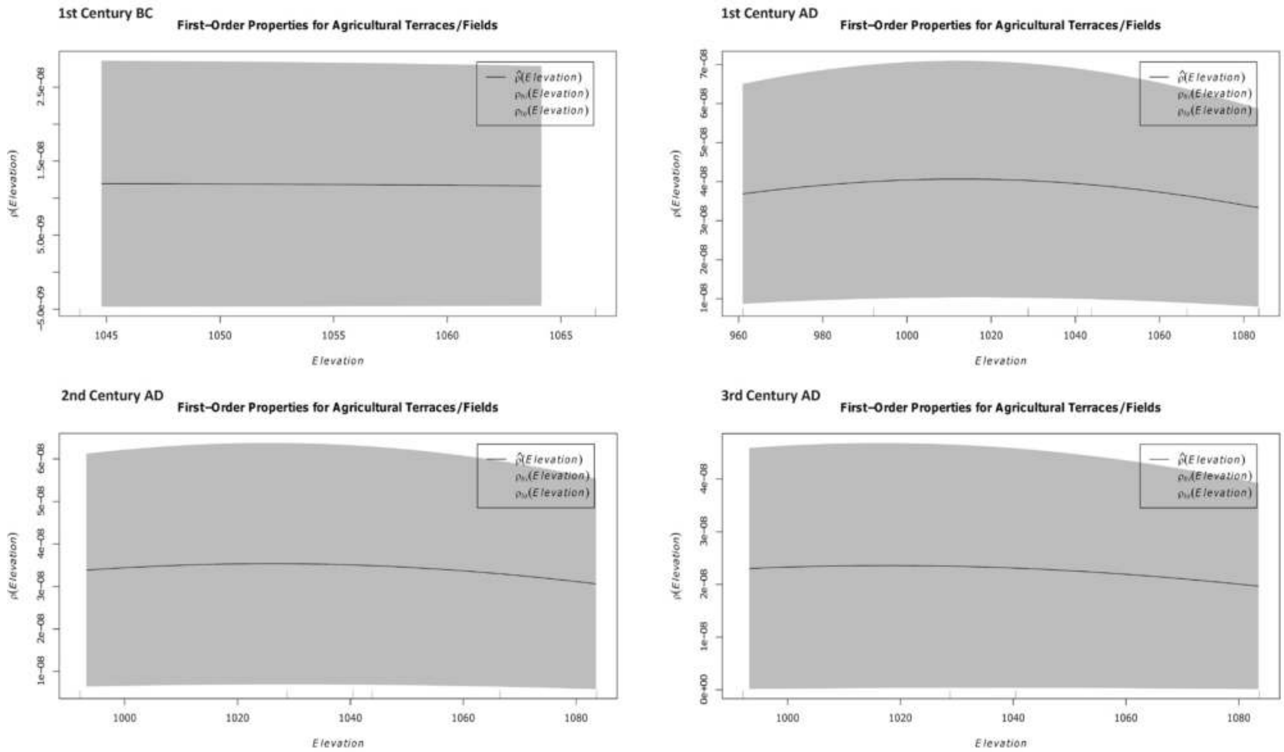


FIG. 86 Intensity function of terrain elevation for agricultural terraces/fields and dams/barrages from the 1st century BC to 3rd century AD.

the extended Jabal Harun area.[529] While none were available for the Nabataean period, samples dating to the Byzantine and Islamic periods suggested that barley was the most common grain as it is better suitable than other cereals (e. g. wheat) for arid and warm climates.[530]

The vast majority of threshing floors (in addition to those recorded as part of settlements) are evidenced along the eastern high plateau, which is generally cooler and has the most rainfall in the study area. Whether these threshing floors were used particularly for the processing of other cereals than barley can only be speculated. However, as the evidenced wine presses gradually went out of use from the 3rd century AD onwards and threshing floors are the most evidenced processing installations in the Petraean hinterland by the 5th century AD, this may suggest that cereal production along the eastern high plateau became increasingly important in the later periods. This seems corroborated by archaeobotanical analyses from urban Petra (cf. chapter 9).

Agricultural Storing Installations

There is little to no archaeological evidence for agricultural storage installations such as possible storehouses or depots in the Petraean hinterland. Only five possible sites may have been used for storing agricultural goods, although these are all described as simple enclosures.[531] A clear functional identification is therefore difficult. They may have functioned as possible camp sites or corrals, although it is generally possible that agricultural goods could have been stored temporarily in such structures (cf. below). Additionally, there are numerous tower-like structures evidenced mostly along the eastern high plateau that are directly associated with agricultural fields and may be considered as possible shelters for farmers or even small stor-

529 The FJHP recorded 14 threshing floors in total. Surface material suggests that only six are tentatively dated to the Nabataean period while the remaining threshing floors are probably modern (Kouki 2013b, 247–248). On the macrofossil analyses conducted in the Jabal Harun area, see Tenhunen 2016; Tenhunen 2013 and Lavento et al. 2013, 225–226 with further references. In addition to barley, olive pits and grape stones were among the sampled plant remains from the Jabal Harun area as well.

530 Kouki 2012, 108 with further references.

531 Dating extremely coarsely between the 1st century BC and the 7th century AD based on surface pottery, these sites are: ARNAS Site No. 157, FJHP Ext.023 (although only dating to the 1st centuries BC and AD), ShamAyl Site No. 117, ShamAyl Site No. 197 and PHSP Site No. 069. Also note that for the Iron Age period, D. Kennedy's 'Circle 5' situated just west of Udruh is also tentatively listed as a possible agricultural storing installation as the structure is discussed as a possible large corral (Kennedy 2013a, 53, 60–61). This structure is further discussed below.

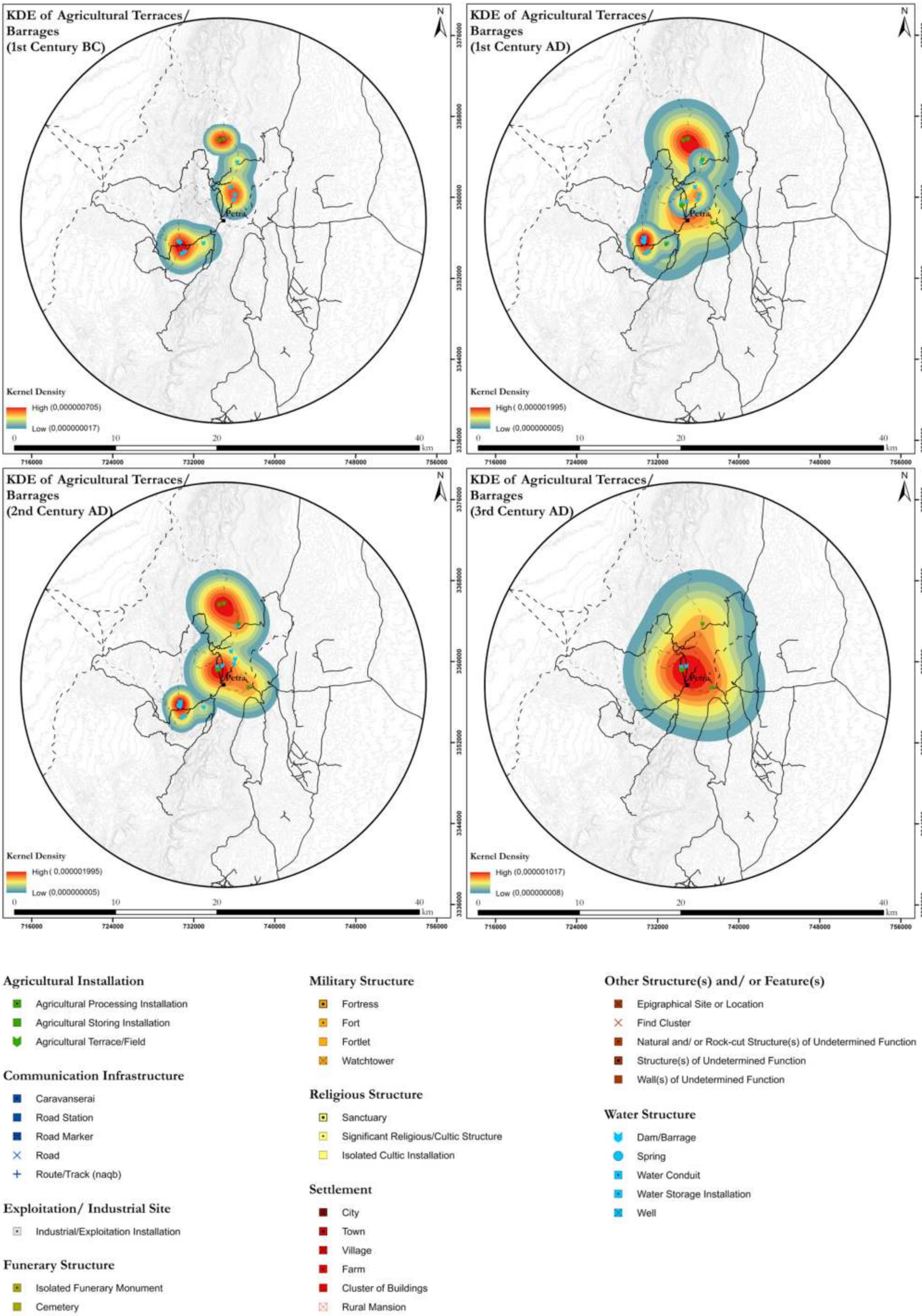


FIG. 87 Kernel density estimations (KDEs) for agricultural terraces/fields and dams/barrages from the 1st century BC to 3rd century AD.

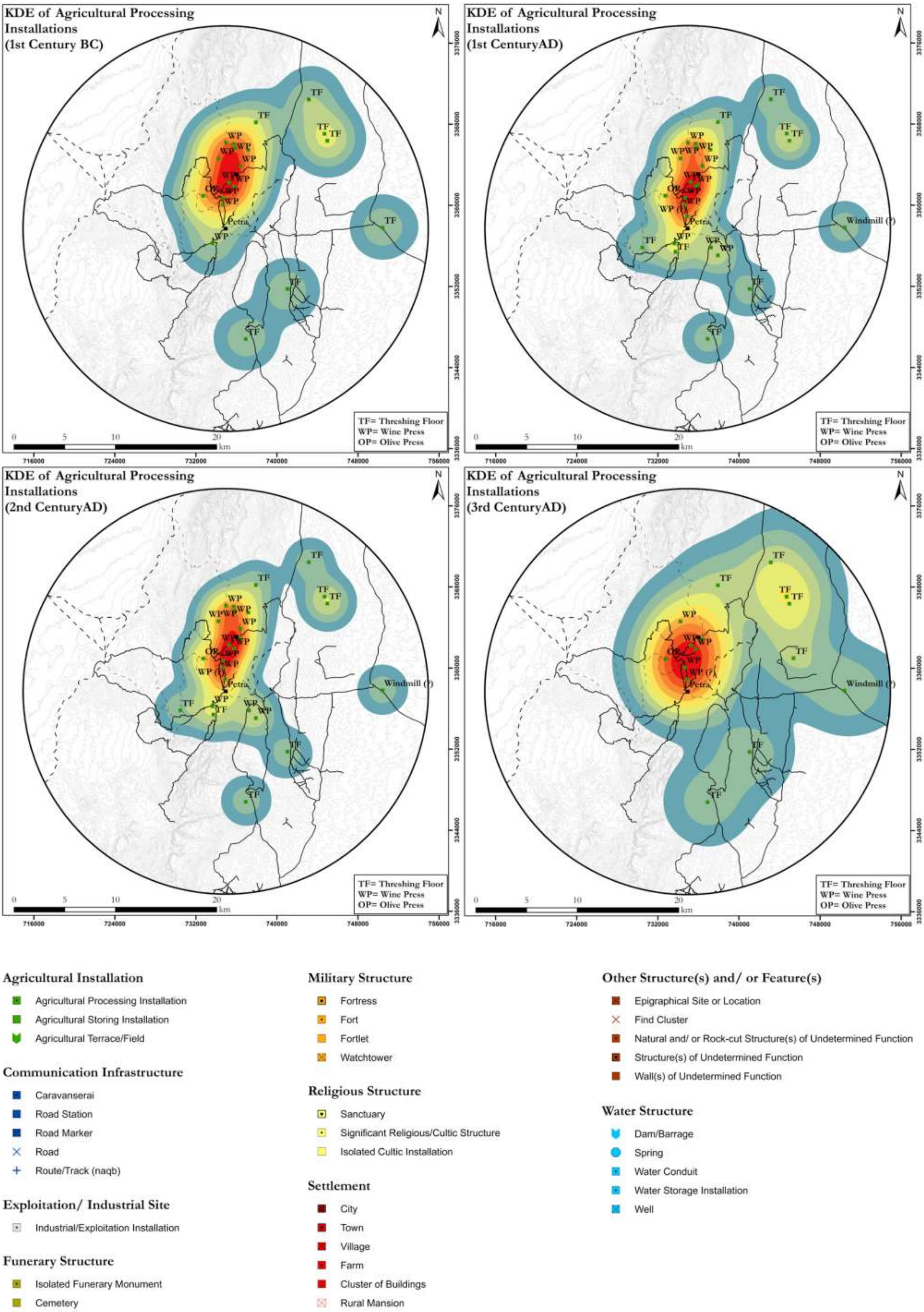


FIG. 88 Kernel density estimations (KDEs) for agricultural processing installations from the 1st century BC to 3rd century AD.

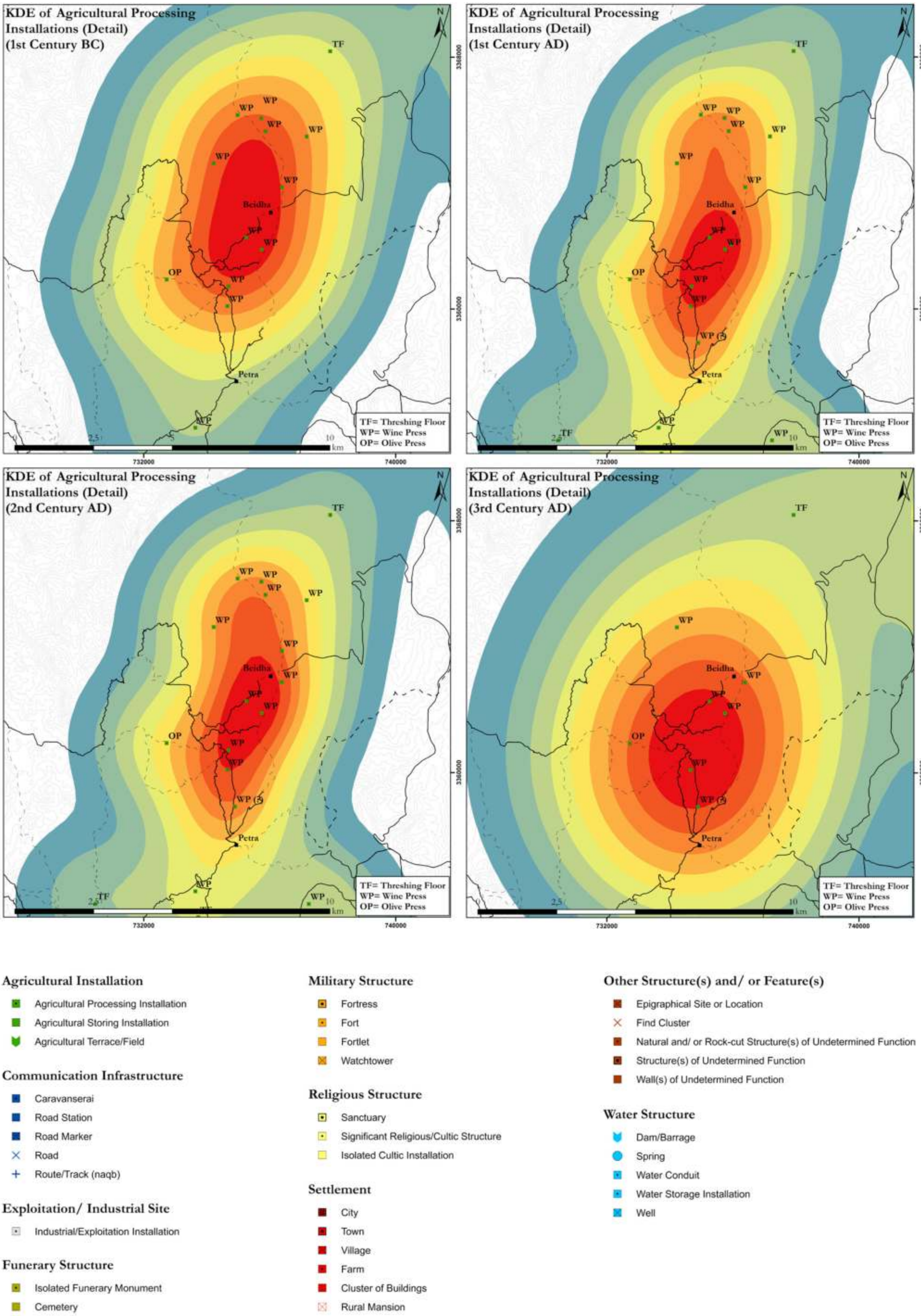


FIG. 89 The main cluster of the KDEs for agricultural processing installations from the 1st century BC to 3rd century AD.

FIG. 90 Various types of wine presses in the ad-Thankia region, the al-Begh'ah plain and in the Beidha area.

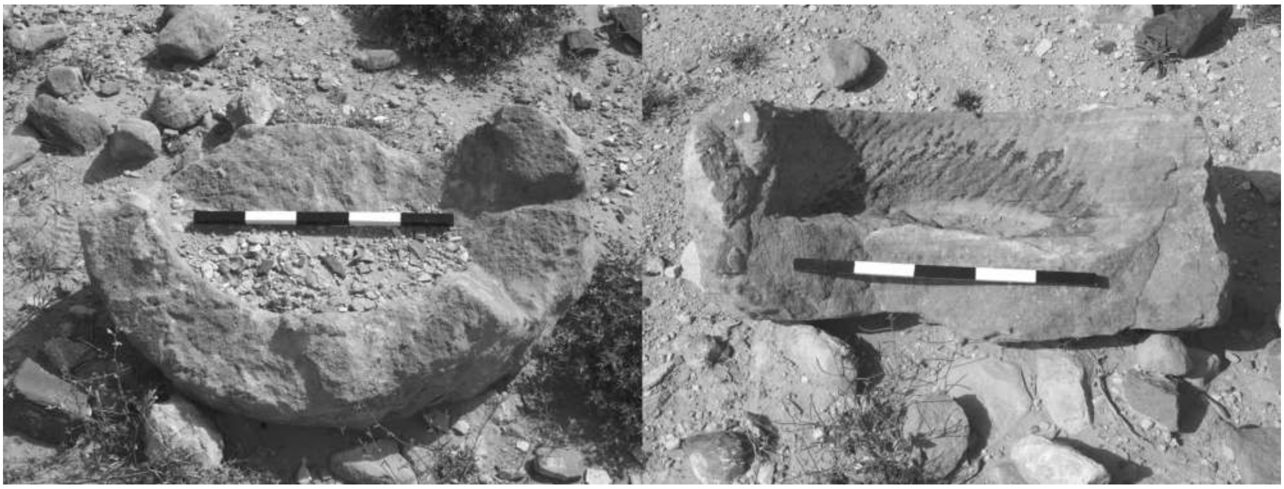


FIG. 91 Fragmented rotary olive crusher (?) at Ras Slaysil.

age facilities for the agricultural goods cultivated from the surrounding fields (cf. chapter 7).[532] Due to the overall lack of clear archaeological evidence for agricultural storage installations, it is therefore suggested that agricultural goods were mostly stored within settlements. It seems likely that this was particularly the case for farms, but the discussed rural mansions may have stored agricultural goods from their immediate surroundings as well (cf. chapter 5).[533]

Water Structures

The highly advanced water supply system of Nabataean Petra is an already well-researched subject that has been a major scholarly focus for many years and remains a widely discussed topic today.[534] Detailed hydro-technological and archaeological studies have revealed the high standard and vast technological abilities of Nabataean hydraulic engineers, who managed to control disadvantageous natural landscape settings as well as arid climate conditions. Not only was the constant availability of water an absolute necessity to guarantee permanent settlement in Petra's semi-arid, desert climate, an intricate water management system was required to prevent significant damages to the city by uncontrolled seasonal flash floods. While current research concentrates strongly on the detailed study of technological aspects of water management mostly within urban Petra, this study discusses the evidenced water structures outside the city's limits. A more detailed, hydro-technological analysis of the various water structures may certainly reveal deeper insights into the nature and functionality of the water management system in the Petraean hinterland, but it would exceed the limits of this study to delve into technological details of the documented structures.[535] Based on the water structures evidenced by the various surveys, this section evaluates how the water management system responded to local climate and natural landscape conditions and further discusses how hydraulic engineering choices affected subsistence and settlement strategies in the Petraean hinterland. In order to do so, the following presents the various water structures that were recorded by the different surveys and which are grouped as 'springs,' 'water conduits,' 'water storage installations,' 'wells' and 'dams/barrages' (cf. chapter 2 for definitions).

Springs

In total, this study identifies 83 natural springs in the Petraean hinterland that potentially supplied the region with fresh water in antiquity. This is based on 28 springs that were documented by the Jordanian Water Authority in the Petra area, published by al-Khashman who further investigated the current hydrological qualities of the recorded springs.[536] Additionally, 39 natural springs were mapped on the available 1:50,000 topographical maps of the Petra region.[537] Based on the georeferenced topographical maps, the location of the documented springs were extracted for further processing.[538] The various surveys recorded 30 additional springs as well.[539] As many springs were recorded by all of the above-mentioned sources, it was subsequently necessary to evaluate all documented springs in order to exclude duplicates. Thus, on this basis and without claim of completeness, this study lists 83 springs for the Petraean hinterland. As many of the evidenced springs are still aquiferous today and there is so far no evidence that would suggest that this was greatly different in antiquity, it must be as-

532 Cf. e.g. Banning 1986, 35–36 for a similar proposal.

533 For example, Shammasa or WMWS 1996 Site No. Bayda 20 are both situated in the al-Begh'ah plain in the Beidha area. At least in the case of Shammasa, a wine press is directly associated with the presumed rural mansion. This indicates that the site processed cultivated grapes and it is possible that the vintage was stored at Shammasa as well.

534 Cf. the major contributions on Nabataean water management technologies: Oleson 2018; 2010; 2007 and 1995; Ortloff 2016; 2014 and 2005; Fiema 2012a; al-Muheisen 2009; Bellwald 2008; Schmid 2008b.

535 More detailed and comprehensive studies on Nabataean hydro-technologies are currently carried by the doctoral research project of L. Weis of the Humboldt-Universität zu Berlin and Brandenburg University of Technology Cottbus-Senftenberg. Cf. also an earlier assessment of Nabataean hydrological installations outside Petra in al-Salameen 2004, 139–141.

536 al-Khashman 2007, 1148–1149 and particularly 1149, table 1. Also consider al-Farajat – Salameh 2010, 327–333 for further studies on the water quality of the springs in the Petra region. Generally, on the main springs that supplied Petra with fresh water, see al-Salameen et al. 2019 (specifically for the Ain as-Sader in Wadi Musa), Fiema 2012a, 121–123; al-Muheisen 2009, 33–35, 38–39, 64–66, 79; Bellwald 2008, 47–61.

537 The relevant topographical maps from 1990 are Sheets 3050-I to 3050-IV of the series K737 (edition 1), scale 1:50,000.

538 S. Isselhorst georeferenced all topographical maps and digitized the documented springs. She kindly provided the data to the author, which is greatly appreciated.

539 Abudanh Survey Site Nos. 285, 296, 299, 300 and 330 (Abudanh 2006, 546, 552, 553, 554, 567); ShamAyl Site Nos. 31, 123, 125, 217, 299, 319 (MacDonald et al. 2016, 151, 240, 241, 327, 396, 413); WMWS 1996 Site Nos. Wadi Musa 18A and G ('Amr et al. 1998, 522, 525) as well as the spring at Udruh (cf. e.g. Driessen – Abudanh 2018, 134–137; Kennedy 2004, 178–180). Although unsystematically, the PHSP also recorded 14 springs in the immediate Petra area for which many thanks are owed to Suleiman Mohammed al-Bdul.

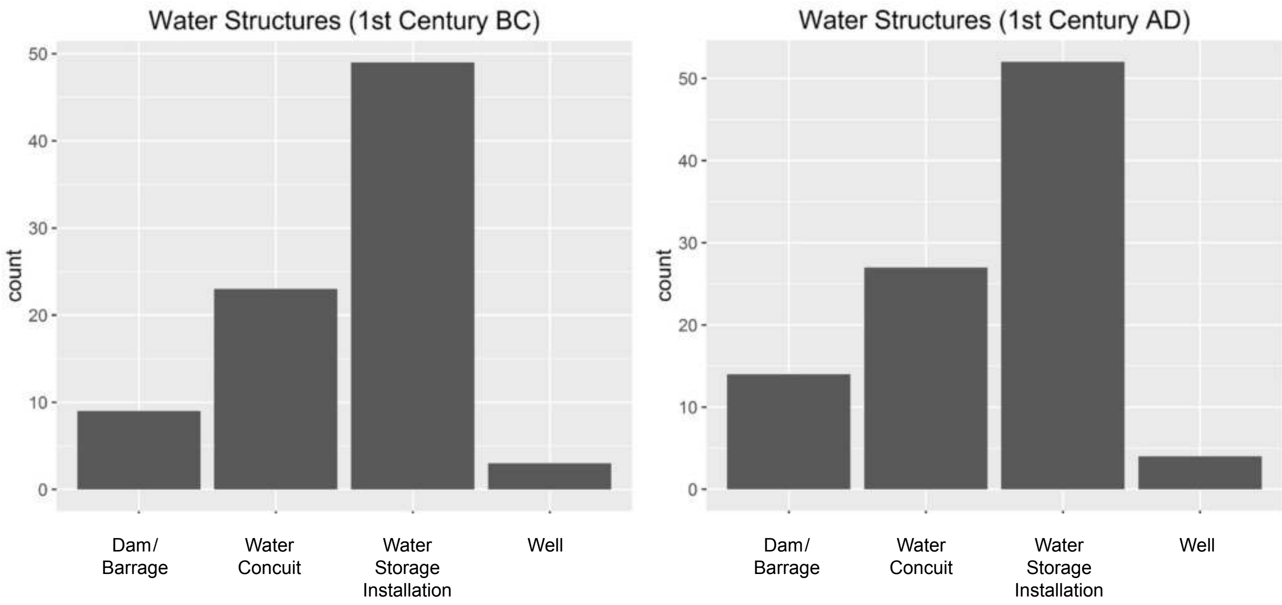


FIG. 92 Number of all water structures dating to the 1st centuries BC and AD.

sumed that all evidenced springs were water-bearing throughout the entire time span considered here.[540]

As noted by numerous studies before, the majority of all springs are situated along the Jabal Shara escarpment between c. 1300–1350 m a.s.l. (FIGS. 92–99).[541] During the winter months, rain water is particularly captured in the Wadi Musa basin and ground water is constantly recharged there, explaining the clear cluster of evidenced springs in the Wadi Musa area.

In terms of water quality, al-Khashman's analysis of sample springs has shown considerable variations in their (modern) physical and chemical properties but, in most cases, fulfilled modern drinking water standards as defined by the World Health Organization (WHO).[542] However, as important springs such as ʾAin Braq or ʾAin Dibidbi which provided Petra with fresh water via Nabataean aqueducts were not included in al-Khashman's analyses, in 2016, the PHSP was able to analyze additional water samples from preselected springs that were not researched previously.[543] The results of the electrical conductivity tests of water samples taken by the PHSP and conducted by the University of Applied Sciences in Lübeck confirm al-Khashman's earlier assessment that the analyzed spring water is well suitable for drinking water. Concerning the discharge rate of the springs, variations were observed ranging from 0,2 $m^3\,h^{-1}$ and 25,8 $m^3\,h^{-1}$, the latter being for ʾAin Musa that was arguably the most important perennial spring that supplied Petra with fresh water.[544]

The main water drainage divide between Shawbak and Wadi Musa flows from the Jabal Shara escarpment downslope in western direction covering an area of c. 80 km^2 running through Petra's Siq-entrance, the city's urban center as well as the Beidha area and continues through to the Wadi as-Siyyagh and subsequently flows further westwards down to the Wadi Arabah.[545] While this is generally confirmed by this study's GIS-based watershed, the inclusion of all evidenced springs also suggests that the modelled watershed extends further in southeastern direction from the Wadi Musa area (FIG. 100).[546] Not only does the suggested

540 However, an increasing aridification of the region by the 4th/5th century AD is assumed (cf. below). Also note that the 6th century AD Petra Papyri mention three springs in the Wadi Musa area that supplied the town with fresh water at that time: ʾAin al-Bassa, ʾAin al-Eis and ʾAin Borakon (Nasarat et al. 2012, 109–110 with further references).

541 Cf. e.g. most recently Ortloff 2016, 2233–2234 and Bellwald 2012, 121.

542 al-Khashman 2007, 1162.

543 As the hydrological results of the PHSP 2016 season still await final publication, the preliminary results were presented at the poster session of the *Landscape Archaeology Conference* 2016 in Uppsala (Sweden) which is referred to here as Isselhorst et al. 2016. The PHSP took water samples from the following springs: ʾAin Braq, ʾAin Amun, ʾAin Dibidbi, ʾAin Sadder, ʾAin Hojm, ʾAin Musa. Additional hydrological research of the PHSP included stable isotope analyses from the sampled springs, which demonstrated that all analyzed spring water derives from precipitation that evaporated from the Mediterranean Sea, thus clearly placing Petra and its hinterland in a Mediterranean climate. S. Isselhorst, M. Strauß and L. Weis are responsible and should be given full credit for the isotope analyses.

544 Ortloff 2014, 96 and 2009; al-Khashman 2007, 1148.

545 Fiema 2012a, 121.

546 The presented watershed of all evidenced springs was conducted by the author based on the SRTM-1 DEM in ArcGIS 10.3.

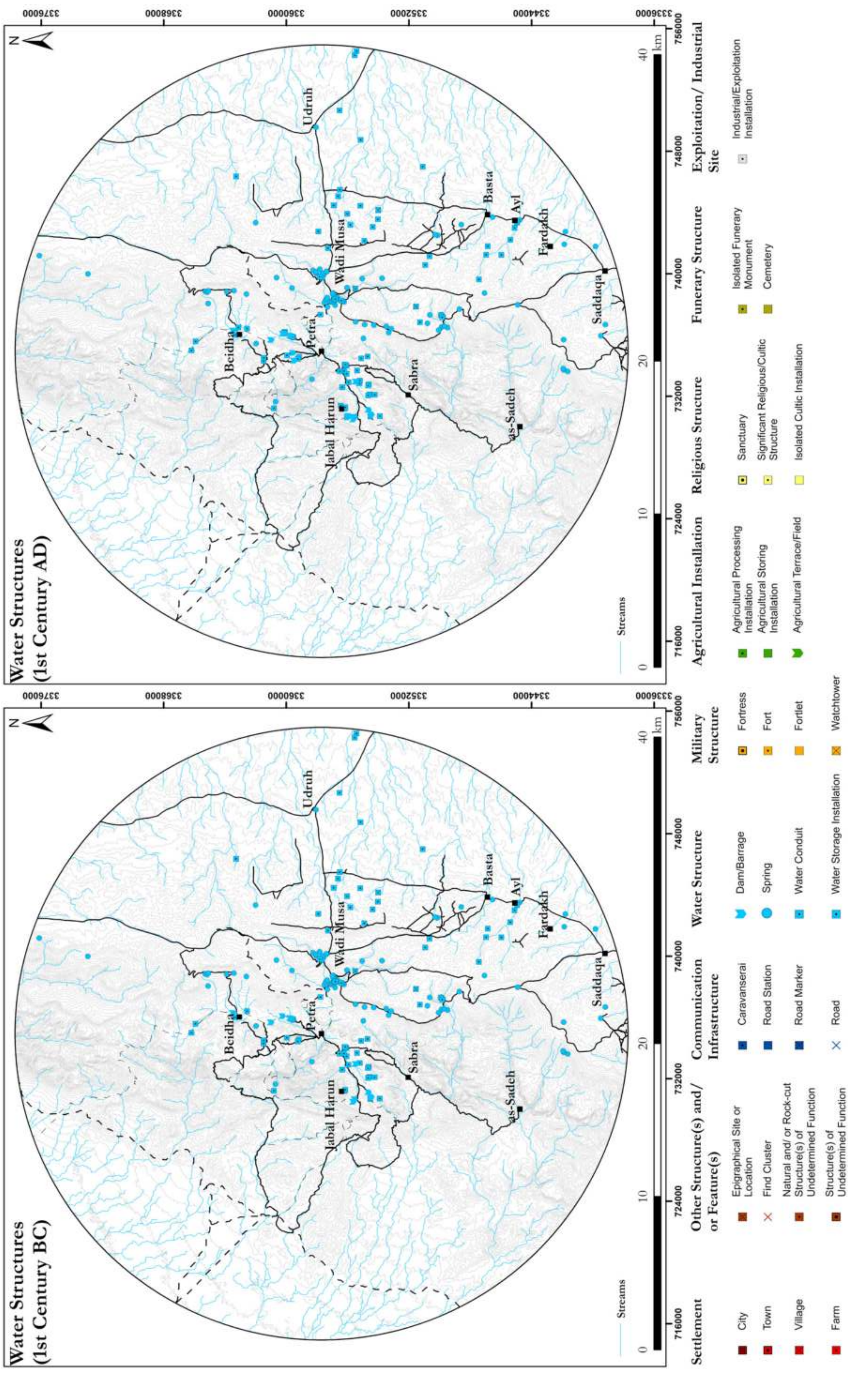


FIG. 93 Distribution map of all water structures dating to the 1st centuries BC and AD.

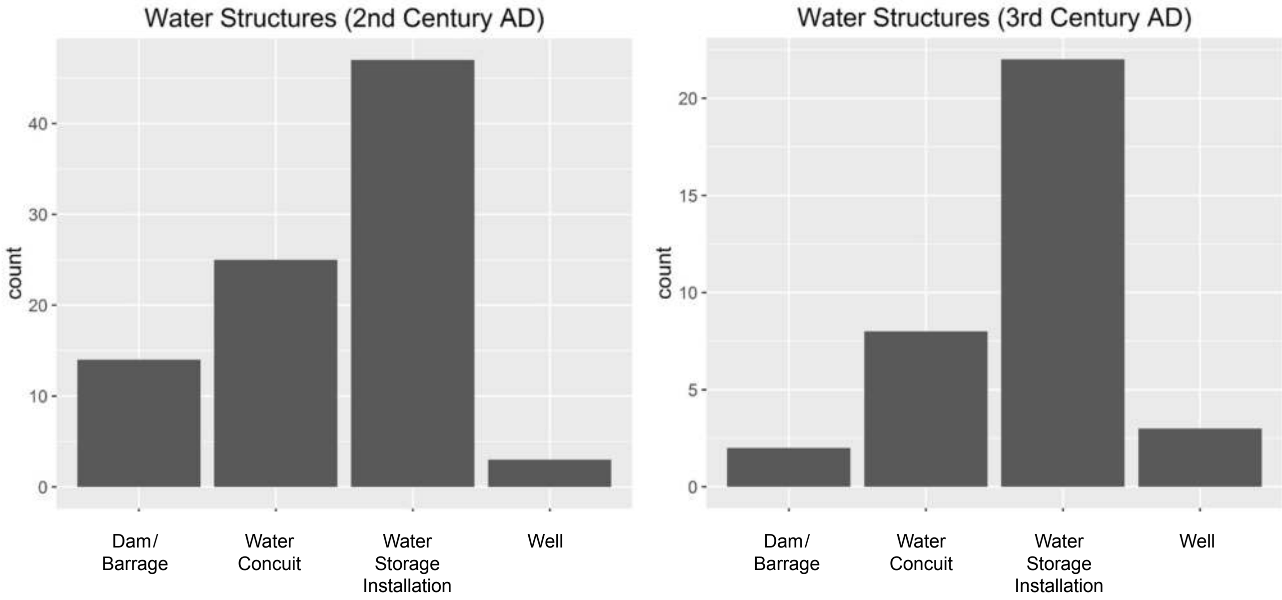


FIG. 94 Number of all water structures dating to the 2nd and 3rd century AD in the Petraean hinterland.

watershed cover a radius of approx. 10 km around Wadi Musa including Petra, the extended Beidha area as well as the eastern part of the as-Sto'e plain, it also encompasses vast areas along the eastern high plateau between Wadi Musa and Ayl. An extensive watershed can be noted immediately north of Saddaqa as well. However, the most important watershed for Petra itself, is the Wadi Musa area where the main water flow is directed towards the city center via the Siq aqueduct as well as the Nabataean diversion dam that re-directed water flow around the Jabal al-Khubtah massif and fed water into the Wadi al-Mataha, which eventually directed water back into the Wadi Musa in Petra's city center.[547] From a hydrological point of view, Petra is therefore located in a considerably advantageous position as the Petra valley clearly benefits the most from the natural water drainage channels in the area – however, only as long as water flow into the Petra valley is controlled and managed.[548]

Finally, the Pearson correlation test (cf. TABLE 31) and GIS-based visibility analyses indicate that the evidenced springs were controlled by lager military structures such as forts (cf. chapter 7). The fact that activities at springs were monitored by military structures is further supported by various survey reports that describe good visibility from presumed military structures to nearby springs.

Water Conduits

While there are only doubtful indications for Iron Age water conduits (cf. chapter 3), none are evidenced for the Hellenistic period. By the 1st century BC and continuing until the 2nd century AD, however, a stark increase of documented water conduits can be observed (cf. FIGS. 92–99). In Petra, this development is mirrored by the construction of the first spring water aqueduct (probably originating in 'Ain Musa) that was revealed during excavations under the Roman period paved road in the Siq as well as underneath the later *temenos* gate in Petra's city center.[549] Most likely following general Hellenistic construction models as it runs completely underground, this first major aqueduct of Petra went out of use in the mid-1st century BC, possibly due to flash flood destructions. After the destruction of the first 'Ain Musa aqueduct through the Siq, an above-ground aqueduct diverting spring water from the 'Ain Musa to Petra was constructed via the northern face of the Jabal al-Khubtah massif which, by the latest, went out of use due to substantial earthquake damage in 363 AD.[550] In addition to the al-Khubtah conduit, a new aqueduct was constructed in the Siq just above walking level in the late 1st century BC bringing fresh water into the city center from 'Ain Musa as well.[551]

547 E. g. Fiema 2012a, 121 and Akasheh 2002.
548 Many thanks are owed to J. Berking for pointing out this seemingly obvious, but often overlooked, observation.
549 Fiema 2012a, 122; Bellwald 2008, 48–49.
550 Fiema 2012a, 123; al-Muheisen 2009, 58–64; Bellwald 2008, 49–53.
551 al-Muheisen 2009, 42; Bellwald 2008, 53–54. As this ceramic pipeline presumably could not withstand the necessary pressure to divert water in higher areas of Petra's city center, an additional branch of the pipeline was constructed on a far higher level in the 2nd century AD. For further technical details on the Siq aqueduct, see Ortloff 2014. Also note that a rock-cut, but closed gravity flow

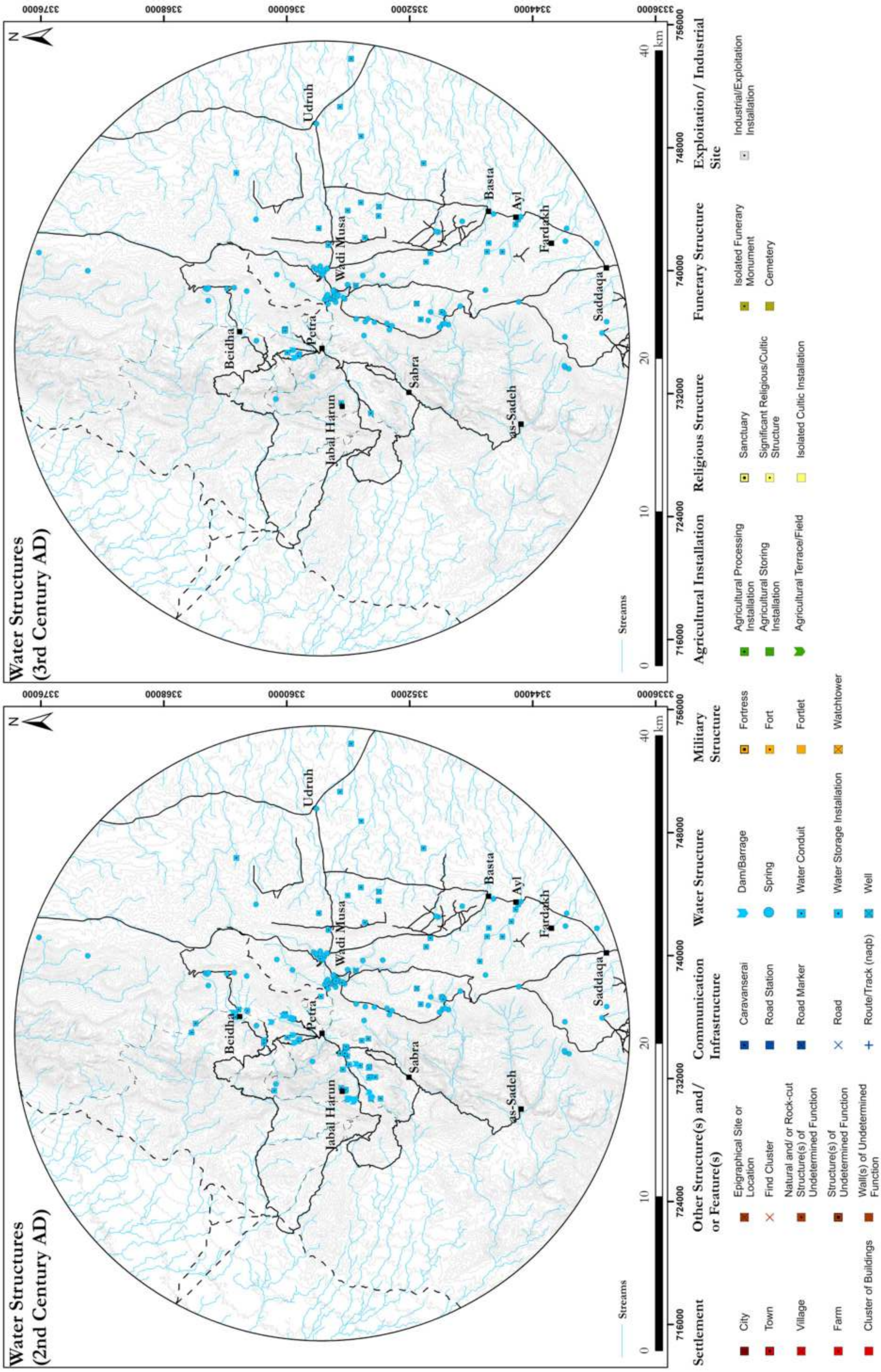


FIG. 95 Distribution map of all water structures dating to the 2nd and 3rd century AD.

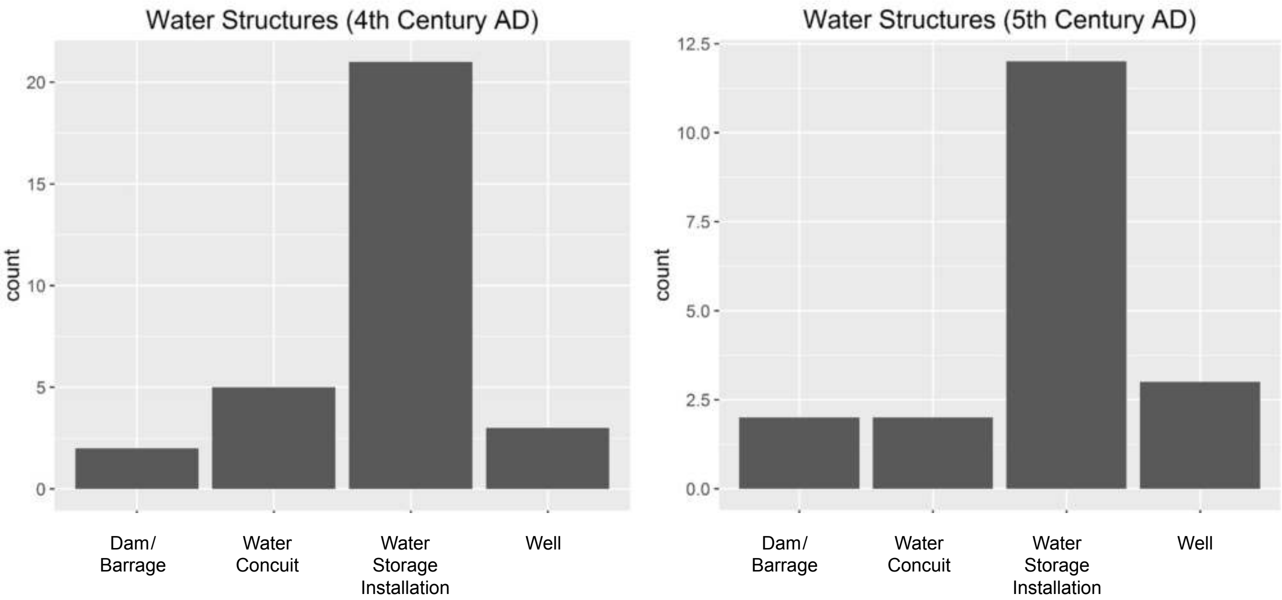


FIG. 96 Number of all water structures dating to the 4th and 5th century AD.

At the same time, Petra's southwestern quarters were supplied with fresh drinking water via the ʾAin Braq aqueduct. This aqueduct diverted water from the ʾAin Braq spring just below the Darb ar-Rasif (so called King's Highway) through steep, mountainous terrain via the Wadi Farasa into a *castellum divisorum* where the aqueduct was branched off to presumably supply the luxurious Nabataean mansion of ez-Zantur as well as the *paradeisos* of the 'Great Temple' in Petra's city center.[552] Petra's northern quarters were supplied by a fresh water aqueduct coming from the spring of ʾAin Dibidbi.[553] As the ʾAin Braq conduit, the ʾAin Dibidbi aqueduct is characterized by a ceramic pipeline as well as rock-cut flow channels and decompression basins distributed along the often steep slopes into the Petra valley. It is assumed that the ʾAin Dibidbi conduit is the latest of the five known aqueducts, constructed at some point in the late 1st century AD.[554] One of the latest results of the PHSP is not only that the ʾAin Dibidbi aqueduct could be mapped extensively further than previous studies, sections of an additional branch of the conduit were discovered immediately west of the spring itself.[555] Recent construction work revealed rock-cut channel stones with significant layers of sinter that followed the natural slope downwards in eastern direction towards Beidha/Siq al-Amti.

This brief and superficial presentation of Petra's fresh water aqueducts highlights the hydro-technological achievements of the Nabataeans. In the wider hinterland of Petra, comparable Nabataean fresh wa-

channel was constructed along the southern side of the Siq in the mid-1st century AD that initially only supplied the forecourt area of the monumental al-Khazne tomb. However, after its partial destruction in the earthquake of 363 AD, it was prolonged further into the city's center (although no longer covered).

552 Fiema 2012a, 123; al-Muheisen 2009, 64–79; Bellwald 2008, 56–60. For a more detailed evaluation on the ʾAin Braq aqueduct running through the Wadi Farasa, most notably the so called Roman Solider Tomb Complex, see Schmid 2008b. Also note that in order to further evaluate the duration of water flow of the ʾAin Braq aqueduct, in 2016 the PHSP probed and analyzed organic material between the upper sinter layers of the ʾAin Braq aqueduct. The resulting C14 dates are as follows. Given are the intervals of the calendar age where the true ages of the samples encompass probability values of c. 68 % and c. 95 %: AB1 R_Date (1770,30) 68,2 % probability; 230 AD (25,9 % probability); 264–275 AD (42,3 % probability); 330 AD (95,4 % probability); 138–345 AD (95,4 % probability). Thus a preliminary conclusion of the analyses is that water was most likely still running through the ʾAin Braq aqueduct between 138 and 345 AD. However, as sinter accumulated before this timespan as well, the conduit was probably no longer attended to at some point before c. 138 AD. The author would like to thank S. Isselhorst for this information, who is responsible for obtaining these results.

553 Fiema 2012a, 123; al-Muheisen 2009, 79; Bellwald 2008, 60–61.

554 Fiema 2012a, 123; Bellwald 2008, 60–61. Another aqueduct is assumed to have run from the Wadi Abu Olleqah/Wadi Turkmaniye although it is extremely destroyed and thus difficult to trace. In order to determine the age of the ʾAin Dibidbi aqueduct, the PHSP probed and analyzed charcoal remains from the mortar bed of the conduit. However, the C14 result suggests an Iron Age date of the charcoal, which clearly contradicts the archaeological evidence that dates the aqueduct to the 1st century AD. A preliminary interpretation of this result is currently that already dead wood was used to mix the mortar. Many thanks are owed to S. Isselhorst for providing the author with this information.

555 S. Isselhorst, L. Weis and M. Strauß are responsible for this important find.

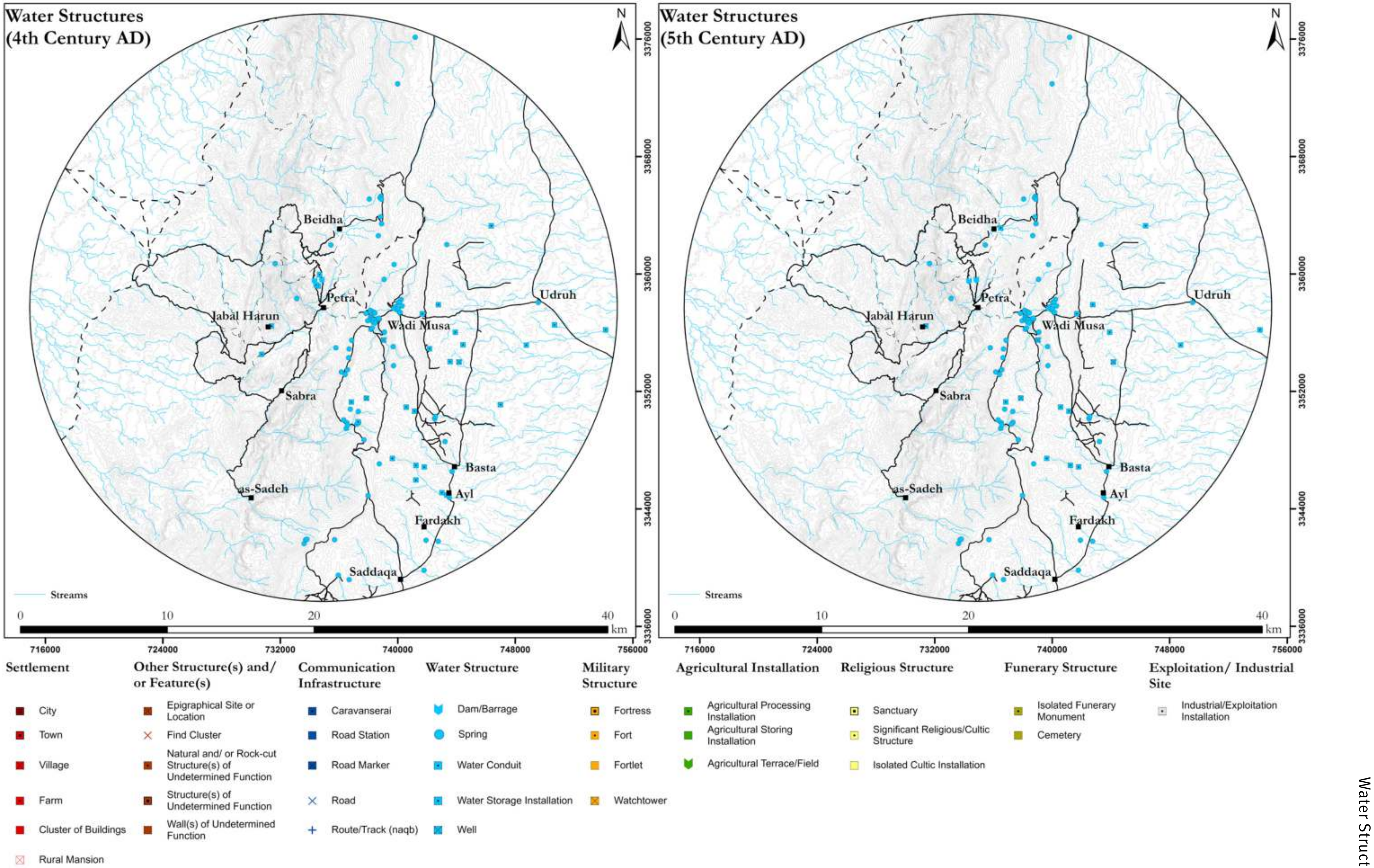


FIG. 97 Distribution map of all water structures dating to the 4th and 5th century AD.

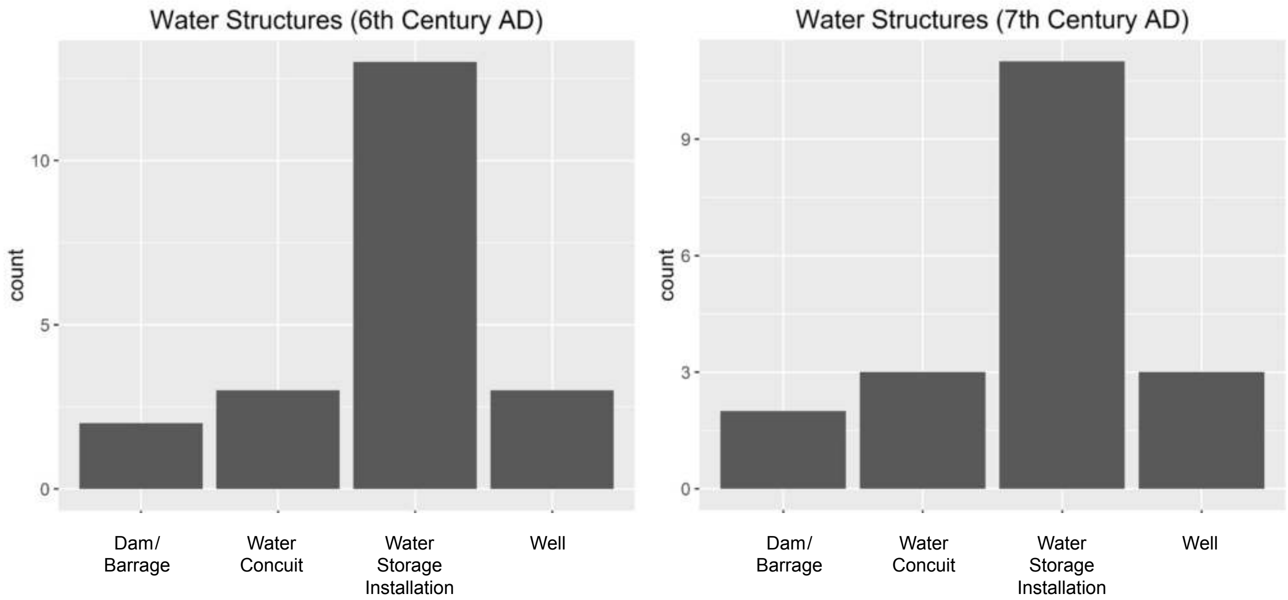


FIG. 98 Number of all water structures dating to the 6th and 7th century AD.

ter aqueducts of similar high technical standards are known at larger Nabataean settlements such as Sabra or as-Sadeh. At Sabra, a partly rock-cut and partly built conduit presumably transported water from the local spring of ʾAin Sabra along the steep slopes of Jabal al-Jathum into a large reservoir behind the rock-cut theater of the settlement from where water was diverted into a large dam.[556]

The settlement of as-Sadeh is situated c. 15 km south of Petra and probably best known for its Nabataean aqueduct that supplied a large reservoir with fresh water from the spring of ʾAin as-Sadeh situated on high ground north of the site.[557] Also, the Nabataean-Roman fortlet/road station of Qasr Umm Rattam situated northwest of Petra along the Wadi Musa (cf. chapters 6 and 7) is also supplied with fresh water from the spring of Amm Massemak situated at the eastern end of the Wadi Musa via a c. 6 km long conduit that feeds a large reservoir at Qasr Umm Rattam (FIG. 101).[558] The stored water was most likely used as both drinking and service water for irrigating the numerous agricultural terraces observed near Qasr Umm Rattam.

Although not as elaborate as the fresh water aqueducts described above, the archaeological evidence for additional water conduits in Petra's hinterland further reflects the hydrological ingenuity of the Nabataeans.[559]

Abudanh documented a section of a water channel built of two rows of vertically set, medium-sized stones along the Wadi Fiqai.[560] Although he postulates a possible (early) Nabataean date for the channel, the channel is better associated with the Byzantine Udruh *qanat* system.[561] Another, presumably Early Nabataean, water channel was cut by modern road works directly opposite the Nabataean settlement of Ayl and just c. 200 m west of the local spring of ʾAin Ayl.[562] The channel is characterized by small (probably vertically set) stones and stone slabs sealed with grey, ashy mortar. The channel's interior was covered with hydraulic plaster and "calcite deposits" (sinter). No more information is available on the channel, but due to its proximity to ʾAin Ayl and the settlement, it may be assumed that the channel diverted fresh water from the spring towards the settlement. Apart from the major ʾAin Musa aqueduct, further Nabataean

556 al-Muheisen 2009, 122–124; Lindner 2003a, 94–95; Lindner 2003b; Lindner – Zeitler 1997, 548–551; Lindner 1982.
557 al-Muheisen 2009, 124; Lindner 2005; Lindner 2003a, 29–54; Lindner 2003b; Lindner et al.1990 and Lindner et al. 1988.
558 al-Muheisen 2009, 121; Lindner et al. 2007; Lindner 2003b; Lindner et al. 2000. Cf. FIG. 277 for an additional illustration of Qasr Umm Rattam. Also note that it is reported that Qasr Umm Rattam derived its water from ʾAin as-Siyyagh in the Wadi as-Siyyagh as this wadi is an extension of the Wadi Musa. However, Amm Massemak is the local name of the spring as local Bedouins informed the author.
559 As smaller channels can be observed virtually everywhere in study area, this presentation of the documented water conduits is only indicative for the intricate water management system in the Petraean hinterland.
560 Abudanh 2006, 419.
561 MacDonald et al. 2016, 449 also recorded Nabataean surface material along the *qanat* as well.
562 ʾAmr et al. 1998, 538.

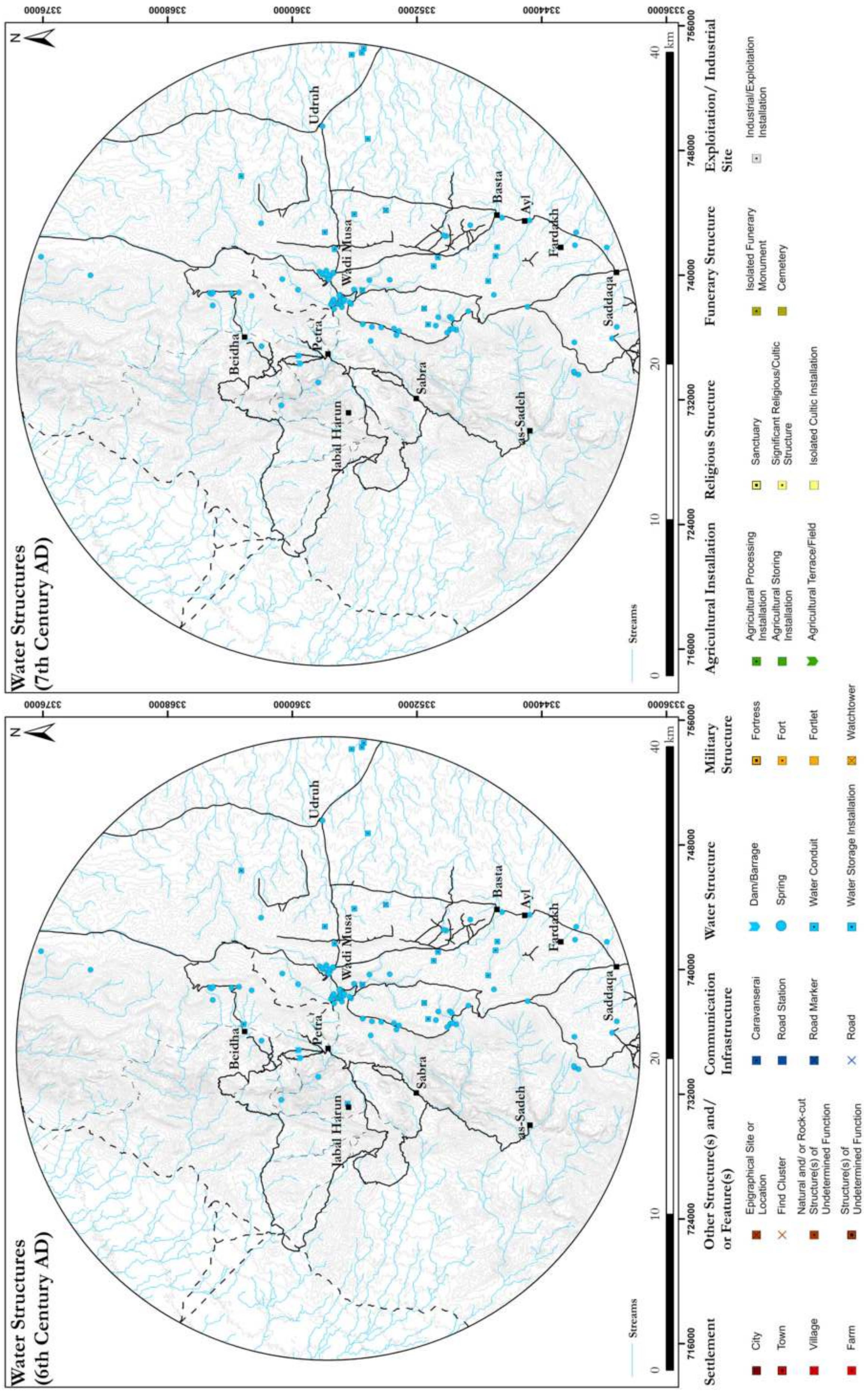


FIG. 99 Distribution map of all water structures dating to the 6th and 7th century AD.

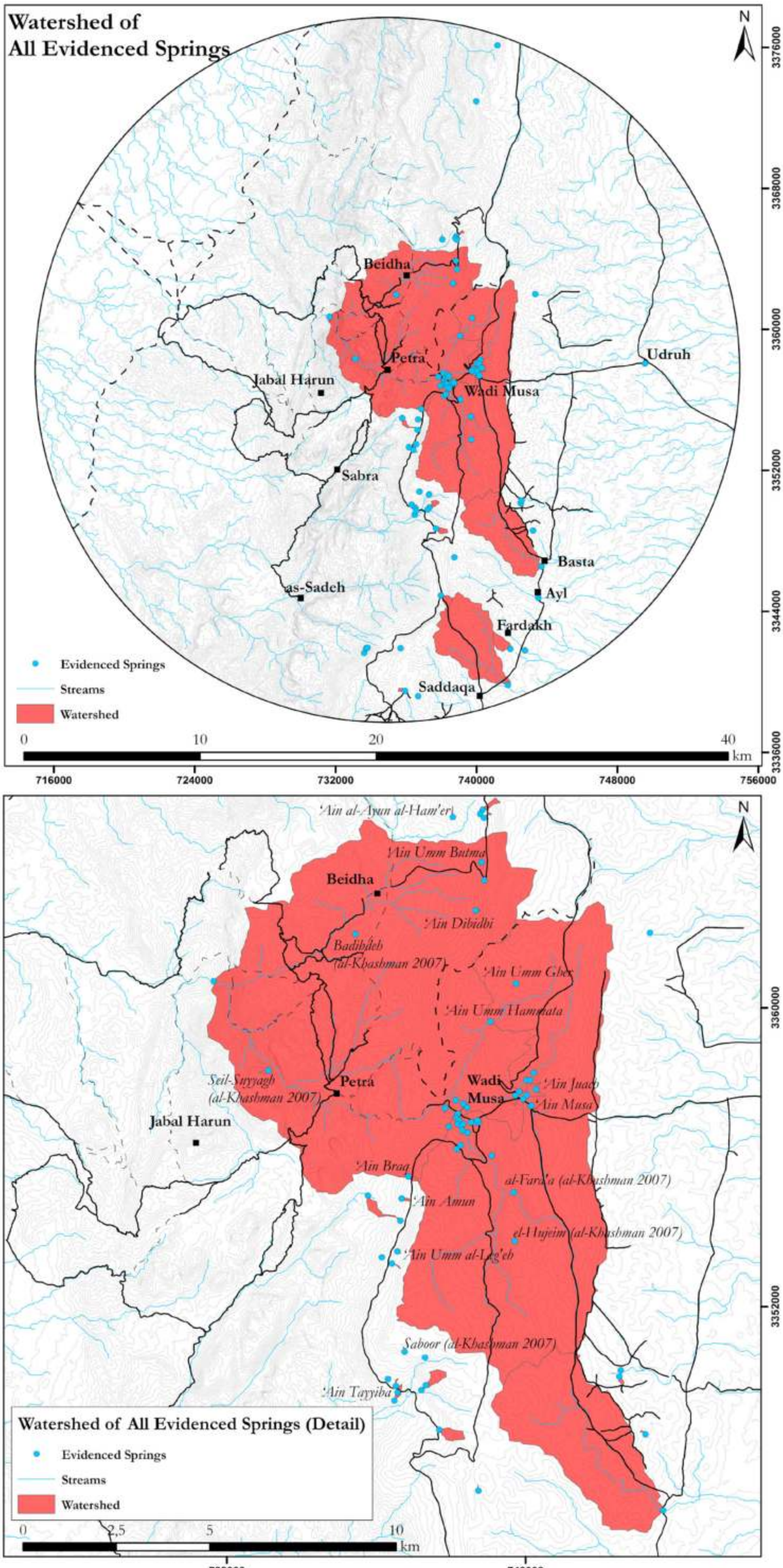


FIG. 100 Above: GIS-based watershed of all recorded springs in the Petraean hinterland. Below: Detailed view of the watershed for the immediate Wadi Musa/Petra area.

FIG. 101 The Qasr Umm Rattam conduit. A: Built section of the conduit running along the upper south bank of the Wadi Musa. B: The spring of Amm Massemak (ʼAin Siyyagh?) supplying the conduit with fresh water. C: Built part of the Qasr Umm Rattam conduit. D: Detailed profile view of the Qasr Umm Rattam conduit showing its mortar layer and channel bed.

channels were discovered within the limits of modern Wadi Musa, one of which possibly originated at the ʼAin al-Bassa spring (one of Wadi Musa's many springs and, as mentioned above, listed in the Petra Papyri) although its destination remains unresolved.[563] Additionally, a small 'tunnel' was noticed west of the modern school in Umm Sayhoun where few fragments of Nabataean surface pottery were recorded.[564] The original surveyors postulate that the presumed tunnel may have been a channel although no hydraulic mortar was observed. If the tunnel truly served as a water conduit, it may be possible that it held a ceramic water pipe. Following this assumption, it may also be postulated that this was once part of the ʼAin Dibidbi aqueduct, although this remains speculative.[565]

In addition to the eastern high plateau and the Wadi Musa area, numerous rock-cut and built water channels were documented in the al-Farasha and as-Sto'e plains by the FJHP. These are mainly associated with rock-cut cisterns such as the 100 m long channel of FJHP Site No. Ext.065 recorded west of Jabal Harun.[566] The FJHP also documented at least one larger water conduit (FJHP Site No. S30) situated east of Umm Khurrama.[567] The conduit is generally well preserved and characterized by a small, 55 m long stone wall. It was probably related to the extensive terrace/barrage system in the Wadi as-Saddat.[568]

By the 3rd century AD, surface material suggests that only the conduits near Ayl and the Didibi aqueduct were still in use, thus attesting to a significant decrease

563 ʼAmr et al. 1998, 521, 525.
564 ʼAmr et al. 1998, 516.
565 WMWS 1996 Site No. Bayda 24 describes a rock-cut channel with ceramic pipes and hydraulic mortar which, according to ʼAmr et al. 1998, 514, is most likely part of the ʼAin Dibidbi aqueduct as well.
566 Lavento et al. 2013, 217 and Kouki et al. 2013b, 19–20.
567 Lavento et al. 2013, 217.
568 Lavento et al. 2013, 214, 217. According to Silvonen et al. 2013, 356, the conduit resembles similar "parallel walls" associated with agricultural terraces/barrages in the Wadi Faynan.

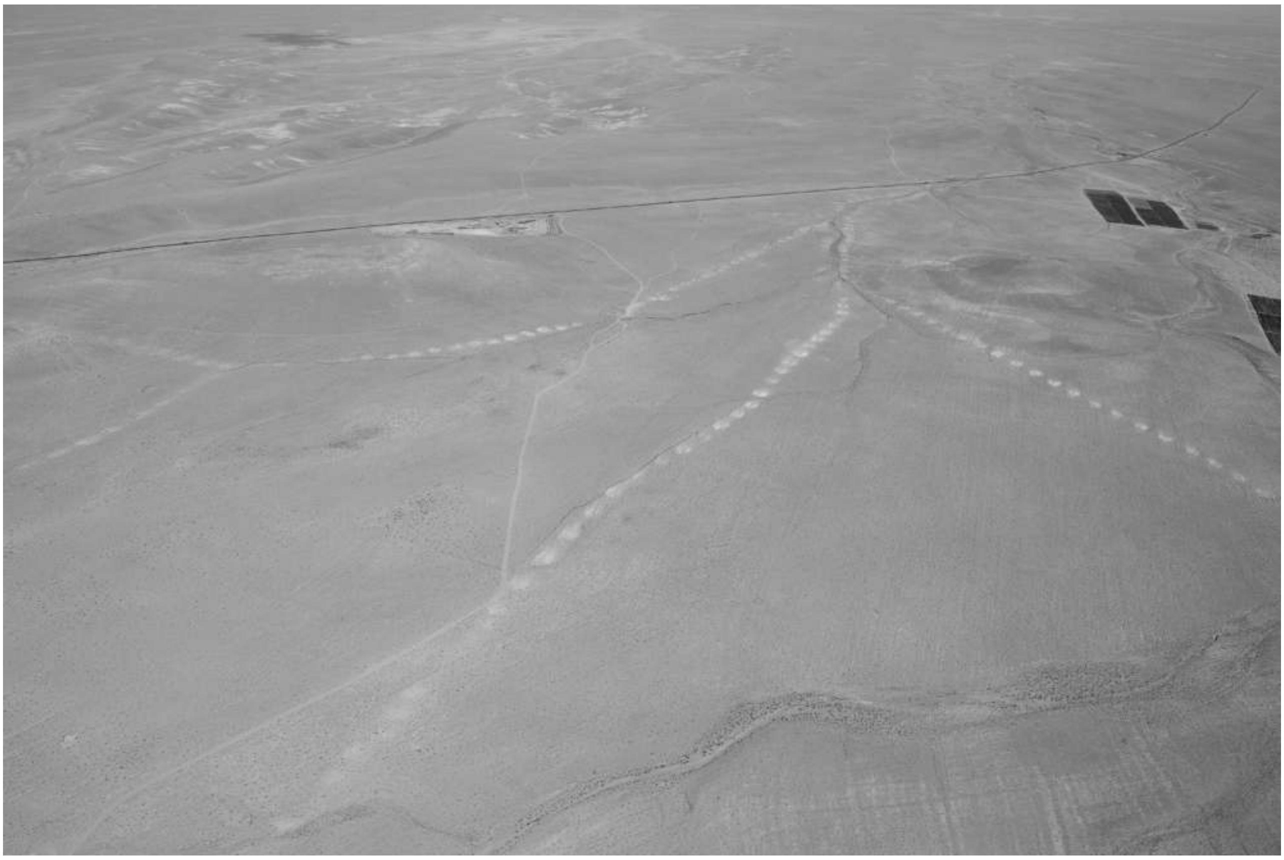


FIG. 102 Aerial view of the Udruh qanat system. Photo: APAAME.

of water conduits by the end of the Nabataean/Early Roman period. While 4th century AD surface pottery was collected at the Ayl conduit, by the 5th century AD the only evidenced water conduit is the Udruh *qanat* system (FIG. 102). In total, four *qanat* branches are documented in the area south-southeast of Udruh with over 200 recognizable shafts.[569] By means of gravity flow, the Udruh *qanat* transported the tapped ground water over a distance a c. 4–5 km to lower grounds where it was then diverted by means of built aqueducts and channels to two large reservoirs (Birket Udruh and Birket al-Fiqai). This water was used to irrigate the numerous agricultural field systems that covered an area of c. 20 ha. As the Petra Papyrus 25 mentions an irrigated and cultivated land plot around Udruh (*patrimonium*) that was sold in 559 AD, a rough dating into the Byzantine period is secured for the Udruh *qanat* system.[570] However, recent OSL and C^{14} samples taken from the deepest sediments of the *qanat* shaft and mortar from the associated channels and reservoirs suggest an original dating to the Nabataean period, leading Driessen and Abudanh to the conclusion that the Udruh *qanat* had a Nabataean-Roman origin and was later renovated and reused in the late Roman, Byzantine and Islamic periods.[571]

Water Storage Installations

This section presents the archaeological evidence for isolated water storage installations (almost exclusively rock-cut cisterns) that are *not* directly associated with rural settlements.[572] As reported by the various surveys, most settlements were equipped with additional water storage installations.

569 Driessen – Abudanh 2015, 302–304 and Abudanh – Twaissi 2010 for general information and further references on the Udruh *qanat* system.

570 Driessen – Abudanh 2015, 302–304: Although one *qanat* shaft was excavated to bedrock, there is no mention of any diagnostic material that could offer further dating evidence for the *qanat* system.

571 The OSL and C^{14}-analyses suggest a date as early as the 1st century AD (Driessen – Abudanh 2018, 141–148 and 2015, 303).

572 In addition to the various cisterns, Abudanh documented a 33 × 44 m large reservoir (Birket al-Fiqai) that was associated with the Byzantine conduit along the Wadi al-Fiqai (Abudanh 2006, 418). The other reservoir associated with the Byznatine *qanat* system was Birket Udruh (Abudanh – Twaissi 2010, 69–70). Also note the large reservoir at Qasr Umm Rattam and a large reservoir at Saddaqa (Fiema 2002a, 211).

While only two sites are documented for the Iron Age periods (cf. chapter 3), by the 1st century BC water storage installations are by far the largest category of all water structures in the Petraean hinterland (cf. FIGS. 92–99). This remains the case throughout all discussed time periods, which clearly suggests that rock-cut cisterns provided the main water source for the inhabitants of the study area in antiquity. However, in Jordan and the Near East in general, rock-cut cisterns have an extremely long history of use.[573] The earliest rock-cut cisterns discovered in modern-day Jordan and Israel date back to the Chalcolithic and Bronze Age periods although the practice of storing water in large cisterns greatly increased during the Iron Age period.[574] Archaeologically, the often bottle-shaped, rock-cut cisterns that were coated in hydraulic mortar are well known in the Negev, and by the Nabataean period, also in great numbers in Petra and other Nabatean settlements throughout Nabataea.[575] Hundreds of Nabataean cisterns were documented within the urban limits of Petra and its immediate vicinity.[576] Via both rock-cut and built channels the cisterns were fed with run-off water that was cleaned by means of pre-positioned basins or settling tanks. Many cisterns, which vary in terms of construction technique, shape and size, were sealed in order to avoid contamination of the stored water.[577]

The vast numbers of known cisterns in and immediately around Petra are mainly associated with the Nabataean period. This is also assumed by Shqairat et al. for their more detailed study of documented cisterns in the Udruh area, although it is claimed that these were consistently used during the following periods and were supposedly still in use in the early modern era.[578] Dating cisterns archaeologically is highly problematic and surface material is only an extremely suggestive dating basis. Generally, cisterns and other water storage installations are dated by associated settlements or other archaeological structures. Ideally, a more detailed study and scientific analysis of hydraulic mortars may offer further chronological indications, but such information is hardly available.[579] The presented statistics should therefore be considered with caution.[580] While keeping this mind, the presented results nevertheless confirm the general conclusions concerning the dating and distribution of rock-cut cisterns in the study area.

As mentioned above, an immense increase of cisterns can be observed in the 1st century BC corresponding to the general sedentarization process and shift to a more agriculture-based Nabataean society as well as the overall development of high-end Nabataean hydro-technological achievements. The majority of all evidenced cisterns are distributed along the eastern high plateau, although there are also numerous cisterns documented in the extended Beidha and Jabal Harun areas located mostly at the base of run-off catchment areas.[581]

Various cistern types, sizes and shape are evidenced in the study area that are greatly dependent on natural landscape conditions such as topography, geology and the availability of run-off water (FIG. 103). The documented cistern types range from large, rock-cut cisterns that were arched and covered by stone slabs, small bottle-shaped cisterns, irregularly shaped cisterns that were cut horizontally into the bedrock or even caves that were further developed into cisterns.[582]

Naturally, the cisterns are mostly not located in the vicinity of springs and many cisterns are recorded to have been situated within various settlements. As most of the settlements are distributed along the eastern high plateau where annual rainfall rates are the highest in the study area, this is not surprising and it becomes clear that the vast majority of all settlements were supplied with seasonal run-off water that was systematically stored in cisterns within the settlements. Although the capacity of the cisterns within settlements was limited, a considerable degree of care was taken to ensure good water quality. This suggests that water stored in such cisterns was mainly used for domestic purposes.[583]

The larger, rectangular cisterns are mainly situated within areas where agriculture was practiced (e.g. the al-Begh'ah plain in the Beidha area or the al-Farasha plain south of Jabal Harun). It may thus be assumed that the vast amounts of water stored in such cisterns

573 Cf. Shqairat et al. 2010, 205–209, 219–220.
574 Oleson 1997, 176 and 1995, 709; Evenari et al. 1982, 171.
575 al-Muheisen 2009, 83–89; Oleson 1995, 709; Evenari et al. 1982, 14–17, 159.
576 al-Muheisen 2009, 83–100, 139–141, 146–147 for a general overview. Also consider the numerous cisterns on top of Umm al-Biyara which translates "mother of the cisterns" that supplied the Iron Age and later Nabataean structures with water (cf. e.g. Schmid et al. 2012, 75–85 and Bienkowski 2011).
577 E.g. Oleson 2001, 606.
578 Shqairat et al. 2010, 208, 219–220.
579 On analyses of Nabataean mortars, see e.g. al-Bashaireh – Hodgins 2011; al-Bashaireh 2008; Shaer 2004.
580 While the overall numbers of the evidenced water storage installations are generally representative, this study makes no claim of completeness as there are simply too many rock-cut cisterns distributed throughout the study area to have been surveyed systematically.
581 Cf. also Lavento et al. 2013, 216–217.
582 Cf. Shqairat et al. 2010, 211–219.
583 Shqairat et al. 2010, 221.

FIG. 103 Selective overview of the various cistern types in the Petraean hinterland. A: Reused large, roofed Nabataean cistern in the al-Farasha plain. B: Reused roofed Nabataean cistern in the al-Farasha plain. C: Large, roofed cistern in the al-Begh'ah plain near Shammasa. D: Large, horizontally cut Nabataean cistern in the ad-Thugra area along the as-Sto'e plain.

may have also been used to irrigate the evidenced agricultural terraces and fields in areas where run-off water was less available. The fact that these large cisterns were all roofed indicates that the preservation of water quality was a major issue as well. Thus, in addition to using the stored water for agricultural or generally utilitarian purposes, the available water may have also served as drinking water for the local population in the respective areas.

The distribution maps of all identified water structures – which mostly consist of isolated water storage installations – with the underlying KDEs for contemporary settlements show that water structures do not necessarily correlate with the main clusters of settlements (FIGS. 104–105). Instead, it appears that water structures are mainly located along the limits of settlement clusters. As suggested by the Pearson correlation tests conducted for the evidenced settlements (cf. chapter 5), strong spatial correlations are only attested between water storage installations and farms during the 1st century AD (cf. TABLES 13–29).[584] However, as indicated by both the KDE and the Pearson correlation tests, with the increasing nucleation of settlements from the 4th century AD onwards, water storage installations appear to be more spatially correlated with main settlement clusters.[585] These results have shown that particularly isolated water storage installations (i.e. mainly cisterns) are generally *not*

584 The Pearson correlation test also suggests strong spatial correlations between water storage installations and towns during the 10th and 8th centuries BC. However, as only few of these site types are recorded for these periods, the indicated strong spatial correlations have only limited meaning (cf. chapter 3).

585 As suggested by the strong spatial correlation indicated by the Pearson correlation test for the 3rd century AD between springs and towns, this process of water structures concentrating around large settlement clusters may have already begun in the 3rd century AD. Further significant spatial correlations are observed between water storage installa-

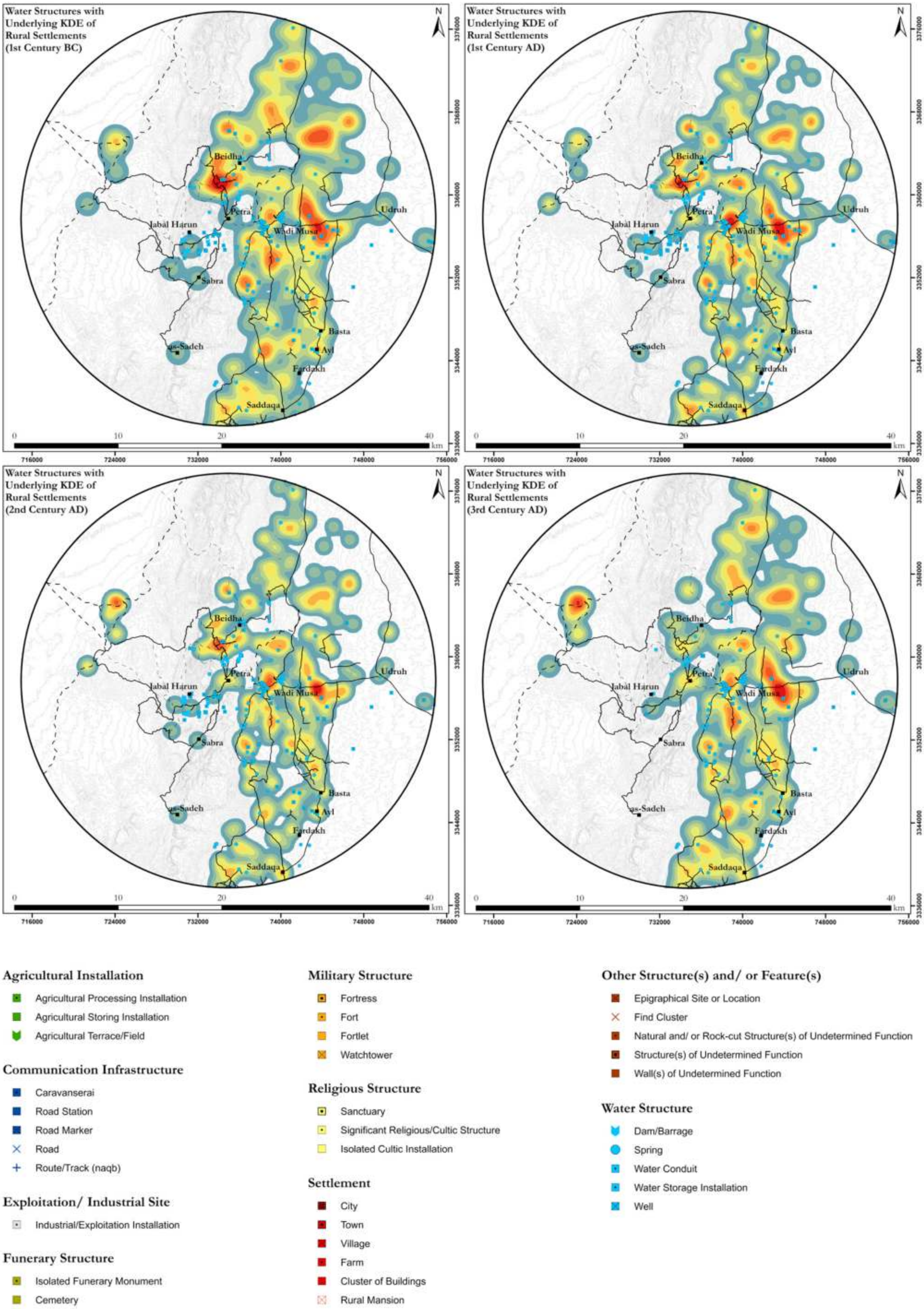


FIG. 104 Distribution maps of all water structures with the underlying kernel density estimation for contemporary settlements from the 1st century BC to 3rd century AD.

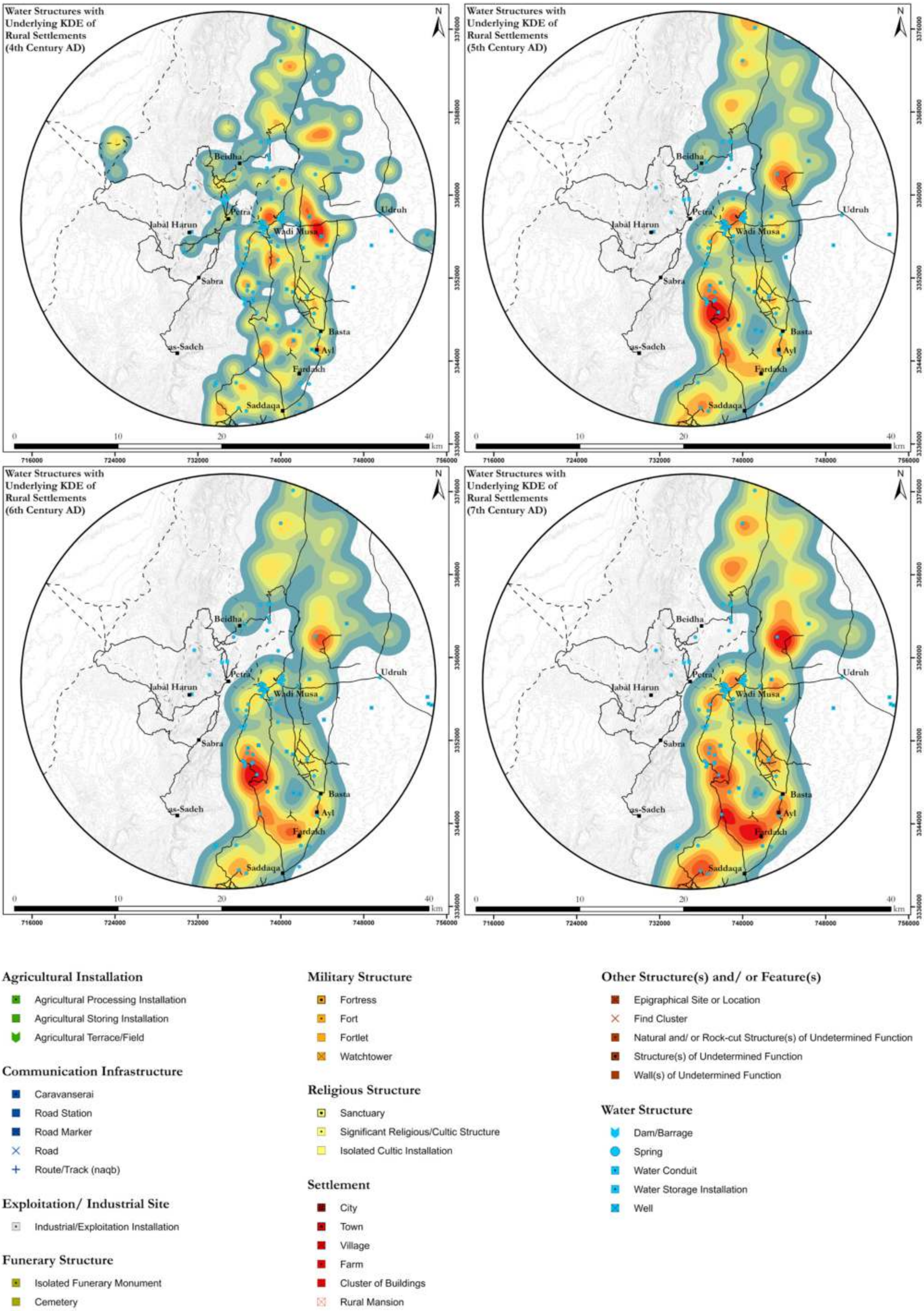


FIG. 105 Distribution maps of all water structures with the underlying kernel density estimation for contemporary settlements from the 4th–7th century AD.

related to settlements of the Nabataean/Early Roman periods in the Petraean hinterland. These were most likely supplied with water from cisterns *within* the respective settlements. Previous studies argue that such isolated cisterns may have been used for small-scale irrigation as many cisterns, particularly along the eastern high plateau, are reported to be located near agricultural fields. The possibility that they were used by pastoralists as watering places for herd animals was explored as well.[586] Indeed, it seems plausible that the large number of isolated cisterns reflect the persisting semi-nomadic lifestyle of the Nabataeans as well as their good knowledge of their territories and available water sources, as noted by Diodorus Siculus in the 1st century BC:[587]

> κατὰ γὰρ τὴν ἄνυδρον χώραν λεγομένην κατεσκευακότες εὔκαιρα φρέατα, καὶ ταῦτα πεποιηκότες τοῖς ἀλλοεθνέσιν ἄγνωστα, συμφεύγουσιν εἰς τὴν χώραν ταύτην ἀκινδύνως.
>
> *For in the waterless region, as it is called, they* [the Nabataeans] *have dug wells at convenient intervals and have kept the knowledge of them hidden from the peoples of all other nations, and so they retreat in a body into this region out of danger.*[588]

Furthermore, in another passage Diodorus also states:

> φιλελεύθεροι δέ εἰσι διαφερόντως καὶ ὅταν πολεμίων δύναμις ἁδρὰ προσίῃ, *φεύγουσιν* εἰς τὴν ἔρημον, ταύτῃ χρώμενοι ὀχυρώματι: ἄνυδρος γὰρ οὖσα τοῖς μὲν ἄλλοις ἀνεπίβατός ἐστι, τούτοις δὲ κατεσκευακόσιν ἀγγεῖα κατὰ γῆς ὀρυκτὰ κεκονιαμένα μόνοις παρέχεται μὴν ἀσφάλειαν.
> τῆς γὰρ γῆς οὔσης τῆς μὲν ἀργελλώδους, τῆς δὲ πέτραν ἐχούσης μαλακὴν ὀρύγματα μεγάλα ποιοῦσιν ἐν αὐτῇ, ὧν τὰ μὲν στόμια μικρὰ παντελῶς κατασκευάζουσι, κατὰ βάθους δ᾽ ἀεὶ μᾶλλον εὐρυχωρῆ ποιοῦντες τὸ τελευταῖον τηλικοῦτ᾽ ἀποτελοῦσι τὸ μέγεθος ὥστε γίνεσθαι πλευρὰν ἑκάστην πλέθρου.
> ταῦτα δὲ τὰ ἀγγεῖα πληροῦντες ὕδατος ὀμβρίου τὰ στόματ᾽ ἐμφράττουσι καὶ ποιοῦντες ἰσόπεδον τῇ λοιπῇ χώρᾳ σημεῖα καταλείπουσιν ἑαυτοῖς μὲν γιγνωσκόμενα, τοῖς δ᾽ ἄλλοις ἀνεπινόητα.
>
> *They* [the Nabataeans] *are exceptionally fond of freedom; and, whenever a strong force of enemies comes near, they take refuge in the desert, using this as a fortress; for it lacks water and cannot be crossed by others, but to them alone, since they have prepared subterranean reservoirs lined with stucco, it furnishes safety. As the earth in some places is clayey and in others is of soft stone, they make great excavations in it, the mouths of which they make very small, but by constantly increasing the width as they dig deeper, they finally make them of such size that each side has a length of one plethrum. After filling these reservoirs with rain water, they close the openings, making them even with the rest of the ground, and they leave signs that are known to themselves but are unrecognizable by others.*[589]

Clearly, Diodorus not only refers to advanced Nabataean hydro-technological ingenuity in terms of the construction of underground cisterns, he also emphasizes the exclusive use of these cisterns reserved only to locals who had the knowledge where to find them. Arguably, this study not only confirms the accounts of Diodorus as the clear majority of all evidenced water structures are water storage installations.[590] Diodorus' report that Nabataean cisterns were "hidden" and restricted only to locals is also supported by the KDE and Pearson correlation test results that indicate no significant spatial correlations between the isolated cisterns and settlements during the Nabataean/Early Roman periods. Arguably, the isolated cisterns may reflect the restricted and exclusive use of widely distributed and "hidden" Nabataean cisterns described by Diodorus.

However, by the 3rd century AD onwards, the overall count of water storage installations decreases dramatically (cf. FIGS. 94–99). Although this development should be considered with caution, the overall decline of water structures – and of water storage installations in particular – may be partially explained by the possible drop in rainfall around 400 AD and the increasing aridification of the study area in later periods.[591] While the general water management system of the Petraean hinterland remained largely based

tions and farms during the 4th century AD, between water storage installations and cluster of buildings as well as between springs and towns during the 5th and 6th centuries AD. For the 7th century AD, strong spatial correlations are suggested between springs and towns.

586 Kouki 2012, 108; Shqairat et al. 2010, 221; Abudanh 2007.

587 Cf. similar claims expressed by Marquaire et al. 2018, 266–268 concerning a Nabataean rainwater collecting system at Dumat al-Jandal as well as Gentelle 2009, 134.

588 Diod. Sic. 2, 48, 2. Translation after Loeb Classical Library edition (1954). Note that the Greek term φρέαρ is translated here as "well," but it can also be understood as tank, cistern or reservoir (LSJ s.v. 1996, 1954).

589 Diod. Sic. 19, 94, 6–9. Translation after Loeb Classical Library edition (1954). Diodorus clearly refers to the bottle-shaped Nabataean cistern as already claimed by Shqairat et al. 2010, 211. In contrast to Diodorus' use of the term φρέαρ in the passage above, note that in this account he refers to "[…] *ἀγγεῖα κατὰ γῆς* […]" which literally translates as "subterranean vessels," although the Greek term "ἀγγεῖον" is also understood as a reservoir (LSJ s.v. 1996, 7). Whether these two terms reflect two different types of Nabataean water storage installations is difficult to determine.

590 This argument was already laid forward by Shqairat et al. 2010.

591 Cf. Kouki 2012, 64–68, 115–121.

on storing run-off water in cisterns, it is interesting to consider whether climatic factors contributed to the construction of the Byzantine *qanat* system at Udruh (thus tapping ground water) as the collection of rainwater became increasingly ineffective with growing regional aridity.

Wells

Only three possible wells were recorded by the various surveys, for which there is only doubtful archaeological evidence. Although the same dating problems as discussed for the water storage installations apply here as well, all presumed wells were documented by MacDonald et al. on the basis of surface pottery, supposedly indicating a date as early as the 1st century BC. However, Late Antique material was also associated with the wells, thus suggesting a long use at least until the 7th century AD (cf. FIGS. 92–99). All three wells (Umm al-Futas, Bir Sarih and Khirbet al-Sa'idiyyah) are distributed along the eastern high plateau. Umm al-Futas (ShamAyl Site No. 60) is described as a rock-cut, round "reservoir/water well" situated on a flat hill and surrounded by agricultural terraces. It was originally coated in hydraulic mortar and steps lead down to its interior (c. 1,30 m deep until modern fill).[592] A settling tank was noted uphill from the well and a channel was documented that supposedly led downhill from it. 'Amr et al. recorded this site as a well.[593] Based on the limited archaeological evidence, it is difficult to identify it as a well that tapped ground water. The settling tank observed uphill from the site may rather suggest that run-off water was collected and diverted into the 'well,' which would indicate that the site is actually another cistern.

Bir Sarih (ShamAyl Site No. 72) is characterized by a c. 5 × 5 m enclosing wall built of well-drafted limestone blocks.[594] The wall is c. 1 m thick and still stands about 1 m above ground level. A "drainage facility" reportedly diverted water into a large, open-air basin. The original surveyors interpret it as a possible watering place for animals. While the archaeological evidence does not negate the possibility that the site is a well, there is also no convincing evidence *for* such an interpretation.

The last possible well evidenced in the study area is Khirbet al-Sa'idiyyah (ShamAyl Site No. 136).[595] Looting activities are reported for the presumed well itself, which has a depth of approx. 4 m. Although no further archaeological information is provided, a c. 28 × 25 m enclosing wall, built of large, irregularly cut stones protects the site. A stone-lined path gives access to the well from a nearby road (possibly Graf's central road; cf. chapter 6). From all discussed possible wells, this site seems to be the most likely candidate to be considered as such.

Dams/Barrages

As can be observed throughout urban Petra, by the construction of highly effective dams, the Nabataeans successfully protected the city against otherwise uncontrollable flashfloods. The most prominent example of such Nabataean hydro-technological ingenuity in Petra is probably the large diversion dam in the Bab as-Siq that re-directed water flow from the Wadi Musa around the Jabal al-Khubtah through an artificially cut tunnel that fed the water stream into the Wadi Mataha.[596] In order to control the vast water masses that were diverted through the al-Khubtah tunnel, large dams were constructed in the Wadi Mataha and Wadi Umm Sayhoun as well, which are also good examples of the extensive construction measures undertaken by the Nabateans to control seasonal flashfloods. Further examples of Nabataean dams within the urban limits of Petra can also be found in the Wadi Farasa and Wadi Mahfur running above the rock-cut theater.[597]

In Petra's hinterland, the evidenced dams/barriages are immediately associated with the agricultural terracing systems and mostly concentrate in the extended ad-Thankia, Beidha, Jabal Harun as well as Udruh areas where run-off water was collected from the surrounding slopes of the respective areas. In addition to the extensive terracing system, barrages and dams were studied extensively by the FJHP for the Jabal Harun area. Berenfeld et al. most recently researched in more detail the intricate Nabataean water management systems in the wadis al-Mu'aysirah East and West between Petra and the al-Begh'ah plain of the Beidha area.[598] These intricate systems of barrages and storage dams that served mainly agricultural purposes highlight the high level of Nabataean water management in Petra's hinterland that has already been studied in detail within the city's urban limits.

592 MacDonald et al. 2016, 182–183; 'Amr et al. 1998, 540.
593 'Amr et al. 1998, 540.
594 MacDonald et al. 2016, 190–191.
595 MacDonald et al. 2016, 249.
596 Fiema 2012a, 124–125; Bellwald 2008, 67–69.
597 Fiema 2012a, 124–125; Bellwald 2008, 67–69; Schmid 2008b.
598 Berenfeld et al. 2016, 87–94.

Other Structures and / or Features Presumably Related to Alternative Subsistence Strategies

The various surveys documented many archaeological sites that are difficult to define functionally. These constitute a problematic dataset for any meaningful archaeological and historical discussion. Referred to as 'other structures and/or features,' they account for 36,5 % (634/1737 sites) of the entire database and are the largest group of documented site types evidenced in this study (FIG. 106). Although they are too numerous to be discussed in detail and their problematic nature prevents convincing archaeological insights into the landscape organization of the Petraean hinterland, they should not be dismissed altogether. Some may be considered as archaeological evidence for alternative, presumably pastoral subsistence strategies in the Petraean hinterland.[599] However, before delving into the specific evidence related to possible alternative subsistence strategies, the following first offers a general presentation of the evidenced 'other structures and/or features.'

The largest subcategory of other structures and/or features are 'structures of undetermined function' followed by 'natural and/or rock-cut structures of undetermined function' (FIG. 107, cf. chapter 2 for definitions). The third largest subcategory are 'find clusters.' Finally, there are few 'walls of undetermined functions' and 'epigraphical sites or locations' evidenced in the Petraean hinterland.

The evidenced other structures and/or features are distributed across the entire study area with a concentration along the central part of the eastern high plateau, the extended Jabal Harun area as well as areas immediately north of Petra towards Beidha (FIG. 108).

Although there is a slight increase of structures of undetermined function in the Hellenistic period (4th – 2nd centuries BC) (eight sites for the 2nd century BC) after a dramatic decrease of all other structures and/or features during the 5th century BC, the Petraean hinterland remains largely void of such sites. It is only by the 1st century BC that a significant increase of all subcategories is noted. The overall count of all other structures and/or features increases dramatically to 313, with over 250 structures of undetermined function alone, followed by 40 natural and/or rock-cut structures of undetermined function. During the 1st century AD, this increase continues with over 400 recorded other structures and/or features in total and the number of structures of undetermined function rising to nearly 300. A slight increase is also noted for the natural and/or rock-cut structures of undetermined function (44 in total) which remain the second largest subcategory of other structures and/or features throughout the following periods. However, these never exceed 45 (2nd century AD). The third largest category are the evidenced find clusters, which reach a maximum of 29 during the 1st and 2nd century AD. Only a comparatively limited number of epigraphical sites or locations as well as walls of undetermined function are evidenced from the 1st century AD onwards.

While the overall situation of the 1st century AD remains largely unchanged during the 2nd century AD, a significant decrease of all subcategories can be observed during the 3rd century AD. In total, there are only 243 recorded other structures and/or features and only 186 structures of undetermined function. Although there is a slight increase of structures of undetermined function in the 4th century AD, the overall decline continues during the 5th century AD with only 107 structures of undetermined function. Despite a slight increase of structures of undetermined function during the 6th century AD, the situation observed for the 5th century AD is mirrored in the 7th century AD as well.

The following discusses the archaeological evidence of the respective subcategories 'find clusters,' 'natural and/or rock-cut structures of undetermined function,' 'epigraphical sites or locations,' 'structures of undetermined function' as well as 'walls of undetermined function.'

Find Clusters

In total, the various surveys have documented 71 find clusters dating from from the 1st century BC until the 7th century AD (FIG. 109). Clear concentrations of find clusters can be observed in the extended Jabal Harun area, around Wadi Musa and to some extent also east of Udruh (FIG. 110). The largest category of find clusters are concentrations of lithics (34 in total),[600] followed by pottery concentrations (20) and subsequently by ten

599 Pastoralism is generally understood as a specialized form of agriculture, but is specifically concerned with the raising and herding of livestock. While pastoralism is a predominantly mobile subsistence strategy, it can either be followed by sedentaries who mainly practice agriculture but also move seasonally with their livestock between fixed pastures (*seasonal pastoralism*) and/or by *non-sedentary nomadic pastoralists* who herd their livestock in regular movement patterns. These are crucial terminological distinctions to be kept in mind. If not otherwise specified, this study employs the generic term 'pastoralism' when both modes can be implied.

600 Most of the lithic scatters date to the Palaeolithic period, but there are also scatters belonging to Post-Palaeolithic

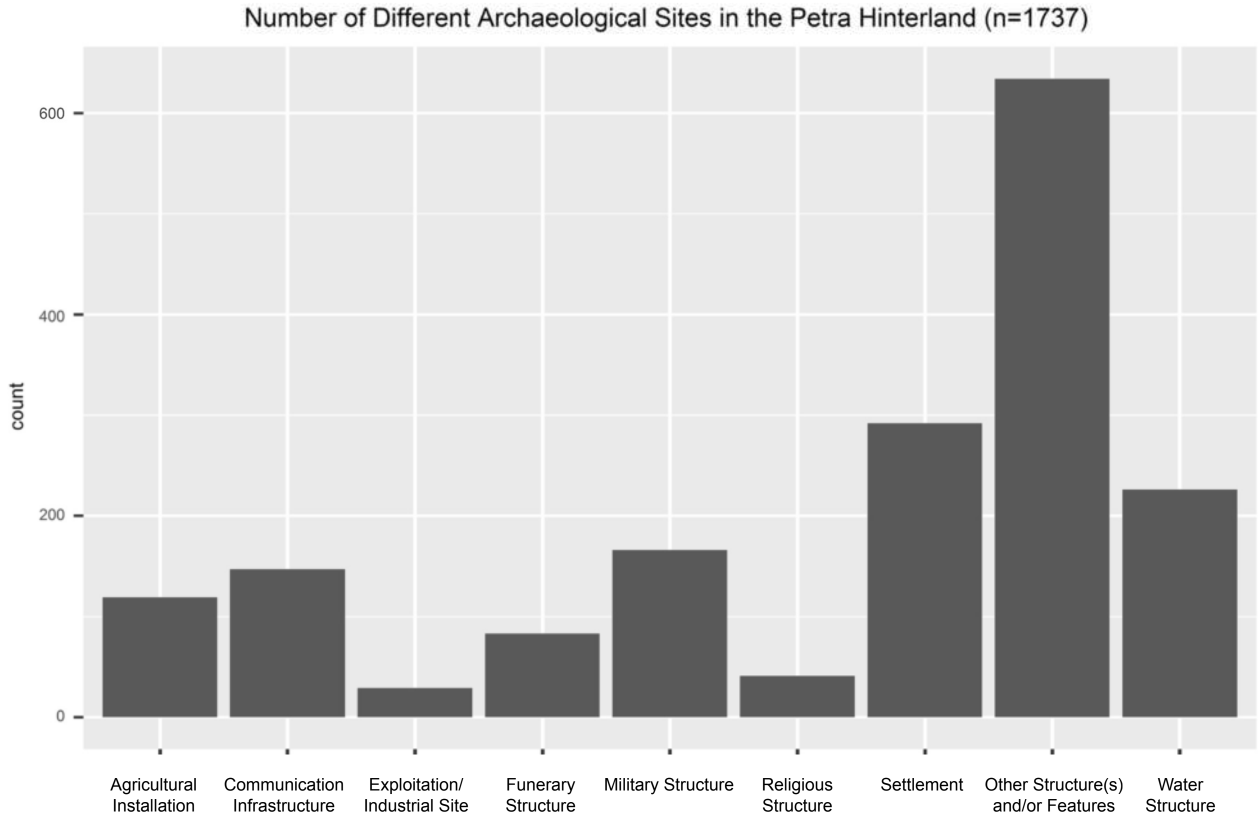


FIG. 106 Overall count of all archaeological sites in the study area showing that 'other structure(s) and/or feature(s)' are by far the largest site category.

isolated clusters of architectural fragments (FIG. 111). There are seven additional find clusters not fitting into any subcategory.

Larger pottery concentrations are found mainly along the eastern high plateau, around Beidha and in the Jabal Harun area.[601] No pottery concentrations are documented for the Hellenistic periods. The majority of the evidenced pottery concentrations date to the 2nd century AD (11/20) followed by nine sites that belong to the 1st century AD. Six pottery concentrations date to the 4th century AD and at five sites the pottery material suggests a date to the 1st century BC, 3rd century as well as 6th – 7th centuries AD. Unfortunately, the various survey reports make only rare comments on the quantity of the recorded pottery sherds, which would help in assessing the value of the pottery concentrations. They are often only recorded simply as 'concentrations of pottery' or 'pottery scatters' without any additional information except for the date. However, some sites are further described – although mostly qualitatively – for example by referring to 'sparse,' 'dense' or 'very rich' pottery concentrations.[602] One exception is the report of over 5300 sherds collected and homogenously dated to

periods (e.g. Chalcolithic-Bronze Age periods). Due to the unsurprisingly early dating of the evidenced lithic scatters, they are of no interest to this study and thus not further discussed. These include FHJP Site Nos. S008, 014, 075, 097, S165 (Silvonen et al. 2013, 350, 352, 370, 378) and ShamAyl Site No. 52 and 220 (MacDonald et al. 2016, 173, 328). Two lithic scatters are associated with later pottery concentrations: At FJHP Site No. S165 in the Jabal Harun area, Nabataean pottery dating to the 1st and 2nd centuries AD was documented together with a few Byzantine and Late Islamic sherds (Silvonen et al. 2013, 399). The lithic scatter and pottery sherds were discovered near a terrace wall and curvilinear structures. It is uncertain whether the finds can be associated with these structures. In addition, another lithic scatter associated with later Nabataean and 'Classical' period surface pottery was also recorded at ShamAyl Site No. 220, situated on the eastern high plateau (MacDonald et al. 2016, 328).

601 The evidenced pottery concentrations are: Abudanh Survey No. 321 (Abudanh 2006, 563); ARNAS Site Nos. 168 and 169 (MacDonald et al. 2012, 173–175); BS Site Nos. 022, 047, 058 (Banning – Köhler-Rollefson 1983, 381–382); LRHE Site No. 046 (Smith 2009, 283); ES Site Nos. 072 and 085 (Hart – Faulkner 1985); FJHP Site Nos. Ext004, 010, 040, 042, 053, 115 (Kouki et al. 2013b, 2, 4, 11, 16, 33) and S17 as well as S31 (Silvonen et al. 2013, 353, 356–357); ShamAyl Site Nos. 002 and 156 (MacDonald et al. 2016, 117, 272) as well as Killick's Udruh Survey Site A (Killick 1983a, 231–236).

602 Cf. e.g. FJHP Site No. Ext004 or 042 (Kouki et al. 2013b, 2 and 12) as well as FJHP Site No. S17 (Silvonen et al. 2013, 353).

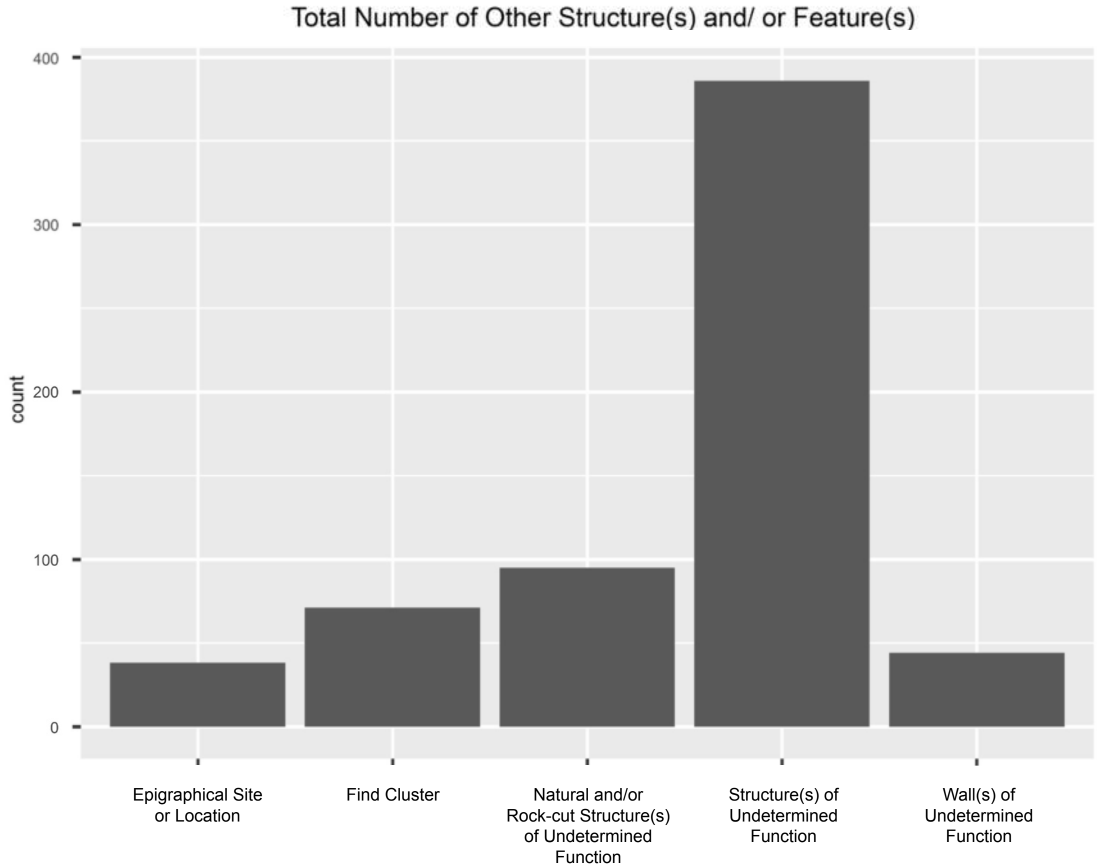


FIG. 107 Overall count of all subcategories of 'other structure(s) and/or feature(s)' in the Petraean hinterland.

the last three quarters of the 1st century AD (FJHP Site No. S17).[603] The local pottery density is stated to have been 260 sherds per 100 m². This was apparently more than 50 times the average sherd scatter of the FJHP, thus indeed a significant find. Additionally, the site is associated with a large lithic scatter (132 lithics) dating to the Palaeolithic periods as well as structural remains that most likely are related to a recent Bedouin camp. Clearly, the site has an extremely long history of use although there is no convincing structural evidence that may indicate its function. It may nevertheless be postulated that the site was used only temporarily as a gathering place for people frequently traversing through and possibly living in the area – as is apparently still the case judging by the possible remains of the Bedouin camp.

Two additional pottery concentrations evidenced by the FJHP in the Jabal Harun area may also reflect the activities of groups of people traversing through and/or living in the Petra area: FJHP Site No. Ext040 describes a sherd scatter of 1st century AD Nabataean as well as Late Roman-Early Byzantine (2nd–4th century AD) pottery material situated on a sheltered plateau of a sandstone outcrop along Wadi al-Bitahi.[604] A concentration of lithics was also noticed at the site which, as FJHP Site No. S17 above, suggests a long history of use. Additionally, a possible bedrock mortar was noticed and water was supposedly available close to the site as indicated by a nearby rock-cut cistern. The original surveyors postulate that the availability of water explains the location of the site.[605] It is at least possible that the availability of water as well as the shelter of the plateau was considered an attractive temporary resting place by people traversing through the area.

FJHP Site No. Ext053 is situated along the bank of Wadi Umm Rattam and is described as a pottery concentration of Nabataean coarse ware dating to the 2nd century AD.[606] While this find alone would be insignificant, the surveyors also noticed a 'foot print' petroglyph incised into the exposed natural bedrock. Whether this 'foot print' can be related to possible ritual pilgrimages (cf. chapter 8) is uncertain, but it

603 Silvonen et al. 2013, 353.
604 Kouki et al. 2013b, 11–12, fig. 30. The quantity of the collected sherds is unknown.
605 Kouki et al. 2013b, 12.
606 Kouki et al. 2013b, 16. The quantity of the observed sherd scatter is not reported.

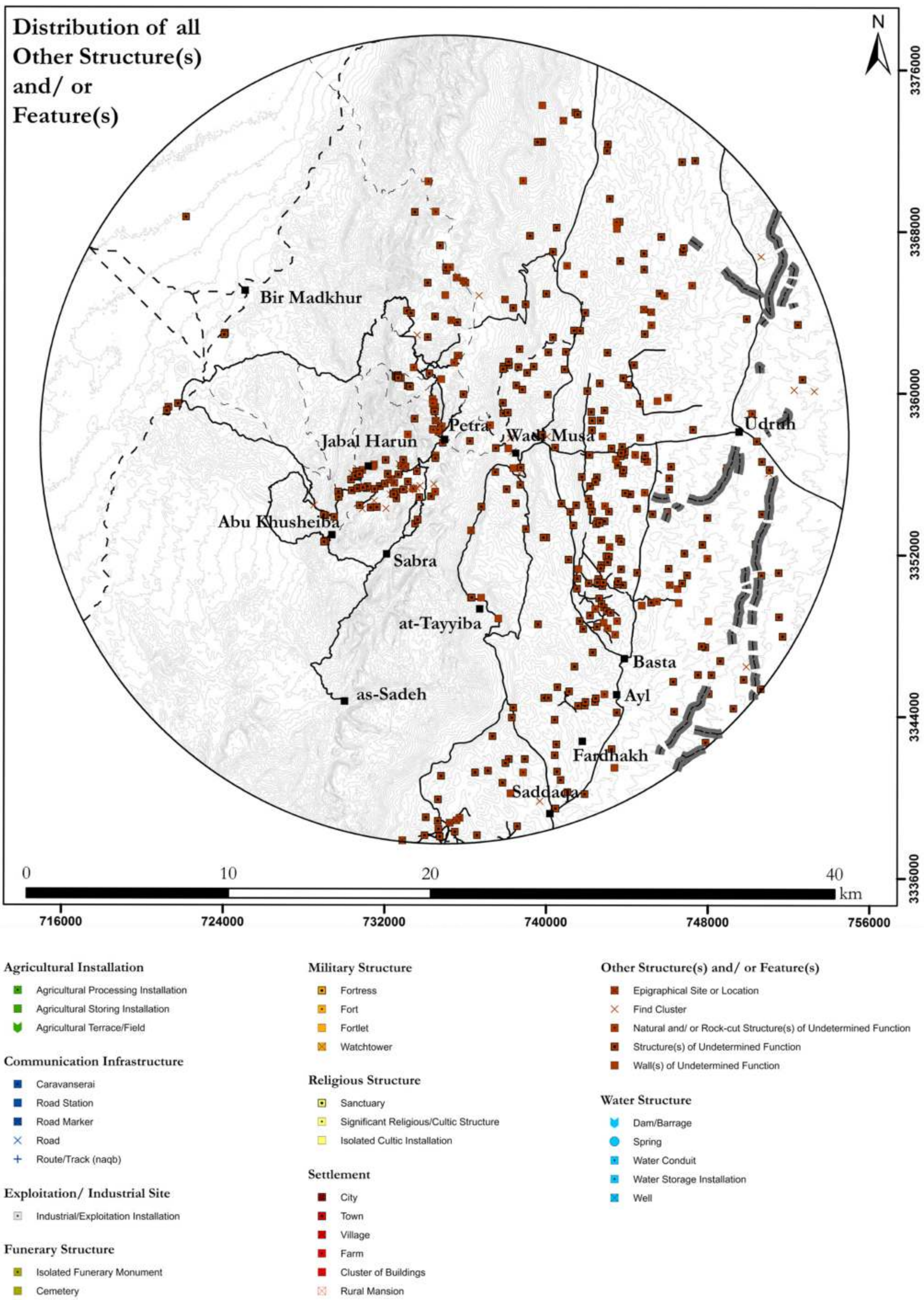


FIG. 108 Distribution map of all 'other structure(s) and/or feature(s),' including the sections of the Khatt Shebib wall.

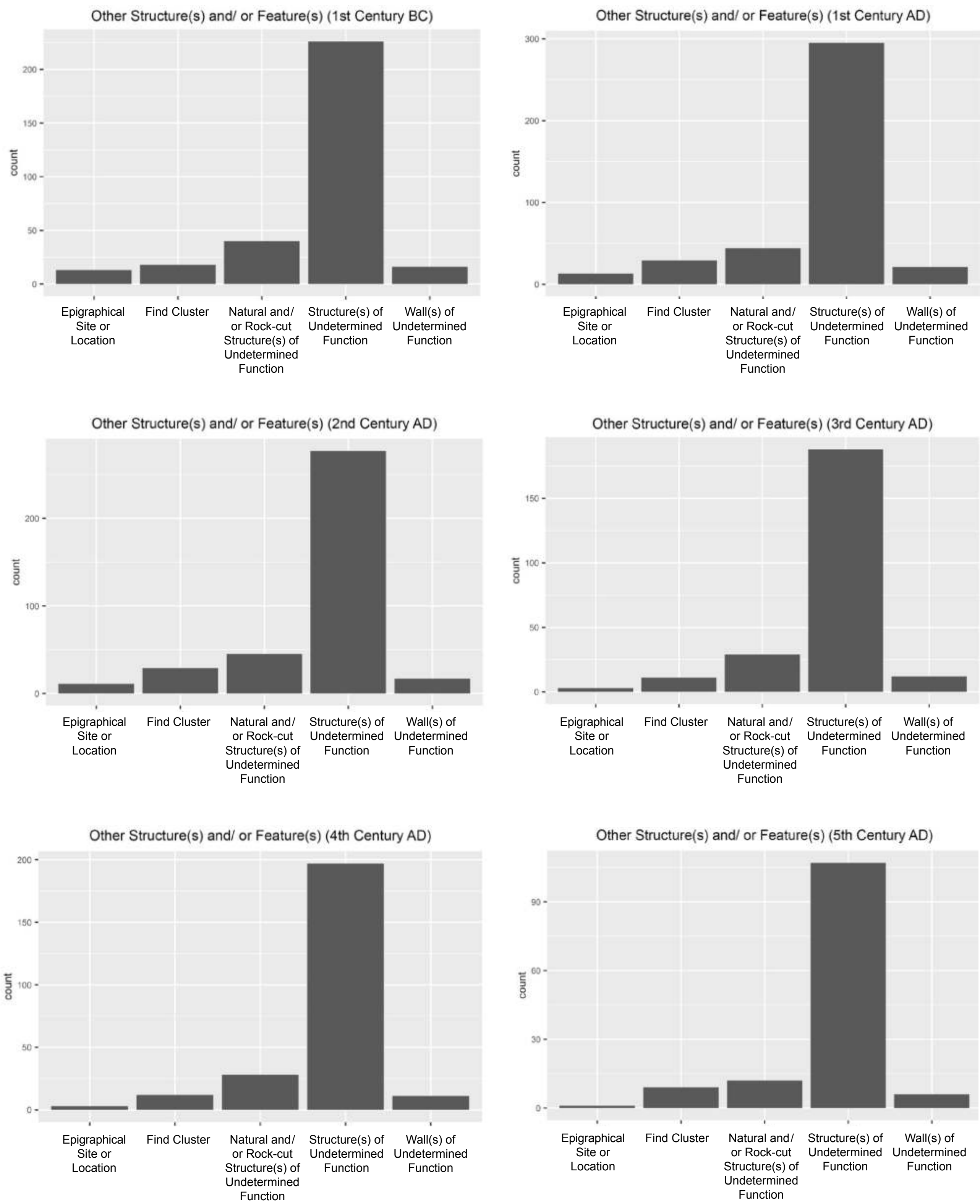


FIG. 109-1 Number of subcategories of 'other structure(s) and/or feature(s)' dating from the Nabataean to Byzantine period (1st century BC – 7th century AD).

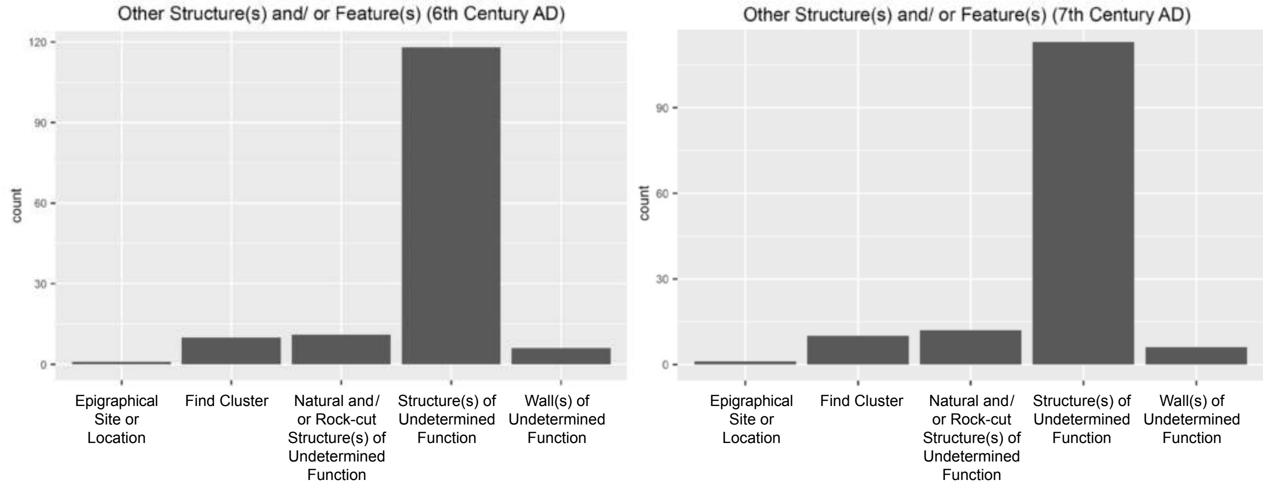


FIG. 109-2 Number of subcategories of 'other structure(s) and/or feature(s)' dating from the Nabataean to Byzantine period (1st century BC – 7th century AD).

may nevertheless indicate that FJHP Site No. Ext053 was visited often by people passing through and/or locals living in the area.

The presented pottery concentrations evidenced by the FJHP highlight the importance of recognizing the potentially widespread use of the natural landscape of the Petraean hinterland – particularly when considering the semi-nomadic, mobile background of the Nabataeans (although acknowledging that the pottery concentrations may reflect activities of local sedentaries as well). This is reminiscent of the accounts of the al-Bdul Bedouin tribe from the Petra area who reported that up until the early 20th century, in times of unrest and hoping to signal for help, local Bedouin would light a large fire on top of a prominent hilltop behind the modern settlement of at-Tayyiba in the Jabal Shara mountain ranges (cf. chapter 7). Supposedly, the fire signal was eventually communicated to other friendly tribes in the Negev who could then reach the Petra area in less than two days. The mentioned hilltop was visited by the author and the bedrock plateau indeed seems scorched by fire. Although the observed scorch marks are likely to be modern, the accounts of the al-Bdul may nevertheless be considered as a *modern* example of the appropriation of the natural landscape for, in this case, strategic communication purposes in the study area. Moreover, although no structures were noticed on the plateau, a pottery concentration of mainly Nabataean-Roman date was recorded (TABLE 21).[607] Although it is extremely difficult to suggest ancient activities on the plateau based on surface pottery alone, the pottery concentration may nevertheless suggest a long habitual tradition of appropriating the dominant natural landscape of the Petra area as gathering places (for presumably various purposes) of peoples in the study area. Similar interpretations may also apply to the other pottery concentrations documented by the FJHP. In further support of this hypothesis, recent investigations in the Jabal Qurma region in the Black Desert of northeastern Jordan have documented pottery scatters of the Roman-Byzantine periods that spread over a relatively large area measuring c. 0,5–1,5 ha.[608] The sherd scatter was discovered at the foot of limestone plateaus and hillocks without any associated structural remains. The surveyors therefore tentatively interpret the scatter as a temporary camp site of people traveling through the desert. This find further emphasizes the suggestion to consider the appropriation of the untouched, natural landscape of people living in and/or traversing across the Petraean hinterland who leave little to no archaeological traces.

Natural and/or Rock-Cut Structures of Undetermined Function

In further support of the claim that people travelling through the Petraean hinterland exploited natural fea-

607 In total, 80 sherds were collected, 39 of which were fragments of Nabataean fine ware (cf. TABLE 21). One painted body sherd may fall under Schmid's phase 3b (70/80 – c. 100 AD) and two diagnostic rim sherds (E1c7 and E1c8) belong to Schmid's phase 3 running from the first quarter of the 1st century AD until the mid-4th century AD (Schmid 2000). One small lamp fragment was collected, which could not be further determined. The remaining 40 sherds were most likely Nabataean-Roman coarse wares. All errors in the pottery readings are that of the author.

608 Huigens 2015, 189. Also cf. Akkermans – Huigens 2018, 508–509.

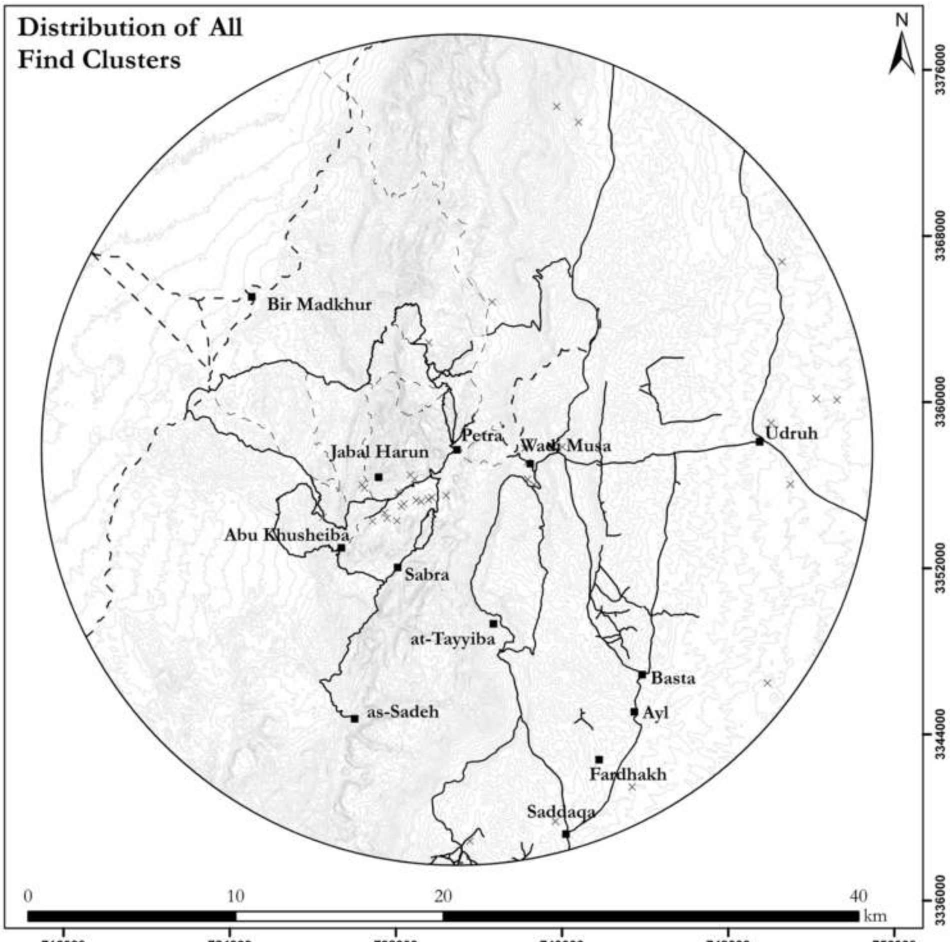


FIG. 110 Distribution map of all find clusters in the Petraean hinterland with the road/route network.

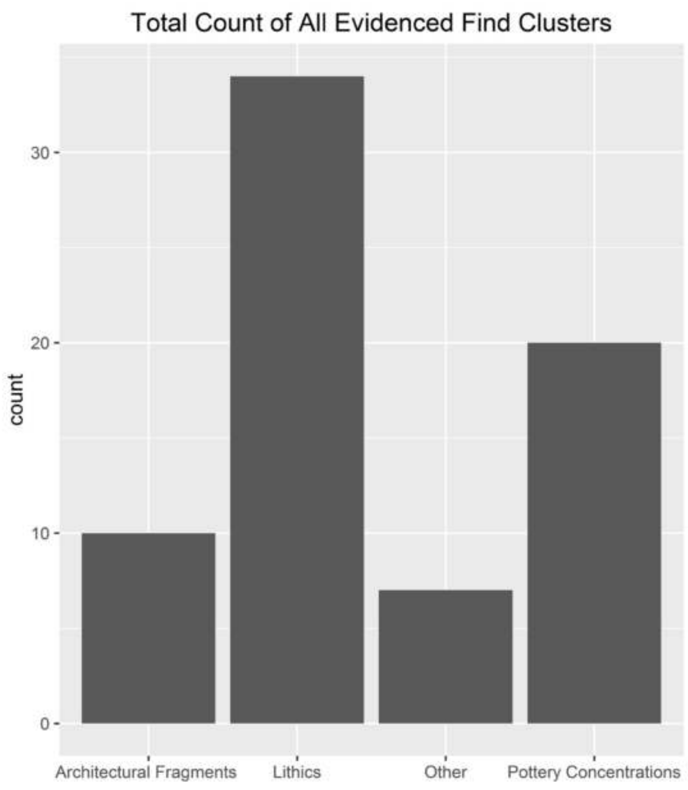


FIG. 111 Total count of find clusters recorded in the Petraean hinterland.

tures of their habitat, are the various natural and/or rock-cut structures of undetermined function. This category describes all natural, largely unaltered sites where the archaeological evidence indicates that these were used by humans. For example, these include natural caves or rock shelters that could have been used for (temporary) habitation, storage of agricultural goods and/or equipment as well as for keeping animals. In total, this study has identified 95 of such sites, which date from the 10th – 6th centuries BC as well as from the 1st century BC until the 7th century AD (cf. FIGS. 44 and 109).[609]

In addition, this category also includes clearly worked bedrock surfaces that cannot be further defined functionally. For example, the various surveys have recorded rock-cut 'cupholes'[610] (for libations?), 'steps' (as foundations for built substructures?)[611] or rectangular depressions which may have been possible pit graves, shaft tombs or simple water basins.[612] The author also noticed several bedrock surfaces in the mountainous areas of the Petraean hinterland into which circular shaped holes were carved. These were tentatively interpreted as post-holes for possible tent-like installations. The most prominent examples for such installations were discovered along Wadi al-Mu'aysirah West as well as on top of Jabal Umm Zaythuna (FIG. 112, cf. also chapter 7).[613] Several other indications for similar 'post-holes' (in total 12) were either indicated in the original survey reports and/or observed by the author (FIG. 113).[614] These were discovered throughout the study area, often on hilltops or other places with good visibility of the surrounding landscape. Dating such features will always remain highly problematic. Two thirds of these presumed 'post-holes' cannot be dated at all. Only three sites (ARNAS Site Nos. 150 and 189 as well as ShamAyl Site No. 256) were tentatively dated by surface material, which suggests an extremely coarse dating range from the 1st century BC to the 7th century AD.[615] As dating rock-cut features based on surface material alone is greatly imprecise to say the least, it is simply impossible to positively associate such possible 'post-holes' for tent-like installations with antiquity. However, recent excavations on Jabal al-Khubtah have revealed various circular post-holes, which most likely held temporary installations in connection with the otherwise rock-cut and freely built *stibadium* complex on Jabal al-Khubtah.[616] An exact dating is also not possible, but the excavated layers above the post-holes give at least a coarse *terminus ante quem* to the pre-Byzantine periods. The *stibadium* complex of the Bab as-Siq in Petra features a series of circular post-holes as well, which probably held similar temporary (tent-like?) installations.[617] Such finds further underline the importance of recognizing the potentially widespread use of temporary installations in the otherwise untouched, natural landscape in and around Petra.

The largest group of natural and/or rock-cut structures of undetermined function, are caves (FIG. 114). In total, 64 natural caves (two thirds of all natural and/or rock-cut structures of undetermined function) were recorded by the various surveys mainly south of the Udruh–Petra road along the eastern high plateau. Some of the caves are enclosed by simple, low walls and could have been used as possible animal pens or as seasonal shelters.[618] There are also simple walls built within some caves which again suggests that these were used has temporary shelters. However, many of the evidenced caves show almost no traces of human activity at all, apart from possible scorched interiors related to more recent use of the caves. Nevertheless, surface material at least very tentatively indicates a possible use of the caves in antiquity.[619] Clearly, dating the use of natural caves is highly problematic and most of the evidenced caves in the study area cannot be dated at all (40/64). However, there are at least 20 caves where surface material

609 All sites are listed in the site catalogue (Appendix I).
610 E. g. Abudanh Site No. 171 (Abudanh 2006, 493), FJHP Site No. Ext037 or FJHP Site No. Ext047 (Kouki et al. 2013b, 11, 14).
611 E. g. FJHP Site No. S6 (Silvonen et al. 2013, 349).
612 E. g. FJHP Site No. Ext055 or PRP Site No. wmw2 (Kouki et al. 2013b, 16; Berenfeld et al. 2016, 94, 105). However, determining an exact function for such sites is indeed difficult and are thus not further discussed here.
613 Cf. Kennedy 2016a, 147–149.
614 Similar 'post-holes' for tent-like installations were presumably indicated by: Abudanh Site No. 171 (Abudanh 2006, 493), ARNAS Site Nos. 150 and 189 (MacDonald et al. 2012, 158, 188); FJHP Site No. Ext037 (Kouki et al. 2013b, 11) and ShamAyl Site No. 256 (MacDonald et al. 2016, 365).
615 MacDonald et al. 2016, 365; MacDonald et al. 2012, 158, 188.
616 Tholbecq 2018, 26; Darchambeau et al. 2016, 63–65, 75. While the exact function of these post-holes remains undetermined, it is possible that they once held a pavilion or some other shading device for the *stibadium* complex.
617 Tholbecq 2018, 9–14.
618 See e. g. the cave at Abdat (Abudanh Site Nr. 071) (Abudanh 2006, 436); the cave at Wadi al-Bier/Abu Danna (Abudanh Site Nr. 205) (Abudanh 2006, 510); the cave at Umm al-Futtus (Abudanh Site Nr. 117) (Abudanh 2006, 461) or a second cave at Wadi al-Bier/Abu Danna (Abudanh Site Nr. 203) (Abudanh 2006, 509).
619 There is of course the possibility that cave-like sites were once horizontally cut cisterns. However, these were not grouped as natural and/or rock-cut structures of undetermined function, but as possible water structures.

FIG. 112 Possible post-holes for tent-like installations on top of Jabal Umm Zaythuna and along Wadi al-Mu'aysirah West. A: View of Jabal Umm Zaythuna with the flat outcrop featuring possible post-holes. B: View of the bedrock surface along Wadi al-Mu'aysirah West with possible post-holes. C: Details of possible post-holes on Jabal Umm Zaythuna. D: Details of possible post-holes along Wadi al-Mu'aysirah West.

and indirect associations to nearby (better dateable) sites tentatively indicate a use in ancient times (cf. FIG. 114). The majority of the dated caves appear to have been in use during the 1st century BC to the 4th century AD.

Despite the problematic dating issue, it nevertheless seems plausible that ancient pastoralists would have used such natural features for temporary shelter or possible animal pens as they do today. There are most likely far more natural caves in the study area which have not been recorded by surveys and which could have been used for similar purposes.

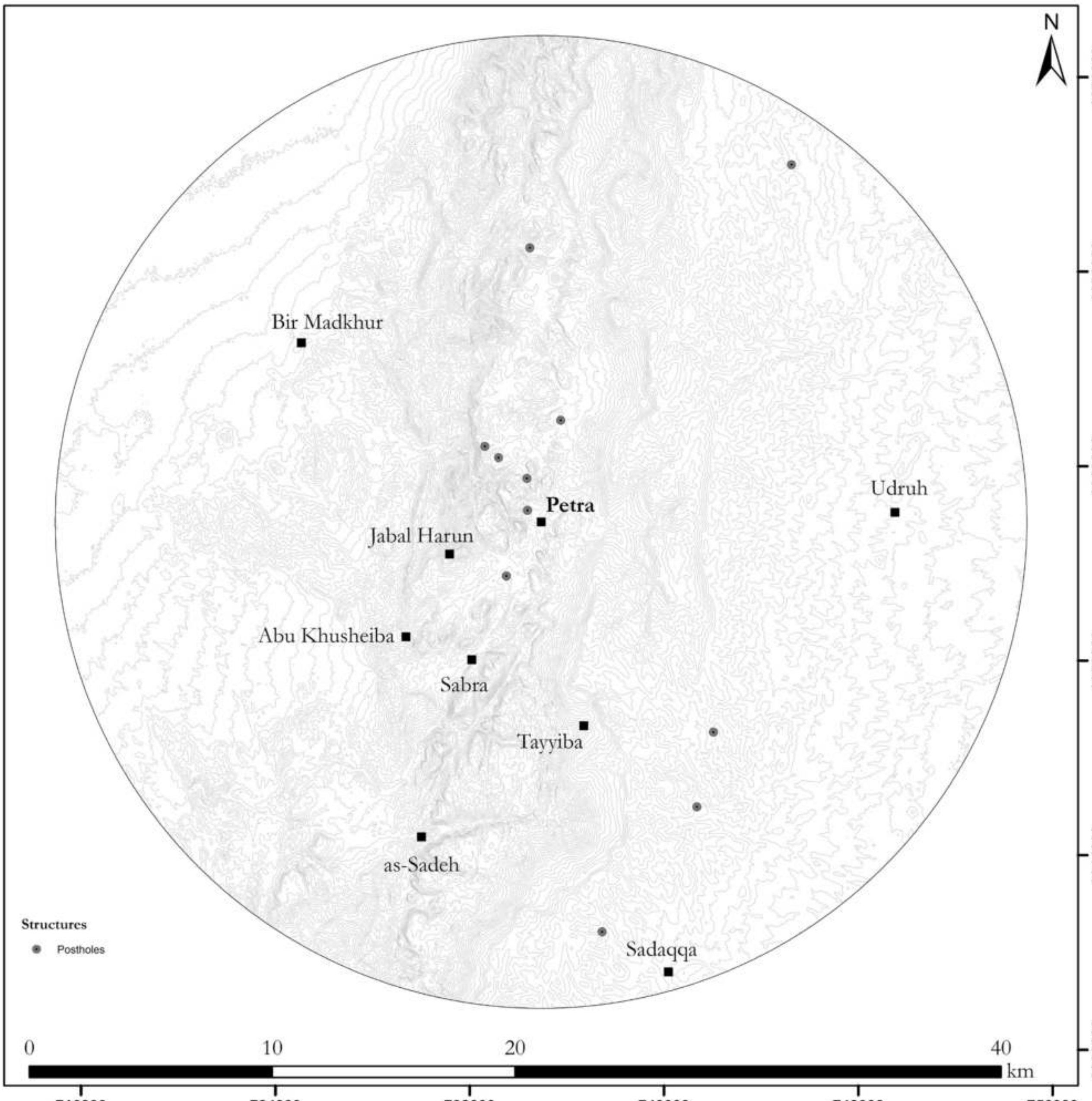
Epigraphical Sites or Locations

Epigraphical sites or locations are evidenced from the 1st century BC until the 7th century AD (cf. FIG. 109). In total, this study has identified 54 epigraphical sites or locations distributed mainly along the eastern high plateau and the Jabal Shara escarpment, but also in the eastern Jabal Harun area and areas immediately north of Petra towards Beidha (FIG. 115). Among these, the various surveys have recorded rock drawings (petroglyphs), wusūm and inscriptions (FIG. 116). These are presented below.

Rock Drawings (Petroglyphs)

In total, the various surveys have documented 15 sites mainly described as rock drawings (petroglyphs) (FIG. 117). However, rock art is commonly observed in the Petraean hinterland, particularly north of Petra toward Beidha, as well as in the Jabal Harun area where good quality rock surfaces prevail. This brief and preselected overview therefore makes no claim to be complete. Instead, it only offers an impression of the numerous forms of rock art dispersed throughout the study area.

Despite recent attempts to offer a more precise chronology of Near Eastern rock art, there are seldom any convincing chronological indicators that



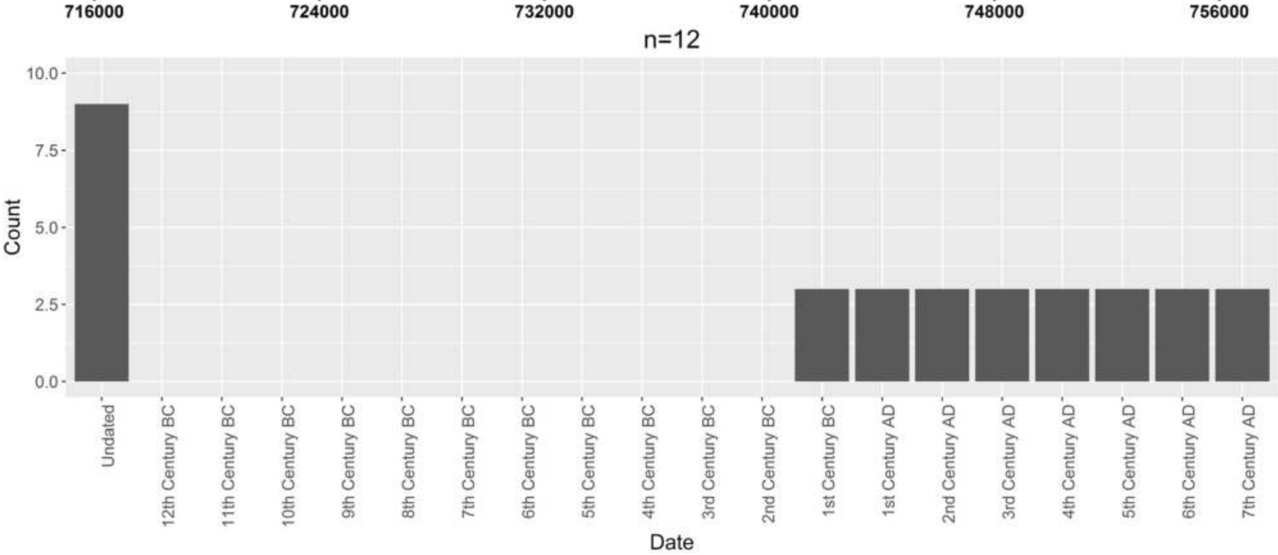


FIG. 113 Distribution map of possible post-holes for tent-like installations in the study area and overall count according to different time periods.

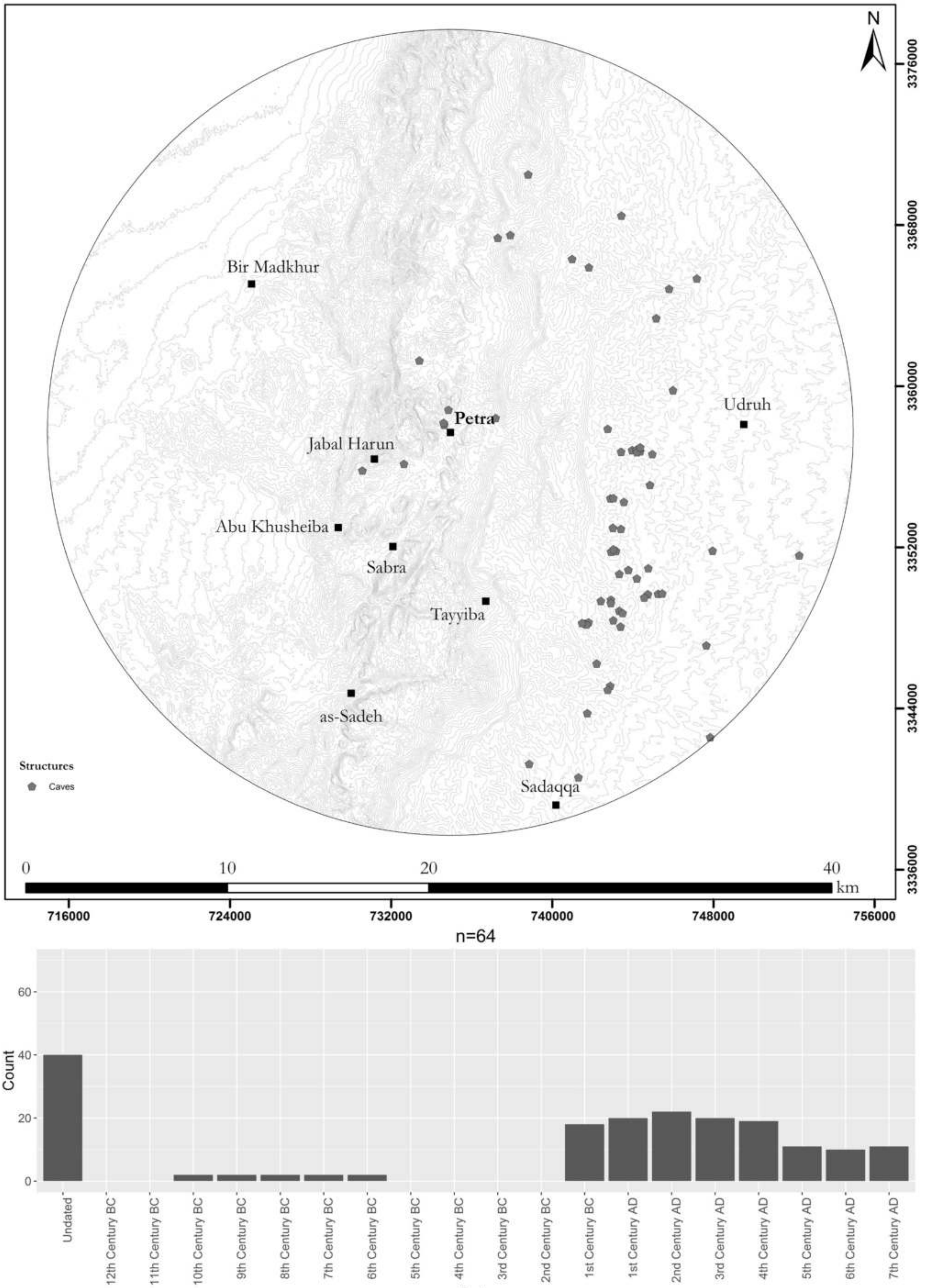


FIG. 114 Distribution map of recorded caves in the study area and overall count according to different time periods.

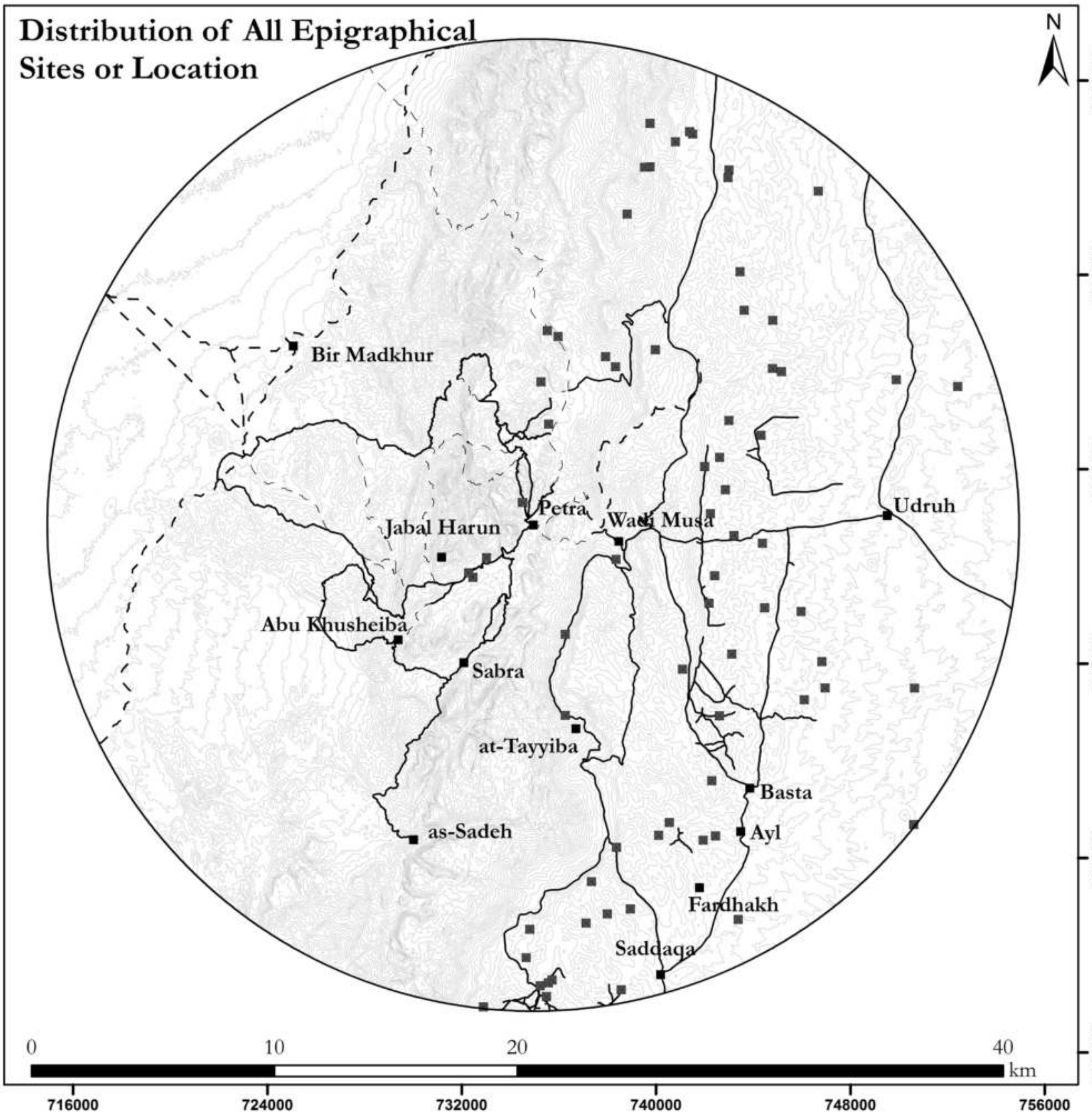


FIG. 115 Distribution map of all epigraphical sites or location in the study area.

can securely date petroglyphs.[620] This circumstance offers an explanation as to why most of the recorded petroglyphs in the study area are undated (cf. FIG. 117). However, there are a few sites where surface material and other archaeological indicators offer a tentative timeframe for the petroglyphs.

In the al-Farasha plain between Wadi an-Naqb and Wadi 'Iyal 'Id, the Nabataean sandstone quarry of FJHP Site No. Ext019 was noted for its various petroglyphs depicting animals and 'footprints,' as well as a bow carved into a c. 25 m long, horizontal ledge.[621] As the quarry is most likely Nabataean, a corresponding *terminus ante quem* for the recorded petroglyphs can probably be assumed.

At the southern slopes of Umm Barra, the FJHP recorded another large panel of petroglyphs (FJHP Site No. Ext005). This is most likely associated with the nearby sandstone quarry of FJHP Site No. Ext006 – thus, a similar situation to FJHP Site No. Ext019. The petroglyphs were carved into a horizontal sandstone surface and include "[…] *numerous foot-motifs, a camel and a thin-bodied ibex, and a circle with a cross* […] *two human figures holding shields and weapons, facing each other*."[622] While the petroglyphs are most likely of

620 Cf. e.g. Brusgaard 2019, 27–30 and Eklund 2013, 291 with further references.

621 Kouki 2013b, 250; Kouki et al. 2013b, 6, fig. 13.

622 Kouki et al. 2013b, 3, fig. 4. Also see Eklund 2013, 283–284.

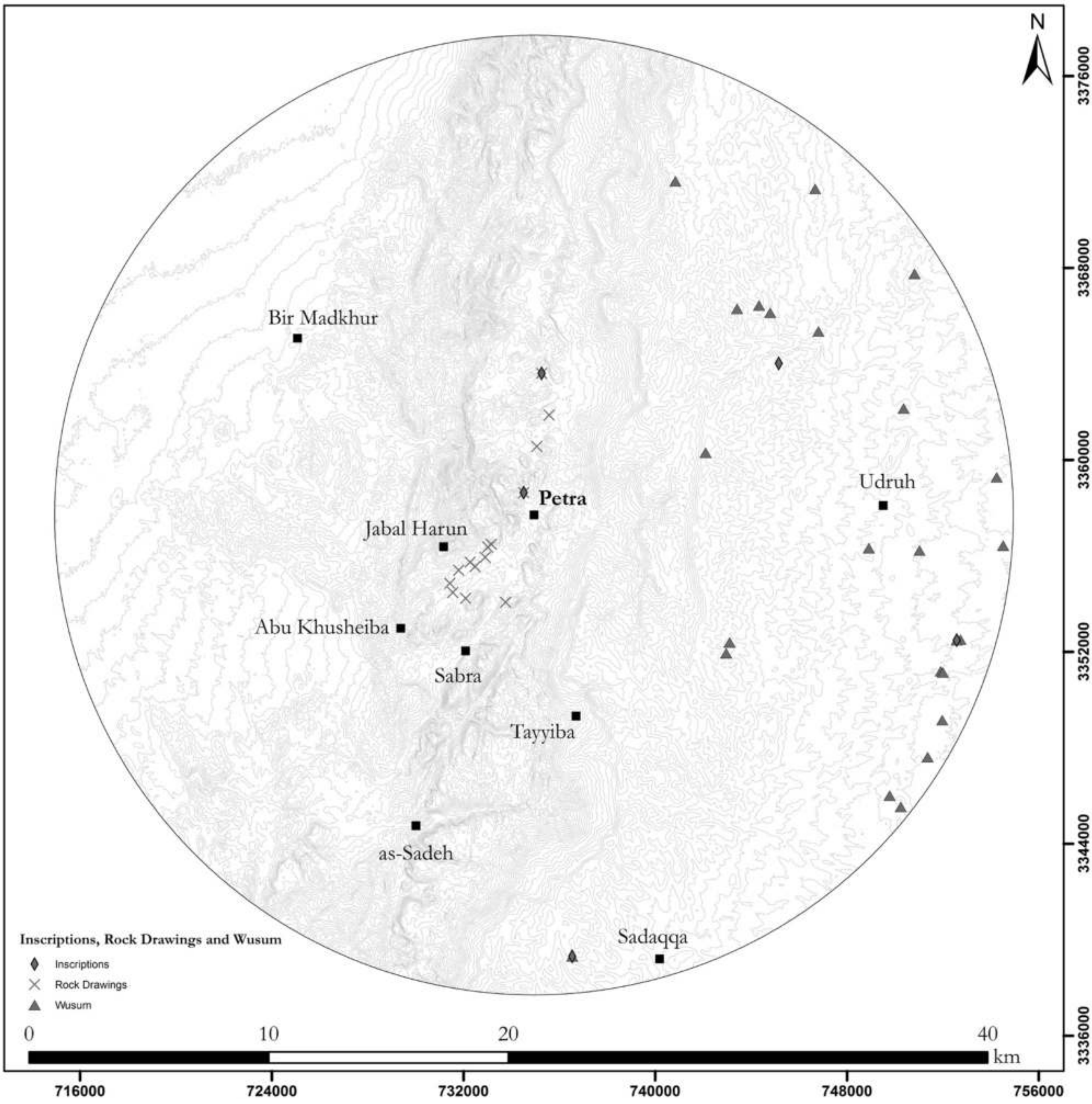


FIG. 116 Distribution map of all inscriptions, rock drawings (petroglyphs) and *wusūm*.

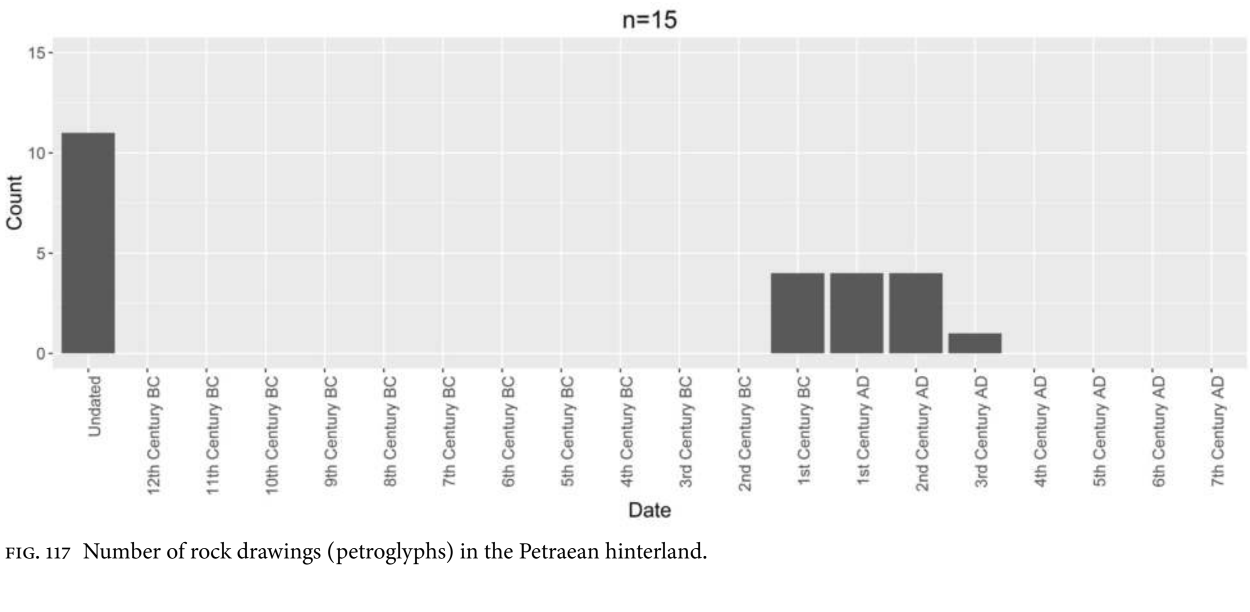


FIG. 117 Number of rock drawings (petroglyphs) in the Petraean hinterland.

FIG. 118 Example of petrogylphs on the bedrock surface near Beidha (BS Site No. 32).

a multi-period date, some at least cover a Nabataean inscription, which may indicate that perhaps some petroglyphs were indeed contemporary with the inscription.

The FJHP identified a further cluster of petroglyphs along the southern bank of Wadi an-Naqb (FJHP Site No. Ext084) carved into a flat bedrock surface, including footprints, circles and a depiction of a hand.[623] Ashlars showing typical Nabataean 45° tool marks were also noticed in the immediate vicinity of the petroglyphs. Whether these can serve as a chronological indicator is questionable.

In the Beidha area, BS Site No. 32 describes rock drawings of camels, dogs, ibexes, 'tally marks' (possible wusūm?), as well as 'inscriptions' carved into an artificially cut, vertical bedrock surface (FIG. 118).[624] Solely based on quarrying marks, the original surveyors date these to the Nabataean period (1st centuries BC and AD). Although this cannot be confirmed with certainty, a *terminus ante quem* may be assumed for that period. The site was most likely used as a temporary gathering place for people travelling through the area.

Another example of petroglyphs in the Petraean hinterland can be found at the burial cairn of PHSP Site No. 117 (FIG. 119) (cf. chapter 8). The little surface pottery material recorded at the cairn may tentatively date it to the Nabataean period. The petroglyphs of humanoid and animal figures carved into a flat sandstone surface are located immediately northwest of the site. While no dating information can be provided, it seems they were associated with the cairn and therefore possibly contemporary with it. Although entirely speculative, they were possibly carved by travelers along Naqb Mistaligile commemorating the deceased in the burial cairn.

Finally, situated c. 5 km northwest of Rajif, the site of Umm Qraieh is a large, flattened sandstone surface into which animal motifs, hunting scenes, rare Thamudic inscriptions ("By Zdqm son of 'byn" and "May Dushara remember Mry son of Jr") as well as possible *wusūm* were inscribed.[625]

Wusūm

Although technically belonging to the superordinate category of petroglyphs, the modern Arabic term *wusūm* refers specifically to territorial tribal markings carved into rock surfaces and branded on livestock as well.[626] In rock art, a singular *wasm* is either depicted upon represented animals or often as individual signs among other petroglyphs. The various surveys have recorded 24 *wusūm* in the study area.[627]

Dating these tribal brands is particularly difficult and provides an explanation of why nearly half of all recorded *wusūm* are undated (FIG. 120). However, on the basis of surface material, associated sites and, occasionally, accompanying Hismaic or Safaitic inscriptions mentioning names and genealogical references, some *wusūm* in the Petra area may be tentatively dated to the Nabataean-Roman periods (1st century BC – 2nd century AD).[628] Nevertheless, these also show an extremely large dating range (in many cases running as late as the 7th century AD), thus indicating that any chronological remarks on the evidenced *wusūm* must be considered with caution.

While this study cannot delve into a detailed description of the evidenced *wusūm*, various signs were observed. These include a series of straight and curved lines, inverted L-shaped, key-shaped and hoof-shaped marks as well as circular and other, more abstract *wusūm* (FIG. 121). While the majority of the evidenced *wusūm* are situated in the eastern periphery of the study area (cf. FIG. 116), there are also several *wusūm*

623 Kouki et al. 2013b, 24, fig. 67.
624 Banning – Köhler-Rollefson 1983, 381.
625 Abudanh et al. 2015a.
626 Cf. similarly brief definitions of *wusūm* in Hayajneh 2016, 516–518; Eklund 2013, 287 and Macdonald 2012. Generally on *wusūm* (at least in modern Saudi Arabia), see the highly criticized (e.g. Rowland 2001) and yet often cited work of Khan 2000. However, K. Berghuijs of the University of Leiden recently re-evaluated the significance of *wusūm* specifically in the Jabal Qurma region in the Black Desert of northern Jordan (Berghuijs 2018).
627 These were analysed by M. Macdonald and H. Hayajneh respectively: Hayajneh 2016; Macdonald 2012.
628 Such sites include Abudanh Site No. 124 (Abudanh 2006, 465), ShamAyl Site Nos. 1, 54, 128, 187, 194, 200, 226, 232, 269, 292, 303 (MacDonald et al. 2016, 116, 174, 243–244. 301–302, 306, 309–310, 334, 343, 376, 391, 400) as well as ARNAS Site No. 23 (MacDonald et al. 2012, 51).

FIG. 119 A: The burial cairn of PHSP Site No. 117 along Naqb Mistalgile. B: Associated petroglpyhs (encircled).

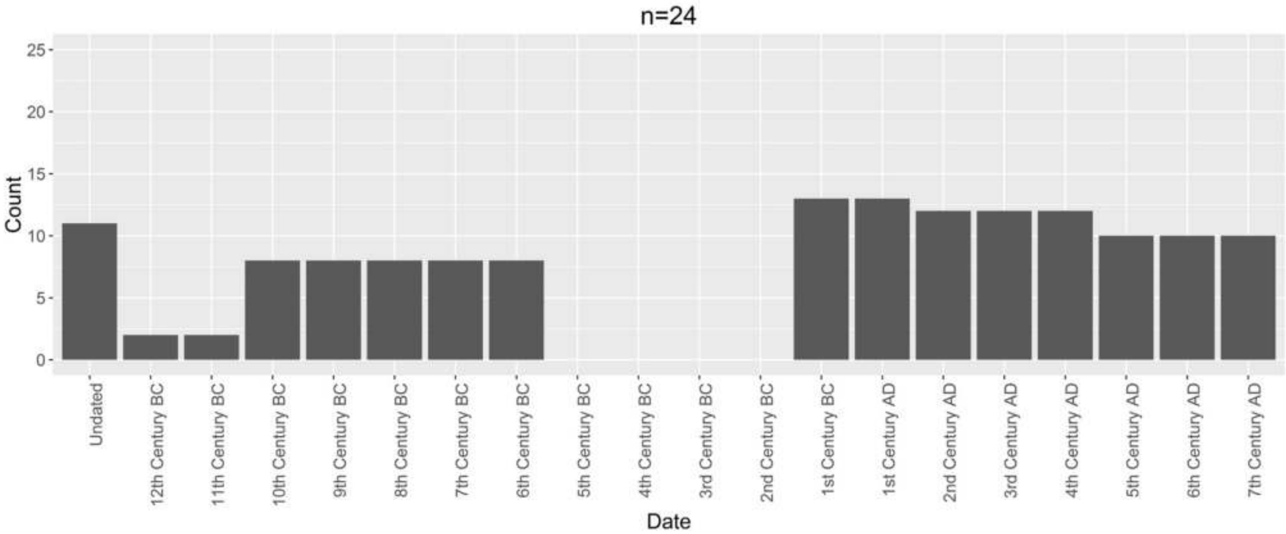


FIG. 120 Number of *wusūm* recorded in the Petraean hinterland.

documented in the Jabal Harun area.[629] Until now, no pattern or cluster of specific *wasm* types was noticed, but as each type of *wasm* presumably represents an affiliation to a specific tribal social group, the presence of the various *wusūm* may nevertheless highlight the tribal-based social structure of Petra and its hinterland. Whether these were carved by locals or members of external tribal social groups cannot be stated.

Inscriptions

The various surveys only documented a few inscriptions in Nabataean, Greek and Arabic script in the study area (as shown in FIG. 122, only five sites exclusively describe inscriptions).[630] These are mostly simple name listings or commemorative lines. Countless similar inscriptions are presumably dispersed throughout the Petraean hinterland, which were never systematically recorded as, for example, L. Nehmé achieved for urban Petra.[631] This section therefore offers only a very limited and preselected overview of the evidenced inscriptions.[632]

Many of the documented inscriptions are associated with petroglyphs, such as the Nabataean sandstone quarry of FJHP Site No. Ext019. The site was not only noted for its various petroglyphs, but also for the associated Nabataean inscription reading "May Qayyāmat be safe."[633]

The FJHP identified another Nabataean inscription at the large panel of petroglyphs of FJHP Site No. Ext005, although the inscription is poorly preserved as it was carved over by the mentioned petroglyphs.[634] No further information concerning the reading is provided. Immediately below Jabal Harun along the *Darb an-Nabi Harun*, three further Nabataean inscriptions were originally recorded by M. Lindner and recently discussed by M. Nasarat and L. Nehmé.[635] All are simple name listings or commemorative lines such as "May Lawdān son of Taymū be safe" and are thus probably related to pilgrims traveling to the presumed sanctuary on Jabal Harun.[636]

Along the route of Wadi al-Mu'aysirah West, the PRP documented a concentration of petroglyphs carved high in the bedrock surface of the wadi bed.[637] Although the original surveyors postulate a date as early as the 1st millennium BC, an associated Nabataean inscription reading "Hail Sa'adullahi, son of

629 Eklund 2013, 287–289 who further evaluated the evidenced *wusūm* in the Jabal Harun area.

630 The various later Arabic inscriptions are not of interest to this study and therefore not discussed here. For example, ShamAyl Site No. 204 (MacDonald et al. 2016, 312) describes only an Arabic inscription.

631 Cf. Nehmé 2012a.

632 There are some recorded inscriptions for which the surveys provide no further information. For example, ShamAyl Site No. 001 describes only "[…] *an inscription on a stone which appears to be part of the NW-facing wall of a tomb/grave (?)*" (MacDonald et al. 2016, 116). Nabataean surface pottery material was noted for this site as well as a cluster of *wusūm* (Hayajneh 2016, 530). Similarly, no further information is provided for the two mentioned inscriptions associated with the presumed camp site of ShamAyl Site No. 054 (MacDonald et al. 2016, 174). Surface material ranging from the Palaeolithic to Byzantine periods was observed at the site, which is mainly described as a concentration of rock art and *wusūm* (Hayajneh 2016, 518–519, 522). The same also applies to ShamAyl Site No. 065 which is described only as "[…] *a series of five inscriptions on pieces of limestone.*" (MacDonald et al. 2016, 187). However, a *wasm* is described for this site (Hayajneh 2016, 514, 531–532).

633 Specifically on the Nabataean signature, see L. Nehmé's contribution in Eklund 2013, 292–293.

634 Kouki et al. 2013b, 3.

635 Nasarat – Nehmé 2013.

636 Nasarat – Nehmé 2013, 297, fig. 2. Cf. also Eklund 2013, 290.

637 Berenfeld et al. 2016, 83.

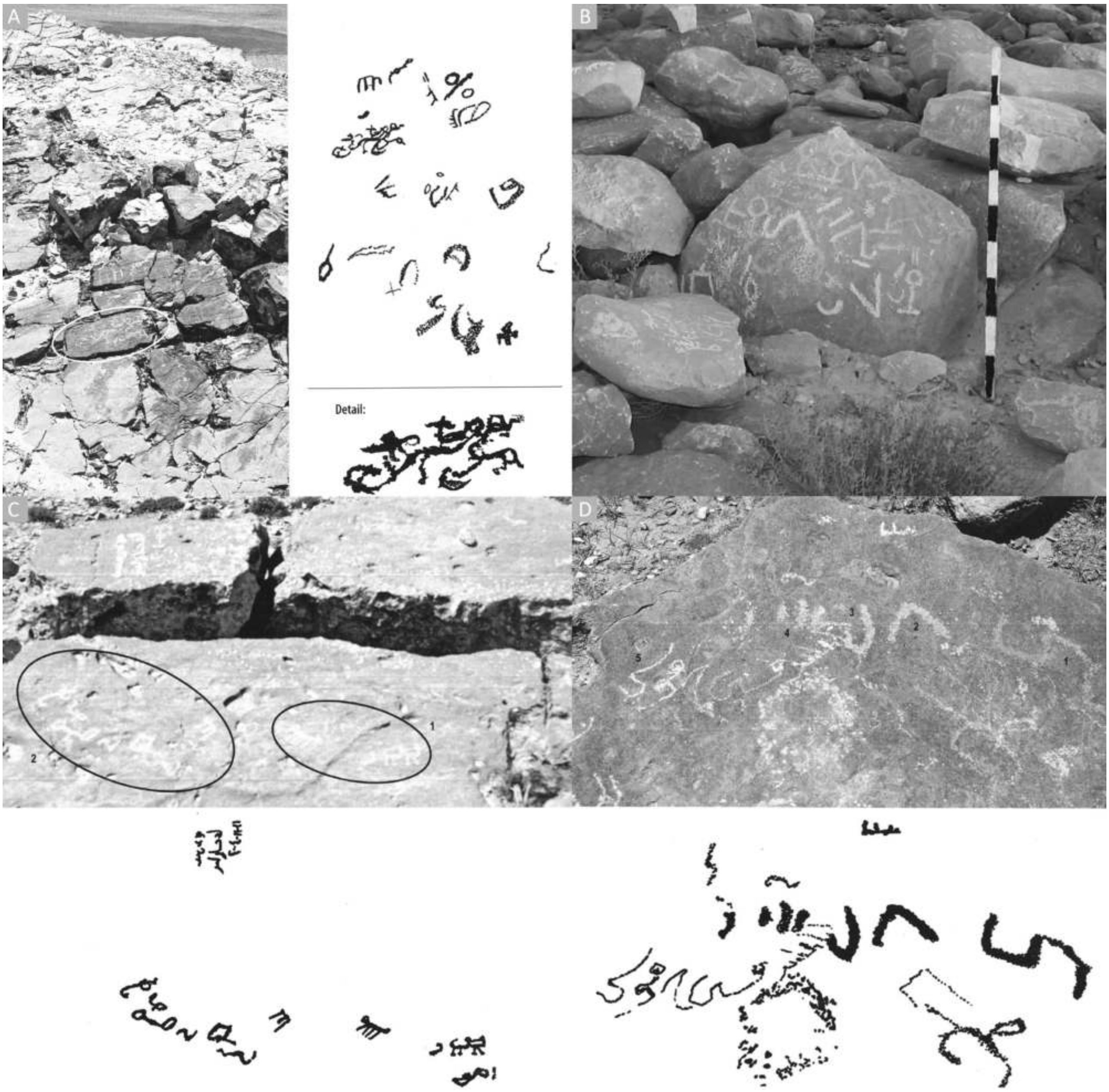


FIG. 121 Preselected overview of some of the various *wusūm* in the Petraean hinterland. A: ShamAyl Site No. 054 after Hayajneh 2016, 518, fig. 6.9. B: Abudanh Survey No. 325 (Tell Abara, Abu Ar'a Wall) after Abudanh 2006, 565. C: ShamAyl Site No. 187 after Hayajneh 2016, 521, fig. 6.10b. D: ShamAyl Site No. 232 after Hayajneh 2016, 529, fig. 6.20A.

Salman" highlights the extreme *longue durée* of the site as a possible gathering place.[638]

In addition to the various rock drawings of BS Site No. 32 in the Beidha area, the site also includes Greek letters that read "RORIETH".[639] No further information is provided. Inscriptions not directly associated with rock drawings include BS Site No. 31, where "ARSALLO" was written in Greek letters along a wall in the Wadi al-Amti.[640] No further information is provided here either, but both inscriptions are most likely names.

Additionally, Zayadine documented two inscriptions along the Wadi Siq al-Ghurab north of the al-Begh'ah plain, near the settlement of Ras Slaysil.[641] They were discovered in an abandoned cave, written side-by-side. One is a commemorative Nabataean inscription for a certain Ausw, son of M 'n 'lahi, son of Pagra, the other is in Greek letters. Probably dating to the 4^{th} – 5^{th} century AD, the latter mentions a local

638 Original translation of the Nabataean text into German by Dalman 1912, 87, No. 45. English translation by the author.
639 Banning – Köhler-Rollefson 1983, 381.
640 Banning – Köhler-Rollefson 1983, 381.
641 Zayadine 1992, 218–223, fig. 3 and Pl. I, 1 and 2.

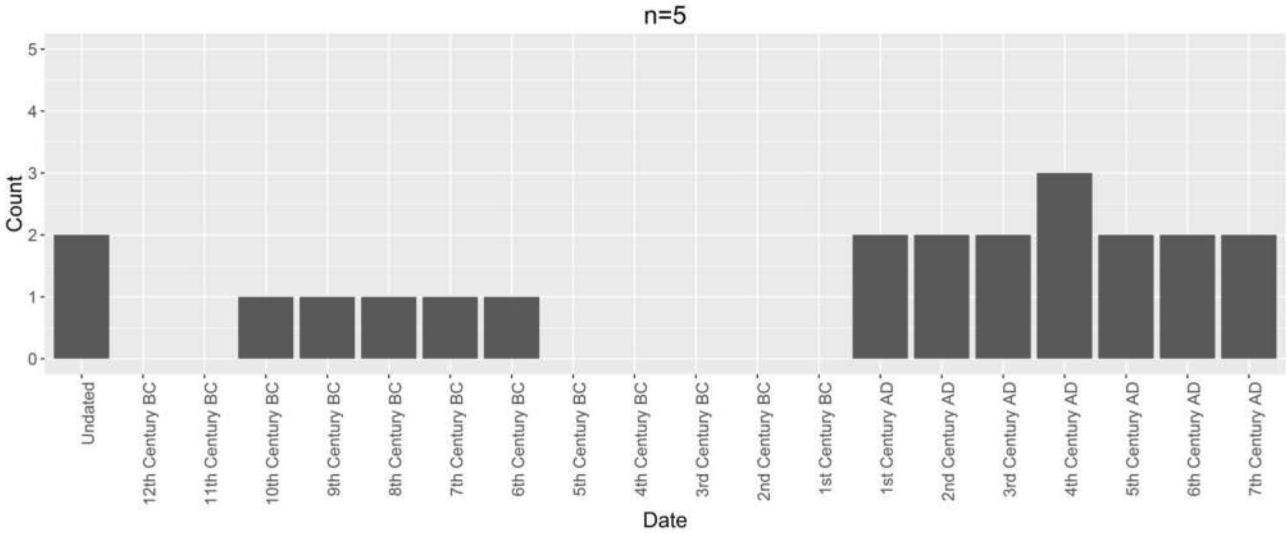


FIG. 122 Number of inscriptions recorded in the Petraean hinterland.

ex-magister hopliton (a certain 'Abdoobodas'), who most likely served as a leader of a local militia monitoring activities along Naqb Namala that runs near the location of the inscription (cf. also chapter 7).[642]

At Siq Amm al-Alda immediately north of Beidha along Naqb Namala, two pyramid *nephesh* are carved into the vertical surface, accompanied by a Nabataean inscription which is now indecipherable.[643] Musil reported a painted Greek inscription, which Zayadine dates to the first quarter of the 5th century AD.[644] It mentions the successful execution of an unknown enterprise overseen by an *epitropos* named Niros. As rock-cut water channels run immediately beside the two *nephesh* and numerous other water structures are known in the area, Zayadine may be correct that Niros oversaw the area's water management to supply by-passing caravans with water. Additionally, Roche and Zayadine identified 12 Nabataean inscriptions some 300 m further north of the double nephesh carved along an overhanging bedrock cliff. These are also simple name listings or commemorative lines following the formula "Peace, X [,son of Y]."[645] Palaeographically dating the inscriptions to the 1st centuries BC and AD, Roche and Zayadine claim they further underline the significance of the Beidha area, particularly Siq Amm al-Alda, for Nabataean caravan trade.[646]

Finally, other Greek inscriptions dating to the Byzantine period are recorded in the Jabal Harun area, at the same location of the above-mentioned Nabataean inscriptions along the *Darb an-Nabi Harun*.[647] As these are also simple names, they most likely refer to pilgrims on the way to the monastery.

Structures of Undetermined Function

The various surveys recorded 384 structures without clearly definable functions (cf. FIG. 107). As indicated above, these structures of undetermined function are by far the largest subcategory of all other structures and/or features (cf. FIG. 109). While distributed across the entire study area, they are mainly concentrated in the extended Jabal Harun area as well as the Jabal Shara escarpment and the eastern high plateau (FIG. 123). Given the problematic nature and large number of these sites, this section does not provide a full archaeological discussion of the evidenced structures.[648] However, numerous sites are of interest for this study as a significant number may be considered as archaeological evidence for pastoral subsistence strategies in the Petraean hinterland. While these are presented in the following, it is again emphasized that the archaeological evidence of the discussed sites is too ambivalent to clearly assign well-definable functions and their interpretations should be considered with caution.

A large number of the discussed sites (in total 42) can be interpreted as camp sites (FIG. 124).[649] While the traditional rectangular broad-room Bedouin tent was most likely not introduced before the Late An-

642 See also Fiema 2002a, 195.
643 Zayadine 1992, 223–225.
644 Zayadine 1992, 224; Musil 1907, 217.
645 Roche – Zayadine 1999, 126–137.
646 Roche – Zayadine 1999, 136–137.
647 See Frösén 2013.
648 All structures of undetermined function are listed in the site catalogue (Appendix I).
649 Also consider a large number of unpublished "unobtrusive" sites identified in the Bir Madkhur area that point to a pastoral lifestyle of local inhabitants (Smith 2018, 216).

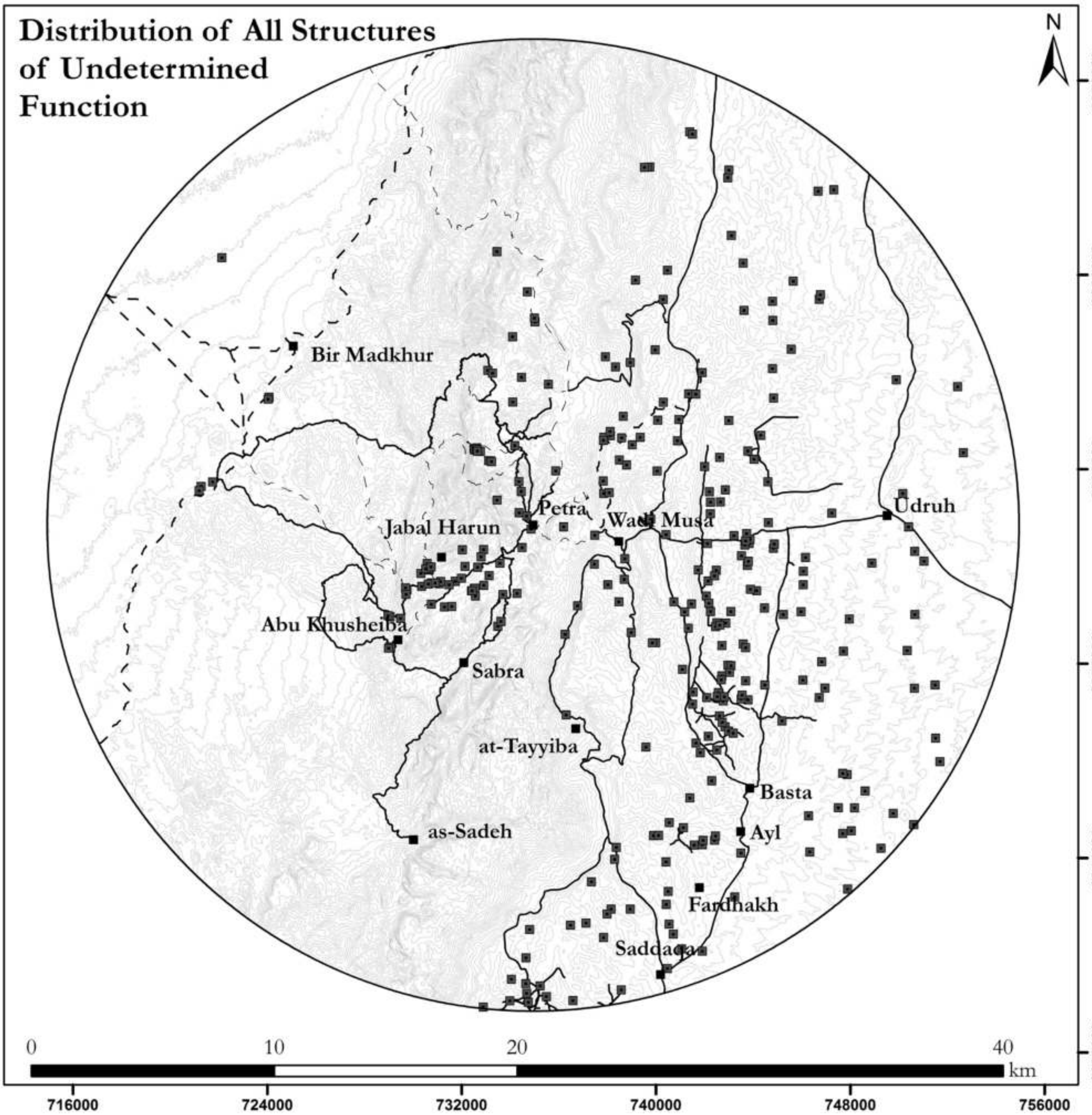


FIG. 123 Distribution map of all structures of undetermined function recorded in the study area.

tique periods or Middle Ages, extensive surveys in the Negev recorded numerous low curvilinear stone settings or walls that most likely served for holding down tent flaps.[650] These presumed camp sites in the Negev measure up to c. 5 m in diameter and the mentioned stone settings or walls were often open at one end for the tent entrances. While clusters of camp sites were observed mostly along alluvial terraces of wadi beds outside the general distribution of agricultural run-off systems and settlements, singular camp sites were often observed in the vicinity of agricultural installations and settlements which, according to Rosen, may reflect seasonal movement patterns of pastoralists into the agricultural zone of the Negev (FIG. 125).[651] In addition to these stone settings, the archaeological remains of camp sites include "[…] *hearths, stone lines, stone piles, cleared areas, and other miscellaneous installations*."[652]

650 Cf. e.g. Rosen – Saidel 2010, 68–70; Rosen 2009, 65–68; Saidel 2009 and Rosen 2007, 358, fig. 11.

651 Rosen 2009, 66 and Rosen 2007, 354. Arguably, the camp sites were not necessarily used exclusively by *nomadic* pastoralists as perhaps implied by Rosen 2009 and 2007. They could indicate varying lifestyles of the region's inhabitants, not all of them necessarily nomadic pastoralists.

652 Rosen 2007, 354 with further references on ethnoarchae-

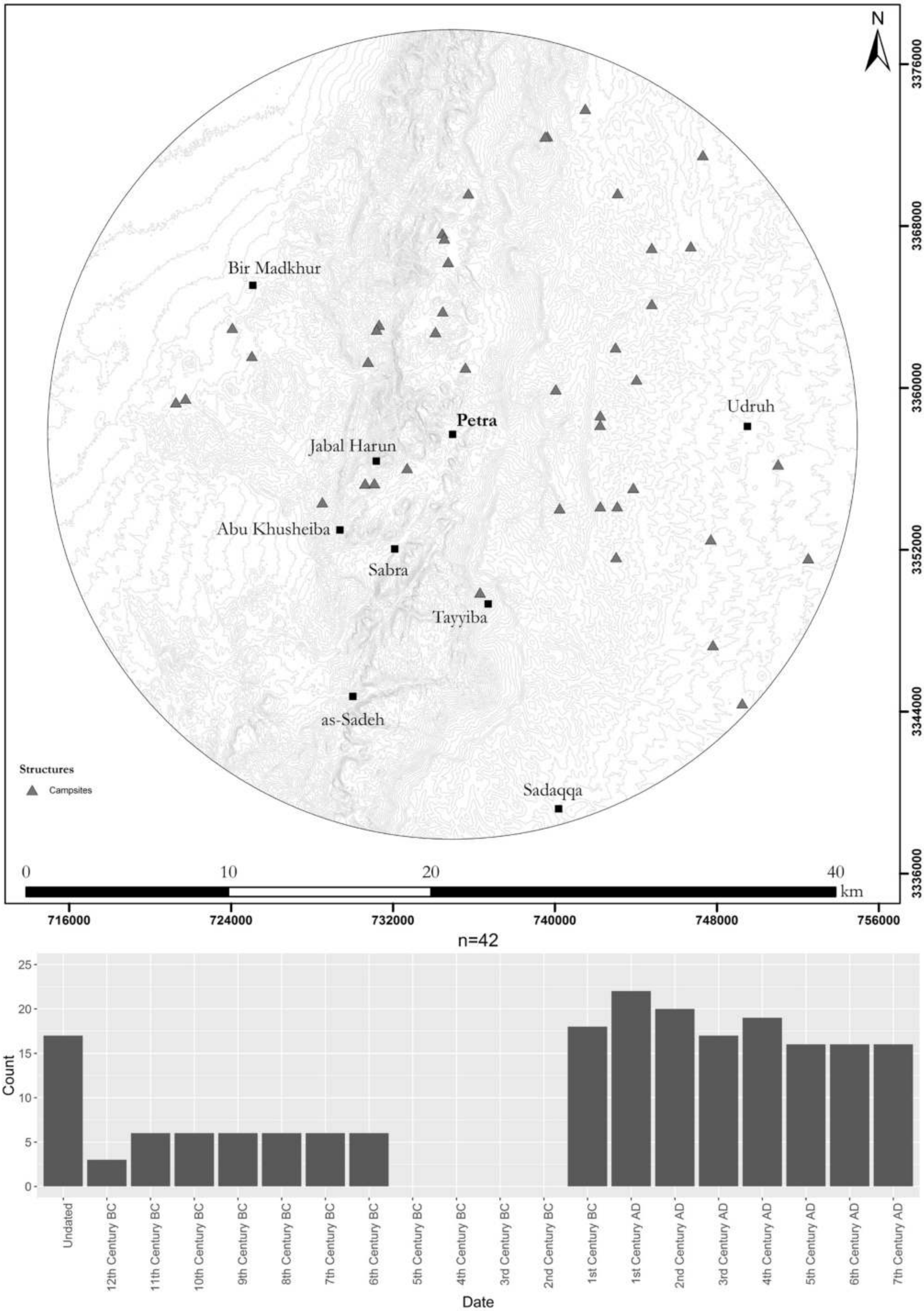


FIG. 124 Distribution map of all possible camp sites in the study area and overall count of camp sites according to different time periods.

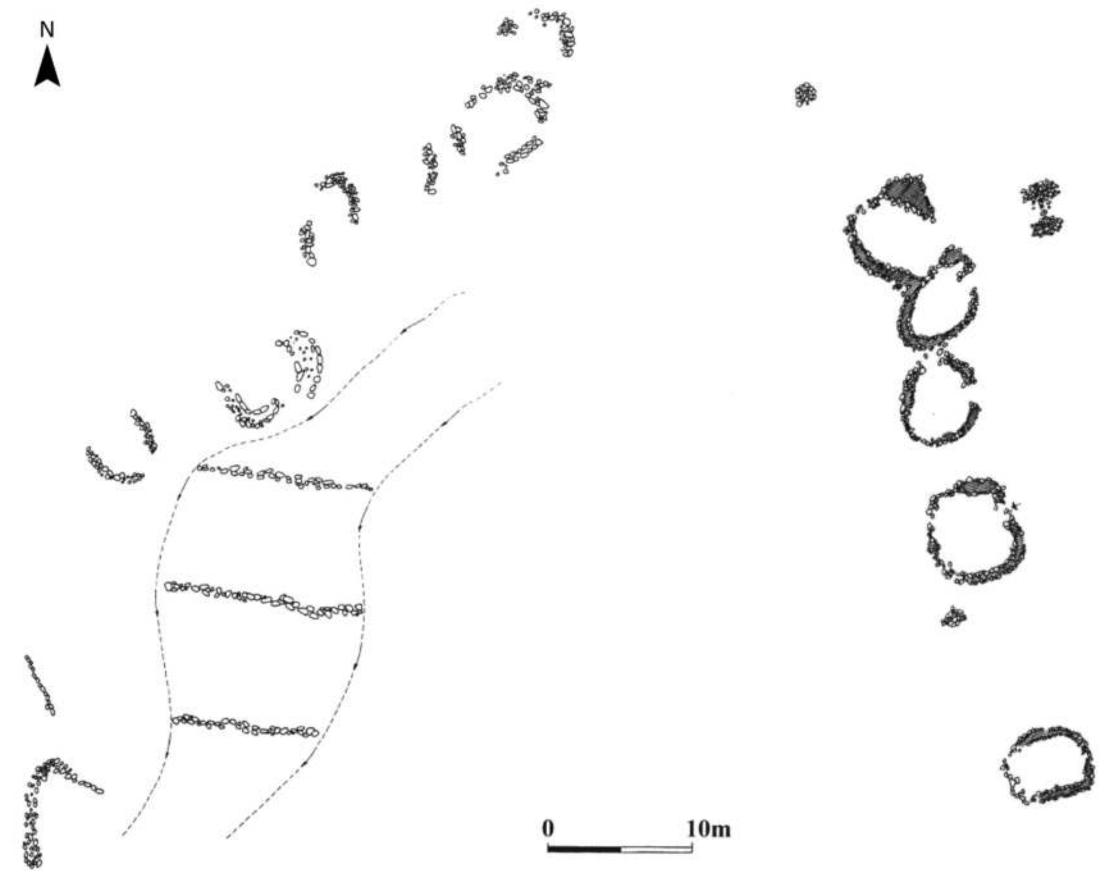


FIG. 125 Site plans of 'Classical period' camp sites and curvilinear structures in the Negev after Rosen 2007, 355, fig. 8 (left) and Rosen 2007, 353, fig. 7 (right).

Most of the surveyed camp sites in the Negev were dated by surface material, which can only serve as a very coarse chronological indicator given the extreme ephemeral nature of the discussed sites. The camp sites were thus dated from the Prehistoric periods to the Early Islamic periods – including many sites presumably dating to the Nabataean and Roman periods.[653] Similarly, the *Jabal Qurma Archaeological Landscape Project* also identified a number of camp sites in Jordan's north-eastern *badia* that date from the Late Hellenistic to Early Roman periods.[654]

One of the more prominent examples of such (Nabataean-)Roman camp sites in the Negev is the excavated site of Giv'ot Reved, where Rosen revealed exclusively Roman period pottery (FIG. 126).[655] In addition to the survey results from the Negev, this serves as archaeological evidence that pastoralism remained an important aspect of rural desert life in the Negev during the historical periods. It is also a good parallel to similar camp sites that seem to be randomly distributed throughout the entire Petraean hinterland (cf. FIG. 124). As the examples from the Negev, the camp sites in the study area are also characterized as low, (semi-)circular or curvilinear walls with possible openings at one end (FIG. 127). Due to the limited archaeological remains, dating these structures is extremely difficult, explaining why approx. one third of the presumed camp sites are undated (cf. FIG. 124). However, surface material indicates that the majority date to the 1^{st} and 2^{nd} centuries AD. Moreover, a significant increase of possible camp sites occurs during the 1^{st} century BC while there are none evidenced for the 5^{th} – 2^{nd} centuries BC and comparatively few during the Iron Age periods. Although further research is required to verify these surely preliminary observations, this increase occurs simultaneously with the dramatic rise of rural settlements (cf. chapter 5). The camp sites may therefore be tentatively considered as archaeolog-

ological parallels describing similar finds (e.g. Banning – Köhler-Rollefson 1992 and Cribb 1991). Consider Rosen – Saidel 2010; Saidel 2009 and Banning 1993 as well.

653 Rosen – Saidel 2010, 69; Rosen 2009, 61–68. Consider the Neolithic-Chalcolithic camp sites in eastern central Jordan discussed in Tarawneh – Abudanh 2013 as well.

654 Akkermans – Huigens 2018, 508–509.

655 Rosen – Saidel 2010, 70; Rosen 2007, 362–369. On the excavation results at Giv'ot Reved, see most importantly Rosen 1993.

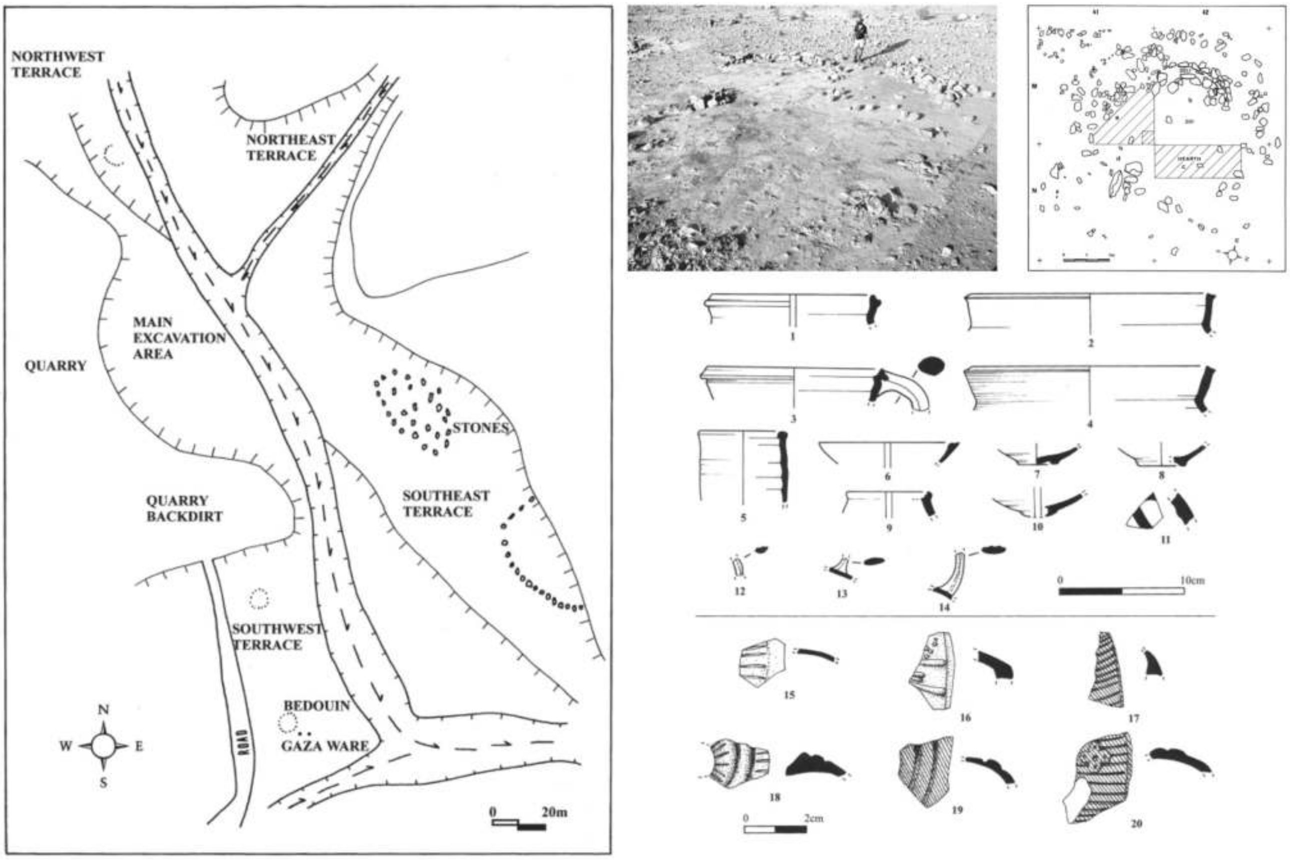


FIG. 126 Sketch plan of Giv'ot Reved. Upper Right: View of excavated camp (Locus 203) and plan of test trenches of Locus 201 after Rosen 2007, 366, fig. 17 and 365, fig. 16. Lower Right: Overview of ceramic finds from Giv'ot Reved after Rosen 2007, 367, fig. 18.

ical evidence that pastoralism remained an important subsistence strategy in the Petraean hinterland in addition to the increased practice of agriculture at a time when the Nabataean 'sedentarization process' accelerated. There is, however, no way of confirming whether the evidenced camp sites were used by seasonal pastoralists or by non-sedentary nomadic pastoralists.

A further archaeological indicator for pastoralism in the study area are the numerous isolated corrals (in total 50) that are distributed predominantly along the eastern high plateau south of the Udruh-Petra road (FIG. 128). Admittedly, it is difficult to clearly differentiate a camp site from a corral in the archaeological record – particularly when based on surface observations alone. However, while corrals can also be of curvilinear shape, their form is far more variable than camp sites and the stone walls of corrals are generally higher as they should hold livestock (FIG. 129). While the same dating problem discussed for the evidenced camp sites applies to corrals, it is nevertheless striking that surface material indicates a predominant date from the 1st century BC to the 4th century AD (cf. FIG. 128). These observations may thus serve as further archaeological indicators that pastoralism was an important subsistence strategy in the Petraean hinterland through time.

Finally, there are two important sites that are particularly difficult to determine functionally and which will probably never be fully clarified. Both sites are extremely large, nearly perfect stone circles measuring 400 m in diameter and are situated in the far eastern periphery of the study area. While the two circles were surveyed by MacDonald et al. as ShamAyl Site Nos. 197 and 221, they are perhaps better known as D. Kennedy's Circles J5 and J6 (FIG. 130).[656]

Circle J5 is situated immediately west of Udruh, not far from the road leading north to Shawbak. It is also cut by the (modern) east-west running Udruh–Petra road (FIG. 131).[657] As noted by Kennedy, a track immediately north of the modern road runs through the circle, which is most likely the ancient course. At the western end of the circle (marked 'X' in FIG. 130), the ancient road leads directly to the western gate of the Late Roman fortress of Udruh. The walls of the

656 MacDonald et al. 2016, 307, 328 and Kennedy 2013a.

657 Generally on Circle J5, see MacDonald et al. 2016, 307 and Kennedy 2013a, 53.

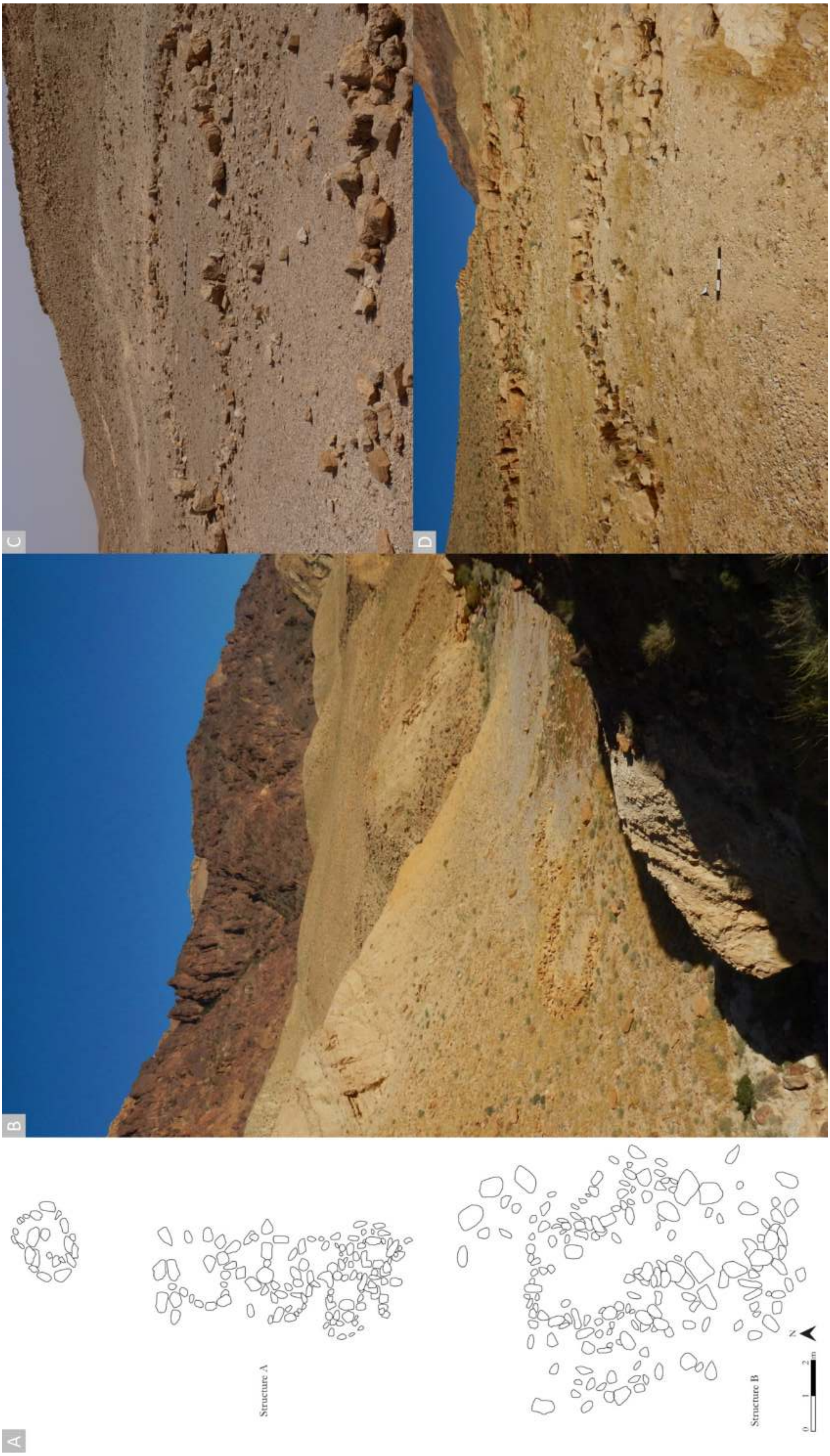


FIG. 127 Preselected overview of possible campsites in the Petraean hinterland. A: Plan of FJHP Site No. S119 after Silvonen et al. 2013, 384, fig. 92. B: View of PHSP Site No. 124. C: PHSP Site No. 27-ST038. D: PHSP Site No. 123.

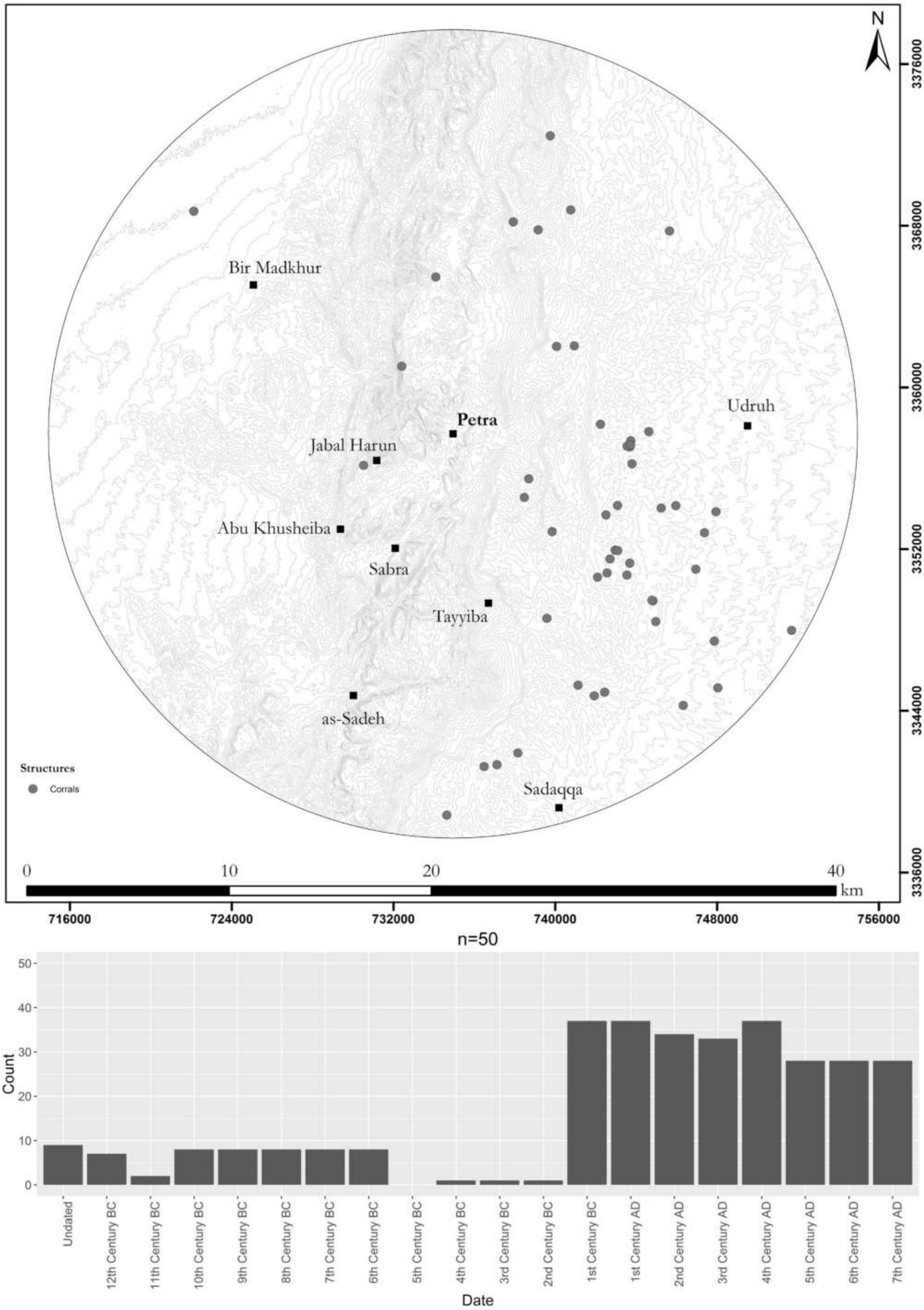


FIG. 128 Distribution map of all possible corrals in the study area and overall count according to different time periods.

FIG. 129 Preselected overview of possible corrals in the Petra hinterland. A: ShamAyl Site No. 007. Photo: APAAME. B: Abudanh Survey Site No. 065 after Abudanh 2006, 433. C: PHSP Site No. 049. D: PHSP Site No. 097.

circle are built of irregular field boulders with a width of c. 1–2 m. No internal structures were noticed. As the *castrum* of Udruh dates to 303 AD (cf. chapter 7) and the road cuts the circle, at least a *terminus ante quem* of 303 AD can be assumed for the circle. ShamAyl recorded surface material from a wide range of periods including Chalcolithic scrapers, lithics as well as Iron Age to Late Islamic surface pottery.[658]

Circle J6 is situated c. 5 km north of Circle J5 in an agricultural area just west of the modern Udruh–Shawbak road (cf. FIG. 131).[659] It is cut by a modern track used for accessing local fields. As Circle J5, it is also built of 1–2 m wide walls of field boulders and no internal structures were observed. Similarly, Circle J6 also shows no openings except for the wadi crossing and that created by the modern track. Surface material recorded within the circle ranges from the Palaeolithic to the Late Islamic periods.[660]

In Jordan, 13 other large stone circles of similar dimensions as Circles J5 and J6 are located between the Wadi al-Hasa and the Jabal Shara escarpment. Two similar structures are known in Turkey as well as one in Syria northwest of modern Homs.[661] Providing a chronology for these circles remains tentative.[662] As none were excavated, the dating of the circles is based solely on surface finds ranging from the Paleolithic to the Islamic periods. The fact that some were cut by Roman (and possibly earlier) roads and/or located near other major communication lines such as the ‘Desert highway’ in Jordan[663] suggests at least a *terminus ante quem* for the circles, but their origin probably goes back to Prehistoric times. However, there is no reason to doubt a possible re-use of the circles in later periods. Archaeologically, none of these circles show openings or any traces of internal structures – as Circles J5 and J6 in the study area. The function of the circles is yet

658 MacDonald et al. 2016, 307.
659 Generally on Circle J6, see MacDonald et al. 2016, 328 and Kennedy 2013a, 53.
660 MacDonald et al. 2016, 328.
661 Kennedy 2013a, 47–57, 61 with further references.
662 Cf. Kennedy 2013a, 60.
663 Kennedy 2013a, 61.

FIG. 130 Aerial images of large stone circles in the eastern periphery of the Petraean hinterland. A: Kennedy's Circle J5. B: Kennedy's Circle J6. Photos: APAAME.

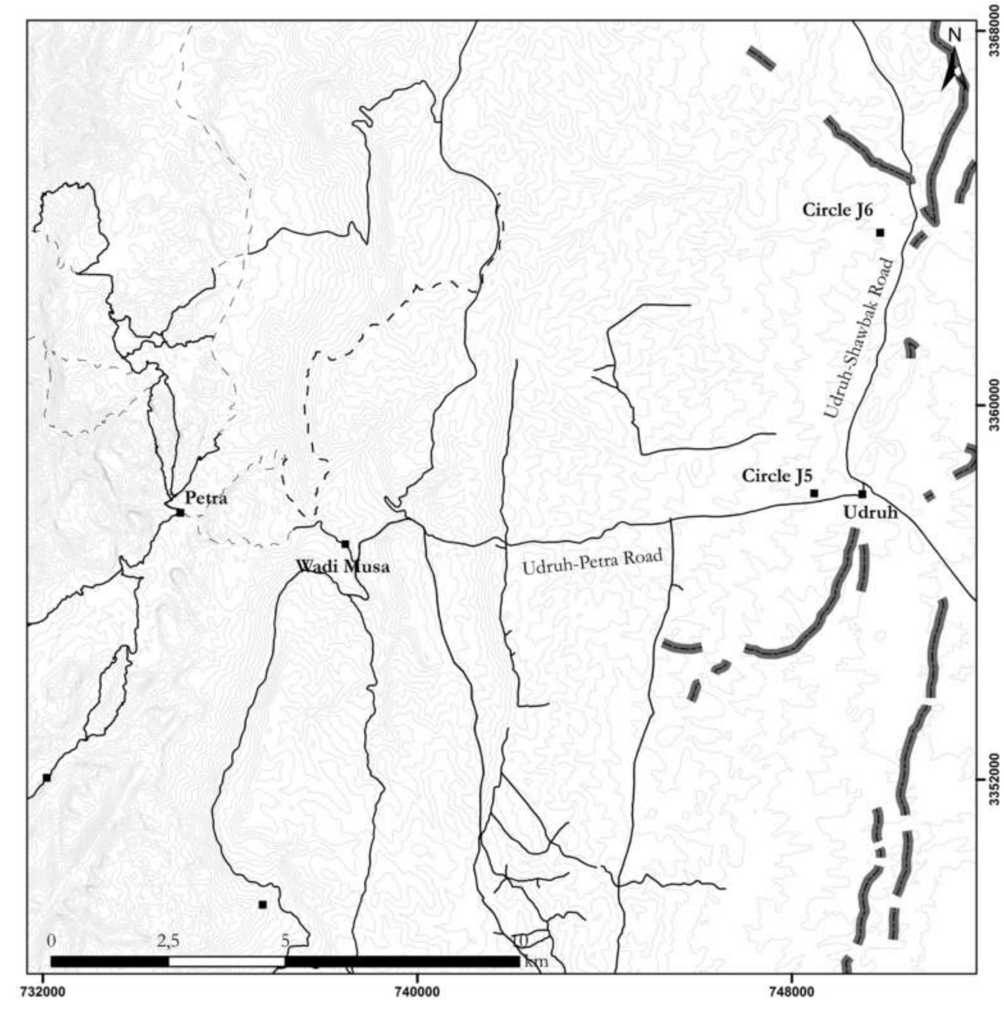


FIG. 131 Location map of Circles J5 and J6 with the regional road network and the course of the Khatt Shebib wall in grey after Kennedy – Banks 2015.

unknown. Propositions that the circles could have served as large animal traps were recently rejected as there are no archaeological indications for considering the circles as a form of desert kite.[664] Other scholars interpreted such circles to have been large corrals for holding livestock.[665] While this is generally possible, the accuracy of the circles' form, as well as the fact that they show no openings and the walls are reportedly too low to have served as corrals, renders such an interpretation certainly debatable. Nevertheless, at this point considering the circles as large corrals seems to be the most plausible proposal. It is at least possible that the walls were originally higher and collapsed over time, perhaps even obscuring possible openings. Only more intensive fieldwork will allow further clarification.

However, an important factor concerning the location of the two circles in the study area has been overseen in the scholarly discourse. While it was emphasized that many circles are situated along important communications lines[666], the immediate association of Circles J5 and J6 with the 'Khatt Shebib' wall has not been discussed so far. As is elaborated in the next section, this observation may help in determining the function of both the circles as well as the highly debated Khatt Shebib wall.

Walls of Undetermined Function

The various surveys recorded 20 walls that are not directly associated with other archaeological sites and which are difficult to define functionally. The evidenced walls are distributed throughout the entire study area, however mostly in areas north of Basta along the eastern high plateau as well as north of at-Tayyiba and Petra (FIG. 132). These walls are constructed by a number of techniques, have various dimensions and are built of different stone material. Based on surface material, they date between the 10th

664 On the different interpretations, see Kennedy 2013a, 60–61 with further references.
665 Findlater 2003, 194.
666 Cf. Kennedy 2013a, 60–61 and Findlater 2003, 194–206.

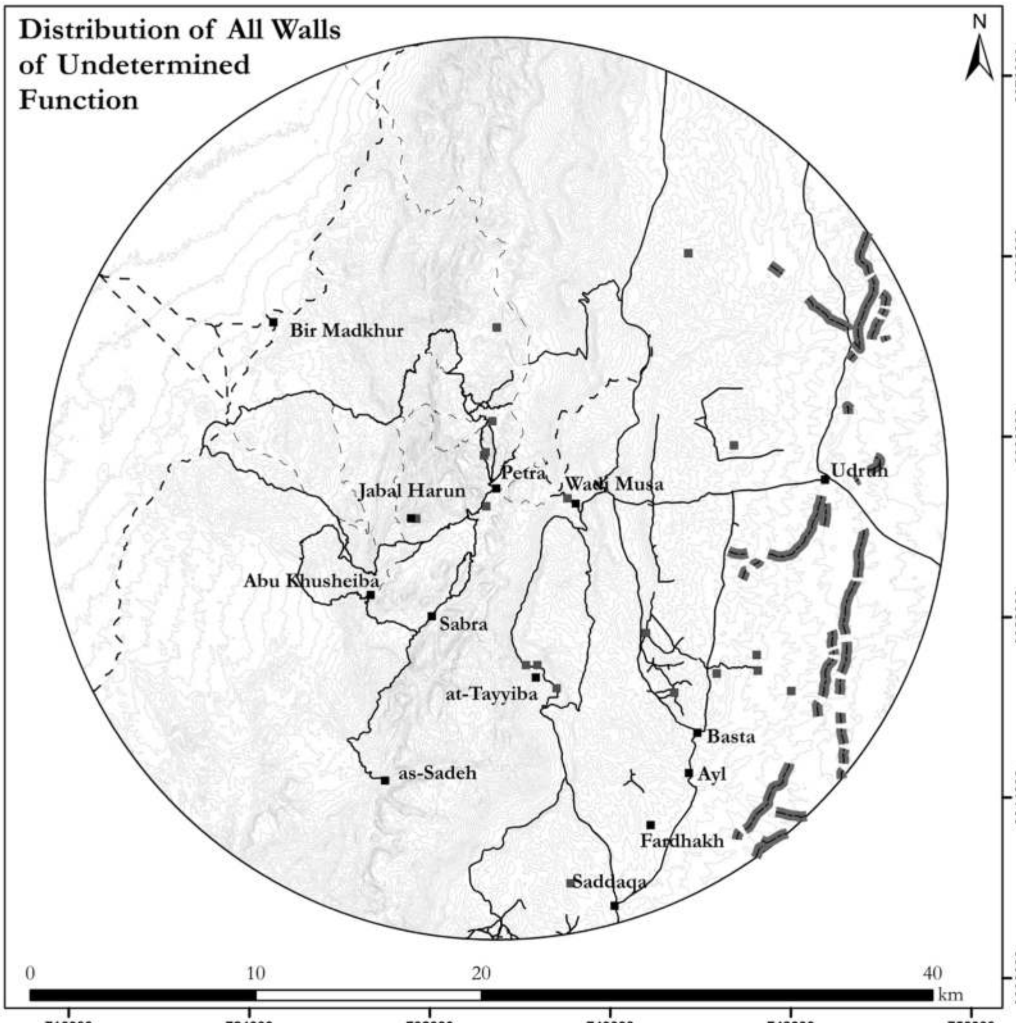


FIG. 132 Distribution map of all walls of undetermined function with the course of the Khatt Shebib after Kennedy – Banks 2015.

and 6th centuries BC as well as from the 1st century BC until the 7th century AD. Although positively assigning a function for the walls is challenging, the majority most likely served as small and insignificant road boundaries, enclosure walls, terrace/retaining walls or simply represent the building remains of undefinable structures. As the limited archaeological information for these walls cannot offer further insights into the landscape organization of the Petraean hinterland, these are not further discussed here.[667]

However, there is one highly interesting 'wall of undetermined function' evidenced in the study area: The over 150 km long wall known as the 'Khatt Shebib' which has been of extensive scholarly interest in the past (FIG. 133).[668] The wall stretches from the Wadi al-Hasa in the north to Ras en-Naqb in the south, thus only a very short stretch of the Khatt Shebib runs through the study area immediately east of Udruh (cf. FIGS. 131 and 132).

Similar long walls are known from Roman North Africa, i. e. the *fossatum africae* stretching across modern Algeria and Libya, as well as the over 220 km long *très long mur* in Syria that probably dates to the Bronze Age as does the significantly shorter wall known as the 'K-line' in the Negev (4,6 km long).[669] Additionally, hundreds of several kilometers long walls are known in Syria, Jordan and Saudi Arabia. As the Khatt Shebib wall, these are built of unworked, unmortared field stones (now collapsed), suggesting a width of 1–2 m. The preserved height lies between 0,5–1 m. Originally, the walls may have been slightly higher, but not significantly. The longest wall in Jordan is the Khatt Shebib. It was first noticed by aerial reconnaissance flights conducted by Sir A. Kirkbride in the first half

667 All walls of undetermined function are listed in the site catalogue (Appendix I).

668 Findlater 2003, 199–203; Findlater 2002, 142–143; MacDonald et al. 2012, 81 (ARNAS Site No. 050); MacDonald et al. 2004, 343 (TBAS Site No. 186); Kennedy – Bewley 2004, 138–139; Kennedy 2004, 190; Abu Jaber 1995, 740; Parker 1986, 86–89; Killick 1986a, 435–437; Kennedy 1982, 163–166; Harding 1967, 154; Kirkbride 1948. More recent contributions are MacDonald et al. 2016, 547–548 and, most importantly, Kennedy – Banks 2015.

669 Kennedy – Banks 2015, 133 with further references. On the *fossatum africae,* see e. g. Mattingly 1995, 170–193.

FIG. 133 Aerial view of the Khatt Shebib wall. Photo: APAAME.

of the 20th century.[670] Subsequent research was conducted by Killick during his archaeological survey of the extended Udruh area. Within the framework of the *Dana Archaeological Survey* (DAS), Findlater could later trace the wall further north than Kirkbride and Killick at Khirbet Qannas situated c. 10 km east of Shawbak.[671] Stretches of the wall were subsequently documented even further north by the *Tafila-Busayra Archaeological Survey* (TBAS) and most recently Kennedy and Banks conducted aerial archaeological studies on the entire stretch of the Khatt Shebib as known to date.[672] The archaeological evidence indicates that the Khatt Shebib was not a continuous wall, as it shows large openings along its course and irregular stretches branch off the wall's main direction.[673] Most notably for this study, there is a 6 km long opening in the Udruh area (cf. FIGS. 131–132) where the wall is interrupted at Tell Abara, before continuing again further north at Khirbet Jarba.[674] Dating indicators for the Khatt Shebib are only tentative.[675] Findlater dates the Khatt Shebib based on Iron Age surface material discovered by DAS at presumed 'towers' discovered along the northern stretch of the wall.[676] Based on surface material discovered at structures associated with the wall in the Udruh area, Killick dates the Khatt Shebib mainly to the Roman periods, but Nabataean structures also seem to have been associated with it.[677] The dating of the Khatt Shebib therefore remains uncertain and Kennedy and Banks are surely correct in their cautious statement that the wall "[…] *is pre-Roman but probably later than the Iron Age*."[678]

The function of the Khatt Shebib is equally debated.[679] Following a Roman date of the wall, previous scholars have argued for a defensive purpose of the Khatt Shebib because it ran along the line of the eastern Roman frontier.[680] Killick and Parker followed similar (and now revised) interpretations of the *fossatum africae* and proposed that the wall mainly served to fend off raids of nomadic attacks from the eastern desert.[681] Harding even claimed that the wall fended

670 Kirkbride 1948, 151.
671 Findlater 2003, 199–203; Findlater 2002, 142–143.
672 Kennedy – Banks 2015; MacDonald et al. 2004, 343.
673 Cf. Kennedy – Banks 2015, 136, 141.
674 Kennedy – Banks 2015, 144. Cf. also 140, fig. 9 and 145, fig. 13.
675 Kennedy – Banks 2015, 151.
676 Findlater 2003, 200–201; Findlater 2002, 142.
677 MacDonald et al. 2012, 466–467 with further references on the Nabataean structures; Killick 1986a, 436.
678 Kennedy – Banks 2015, 151.
679 For a more recent discussion on the function of the Khatt Shebib, see Kennedy – Banks 2015, 148–151.
680 E. g. Bowersock 1971, 239.
681 Parker 1986, 86; Killick 1986a, 436.

off cavalry.[682] This was later dismissed by Findlater, as the wall is too low or situated at the bottom of slopes to have served any large-scale defensive purposes.[683] Findlater also argues that Khirbet Qannas – the only presumed major Roman military site situated along the northern stretch of the Khatt Shebib – was not connected to the wall as it was robbed of building material for the construction of Khirbet Qannas.[684] Moreover, the *via nova Traiana* cuts the Khatt Shebib along its northern stretch which surely undermines the wall's security function. Findlater nevertheless claims that the main site type observed along the northern course of the Khatt Shebib are towers of predominantly Iron Age date. He thus concludes that

> […] *the placement of the wall along the edge of the mountain range, and the sitting of the towers, all in line of sight and with very little hidden ground, strongly suggests the maintenance of a boundary area.*[685]

However, Kennedy and Banks recently claimed that Findlater's 'towers' rather resemble small shelters for hunters as observed along the walls of desert kites, thus dismissing a military understanding of the towers and instead refer to them as simple 'hides' that were possibly used seasonally.[686]

Convincingly, Kirkbride already noted that the wall stretches along the 100 mm rainfall isohyet, which seems to be confirmed by R. Banks' recent mapping of the modern rainfall isohyets and the course of the Khatt Shebib (FIG. 134). Previous scholars have claimed that agricultural installations and settlements are situated largely west of the wall, and thus propose the Khatt Shebib as a demarcation wall between the vast desert areas to the east and the cultivable lands to the west.[687] This study confirms these previous observations for the Petraean hinterland (FIGS. 135 and 136).

To further evaluate the Khatt Shebib as a boundary line between a predominantly settled population to the west and possible pastoralists in the east, it was useful to briefly venture outside the defined study area, and consider *all* recorded sites provided by the various surveys situated east of the Khatt Shebib (FIGS. 137–144). Although a full discussion of the recorded sites cannot be offered here, both the distribution maps as well as the overall counts of the archaeological sites east of the Khatt Shebib clearly show that only a comparatively small number of sites are located east of the wall.[688] While a small increase can be observed during the 1st – 4th century AD, the number of sites drops by the 5th century AD substantially. Throughout all periods, the second largest category of archaeological sites east of the Khatt Shebib are presumed military sites, followed by a few rural settlements and some possible funerary structures. During the 6th and 7th century AD, a slight increase of all these sites can be observed which may correspond to the general eastern shift of settlements during that time (cf. chapter 5).

However, the most noticeable observation is that the largest category of sites east of the Khatt Shebib are, by far, 'other structures and/or features.' If these sites include a similarly large number of possible camps, corrals or other structures that can be regarded as possible archaeological evidence for pastoralism, this would support the claim that the Khatt Shebib served as a boundary wall between a predominantly settled community in the west and a predominantly pastoral population in the east. Similar to the Syrian *très long mur* or Mattingly's interpretation of the boundary wall in Tripolitania, the Khatt Shebib seemingly marked an area "[…] *where there was a rapid transition from a predominantly agricultural to a predominantly pastoral way of life*."[689] This would explain the open parts of the wall: It did not serve any major defensive purposes, but instead functioned as a demarcation line that could be monitored; perhaps even by the evidenced military structures east of the wall. More importantly, the Khatt Shebib directed and regulated movement of possible pastoral peoples of the eastern desert areas to selected access points into the predominantly settled regions – including the Udruh area.[690] Following this argument, the above-mentioned Circles J5 and J6 may have thus functioned as large corrals as both circles are situated at the ends of the Khatt Shebib's opening. Although entirely speculative, the circles may have held livestock of pastoral peoples coming from the eastern desert areas who entered the predominantly agricultural zone of the Petraean hinterland to trade with settlers. The circles may have served as open market areas where pastoral nomads of the east displayed their livestock in exchange for

682 Harding 1967, 154.
683 Findlater 2003, 200; Findlater 2002, 142.
684 Findlater 2003, 200; Findlater 2002, 142.
685 Findlater 2003, 201.
686 Kennedy – Banks 2015, 148.
687 Cf. Kennedy – Banks 2015, 149 and Findlater 2003, 200.
688 This may also reflect the original survey boundaries and therefore lack of archaeological data.
689 Mattingly 1995, 171. On the *très long mur,* see e.g. Abu Jaber 1995, 740 cited after Kennedy – Banks 2015, 149.
690 There is no archaeological evidence to suggest that the eastern desert was inhabited exclusively by pastoral *nomadic* peoples. Presumably, this has been claimed merely on the basis of the harsh desert environment which supposedly was mainly roamed by nomads. However, there are no positive arguments suggesting that the areas east of the Khatt Shebib were exclusively inhabited by pastoral *nomads*.

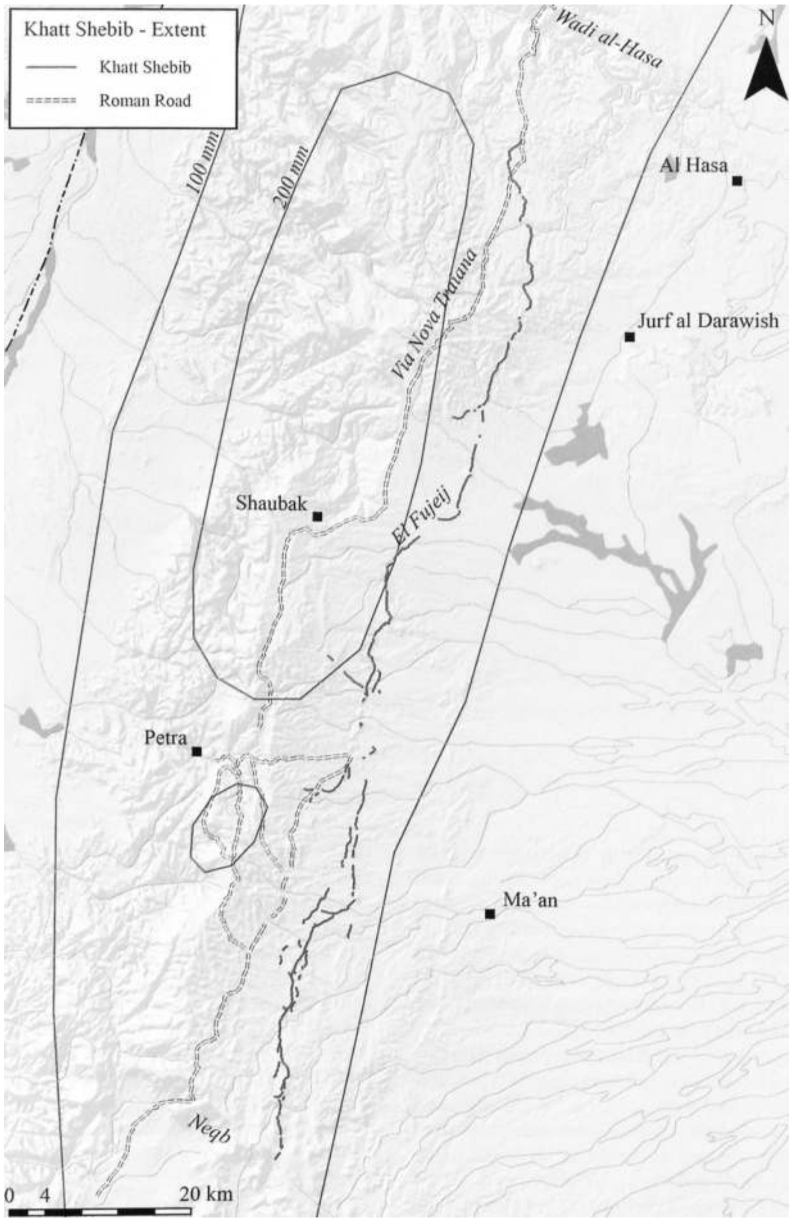


FIG. 134 The Khatt Shebib wall in relation to the modern 100 mm rainfall isohyet after Kennedy – Banks 2015, 150, fig. 21.

agricultural goods from settlements west of the wall. The circles' close vicinity to the major settlements of Khirbet Jarba (Circle J6) and Udruh (Circle J5) as well as their location along important communication lines supports this commercial interpretation.[691]

Exploitation/Industrial Sites

The sections above dealt with the archaeological evidence for agricultural activities, the water management system as well as other structures and/or features offering insights into alternative, pastoral subsistence strategies in the Petraean hinterland. In addition to the extensive trade-related infrastructural network (cf. chapter 6), other avenues were explored to achieve further economic gain. Most notably, such measures include extensive copper mining activities in the Wadi Faynan as well as the Nabataean production of and trade with commercial bitumen (natural asphalt) and, presumably, perfumed oils.[692] Scholars have specifically emphasized the latter as a major Nabataean industry. This is based on the discovery of a hoard of Nabataean piriform *unguentaria* in the Temple of the Winged Lions

691 Khirbet Jarba and Udruh can be referred to as possible towns only for the later Roman and Byzantine periods as there is little to no archaeological evidence for previous periods at these sites (cf. chapter 5).

692 On the Nabataean bitumen industry, see e.g. al-Salameen 2004, 221–224 and Hammond 1959; on copper mining activities in Wadi Faynan, see e.g. Hauptmann 2007; Levy et al. 2012 and Hauptmann 1986.

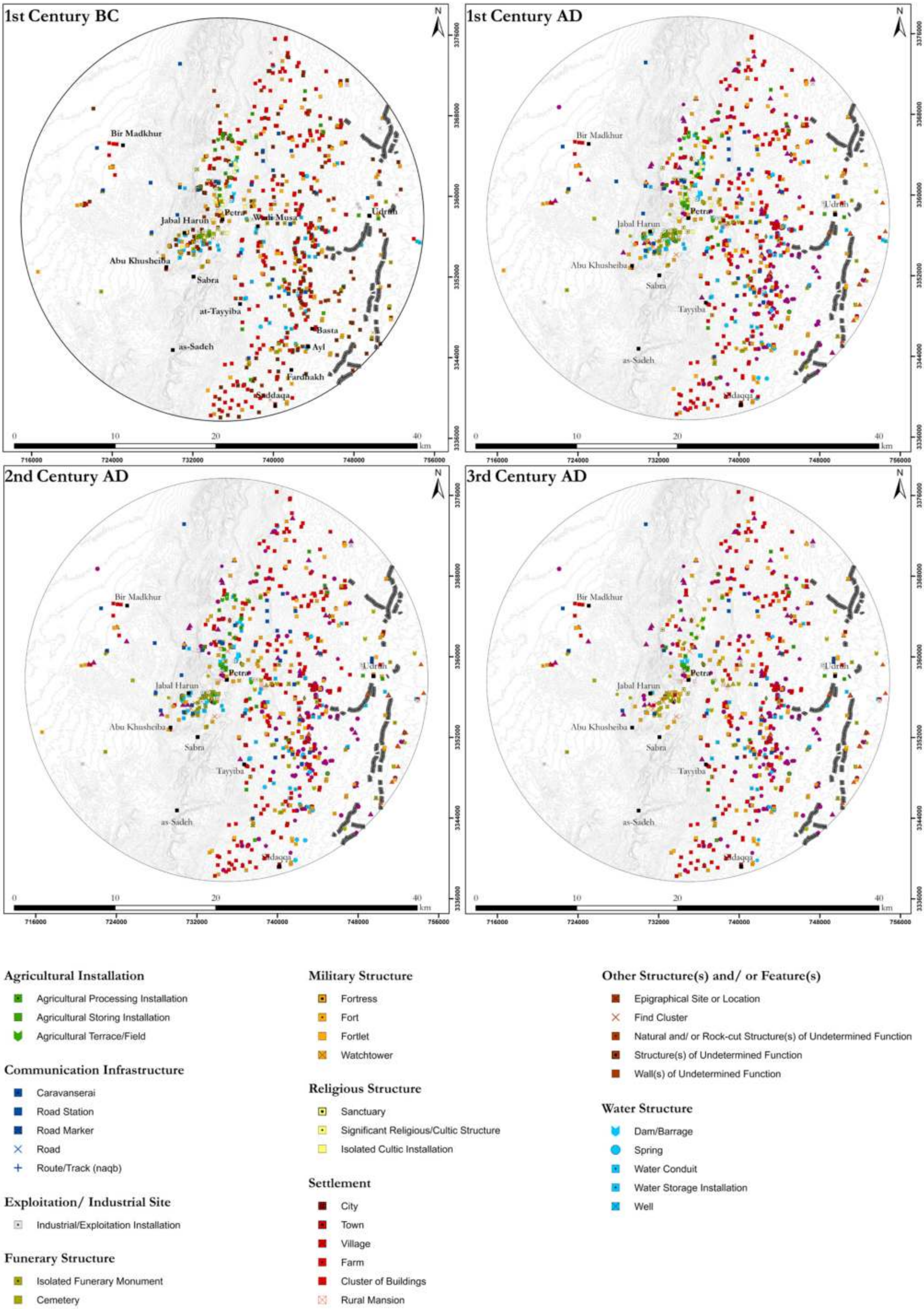


FIG. 135 All archaeological sites recorded in the Petraean hinterland from the 1st century BC to the 3rd century AD in relation to the presumed boundary wall of the Khatt Shebib. Course of the Khatt Shebib after Kennedy – Banks 2015.

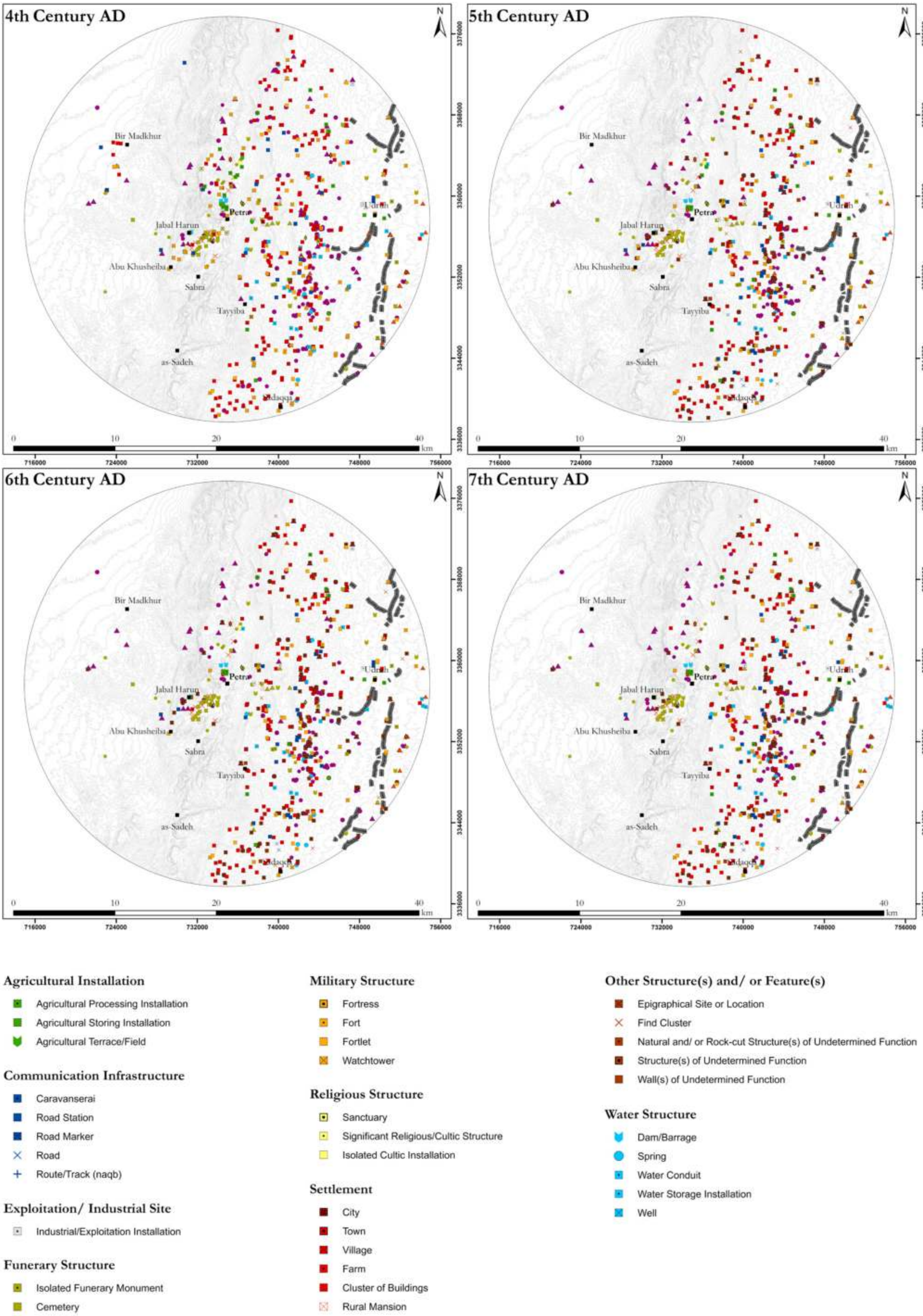


FIG. 136 All archaeological sites recorded in the Petraean hinterland from the 4th – 7th century AD in relation to the presumed boundary wall of the Khatt Shebib. Course of the Khatt Shebib after Kennedy – Banks 2015.

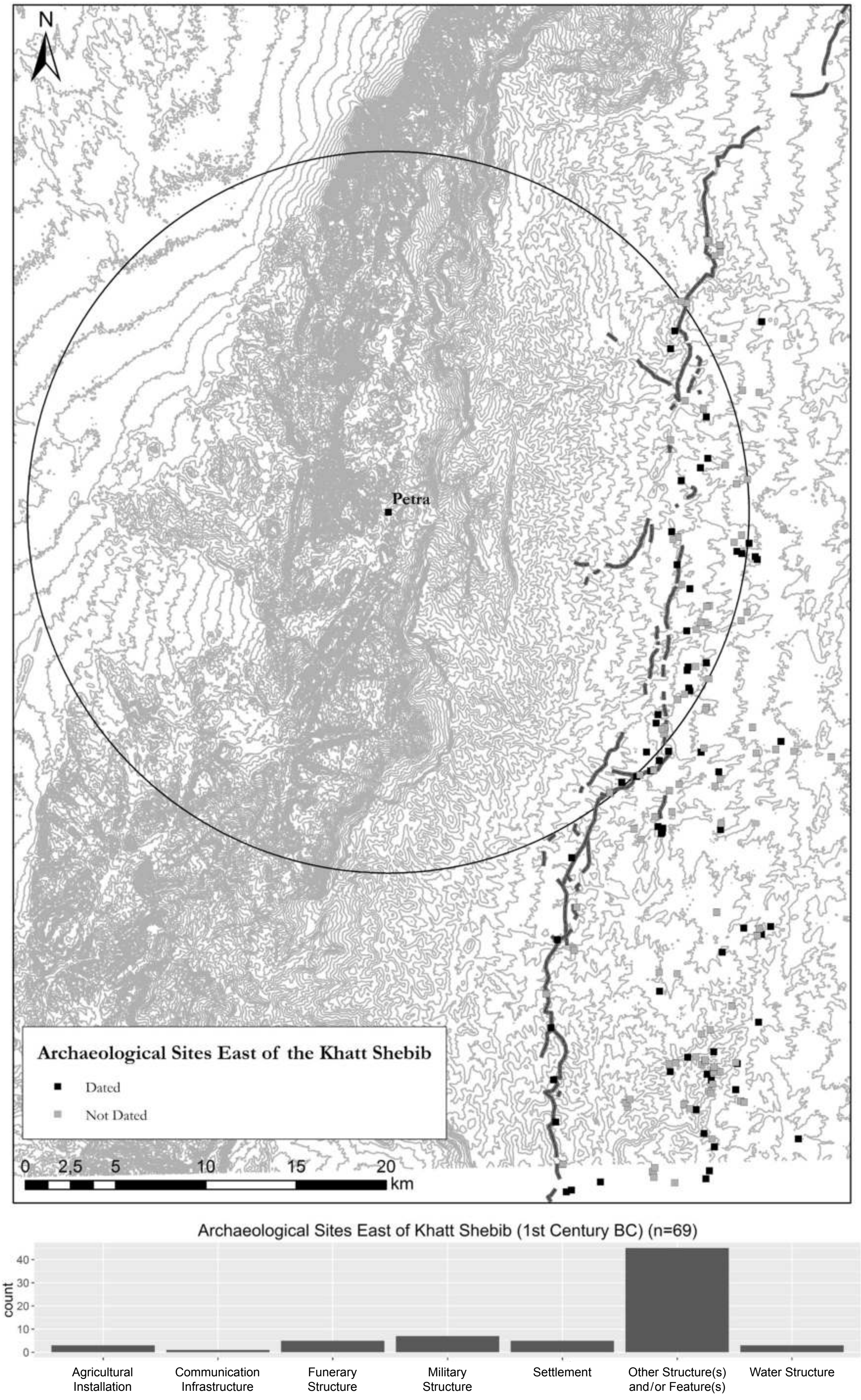


FIG. 137 Overall count and distribution map of all archaeological sites recorded by the various surveys situated east of the Khatt Shebib dating to the 1st century BC. Course of the Khatt Shebib after Kennedy – Banks 2015.

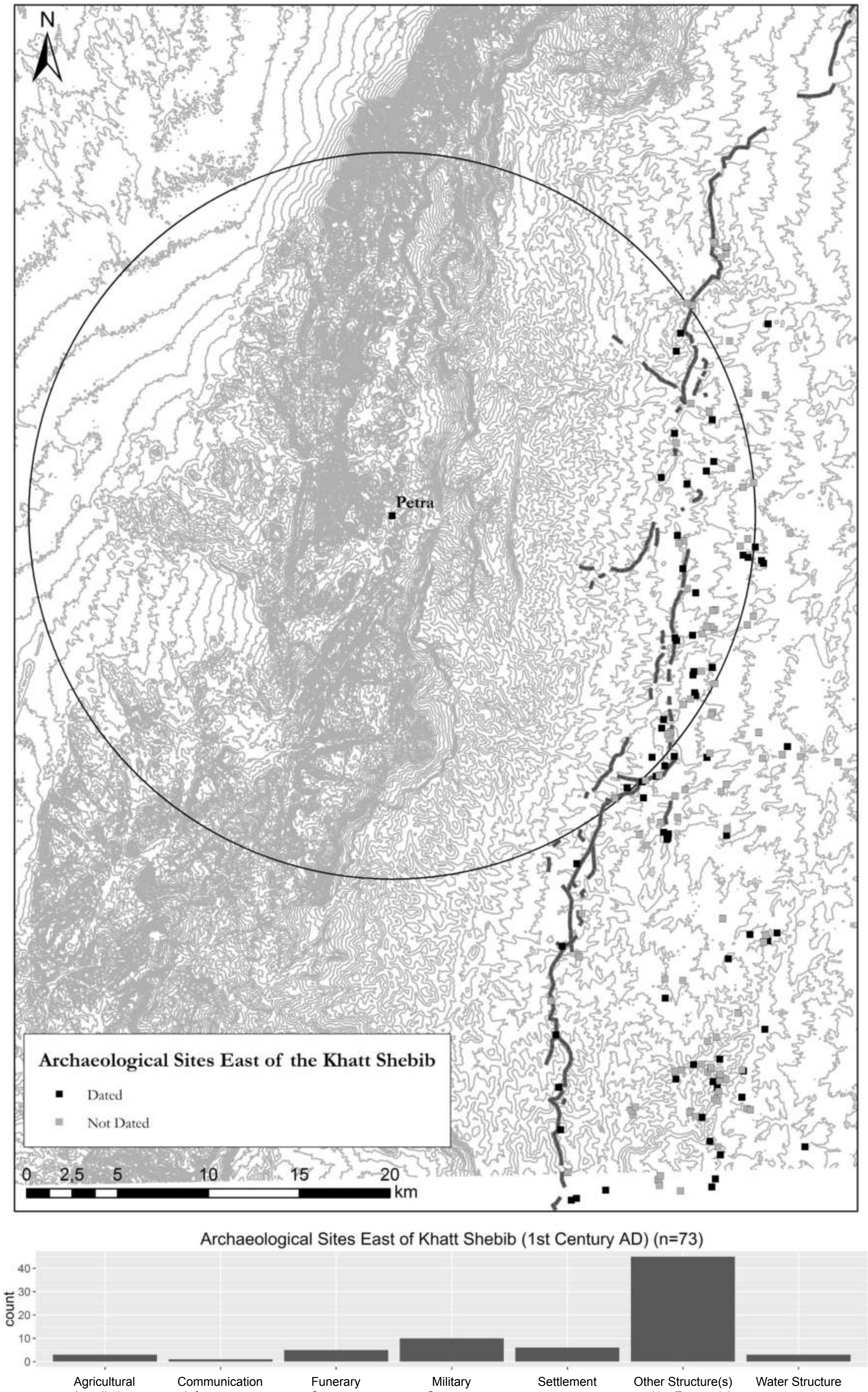


FIG. 138 Overall count and distribution map of all archaeological sites recorded by the various surveys situated east of the Khatt Shebib dating to the 1st century AD. Course of the Khatt Shebib after Kennedy – Banks 2015.

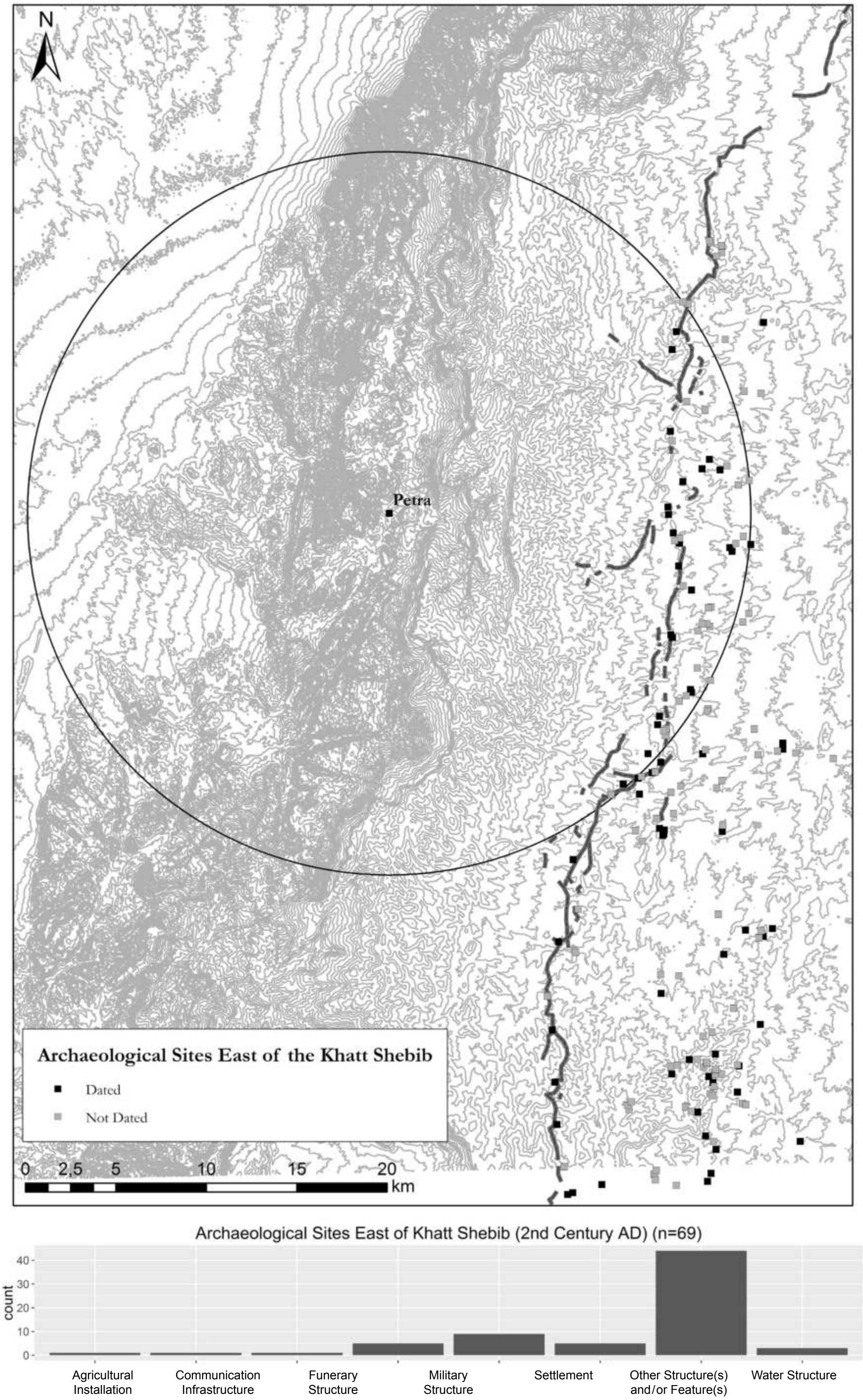


FIG. 139 Overall count and distribution map of all archaeological sites recorded by the various surveys situated east of the Khatt Shebib dating to the 2nd century AD. Course of the Khatt Shebib after Kennedy – Banks 2015.

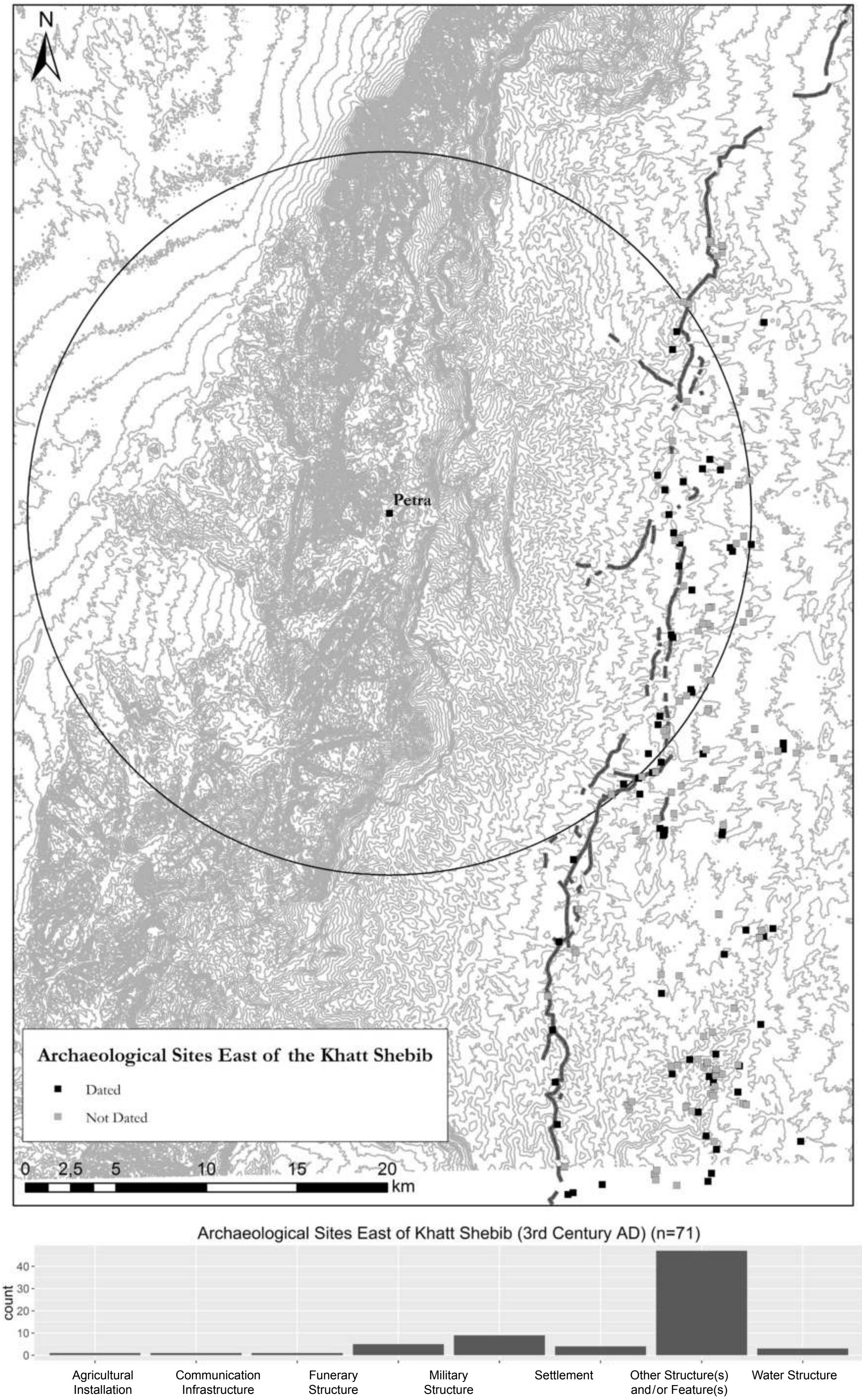


FIG. 140 Overall count and distribution map of all archaeological sites recorded by the various surveys situated east of the Khatt Shebib dating to the 3rd century AD. Course of the Khatt Shebib after Kennedy – Banks 2015.

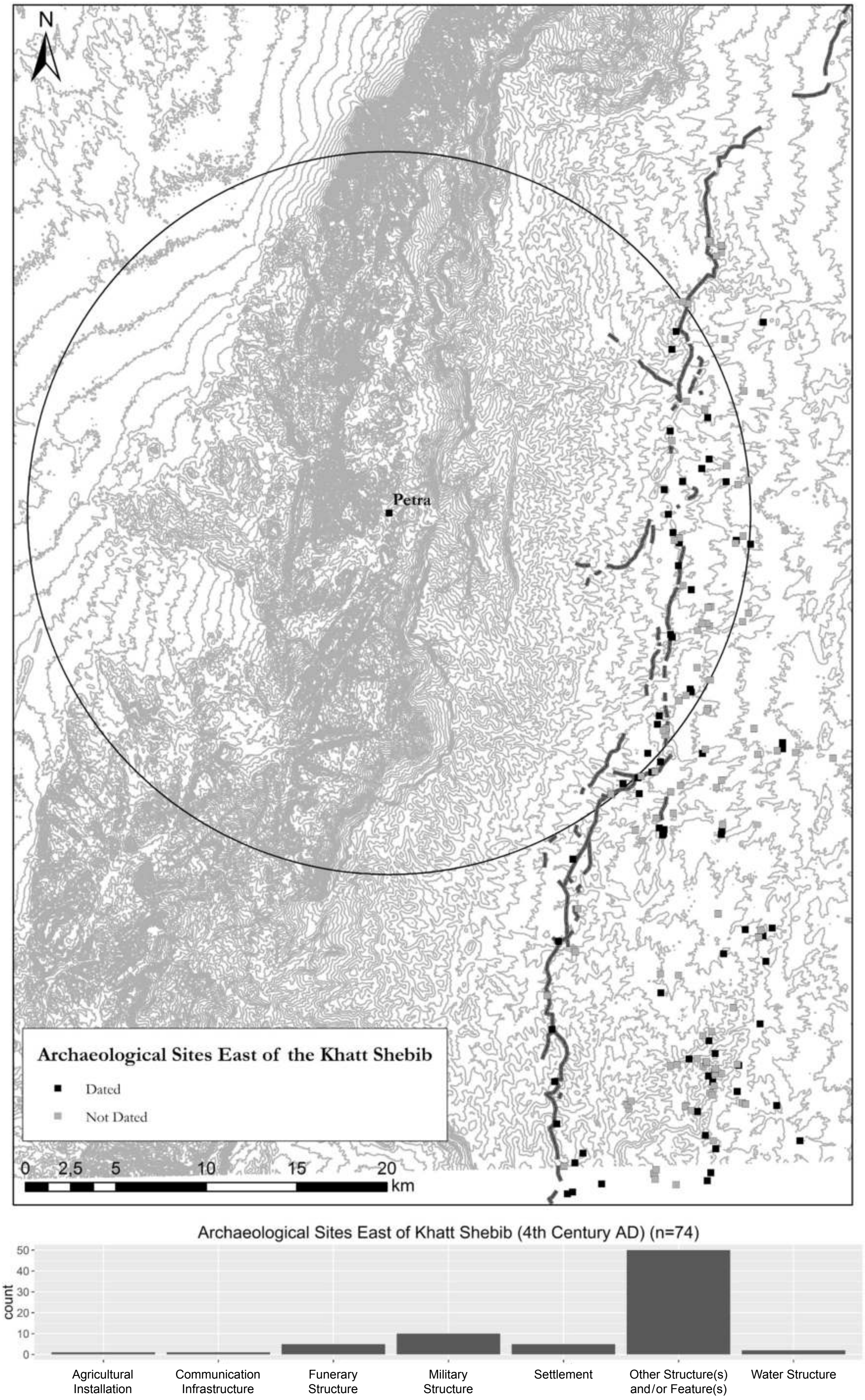


FIG. 141 Overall count and distribution map of all archaeological sites recorded by the various surveys situated east of the Khatt Shebib dating to the 4th century AD. Course of the Khatt Shebib after Kennedy – Banks 2015.

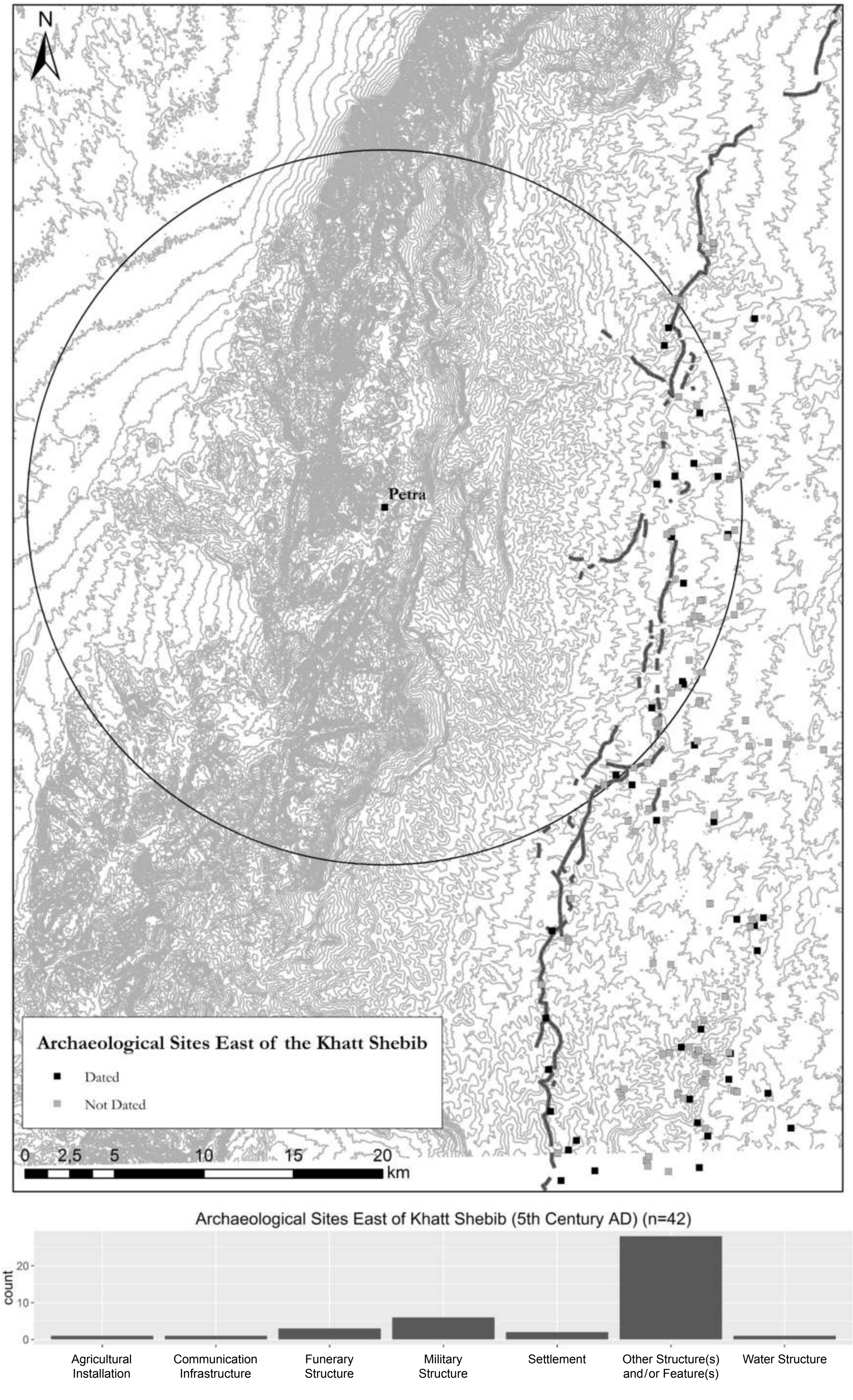


FIG. 142 Overall count and distribution map of all archaeological sites recorded by the various surveys situated east of the Khatt Shebib dating to the 5th century AD. Course of the Khatt Shebib after Kennedy – Banks 2015.

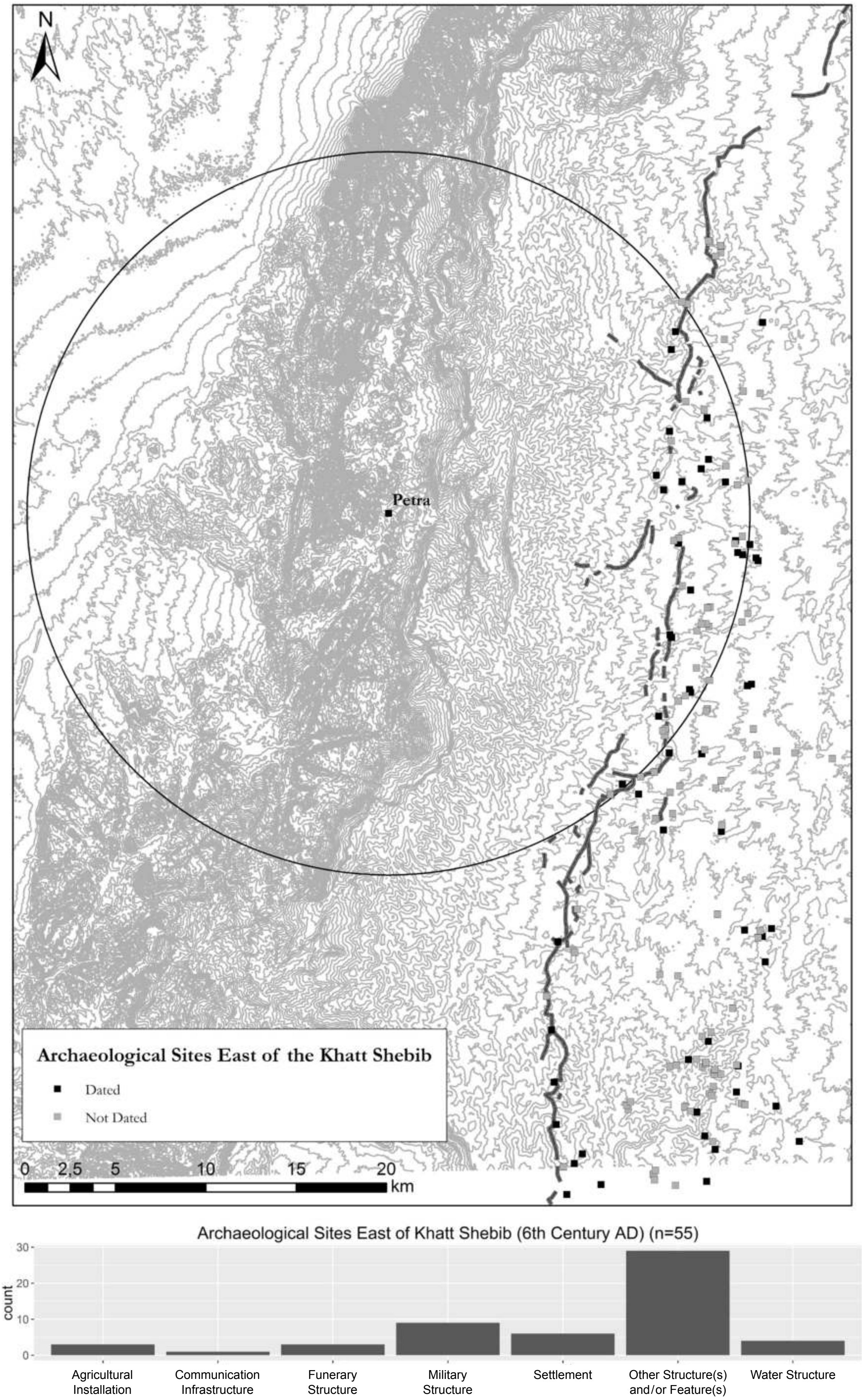
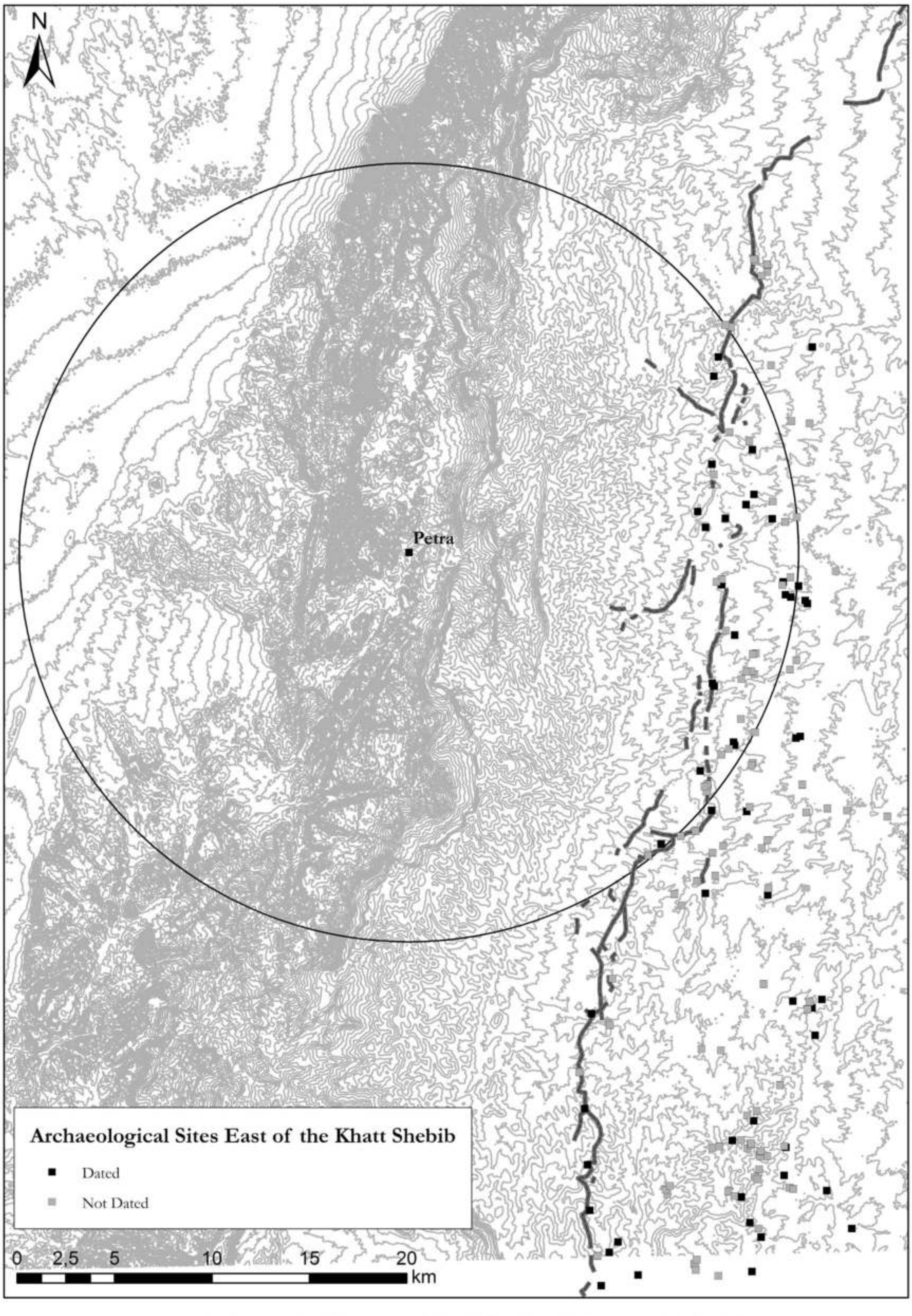


FIG. 143 Overall count and distribution map of all archaeological sites recorded by the various surveys situated east of the Khatt Shebib dating to the 6th century AD. Course of the Khatt Shebib after Kennedy – Banks 2015.



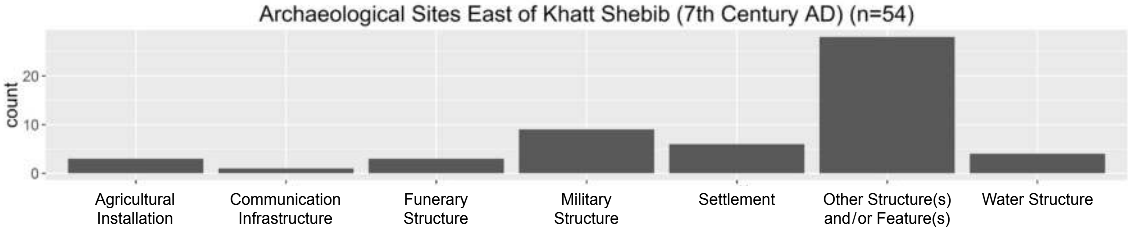


FIG. 144 Overall count and distribution map of all archaeological sites recorded by the various surveys situated east of the Khatt Shebib dating to the 7th century AD. Course of the Khatt Shebib after Kennedy – Banks 2015.

at Petra that has led D. Johnson to declare Petra as the production center for an industrial-scale Nabataean unguent trade.[693] Indeed, Pliny and Dioskurides state that the Nabataeans harvested core ingredients such as resins, (perfumed) oils as well as medicinal ointments, which Johnson claims to have confirmed by a self-conducted botanical survey of the Petra area.[694] Largely overseen by scholarship, however, Schmid rejects the claim that Petra functioned as a major Nabataean production center of unguents.[695] While acknowledging the reports given by Pliny and Dioskurides, other sources mention the Nabataeans only as traders of incense, myrrh and other spices, without any specific reference to the refinement of these products.[696] Furthermore, arguing that *unguentaria* belong to the most uniform vessel type in antiquity, and therefore can only be roughly distinguished between Hellenistic and Roman types, Schmid questions the secure identification of distinct Nabataean *unguentaria* forms.[697] It is therefore doubtful that *unguentaria* discovered elsewhere in the Mediterranean can easily be identified as 'Nabataean' as claimed by Johnson, who considers these findings as further evidence that Nabataean unguents were exported internationally.[698]

Importantly, the only archaeological evidence for the presumed Nabataean perfume industry is the (unquantified) amount of *unguentaria* from the Temple of the Winged Lions at Petra.[699] Recent studies on other Hellenistic/Roman contexts, however, clearly show that the presence of *unguentaria* alone is too inconclusive to suggest any form of local perfume production. Moreover, it is doubtful that *unguentaria* were used as shipment containers.[700] If unguents were mass-produced at Petra for international trade, one would expect specific workshops as are known archaeologically from other major Hellenistic/Roman sites such as Delos, Capua, Pompeji or Paestum.[701] The only exception is the *officina* at 'En Boqeq, including a possible press bed with resin and aromatic plant residue as well as several boilers for the saturation of oils and aromatics. Pottery and numismatic evidence suggest a small Nabataean occupation, but production was most likely for local purposes only and not intended for international export.[702]

While the possibility that the Nabataeans produced and traded with unguents should not be dismissed entirely, there is no convincing evidence for any major production site – neither in Petra, nor elsewhere in Nabataea. The economic significance of the Nabataean 'perfume industry' should therefore not be overrated. Unguents were simply one of various important resources which the Nabataeans knew to exploit for economic gain, but they were arguably not more significant than, for example, that of the Nabataean bitumen or copper trade. To date, there is no convincing evidence that would suggest that Petra was a major unguent production site and the significance of a possible Nabataean perfume industry must be seriously reconsidered.

The Nabataeans were nevertheless strongly involved in the exploitation and further processing of available natural resources. This section therefore deals with the archaeological evidence concerning the industrial potential of the immediate Petraean hinter-

693 Johnson 1990, based on his doctoral thesis *Nabataean Trade. Intensification and Culture Change* presented to the University of Utah, Salt Lake City in 1987. Scholars accepting Johnson's assertion that unguents were mass-produced at Petra include e.g. Koulianos 2015; Erickson-Gini 2010, 42–43; (although more critical) al-Salameen 2004, 225–228; Hackl et al. 2003, 74–75; 575–578; Fiema 2003, 41; Roche 1996, 95–96.

694 Cf. Hackl et al. 2003, 74: Plin. HN, 12, 73, 102, 119, 120 and Diosk. mat.med. 1, 17, 1–2; 1, 19.3; 4, 157, 1. On Johnson's botanical survey, cf. e.g. Erickson-Gini 2010, 42 citing Johnson 1987, 29–33.

695 Schmid 2007a, 75–76 and 2000, 75–76.

696 Diod. Sic. 19, 94, 1; Str. 16, 4, 18. Cf. also Durand 2012.

697 Although more recent studies on ancient *unguentaria* do identify local varieties made in local fabric, but distributed only on a regional scale (Reger 2005, 275–277, 281).

698 Including Dacia, Rome, Givat Hamivter, Dura Europos, Stobi and Argos (Johnson 1990, 240–241).

699 On Johnson's lack of quantification of the *unguentaria* hoard, cf. Koulianos 2015, 21–23 and Schmid 2000, 76. Although not explicitly addressing the issue, cf. also Erickson-Gini – Tuttle 2017, 129–131. Note that a Nabataean inscription carved in the Wadi Abu Olleqah might mention a "perfumer," but the translation is only approximate and may refer to a variety of professions (Nehmé 2018, 6).

700 Reger 2005, 270, 272–275.

701 Reger 2005, 266–272; Brun 2000, 282–299; Mattingly 1990. A possible late 7th/early 6th century BC perfume production site is also known from En Gedi and a 1st century AD house at Jerusalem (Brun 2000, 279–280). Perfume was apparently produced at Jericho (Durand 2012, 83) as well. At Petra, the only 'workshops' identified at the Temple of the Winged Lions in the immediate vicinity of the unguentaria hoard are the so called 'Painters' Workshop,' the 'Marble Workshop' and the 'Metal Workshop' (Hammond 1987). These were used only for the construction/refurbishment of the temple (cf. also Wenning 2017, 118).

702 Brun 2000, 280–281; Fischer et al. 2000. Cf. also Durand 2012, 83. Erickson-Gini 2010, 43 also postulates that the discovery of a Late Roman olive press at Moyat 'Awad along the Petra–Gaza road, *unguentaria* and various mortars suggests that oils were produced there as well (cf. chapter 6). While this may have been the case, it is unlikely that these were refined perfumed oils as there are no indications for a wedge press as known e.g. from Hellenistic/Early Roman perfume production sites at Delos or Paestum (Reger 2005, 266–272; Brun 2000, 282–299; Mattingly 1990).

land as the various surveys documented a number of archaeological installations or sites that exploited or further processed natural resources for the production of secondary products.[703] Such sites include possible quarries, clay pits or copper mines as well as workshops where natural resources were further processed. These sites are grouped into the generic category 'industrial/exploitation installations,' which are presented in the following.

Industrial/Exploitation Installations

In total, 24 industrial/exploitation installations were identified. These were further divided into three categories: quarries, mines (including clay pits) and workshops (FIG. 145).[704]

While only one small quarry and the copper mine of Umm al-'Amad are evidenced for the Iron Age (cf. chapter 3), by the 1st century BC a considerable increase can be observed (FIG. 146). The overall count rises to 15 industrial/exploitation installations. Two sites are mines, the remaining 13 are quarries. One pottery workshop (az-Zurraba) is documented by the 1st century AD. While during the 1st century AD the overall count remains the same, the quarry near Umm Hilal apparently is abandoned, but the workshop at Khirbet al-Fiqai is supposedly established in the 2nd century AD. By the 3rd century AD, four quarries are abandoned, marking a significant decrease of industrial/exploitation installations with now only nine sites evidenced for this period. Only six quarries, the copper mine at Umm al-'Amad as well as the workshops at az-Zurraba and Khirbet al-Fiqai are active. This overall decline continues in the 4th century AD as well, when Umm al-'Amad and Khirbet al-Fiqai are abandoned. During the 5th and 6th centuries AD, only az-Zurraba and two quarries are evidenced along the eastern high plateau. By the 7th century AD, az-Zurraba is abandoned as well.

Concluding this general overview on the chronological development of the industrial/exploitation installations, the following sections discuss the archaeological findings in further detail.

Quarries

In addition to the larger sandstone quarries of Petra in the Wadi as-Siyyagh, Wadi Turkmaniye and Umm Sayhoun, numerous smaller sandstone quarries can be observed throughout the entire city of Petra.[705] As they are in close vicinity to various rock-cut and freely built structures, most notably the rock-cut tombs, it is assumed that stone construction material was extracted locally which saved both time and expense. This is mirrored in Petra's hinterland as well. However, a vast number of particularly small quarries can be observed throughout the entire study area. These could not be systematically recorded by the various surveys as there are simply too many. While quarries are the largest category of all industrial/exploitation installations, the presented sites are therefore only indicative for the countless other, unrecorded quarries.

While only one small chert quarry along the eastern high plateau was worked in the Iron Age (cf. chapter 3), the number of evidenced quarries rises dramatically by the 1st century BC (13 in total). These are mainly situated along the eastern high plateau. Based on surface pottery material, such sites include the major limestone quarry located within sight of the modern village of Udruh and its Late Roman fortress (FIG. 147). The quarry measures an area of c. 7500 m² and the still visible quarries run 2–3 m deep. While Killick assumed that the Udruh quarry is one of the largest known quarries in all of Jordan, the evidenced quarries at Muhaidhrat and Fardhakh are even larger.[706] A letter written by a member of the *legio III Cyrenaica* shortly after the Roman annexation in 106 AD mentions that the stationed troops were involved in stone cutting (cf. chapter 7). Although it remains unknown where the legion was stationed and the mentioned stone-cutting activities could have taken place anywhere in the Petra area, it is likely that the Roman troops were stationed at Tell Abara near the Udruh quarries. If this is the case, it may be possible that the reported "stone cuttings" took place at the Udruh quarries.[707] Arguably, while the main quarrying activities were most likely associated with the construction of the *castrum* of Udruh, surface pottery material indicates that quarrying took place as early as the mid-1st century BC and continued until the Late Islamic period. It is therefore possible that the Udruh quarry was not only used for the construction of the fortress, but was already exploited in the Nabataean and, later, in the Byzantine periods as well.

Just south of the Udruh quarry near Umm Hilal and west of Bir Abu Danna, F. Abudanh identified another major limestone quarry which, according to

703 Cf. al-Salameen 2004, 210–234.
704 Only 16 of all 24 industrial/exploitation installations can be dated by surface material.
705 For an overview of the known quarries at Petra, see e.g. al-Tell 2011, 48–58 with further references.
706 Killick 1983b, 127; Killick 1982, 415. The UAP is currently re-examining the quarries (Emaus – Goossens 2015).
707 P. Mich. VIII, 466. Kennedy 2004, 47–48 and 175–176.

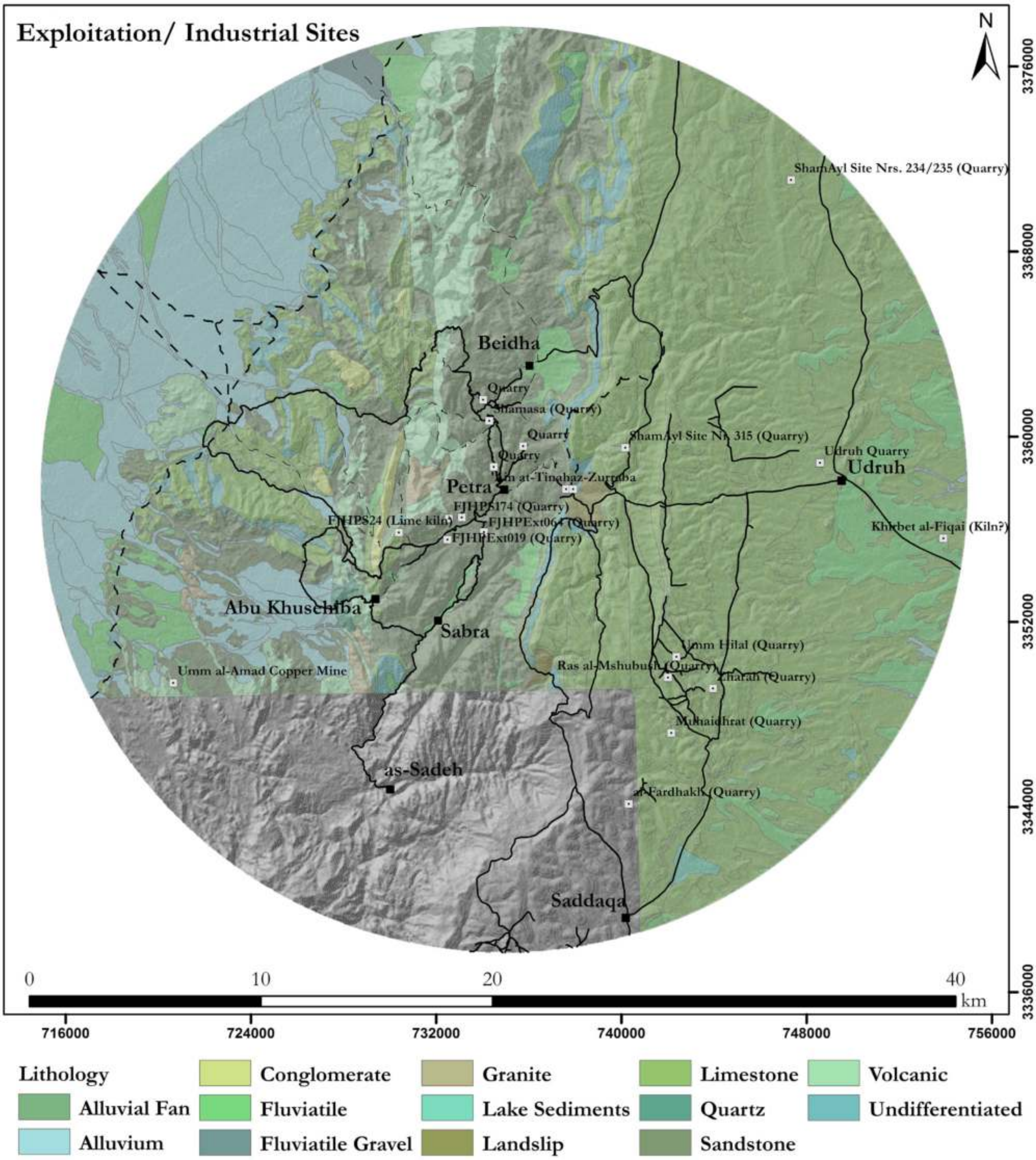


FIG. 145 Overview map of all exploitation/industrial sites in the Petraean hinterland with underlying geological formations and the evidenced road/route network.

the surface pottery material, may have also been used by the (early) Nabataean period as well.[708]

In addition to ShamAyl Site No. 315, MacDonald et al. have located another limestone quarry along the eastern high plateau. Situated in the far northeastern quarter of the study area, ShamAyl Site No. 235 is described as a small quarry (c. 460 m²) with an associated cave.[709] Surface finds range from the Chalcolithic to the Late Islamic periods. While no Roman or Byzantine material was recorded, the quarry was most likely used over a long period of time.[710]

Although no dating material was collected, Abudanh identified four flint and limestone quarries distributed along the eastern high plateau at Ras

708 Abudanh 2006, 474–475.

709 MacDonald et al. 2016, 346.

710 Immediately next to ShamAyl Site No. 235, MacDonald et

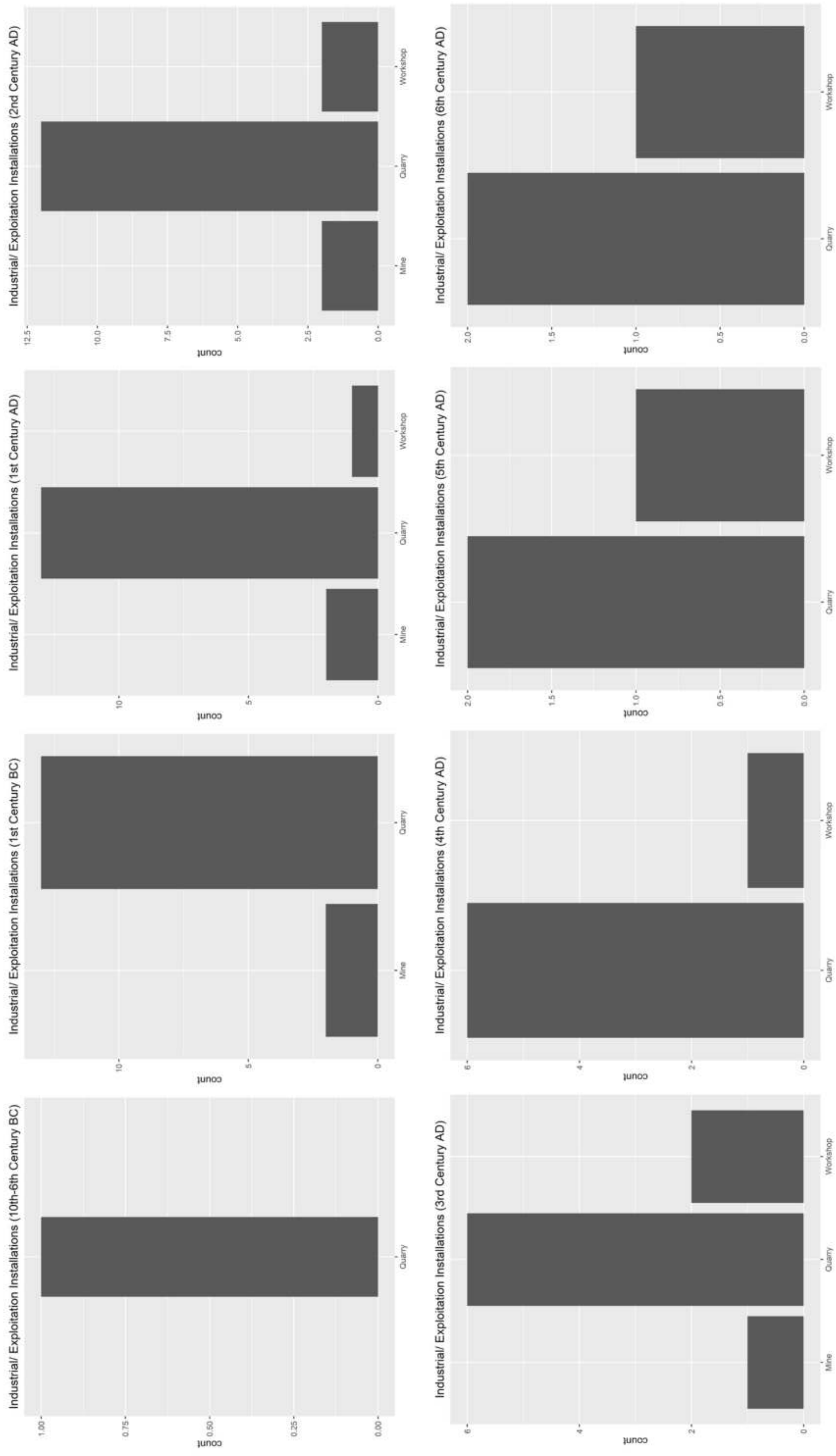


FIG. 146 Number of all dateable industrial/exploitation installations from the Iron Age periods to the 6th century AD.

FIG. 147 Limestone quarries northwest of Udruh. Photo: APAAME.

al-Mshubush, Muhaidhrat, Zhara and Fardhakh.[711] The quarry at Zhara is relatively small, but the quarries at Muhaidhrat and Fardhakh are even larger than the Udruh quarry (both measuring c. 10,000 m²). They were most likely exploited for the construction of the hilltop structure of Khirbet Muhaidhrat and the Nabataean-Byzantine settlement of Fardhakh.

While no other quarries were recorded along the eastern high plateau, other quarries where surface material suggests a 1st century BC date are located in the extended Beidha and Jabal Harun areas immediately north and southwest of Petra. Small, local quarries can be observed virtually everywhere in these areas, suggesting that building material was extracted largely locally and not transported from further away.[712] As mentioned above, the documented quarries can only indicate the large amount of smaller quarries that were exploited predominantly during the Nabataean period as tool marks and surface pottery suggest.[713]

For example, Banning identified such a small Nabataean sandstone quarry on a hilltop along the northern stretch of the Wadi Siq al-Ghurab (an-Jur) in the Beidha area (FIG. 148) and ʾAmr et al. identified an extensive sandstone quarrying area immediately north of Petra.[714] The PRP identified a small sandstone quarry along the routes of Wadi al-Muʿaysirah East and West leading from Petra to the al-Beghʾah plain near Beidha.[715] The PHSP also recorded a small sandstone quarry south of Shammasa (cf. chapter 5) where a Nabataean stonemason carved a small *baetylus* into the vertical rock surface of the quarry (FIG. 149).[716]

al. recorded ShamAyl Site No. 234 encompassing an area of c. 70 × 130 m and which is most importantly identified as a Paleolithic lithic production site (MacDonald et al. 2016, 345). Iron Age II (10th – 6th century BC) as well as "Classical" (c. mid-4th century BC – mid-7th century AD) surface pottery material was recorded at the site as well. Moreover, rock-cut "grinding holes" and rock art were noticed.

711 Abudanh 2006, 484–485, 503, 518, 539.

712 Cf. also Kouki 2013b, 250 and Rababeh 2005, 80–83.

713 Typical Nabataean quarries in Petra are cut vertically with horizontal surfaces where grooves are still visible where the stone blocks were cut. The vertical rock-faces of Nabataean quarries typically show herringbone pick-marks (Bessac 2007, 77–88; Lindner 2006, 119 and Rababeh 2005, 49–55).

714 ʾAmr et al. 1998, 515. See Banning – Köhler-Rollefson 1983, 382 for the quarry along the Wadi Siq al-Ghurab.

715 Berenfeld et al. 2016, 105–107, Appendix 1: PRP Site No. wme2, wme72 and wmw50.

716 For a prominent example of the religious significance of Nabataean quarrying activities, see Merklein's and Wenning's discussion of the quarries near the Isis sanctuary in the Wadi as-Siyyagh (Merklein – Wenning 2001). Generally on the religious significance of stonemason marks at

FIG. 148 The an-Jur quarry along the Wadi Siq al-Ghurab in the Beidha area.

In the Jabal Harun area, a similarly small (18 m²), vertical Nabataean sandstone quarry was documented by the FJHP (FJHP Site No. S174).[717] Further evidence for Nabataean quarrying activities was observed in the eastern as-Sto'e area near the so-called Snake Monument. For example, FJHP Site No. Ext064 is a small Nabataean sandstone quarry immediately southeast of the Snake Monument (c. 420 m²) and was most likely associated with structures built in its vicinity.[718]

In the al-Farasha plain between Wadi an-Naqb and Wadi 'Iyal 'Id, the FJHP recorded another Nabataean sandstone quarry (FJHP Site No. Ext019), where the natural bedrock was cut several meters high creating a c. 25 m long, horizontal ledge.[719] Carved into the ledge are various petroglyphs depicting animals, footprints as well as a bow.[720] The quarry was most likely used for extracting building material for near-by structures including barrages that were partly built of well-cut ashlars. Further small-scale quarrying activities in the Jabal Harun area are evidenced at FJHP Site Nos. Ext120 and Ext006.[721] Finally, M. Lindner surveyed Nabataean quarries along the Jabal Mutheilya in Sabra, which most likely provided stone material for the settlement.[722]

Surface material and tool marks observed at the quarry sites suggest that all evidenced quarries date to the Nabataean period (1st centuries BC and AD). No 2nd century AD material was observed at the recorded quarries at Umm Hilal or at the evidenced quarries in the Beidha area. However, as dating quarries is particularly difficult, the absence of dating evidence does not necessarily have to indicate a discontinuity, but it seems that the more dramatic decline of datable quarries by the 3rd century AD is already foreshadowed in the 2nd century AD. Supposedly, the only active quarries during the 3rd and 4th centuries AD are the evidenced sites along the eastern high plateau (most notably the Udruh quarry) as well as the quarries along the wadis al-Mu'aysirah East and West. This abandonment continues during the 5th – 7th centuries AD when only the Udruh quarry and ShamAyl Site No. 315 are still in use.

Mines

Only two mines were documented in the Petraean hinterland. One is the clay pit discovered in the immediate vicinity of the modern town of Wadi Musa at 'Ain at-Tinah where surface material suggests a Nabataean date.[723] 'Ain at-Tinah is described as an 80 × 45 m large and 15 m deep clay pit situated along the slopes of Jabal Tinah. In addition to the clay pit itself, earlier observations noted structures that may have been associated with the production of pottery.

Nabataean quarries, cf. chapter 8 with particular reference to Wadeson – Wenning 2015 and Wadeson – Wenning 2014.

717 On the various quarries discovered by the FJHP, see Kouki 2013b, 249–250. All quarries evidenced by the FJHP extracted local sandstone of the Umm 'Ishrin formation. Specifically on FJHP Site No. S174: Silvonen et al. 2013, 401, fig. 132.

718 Kouki 2013b, 250; Kouki et al. 2013b, 19, fig. 54.

719 Kouki 2013b, 250; Kouki et al. 2013b, 6.

720 In addition to a simple Nabataean signature reading "May Qayyāmat be safe" (L. Nehmé in Eklund 2013, 292–293).

721 Kouki 2013b, 250. Specifically on FJHP Site No. Ext006: Kouki et al. 2013b, 3. On FJHP Site No. 120: Kouki et al. 2013b, 34.

722 Lindner 2006.

723 Bienkowski 2012, 144; 'Amr – al-Momani 2001, 262 and 'Amr et al. 1998, 518; 'Amr 1997.

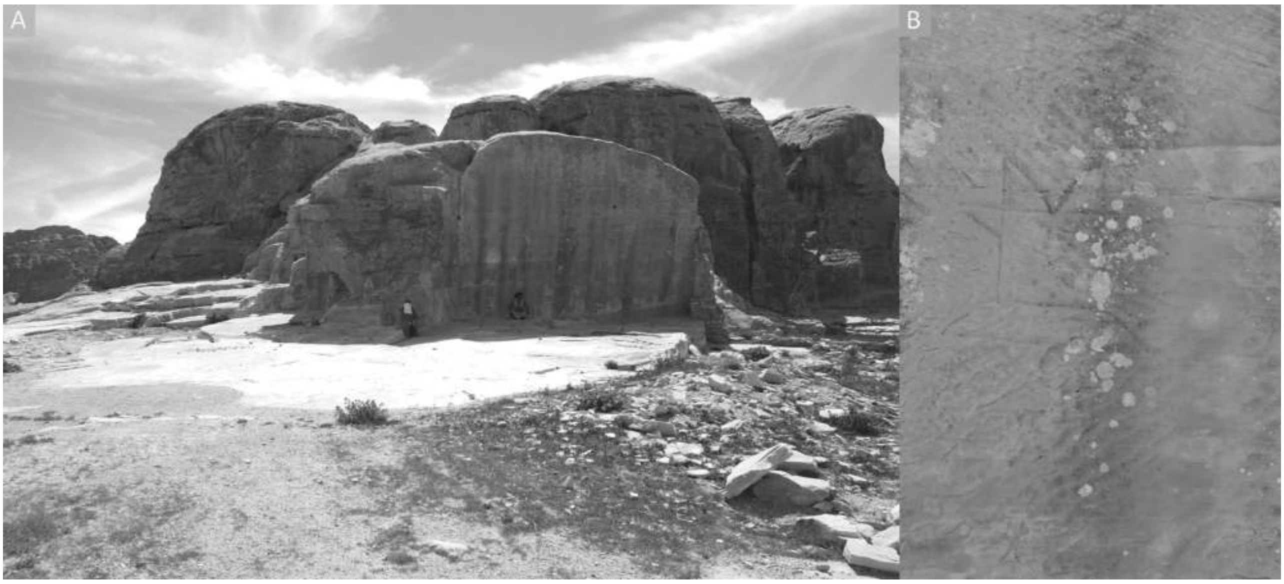


FIG. 149 A: The Nabataean sandstone quarry south of Shammasa. B: Detail of carved *baetylus* or altar.

Although this is yet to be clarified, ʾAin at-Tinah was most likely the main source for clay used for the production of Nabataean ceramics.

Further evidence for the exploitation of natural resources in the study area are the copper mines in the wadis Abu Khusheiba, Abu Qurdiyah and Sabra situated c. 13 km west of the major Nabataean settlement of Sabra.[724] Along these wadis, several copper slag heaps were discovered in front of six small copper mines indicating that smelting activities were conducted locally (FIG. 150).[725] These partially collapsed copper mines were constructed as so-called 'room-and-pillar mines.' They were c. 2 m high and extended about 50 m horizontally into the natural bedrock. The most prominent (and still accessible) mine in the area is the copper mine of Umm al-ʾAmad (translated as "mother of columns") which is characterized by a low entrance that leads into the larger chamber where pillars were left standing in order to prevent the mine to collapse (FIG. 151).[726] The dating of these mines is based on surface finds (ceramics and coins) suggesting two major periods of use: Early Iron Age (12th – 9th century BC) and the Nabataean-Roman periods (1st – 4th century AD).[727]

In addition to the mines and slag heaps, Kind also mentions several structures of presumably similar date in the immediate vicinity of the mines. These structures include the monumental rock-cut tomb of Mukheifer (cf. chapter 8), possible shaft tombs as well as presumed domestic structures that were most likely associated with the mining activities.[728] Even if this small settlement was associated with local copper mining activities, it's larger economic role in the study area cannot be satisfactorily discussed without further fieldwork.[729] However, based on Kinds metallurgical assessments and chemical analyses of the documented slags, the amount of copper in the local bedrock is extremely low (less than 1 %), explaining why only a few tons of copper ore could be extracted.[730] The copper mines in the Petra area were thus no competition for the large copper mines at Timnah or Wadi Fayan.[731] The copper slags supposedly found at Sabra (cf. chapter 5) nevertheless suggest that copper mining had at least a local economic significance. While this has led previous scholars to suggest that Sabra was a copper smelting site, this is doubtful as long as there are no smelting furnaces dis-

724 Lindner 2003a, 96; Lindner 1986a, 183–188; Hauptmann 1986, 31–33. However, the most comprehensive work on the copper mines around Umm al-ʾAmad is still Kind 1965, 64–73.

725 No furnaces could be evidenced so far.

726 The copper mine of Umm al-ʾAmad in the southwestern Petra area is not to be confused with the major copper mine of the same name just a few kilometers south of Wadi Faynan (c. 40 km north of Petra) dating to the 3rd century AD (cf. e.g. Hauptmann 1986, 41). The (modern) Bedouin name "Umm al-ʾAmad" – mother of columns – supposedly refers to mines of the room-and-pillar technique in general and is not specific to a certain mine (Hauptmann 1986, 43, n. 27; Lindner 1986a, 188).

727 However, 1st century AD (Nabataean) material was rare. Kind 1965, 71–73. Cf. also Hauptmann 1986, 33.

728 Kind 1965, 64. However, Lindner 1986a, 188 doubts the association of the surveyed structures with the mines as the distances noted by Kind were supposedly incorrect.

729 Cf. also Hauptmann 1986, 33.

730 Kind 1965, 64–69.

731 Cf. al-Salameen 2004, 218–219 for a brief overview of copper mines throughout the Nabataean realm.

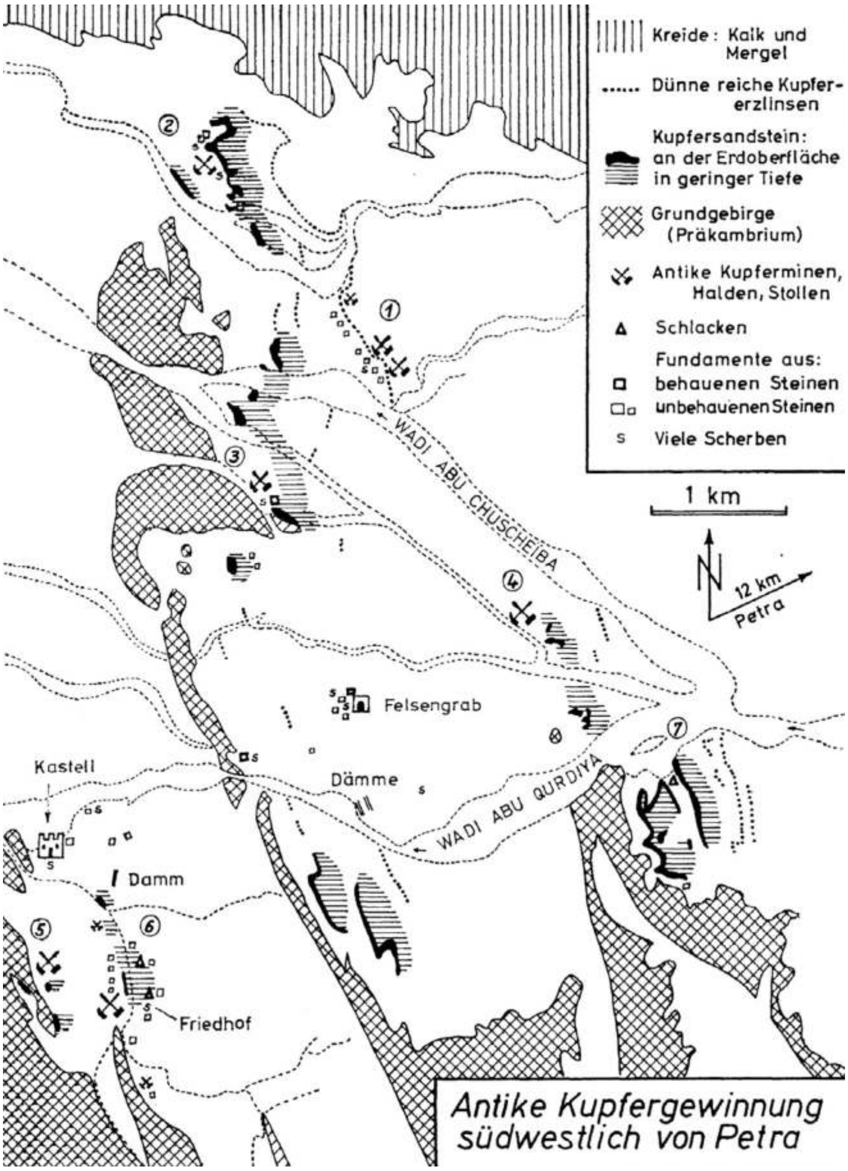


FIG. 150 Overview map of small copper mines in the area of Umm al-ʾAmad after Kind 1965, 63, Abb. 3.

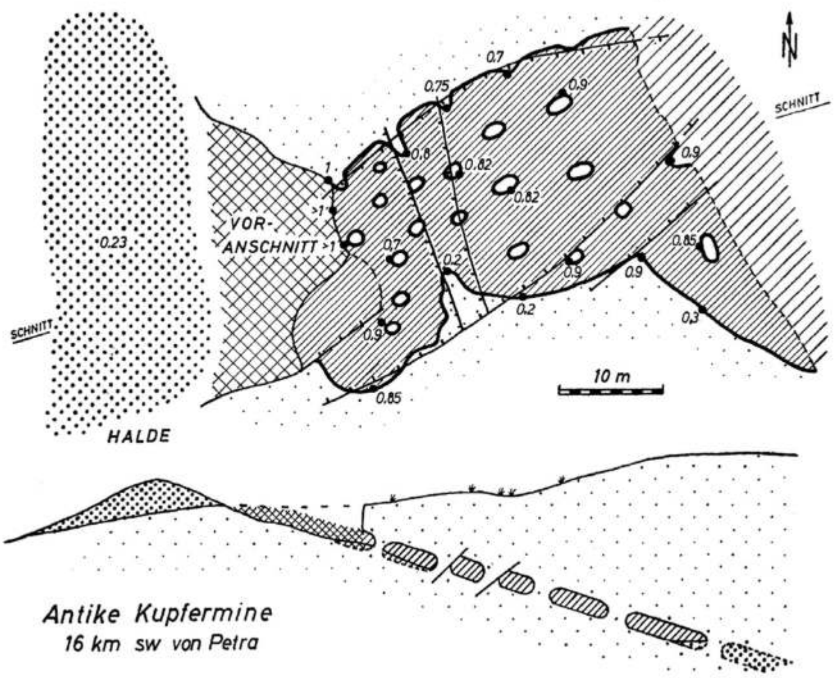


FIG. 151 Schematic plan and sectional view of the copper mine of Umm al-ʾAmad after Kind 1965, 68, Abb. 6.

covered at Sabra.[732] Although speculative, the Sabra slags could have been processed in the Umm al-'Amad area and then transported to Sabra as trading goods. Also, the major Nabataean-Roman settlement of Abu Khusheiba is not far from the copper mines and it is assumed that the settlement is, at least partially, associated with copper mining activities in the Umm al-'Amad area.[733] This may be another indicator that the copper from Umm al-'Amad was extracted and processed for small-scale trade purposes. However, the local copper deposits did not permit to produce copper at any larger scale.

Workshops

The most important workshop in the study area is the pottery workshop of az-Zurraba discovered in the modern town of Wadi Musa where the remains of twelve pottery kilns were excavated in the 1980s.[734] Flour mills and evidence for glass manufacture were discovered during the excavations as well.[735] The associated finds suggest that production at az-Zurraba started in the 1st century AD and continued into the 6th century AD. The find spectrum indicates that a wide array of ceramic products were produced at az-Zurraba, including constructional ceramics (rectangular bricks, roof tiles, ceramic water pipes, circular *suspensurae* as well as *tubuli*), various storage vessels and other coarse wares as well as Nabataean fine ware.[736] The kilns were fired using the mass of squeezed olive skins and crushed olive pits from the nearby olive presses (cf. above). The necessary production water was stored in a large reservoir that was presumably filled by the al-Khubtah conduit.[737]

In addition to az-Zurraba, Killick presumably excavated Nabataean ceramic kilns at Udruh highlighting the importance of the site as a possible Nabataean production center well before the construction of the Late Roman *castrum*.[738] Based on associated numismatic evidence, the kilns are dated from the 2nd century BC until the 1st century AD.[739]

Abudanh documents four "significant walled and circular holes" at Khirbet al-Fiqai south of Udruh, which he tentatively identifies as potential kilns.[740] These were built of small limestone ashlars and have a diameter of c. 2–3 m. Surface pottery indicates that the site was occupied during the Nabataean/Roman periods (2nd and 3rd centuries AD) as well as during the Islamic periods. Although small quantities of "fired material" were observed along the edge of one of the presumed kilns, no further information is available on what was produced at Khirbet al-Fiqai.

The FJHP documented a large, circular lime kiln (c. 5,2 m in diameter) west of Jabal Harun along the lower limestone slopes of Umm Khurrama.[741] The 3,5 m deep kiln is built of dry masonry and clearances of the structure by the FJHP have revealed a small air valve. Although it is possible that it was a later addition to the kiln, another stone structure was discovered that may have served for further ventilation. Small limestone blocks were neatly arranged along the kiln's interior walls, presumably ready for burning although no ash layers or other evidence for previous burnings were noticed. No evidence of a roof structure was documented. While there is no archaeological dating evidence for the kiln, similar examples from the Near East indicate that these kiln types were still used in the 20th century. However, there are close parallels to the lime kiln excavated in the Late Roman fortress at Lejjun which revealed Early to Late Byzantine as well as Islamic material. The FJHP thus suggests an original Byzantine date for the kiln, which possibly produced lime mortar needed for the construction of the monastery on Jabal Harun.[742]

Finally, two smaller structures discovered in the extended Jabal Harun area were also tentatively identified as possible lime kilns by the FJHP, as small limestone blocks were piled in an earthen depression. However, as such small kilns are known since the Iron Age, no precise dating can be suggested.[743] If these sites were lime kilns, they were most likely for small-scale, local use only.

732 Hammond 2000, 153 and Glueck 1935, 80–81 state that the slags were supposedly associated with Nabataean pottery and are concentrated mainly northwest of the site. Tholbecq et al. 2016, 294 consider the smelting activities to be late.
733 King et al. 1989, 205–207.
734 Bienkowski 2012, 144; 'Amr – al-Momani 1999 and 'Amr 1991.
735 Possible water mills were recorded in the Wadi Musa area ('Amr et al. 1998, 520–522, 528–529 and 'Amr – al-Momani 2001, 264). These are most likely of Late Islamic date.
736 On the hypothesis of a possible Nabataean brick industry, see Harvey 2018.
737 Bienkowski 2012 and Fiema 2012a.
738 Killick 1987, 173–174; Killick 1986b, 51–52. See also Wenner 2015, 120 and al-Salameen 2004, 238 who discuss the Udruh kilns as well.
739 Recent survey activities of the UAP could not identify Killick's kilns. Trial excavations and geophysical studies are planned to clarify the issue (Driessen – Abudanh 2019, 457).
740 Abudanh 2006, 419–420.
741 Kouki 2013b, 248–249, figs. 4 and 6; Silvonen et al. 2013, 355.
742 Kouki 2013b, 249.
743 Kouki 2013b, 249; Kouki et al. 2013b, 21.

Chapter 5
The Settlement Pattern

The previous chapter discussed the available archaeological evidence pertaining to the different subsistence strategies in the Petraean hinterland. This included isolated agricultural installations, water structures, exploitation/industrial exploitation sites as well as other structures and/or features related to possible pastoral subsistence strategies. This chapter deals with the various rural settlements evidenced in the Petraean hinterland, which were mostly associated with farming and the production of agricultural goods. Adhering to the definitions of the individual site classes (cf. chapter 2), the following discusses possible 'towns,' 'villages,' 'cluster of buildings (hamlets),' 'farms' and 'rural mansions.'

The most comprehensive study on rural settlements in the Petraean hinterland to date is P. Kouki's seminal work, *The Hinterland of a City. Rural Settlement and Land Use in the Petra Region from the Nabataean-Roman to the Early Islamic Period* published in 2012. In 2015, S. E. Wenner also evaluated changes in land use and the settlement pattern within the Petra region, but her aim was primarily to contextualize her analysis of ceramic finds collected by the *Udruh Archaeological Project* (UAP) with other survey results in the region (cf. chapter 1).[744] Kouki's work therefore remains the main reference when considering rural settlement patterns in the study area.

By reconsidering published survey data, she aimed at establishing the pattern of rural settlements and site hierarchies and to further research land use changes and aspects of land ownership in the Petra region.[745] Kouki follows a strong environmental approach and, based on climate as well as environmental data, hypothesizes that the climate of the Petra region grew increasingly arid and may thus be considered as one major factor for the significant decrease of agriculture and the abandonment of permanent settlements in the Petraean hinterland in Late Antiquity. However, she also claims that the development of the rural settlement pattern in the Petraean hinterland was most likely dependent on various factors, reflecting the changing socio-political and economic circumstances of the Petra region over time.

Kouki based her study on a sample set of sites provided by three surveys: the WMWS, Abudanh's survey of the Udruh region, the FJHP as well as other pre-selected individual sites already archaeologically well explored by previous scholars but not part of larger regional surveys (cf. chapter 1).[746] On the basis of this sample dataset, Kouki considered the evidenced sites only as settlements if the reported building remains were structurally significant and datable by surface pottery. She did not consider structures that were interpreted to have had a cultic, funerary or military function, resulting in a dataset of 162 sites. With the inclusion of previously unpublished survey data, this study now considers over 290 rural settlements in addition to other site categories not discussed by previous studies.[747] Additionally, Kouki studied her dataset by "[…] *means of maps and statistics* […]"[748] without conducting landscape archaeological spatial analyses as performed here. This chapter therefore reassesses and expands on the results of Kouki's important work by means of this study's landscape approach, hoping to provide further insights into the change of rural settlement patterns in the Petraean hinterland.

Towns

While there is only limited evidence for Iron Age 'towns' (cf. chapter 3), there are no indications of continued occupation between the 5th and 2nd centuries BC (cf. FIGS. 52–53 and FIGS. 152–154). By the 1st century BC, however, settlement activities at Saddaqa, Khirbet Tal' at 'Umar and Gaia revived.[749] Particularly Gaia reached its largest extent, most likely defined by substantial boundary walls.[750] The town had a mon-

744 Wenner 2015, 81–87.
745 Kouki 2012, 15–17.
746 Kouki 2012, 77–78.
747 Archaeological data not yet available to Kouki, but now considered in this study, include the JSS, ARNAS, ShamAyl, PAWS, the PRP, the PHTP and the PHSP.
748 Kouki 2012, 16.
749 For a description of Saddaqa, see chapters 3 and 7.
750 Cf. 'Amr 2012, 143, Abb. 2.

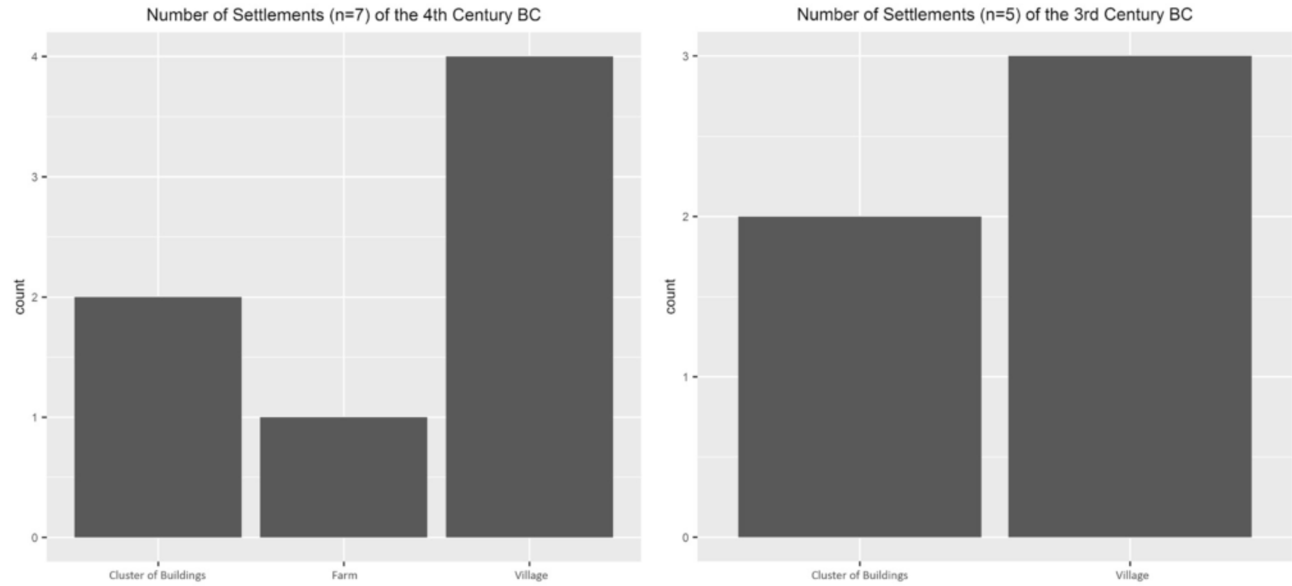


FIG. 152 Number of all settlements dating to the 4th and 3rd century BC.

umental temple (cf. chapter 8), a significant ceramic workshop at az-Zurraba and olive oil was produced locally (cf. chapter 4). Several luxurious Nabataean 'villas' are also known within the boundaries of ancient Gaia. A major factor for the establishment of Gaia was most likely the good availability of spring water, most notably from 'Ain Musa. Situated along the Darb ar-Rasif (later the *via nova Traiana*), Wadi Musa was a central node for long distance caravan trade (cf. chapter 6). Following the Roman annexation, archaeological evidence suggests that the town continued largely unchanged. By the 4th century AD, the settlement appears to have decreased in size, with structures concentrating mostly in the town's center. A possible Byzantine church of the late 5th century AD may indicate that the site nevertheless remained a significant settlement in the Petraean hinterland in Late Antiquity.

In addition to Gaia and Saddaqa, the 1st century BC also marks the foundation of new major settlements at Khirbet Jarba, Udruh, Abu Khusheiba, Sabra and as-Sadeh.

Measuring more than 2 ha, Khirbet Jarba is an extensive site situated on a hilltop north of Udruh immediately east of the road leading to Shawbak (FIG. 155). It is characterized by many rectangular structures of various sizes densely built on the hilltop.[751] There are many corrals at the base of the hilltop and agricultural terraces mark the hill's slopes. Surface pottery suggests that the site was continuously settled from the 1st century BC until the Islamic periods.[752] Textual evidence mentioning the peaceful capitulation of Aila and Udruh to the forces of the Prophet Mohammed in 630 AD also lists Khirbet Jarba, indicating the importance of the settlement in the Late Byzantine/Early Islamic period.[753] Due to its extensive reuse in Late Antiquity, the original Nabataean character of Khirbet Jarba is difficult to determine.

The same challenge applies to Udruh, which developed into a major Diocletianic fortress at the beginning of the 4th century AD (cf. chapter 7). However, abundant Nabatean surface material was observed in and immediately around Udruh by various surveys.[754] Killick claims to have discovered a Nabataean ceramic kiln within the walls of the later *castrum* and documented over 100 kg of Nabataean pottery during excavations at Udruh between 1980 and 1985.[755] More recent surveys and small-scale excavations at Udruh conducted by the Al Hussein Bin Talal University not only revealed more substantial Nabataean pottery material from the 1st–2nd centuries AD, but also two limestone blocks with a Nabataean *nephesh* as well as a *baetylus* used as *spolia* for the Late Roman fortress and Byzantine church at Udruh.[756] Ample archaeological evidence therefore suggests a major Nabataean settlement at Udruh long before the construction of the Late Roman fortress. This is further corroborated by historical sources that refer to Udruh (ancient Adrou) exclusively as a civilian settlement as early as Ptolemy's first mentioning of the site in the first

751 MacDonald et al. 2016, 349. South of the site, there is a singular tower.
752 MacDonald et al. 2016, 349; Abudanh 2006, 412–413.
753 Fiema 2002, 234 and 237 with n. 321.
754 Driessen – Abudanh 2018, 132–133; Parker 1986, 95 as well as Glueck 1935, 76–77 and Brünnow – von Domaszewski 1904, 59–60.
755 Driessen – Abudanh 2013, 52, n. 23 and Killick 1987.
756 Fiema 2002, 234 and 237 with n. 321.

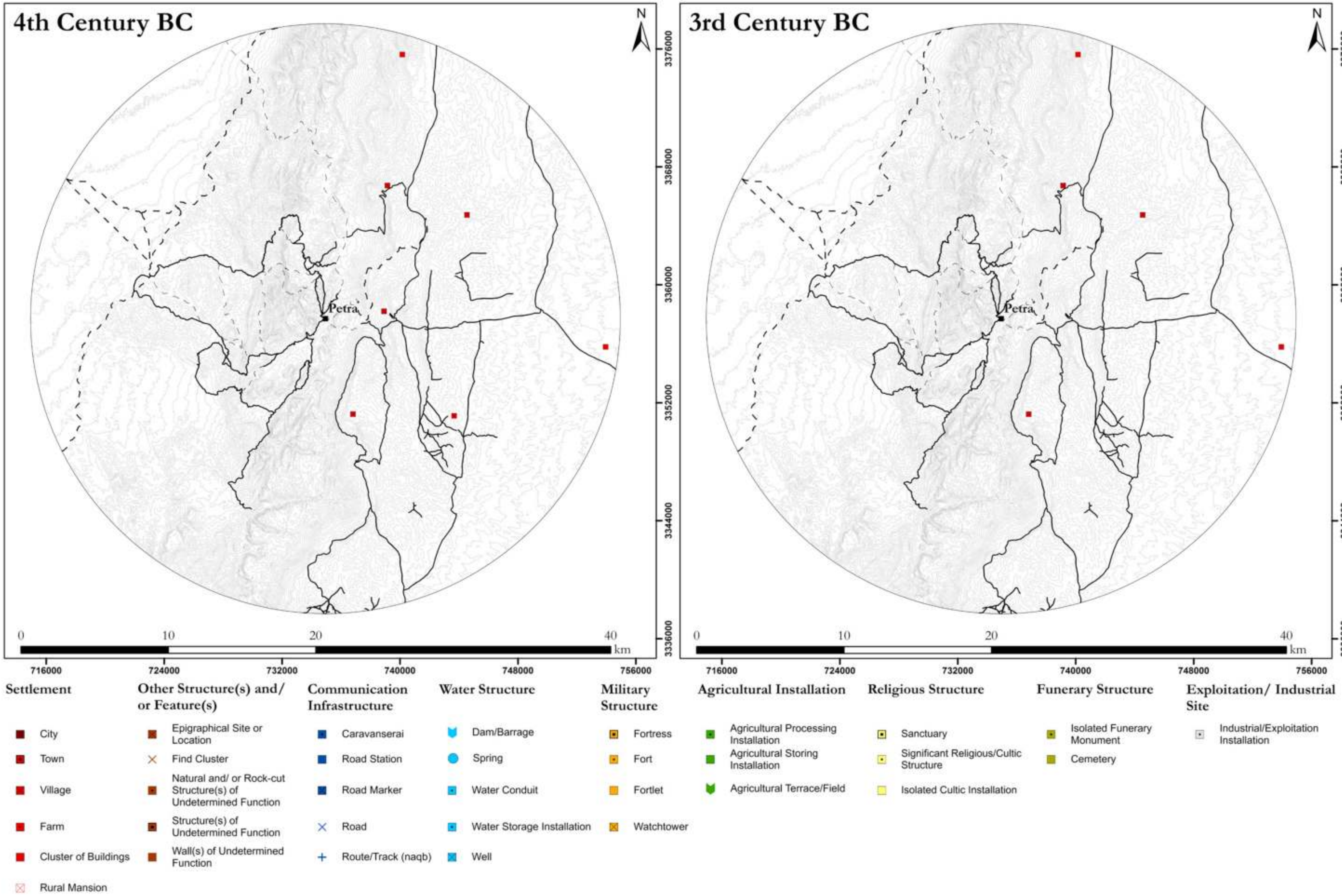


FIG. 153 Distribution map of all settlements dating to the 4th and 3rd century BC.

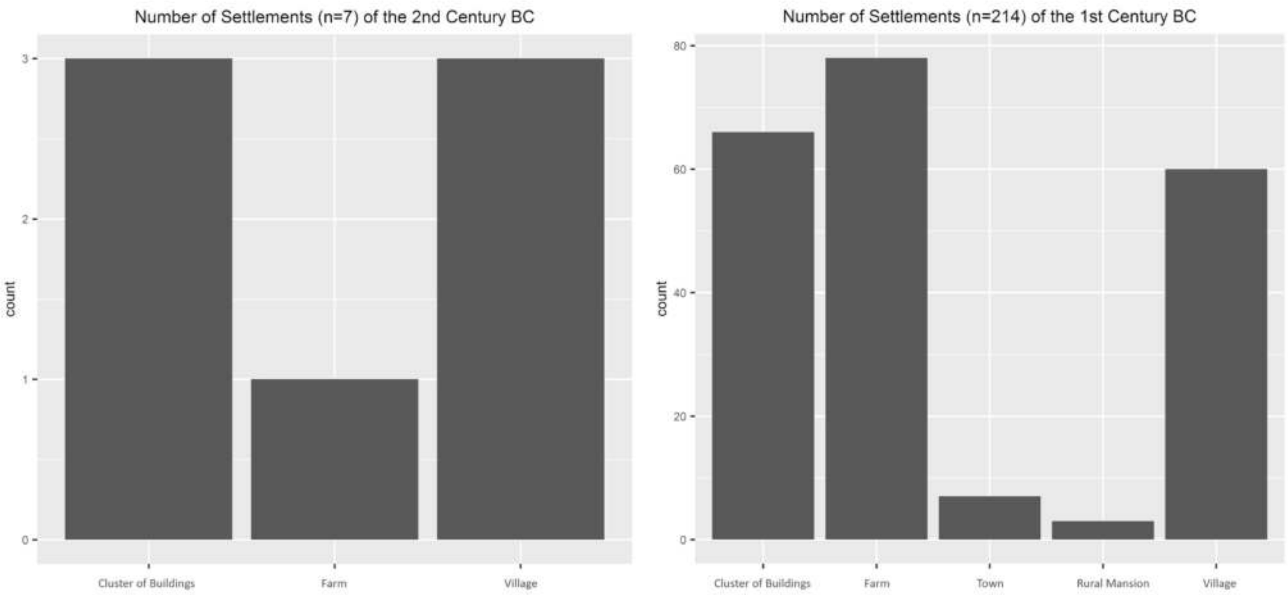


FIG. 154 Number of all settlements dating to the 2nd and 1st century BC.

half of the 2nd century AD.[757] The site can therefore be considered a major Nabataean settlement, possibly even a town, that prospered from caravan trade as it is situated along important routes, forming a significant infrastructural focal point connecting the Petraean hinterland with the vast desert area east of Udruh. The site seems to have been continuously occupied during the annexation process until the *castrum* was constructed. The military occupation of Udruh may have lasted only until the mid-4th century AD when the site regained its primary status as a civilian settlement. This is suggested by early 5th century AD episcopal lists referring to bishops from the town of *Augustopolis*, which has been safely identified as modern Udruh.[758] The 6th century AD Beersheva Edict as well as the Petra Papyri also mention *Augustopolis*.[759] Furthermore, the town is reported to have been rebuilt by the Ghassanid Jabla Ibn al-Harith and submitted peacefully to the Muslim forces in 630 AD after the payment of 100 dinars for protection.[760] Known as *Adruh* in the Early Islamic period, it was the main town in the district of al-Shara of the al-Balqa province.[761]

Abu Khusheiba is situated c. 7,5 km southwest of Petra and is a major Nabataean settlement along the route Naqb Saqqara that connects the site with Petra's immediate southwestern hinterland. After reaching the site via Naqb Saqqara, one continues further westwards through Wadi Abu Khusheiba to the Wadi Arabah, from where access to farther-reaching trade routes either further west along the Petra–Gaza road or along the Wadi Arabah's north-south axis is available (cf. chapter 6).[762] The site can also be accessed from Sabra via Naqb ad-Beidab. Abu Khusheiba is thus situated along important ancient trade routes that connected Petra with its farther-reaching western hinterland with a possible relation to the nearby copper mines of Umm al-'Amad (cf. chapter 4).[763] The infrastructural and economic importance of Abu Khusheiba certainly explains the extensive archaeological record (FIG. 156): Lindner has identified eleven large, well-built structures at Abu Khusheiba. He postulated that two of these structures could have been of possible cultic function or at least of luxurious domestic nature.[764] While these interpretations are based on preliminary surface observations alone and should be considered critically, the vast amount of Nabataean fine and coarse ware (mostly from the 1st century AD), marble fragments, a terracotta figurine as well as the overall good quality of the various structures clearly suggests that Abu Khusheiba was a major Nabataean settlement of particular prosperity. The numerous agricultural terraces observed in the immediate vicinity of Abu Khusheiba attest further to the site's importance. The terraces arguably supplied a

757 Ptol. Geog. 5, 16, 4.
758 Kennedy – Falahat 2008, 152.
759 Kennedy – Falahat 2008, 152. Fiema 2002a, 209.
760 Fiema 2002a, 210 with further references; Brünnow – von Domaszewski 1904, 431.
761 Fiema 2002a, 210 with further references; Brünnow – von Domaszewski 1904, 431.
762 The only comprehensive work on Abu Khusheiba remains M. Lindner's brief reports on the site. See Lindner 2003a, 66–74 and Lindner 1992a.
763 King et al. 1989, 205–207.
764 Lindner 2003a, 66–74 and Lindner 1992a.

FIG. 155 Aerial view of Khirbet Jarba with surrounding fields. Photo: APAAME.

larger number of people.[765] Thus, although there is yet little known archaeologically of Abu Khusheiba, the site's infrastructural significance as well as its known archaeological remains indicate a major, town-like settlement that seemingly thrived from the 1st century AD onwards until it was abandoned at some point during the 3rd/4th century AD.

The site of Sabra is not only connected with Abu Khusheiba. More importantly, it stretches along the banks of Wadi Sabra, an important route connecting the western Petraean hinterland with the Wadi Arabah. Arguably, this route is one of the best suitable routes for camel-based travel (cf. chapter 6). In addition to Naqb ad-Beidab and Wadi Sabra, Sabra is also accessible by two other camel routes (Naqb ar-Risha'rish and Naqb ad-Dab'e). These routes better connected Sabra with the al-Farasha plain below Jabal Harun as well as with the significant settlement of as-Sadeh further south. Located at the crossroads of these camel routes, Sabra was an important infrastructural and economic focal point. This was probably a major factor for the monumentality of the site.[766] Sabra's core is undoubtedly the large sanctuary crowning the settlement on a small hilltop on the northern wadi bank (FIG. 157).[767] The sanctuary is characterized by three surrounding (crypto-)porticoes built at the beginning of the 1st century BC and 1st century AD. It enwalled at least one monumental temple which was constructed in the mid-1st century AD. At the turn of the late 1st/early 2nd century AD, the sanctuary was significantly extended corresponding to the construction date of the heated bathing complex immediately to the west of the sanctuary. Both structures were continually used during the Roman period, but toward the Late Roman period underwent significant modifications of a yet uncertain nature. Opposite of the sanctuary, a theatre – framing a huge water reservoir and complex hydraulic system for

765 Lindner 2003a, 72 hypothesizes a population size of over 100 people based on the recorded structures at Abu Khusheiba. Lindner also stresses the significance of the site: *"Die Keramik und die sonstigen wenigen Streufunde markieren eine Siedlung von gewissem Wohlstand und mit einer baulichen Ausstattung, die über die eines «Dorfes» hinausgeht."*

766 Sabra may be identified with 'Sabure' listed in the Notitia Dignitatum (Tholbecq 2016, 1072).

767 For the most recent archaeological investigations at Sabra, see the works of the French archaeological mission under the direction of L. Tholbecq, most recently published in Tholbecq et al. 2019 and 2016 as well as Tholbecq 2016, 1072. However, the site has already been extensively researched before by previous scholars. See e.g. Lindner – Zeitler 1997 and Zeitler 1992 with further references.

FIG. 156 Overview of some of the major structures along the southern slope of Abu Khusheiba.

the provision of water – was carved out of the bedrock, possibly seating a few hundred people during religious festivities associated with the sanctuary.[768] Whether these festivities were associated with caravan trade is uncertain, but the presence of a large rectangular structure, which is currently interpreted as a possible caravanserai or fort, further underlines the infrastructural importance of the site.[769] Copper slags were also discovered at Sabra, leading previous scholars to suggest that the site was a copper smelting site. These slags were associated with Nabataean pottery and are concentrated mainly northwest of the site.[770] However, it is doubtful that copper was directly smelted at Sabra, as no smelting furnaces are known at the site thus far. Although the sanctuary area underwent major changes in the Late Roman period and previous soundings at the bathhouse and temple revealed Late Roman/Byzantine material as well, the nature of the site remains undetermined for these later phases. The site was probably abandoned at some point during the 4th century AD.[771]

The significant settlement of as-Sadeh is situated c. 11 km south of Sabra. From there, as-Sadeh can be reached via the route of Naqb ar-Risha'rish following the Wadi Arabah southwards until entering the Wadi Hamada and turning into the Wadi as-Sadeh. It is likely that major camel caravans coming from South Arabia and stopping at ancient Hawara (modern Humeima) could have also turned northwestwards in direction of as-Sadeh (cf. chapter 6). As-Sadeh can therefore be considered a major settlement along important trade routes as well.[772] The site stretches along the steep slopes of the Wadi as-Sadeh featuring several structural remains and agricultural terraces (FIG. 158). The main settlement area is on a hilltop above the wadi, including a possible Nabataean temple.[773] While there is only little known about the site in previous periods (cf. chapter 3), settlement activity concentrated along the lower slopes of

768 Most recently on the theater: Tholbecq et al. 2019.
769 See e.g. Tholbecq et al. 2016, 289–290. This study rejects the interpretation of the structure as a fort (cf. chapter 7).
770 Glueck 1935, 80–81. Tholbecq et al. 2016, 294 considers the smelting activities to be late.
771 On the soundings, see Lindner – Zeitler 1997.
772 Cf. also e.g. Lindner 2003a, 31–32.
773 Generally on as-Sadeh, see the works of M. Lindner: Lindner 2005 and 2003a, 29–54; Lindner et al.1990 and 1988.

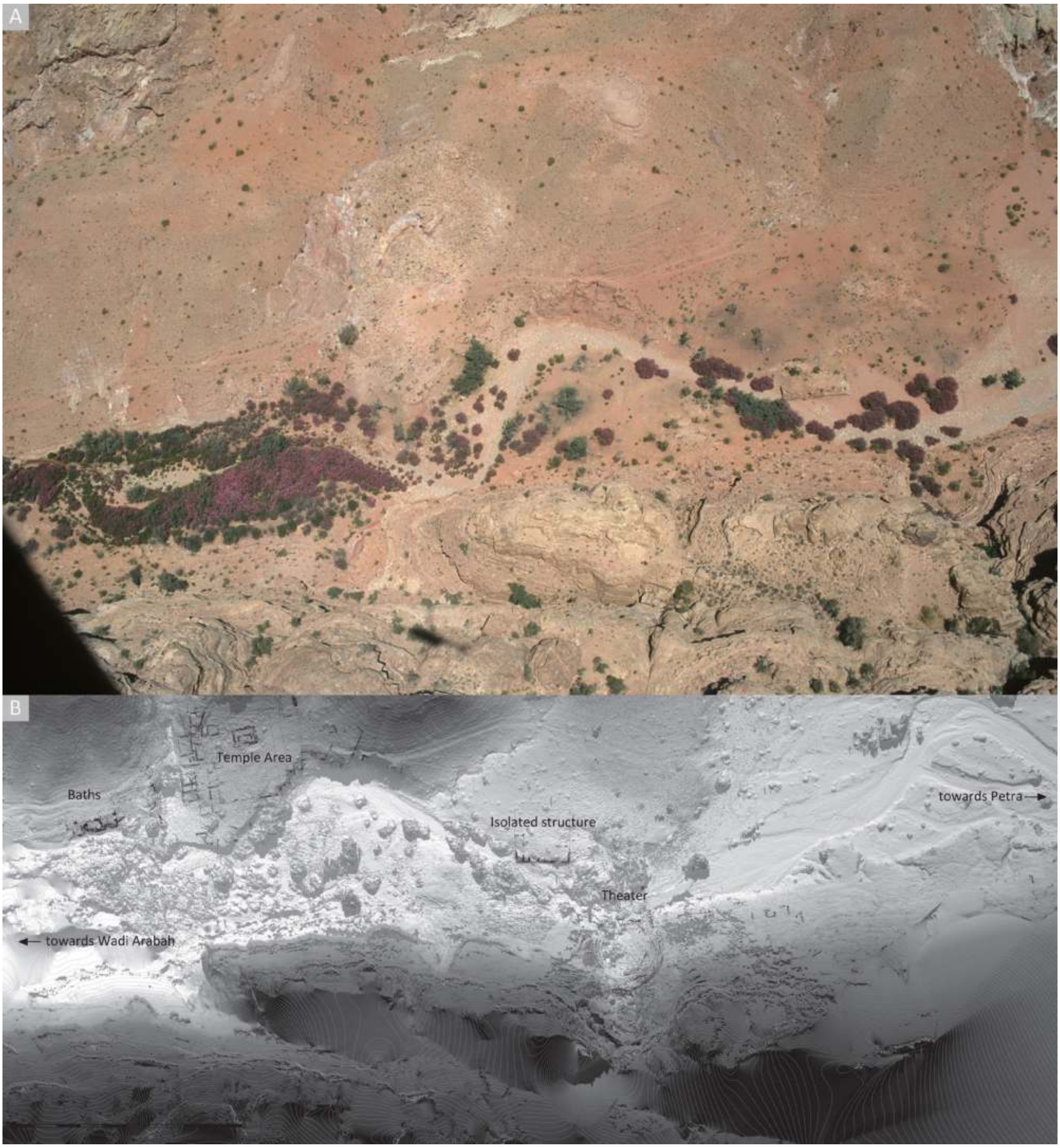


FIG. 157 Overview of the major Nabataean settlement of Sabra. A: Aerial view. Photo: APAAME. B: Plan after Tholbecq et al. 2016, 280, fig. 3.

the Wadi as-Sadeh in the Nabataean period. The various structures probably served mainly utilitarian purposes. As-Sadeh is most famous for its Nabataean aqueduct. It was both freely built and carved into the natural bedrock of the Wadi as-Sadeh gorge and diverted fresh spring water to the settlement. Based on surface material and the documented structures, the site was as a major settlement, at least during the Nabataean-Roman periods (1st to 3rd centuries AD). It was probably abandoned during the late 3rd/early 4th centuries AD.

During the 1st centuries BC and AD, the major Nabataean settlements of Khirbet Jarba, Udruh, Saddaqa, Abu Khusheiba, Sabra and as-Sadeh played an arguably important role in the Petraean hinterland. While Abu Khusheiba, Sabra and as-Sadeh were abandoned by the Late Roman/Early Byzantine period (late 3rd/early 4th centuries AD), the only major, town-like settlements still occupied in Late Antiquity were Saddaqa, Khirbet Tal' at 'Umar, Gaia and Khirbet Jarba.

These sites were mostly related to the management and administration of trade activities as they are situated along significant trade routes. An important question is whether these settlements were 'satellite

FIG. 158 A: Overview sketch of the archaeological remains of as-Sadeh viewing to the SW after Lindner 2003a, 32, Abb. 4. B and D: Remains of the partly built, partly rock-cut aqueduct that fed as-Sadeh with fresh water. C: Entry into the Wadi as-Sadeh gorge. View to NNE.

settlements' of Petra (as is suggested for Sabra[774]), or autonomous communities that were subjected to the Nabataean kings residing in Petra. For example, Lindner hypothesized that Abu Khusheiba was established either directly by the Nabataean court or by a wealthy local tribal leader:

> *Man ist geneigt, solche Unternehmungen in nabatäischer Zeit dem „Hof" oder reichen Stammesführern (Scheichs) zuzuschreiben, die auf diese Weise ihre Gewinne anlegten und gleichzeitig durch die Förderung des Gemeinwohls auch Ansehen gewannen.*[775]

The impact of persisting tribal social structures on territorial management in the Petraean hinterland is indeed a crucial issue.[776] The few historical references to Nabataean landownership come from the 'Papyrus Starcky' as well as the Babatha archive dating around the mid-1st century AD.[777] These documents state that, at that time (and likely before), land was considered private property, but this concerns agricultural lands only and does not explain how or who managed territories of larger urban centers outside Petra. However, the documents do suggest a well-developed sense of territoriality and land ownership in Nabataean times.

774 Note e.g. the title of Tholbecq et al. 2016 "Sabrah, a satellite hamlet of Petra."

775 Lindner 2003a, 73. Lindner's proposal that Abu Khusheiba was administered by a local tribal leader may be underlined when considering that the monumental rock-cut tomb of Mukheifer (cf. chapter 8) is not far from Abu Khusheiba and may have been the burial place of a local leader. However, this can only remain hypothetical.

776 Lindner (2003a, 51–52) provides an interesting ethnographical observation when describing his team's arrival at as-Sadeh in the late 1980s. Arriving at night and accompanied by a representative of the Department of Antiquities as well as local Bedouins from the Petra area, Lindner and his team were arrested because they unknowingly trespassed through the territory of the *Sa'idiyin* tribe without asking for permission and hiring local *Sa'idiyin* workmen in advance. While it is problematic to uncritically compare tribal structures of modern Bedouin societies with antiquity (cf. Macdonald 1991), this account nevertheless highlights the importance of considering the potential impact of tribal social structures on travel and territorial management in the Petraean hinterland.

777 See Kouki 2012, 124 with further references.

On this basis, the possibility may be explored that the presented 'towns' acted as autonomous communities with well-defined territories while answering to the political will of Petra (cf. chapter 9).

Villages

As too many villages were identified to go into detailed archaeological discussions of individual sites, this section focuses more on the statistical and landscape archaeological evaluation of the available data.

While nearly all rural settlements were abandoned during the 5th century BC (with the exception of Tawilan and Abu Danna as stated in chapter 3), additional villages are reoccupied at Khashm as-Suwwan (ShamAyl Site No. 25), Khirbet al-Arja (ShamAyl Site No. 205) as well as ShamAyl Site No. 353 in the 4th century BC. However, with only seven settlements in total, the Petraean hinterland continues to be largely void of settlements (cf. FIGS. 152–153). During the 3rd and 2nd centuries BC Tawilan is also abandoned (cf. FIGS. 152–154).

Corresponding to the sedentarization of the Nabataeans and increasing monumentalization of urban Petra, Petra's hinterland experiences an explosive increase of rural settlements by the 1st century BC. The total number of settlements rises to 214, or more than double than in the previous periods. In accordance with this general increase, the number of villages rises significantly as well (60/214 settlements in total). Villages are now only the third largest category of all settlement types falling behind smaller settlements such as cluster of buildings and single farms (cf. FIGS. 154 and 159). This is a different picture than that presented by Kouki for the 1st century BC, who claimed that not even ten settlements date to this period.[778] While Kouki could evidence only an extremely low number of archaeological sites for the 1st century BC, she argues that this represented the slow and gradual transformation of Nabataean society towards a sedentary lifestyle and the heightened need of agricultural products triggered by the increase of trade in the 1st century AD. However, as this study can now present a significantly higher number of rural settlements for the 1st century BC, this process seems to have been completed one century earlier. Kouki's claim of a 'three-tiered settlement hierarchy' for the 1st and 2nd centuries AD, which is characterized by many smaller settlements including single farms, a few medium-sized settlements (e.g. hamlets etc.) and even fewer large settlements (i.e. villages and towns)[779], seems mirrored by the stark increase of smaller settlement types that significantly exceed the number of larger settlements such as villages. However, this can already be observed here for the 1st century BC.

The KDE of all evidenced villages for the 1st century BC now suggests an even more differentiated clustering of villages than for the previous periods (FIG. 160). This can be observed for the Jabal Shara escarpment north of Petra, but most notably in the immediate Wadi Musa area. Although the Jabal Shara area appears to be the focal point of villages, areas around Ayl/Basta as well as northwest of Udruh are also densely clustered by villages. The Pearson correlation test only suggests weak and very weak spatial correlations between villages and other archaeological sites, which seems to support the hypothesis of a rising importance of smaller settlements by the 1st century BC (TABLE 22).

This general trend of the settlement pattern continues in the 1st century AD as well. The number of villages rises according to the continually increasing count of settlements in general, although villages are now the second largest category (75/268) behind single farms (FIG. 161). However, the KDE suggests that villages are now less clustered in areas north of the Petra-Udruh road (FIG. 162). Instead, they seem to cluster predominantly in the southeastern part of the study area. Clusters of villages can be observed at the crossroads of the Darb ar-Rasif and Graf's central road south of at-Tayyiba (cf. chapter 6) as well as the Wadi Musa, al-Bitar and Ayl areas and the region north of Fardakh. All village clusters concentrate around the evidenced road network along the eastern high plateau. As for the 1st century BC, the Pearson correlation test does not indicate any significant spatial relation to other archaeological sites, which further confirms the importance of smaller settlements (TABLE 23).

In the 2nd century AD, the situation remains the same, although there is a slight increase of settlements, including villages (now 79/270) (cf. FIGS. 161 and 163). The KDE results support this (FIG. 164). The Pearson correlation test also remains unchanged (TABLE 24).

By the 3rd century AD, a significant decrease of all rural settlements can be observed and villages are no exception (now counting 62/201) (FIG. 165). Nevertheless, villages remain the second largest category of all settlements despite the equally declining number of smaller settlement types such as cluster of buildings and farms. Apart from the area south of at-Tayyiba, the KDE now suggests a generally less dense cluster of villages south of the Petra-Udruh road (FIG. 166). A slight shift of villages to the east can also be observed.

778 Kouki 2012, 84 and 82–83, fig. 4–6 as well as 86, Map 18.

779 Kouki 2012, 97, 129.

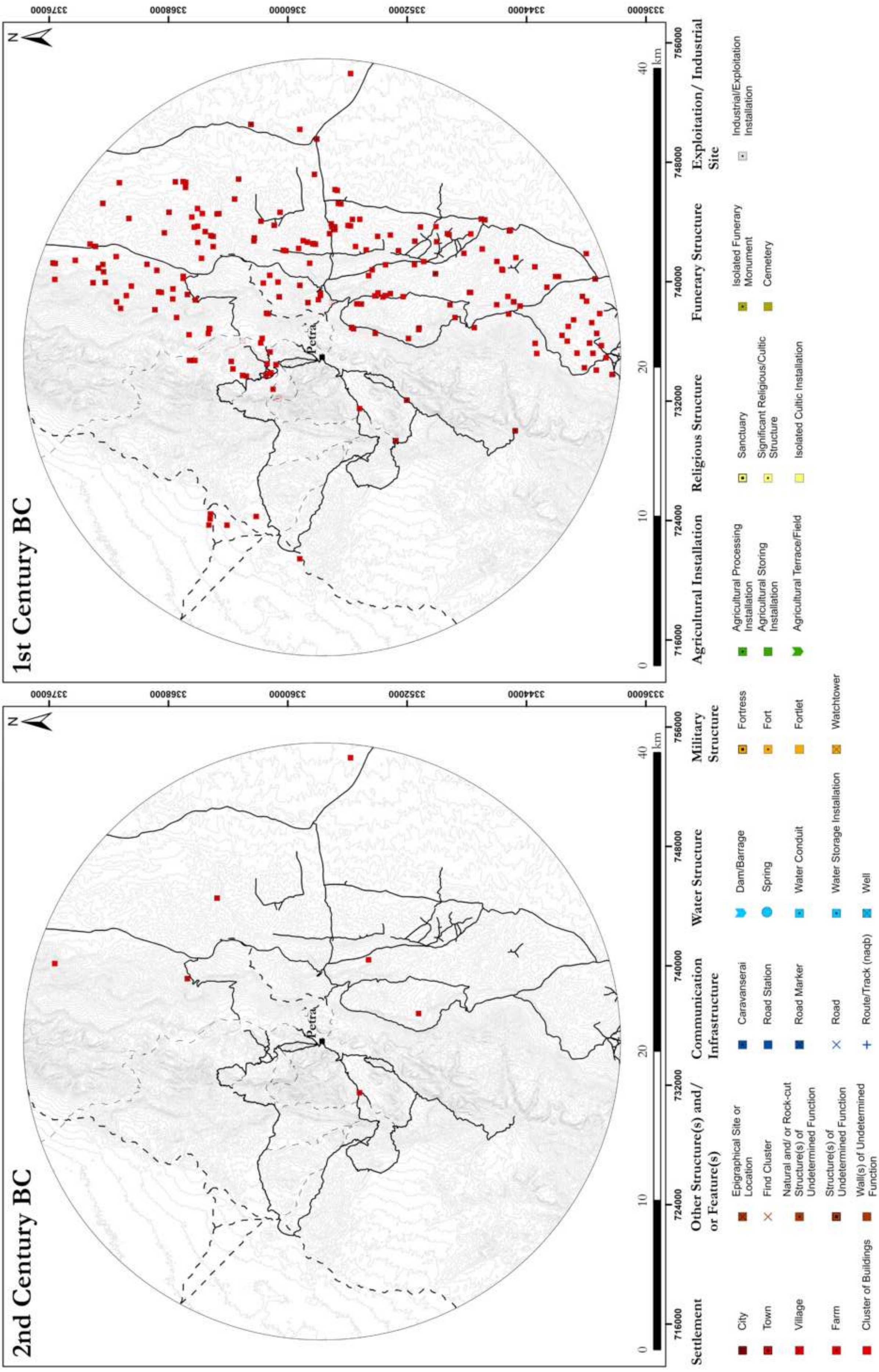


FIG. 159 Distribution map of all settlements dating to the 2nd and 1st century BC.

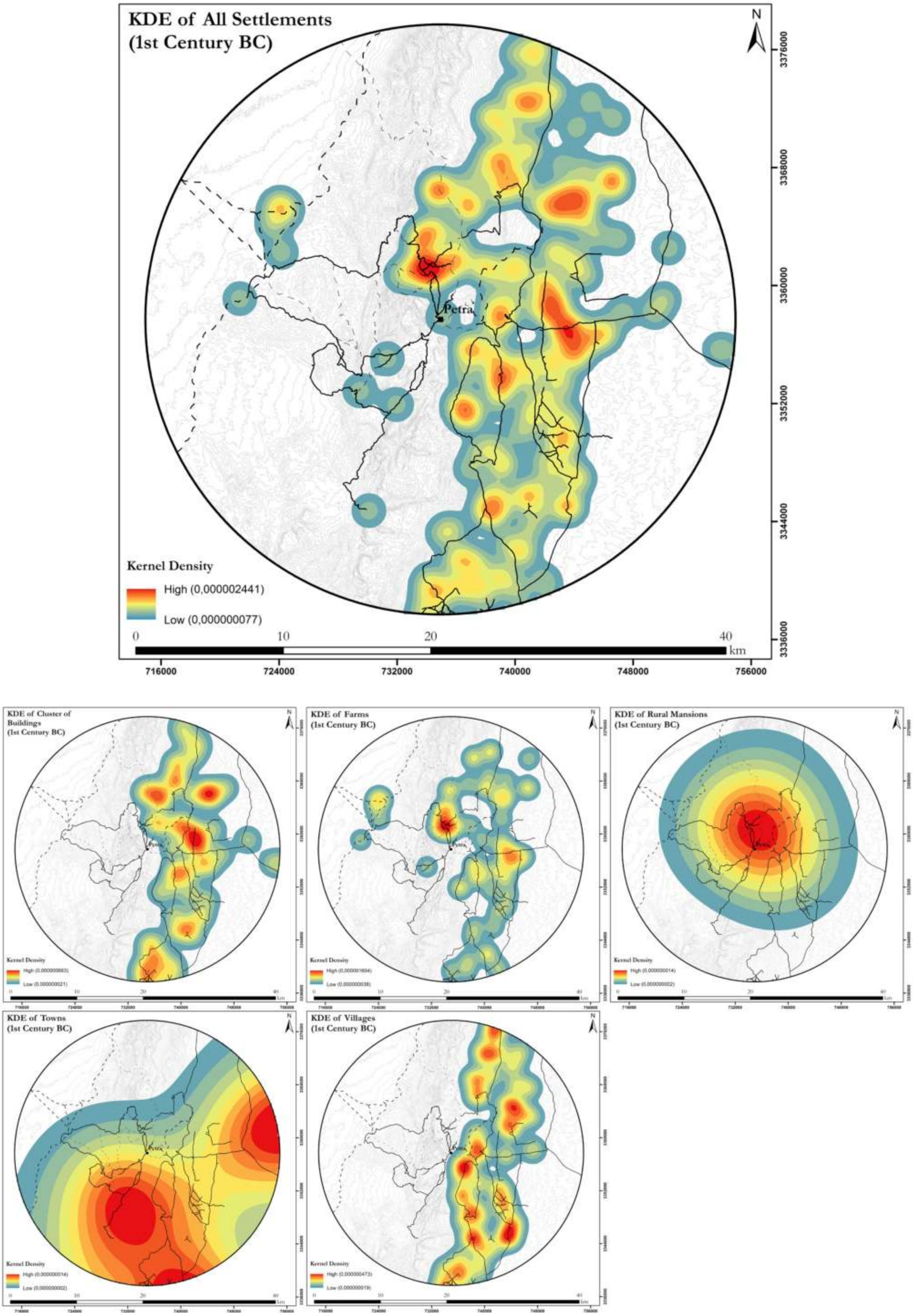


FIG. 160 Kernel density estimations of all settlements (above) and the individual subcategories of settlements dating to the 1st century BC.

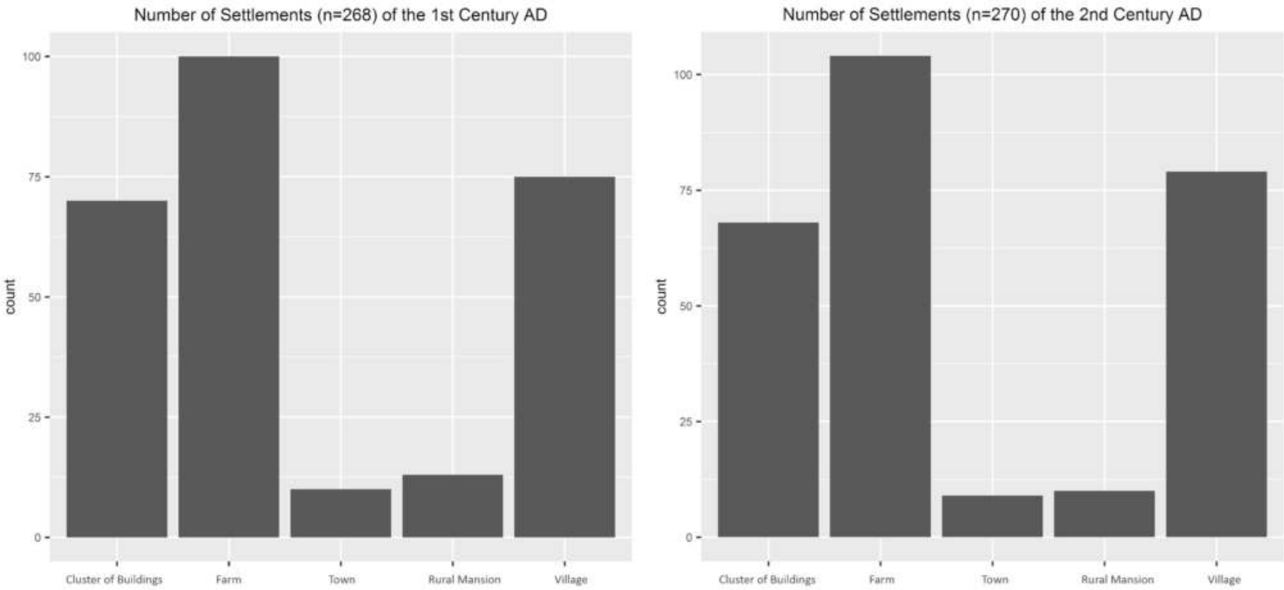


FIG. 161 Number of all settlements dating to the 1st and 2nd century AD.

The Pearson correlation test still does not indicate any significant spatial correlation to other sites, which possibly suggests that smaller settlements continued to be more important despite their declining numbers (TABLE 25). These findings may confirm Kouki's assumption that with the decline of long-distance trade by the 3rd century AD, the need for agricultural products became increasingly less, thus marking a growing nucleation around larger settlements and decreasing importance of smaller settlements that she observed for the late 3rd/early 4th centuries AD.[780]

Arguably, this development is also tentatively reflected by this study's analysis of settlements for the 4th century AD. The number of villages rises slightly (67/204) while smaller settlements such as cluster of buildings and farms continue to decrease (cf. FIGS. 165 and 167). However, villages continue to be only the second largest category behind farms. The KDE for the 4th century AD suggests a continuing shift of villages towards the east (FIG. 168). The areas around Wadi Musa, Ayl/Basta as well as the region northwest of Udruh are again slightly more densely clustered. The Pearson correlation test does not indicate any changes, thus suggesting that the presumed nucleation around larger sites proceeded only gradually during the 4th century AD (TABLE 26).

The evidence for the 5th century AD seems to highlight this development more clearly: The overall count of settlements continues to decrease significantly, including the total number of villages (57/152) (FIG. 169). Villages are now the largest category of all evidenced settlements – which has not been the case since the 3rd century BC. The KDE demonstrates that the nucleation process of villages seems to apply mostly to the area south of at-Tayyiba along the Jabal Shara escarpment although a less dense cluster of villages continues the already observed eastern shift (FIG. 170). The Pearson correlation test still suggests no significant spatial correlation between villages and other sites (TABLE 27). This may be due to the described concentration of villages around the southern at-Tayyiba area.

For the 6th century AD, the same observations can be made (FIGS. 169, 171 and TABLE 28), although the KDE indicates a clearly denser cluster of villages between the at-Tayyiba and Fardakh area than before (FIG. 172).

During the 7th century AD, villages continue to be the largest category of all settlements (53/144) despite the overall decreasing number of settlements (FIGS. 173–174). The KDE shows that the cluster of villages between at-Tayyiba and Fardakh already observed for the 6th century AD increased significantly, together with dense clusters at areas north of Saddaqa and northwest of Udruh (FIG. 175).[781]

The results on the development of villages in the Petraean hinterland generally confirm Kouki's argument for an increasing nucleation around larger settlements beginning gradually in the 4th century AD and becoming most evident for the 5th century AD. The count of smaller settlements decreases and larger

780 Kouki 2012, 85–90 and 130.
781 The Pearson correlation test now suggests a strong spatial correlation between walls of undetermined function (TABLE 29). This is probably due to the several wall lines identified by the WMWS in the at-Tayyiba area (ʾAmr et al.1998, 533 and 535).

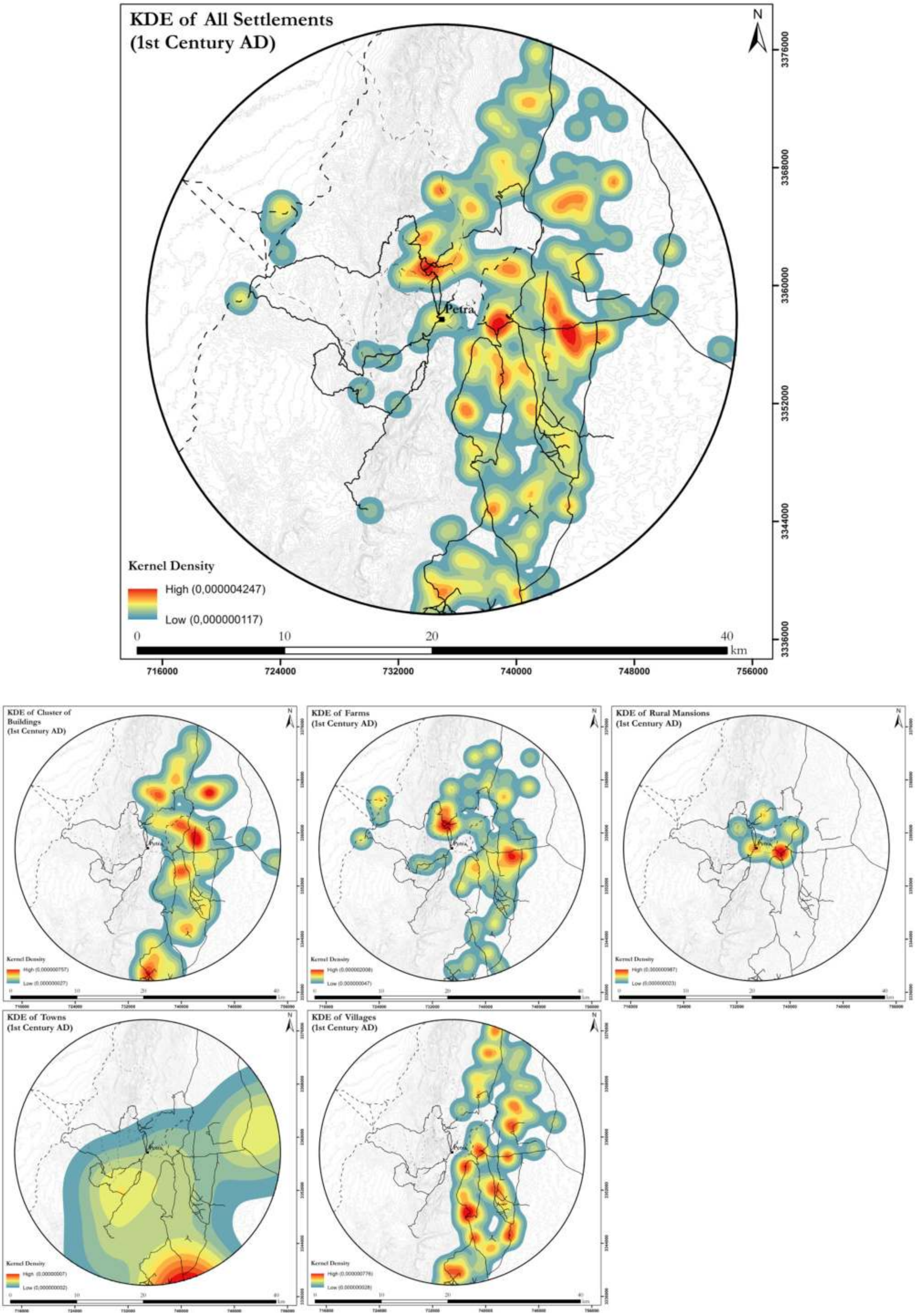


FIG. 162 Kernel density estimations of all settlements (above) and the individual subcategories of settlements dating to the 1st century AD.

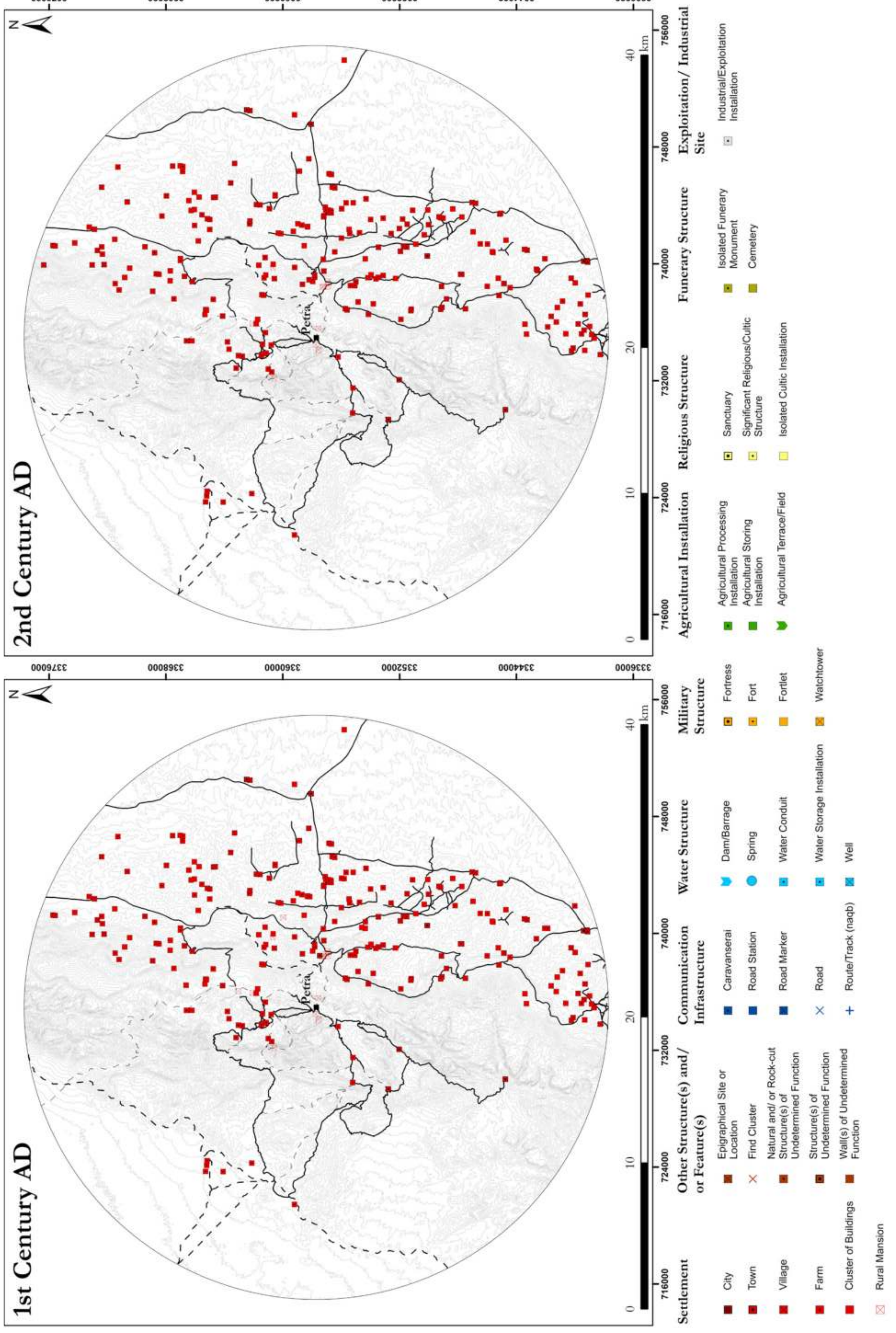


FIG. 163 Distribution map of all settlements dating to the 1st and 2nd century AD.

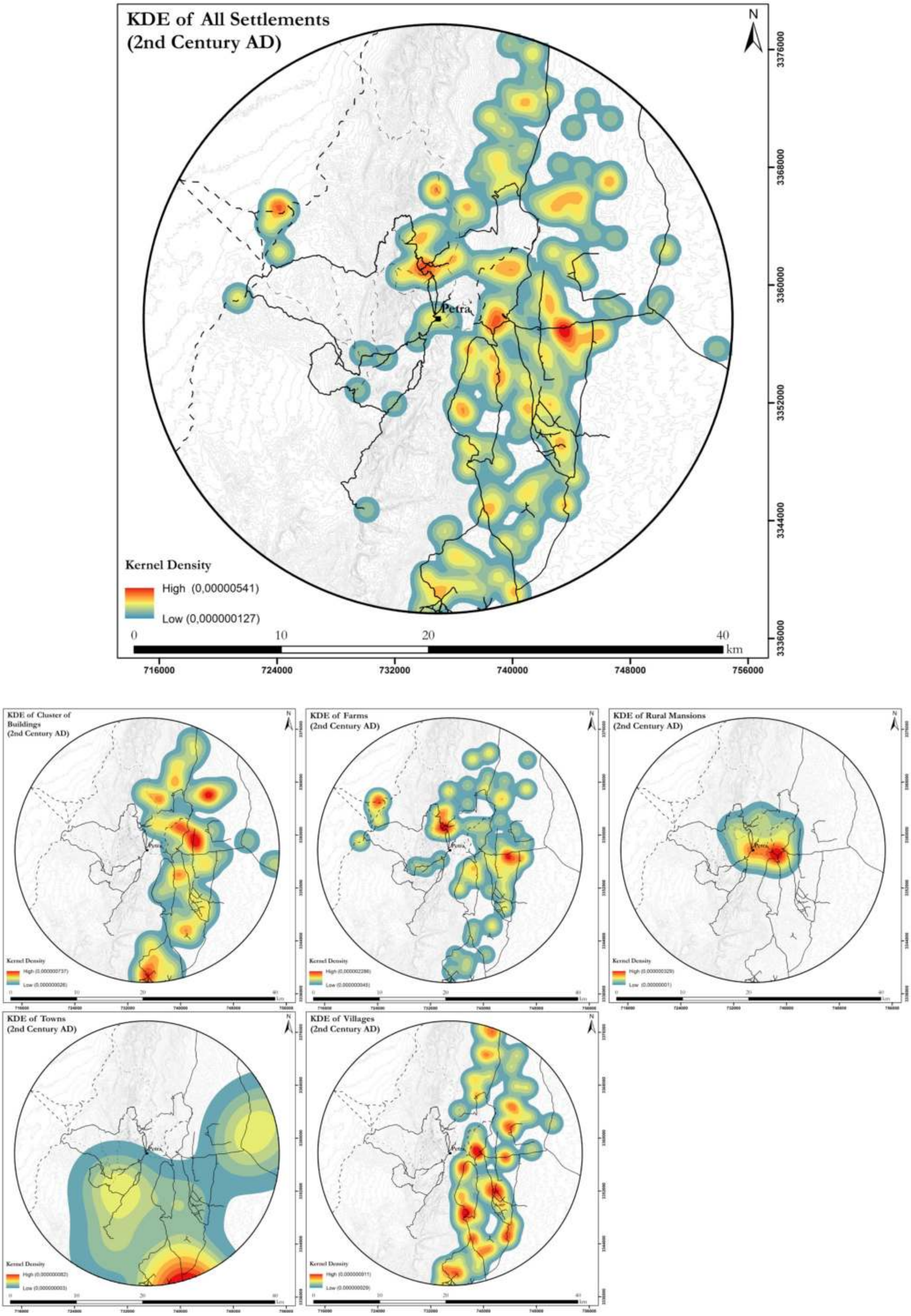


FIG. 164 Kernel density estimations of all settlements (above) and the individual subcategories of settlements dating to the 2nd century AD.

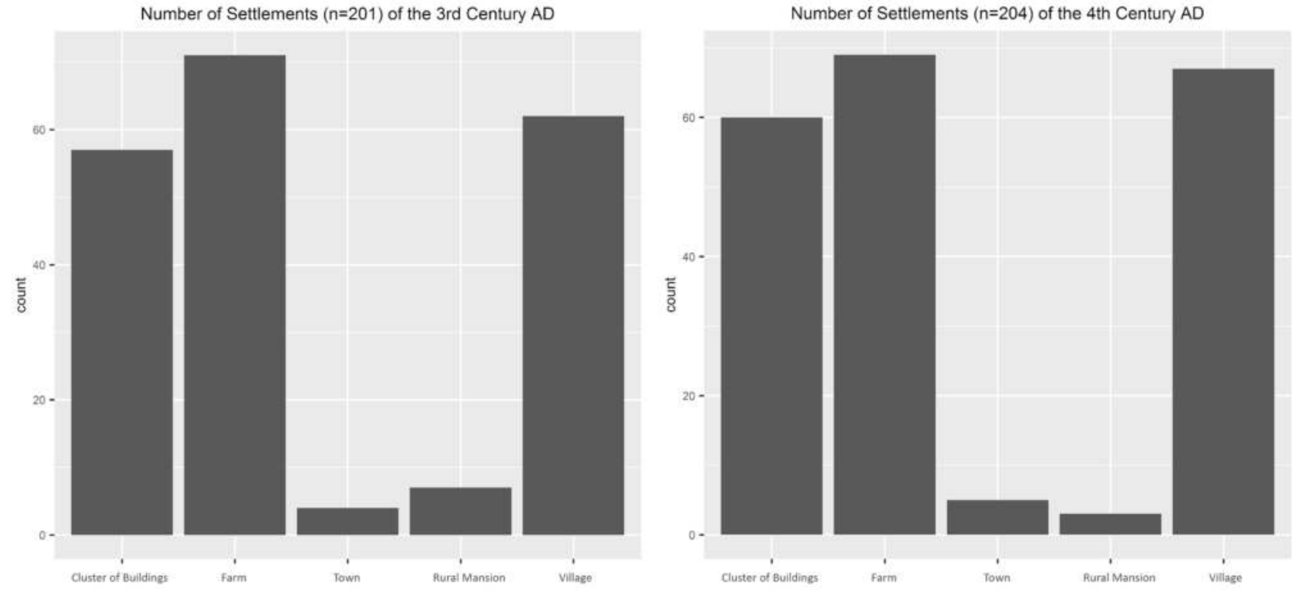


FIG. 165 Number of all settlements dating to the 3rd and 4th century AD.

settlements such as the presented villages grow increasingly important in Petra's hinterland. The nucleation of villages continues during the 6th and 7th centuries AD while the number of small sites continues to decrease. By the 7th century AD, the settlement pattern grew even more concentrated around large villages as suggested by the KDEs. However, Kouki's claim that during the Late Byzantine period settlements concentrated more along the eastern peripheries of the study area between Udruh and Ma'an cannot be confirmed here – at least not for the evidenced villages, which seem to remain largely west of Udruh.

Cluster of Buildings (Hamlets)

The site class 'cluster of buildings' encompasses an agglomeration of structures that most likely functioned as a civilian settlement and can thus be equated with the often loosely defined term 'hamlet.' As for the described villages, due to the high number of sites identified as cluster of buildings, it is impossible to discuss all in full archaeological detail. This section therefore emphasizes the statistical and landscape archaeological evaluation of the evidenced clusters of buildings.[782]

While all clusters of buildings are abandoned by the 5th century BC (cf. chapter 3), only ShamAyl Site No. 282 is resettled. Khirbet al-Faqi (ShamAyl Site No. 143) is apparently founded in the 4th century BC. Both are situated along the Jabal Shara escarpment (cf. FIGS. 152–153).[783] These remain the only two clusters of buildings during the 3rd century BC (cf. FIGS. 152–153), but JSS Site No. 117 is additionally settled in the 2nd century BC as well when clusters of buildings develop into the largest category of all settlements (3/7) alongside villages (cf. FIG. 154).[784]

During the 1st century BC, the overall count of all settlement types increases dramatically and the number of clusters of buildings rises to 72 (out of 214 settlements in total), thus being the second largest category of all evidenced settlements (cf. FIG. 159). As indicated by the KDE, the overall pattern is similar to that of the 10th century BC, but the observed clusters are significantly denser (cf. FIG. 160). This particularly concerns the areas around Saddaqa, regions northeast of Wadi Musa as well as the far northeastern part of the study area. There is a significant cluster west of the Jabal Shara escarpment in the area north of Beidha as well. The Pearson correlation test does not suggest any strong spatial correlations to other archaeological sites (cf. TABLE 22). This may indicate that the evidenced clusters of buildings were increasingly isolated communities and highlight the growing importance of smaller settlements such as farms.

During the 1st century AD, the overall count of clusters of buildings stagnates (still 72 evidenced

782 All evidenced clusters of buildings are listed in the site catalogue (Appendix I). Note that M. Ladurner is studying one possible Nabataean hamlet (1st – 2nd century AD) with a later Byzantine phase at Khirbet at-Trabsieh along the eastern high plateau in further detail (Ladurner 2017).

783 MacDonald et al. 2016.

784 Villages possibly settled during the Hellenistic period are: Khashm as-Suwwan (ShamAyl Site No. 25), Khirbet al-Arja (ShamAyl Site No. 205) as well as ShamAyl Site No. 353 (cf. above).

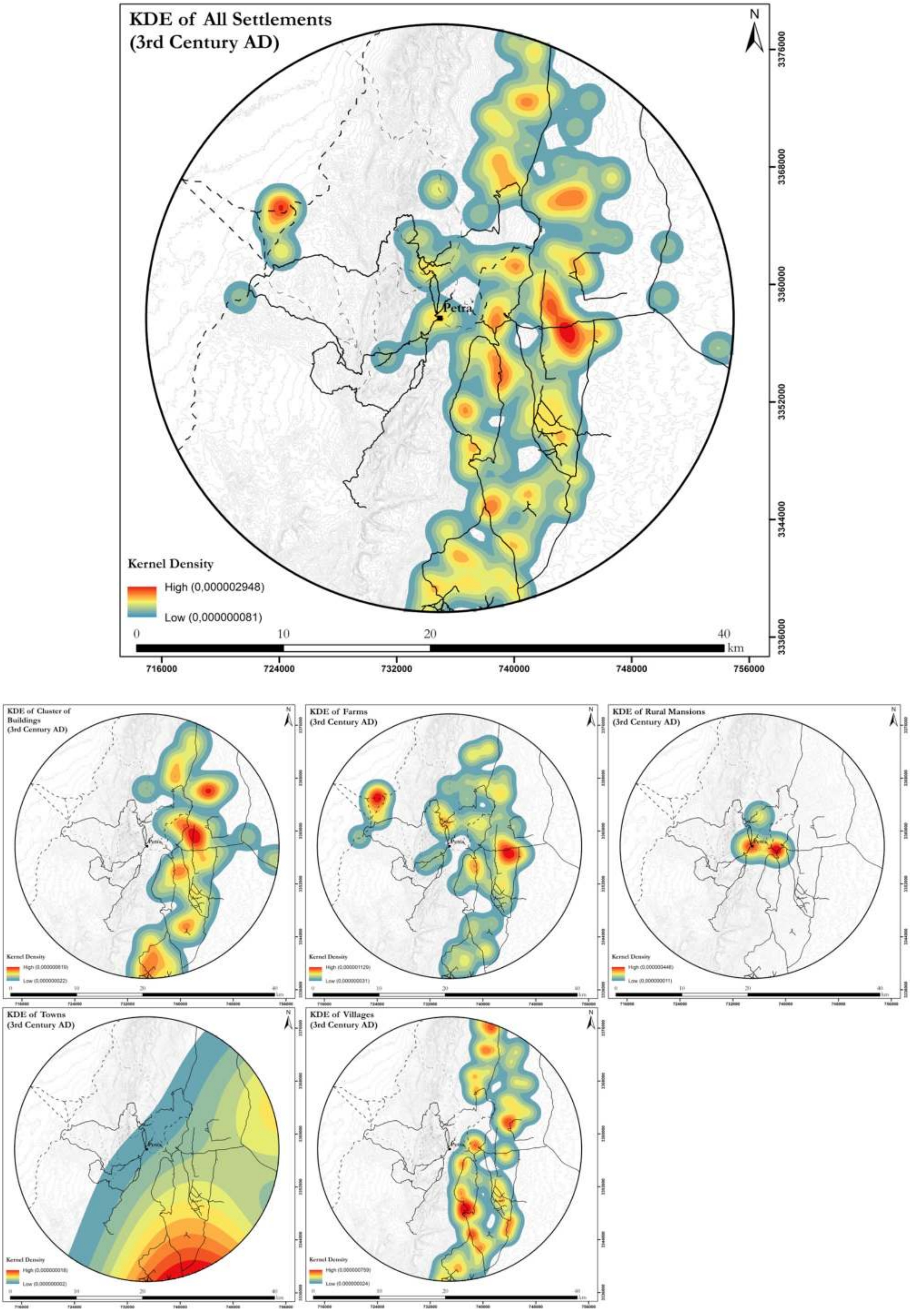


FIG. 166 Kernel density estimations of all settlements (above) and the individual subcategories of settlements dating to the 3rd century AD.

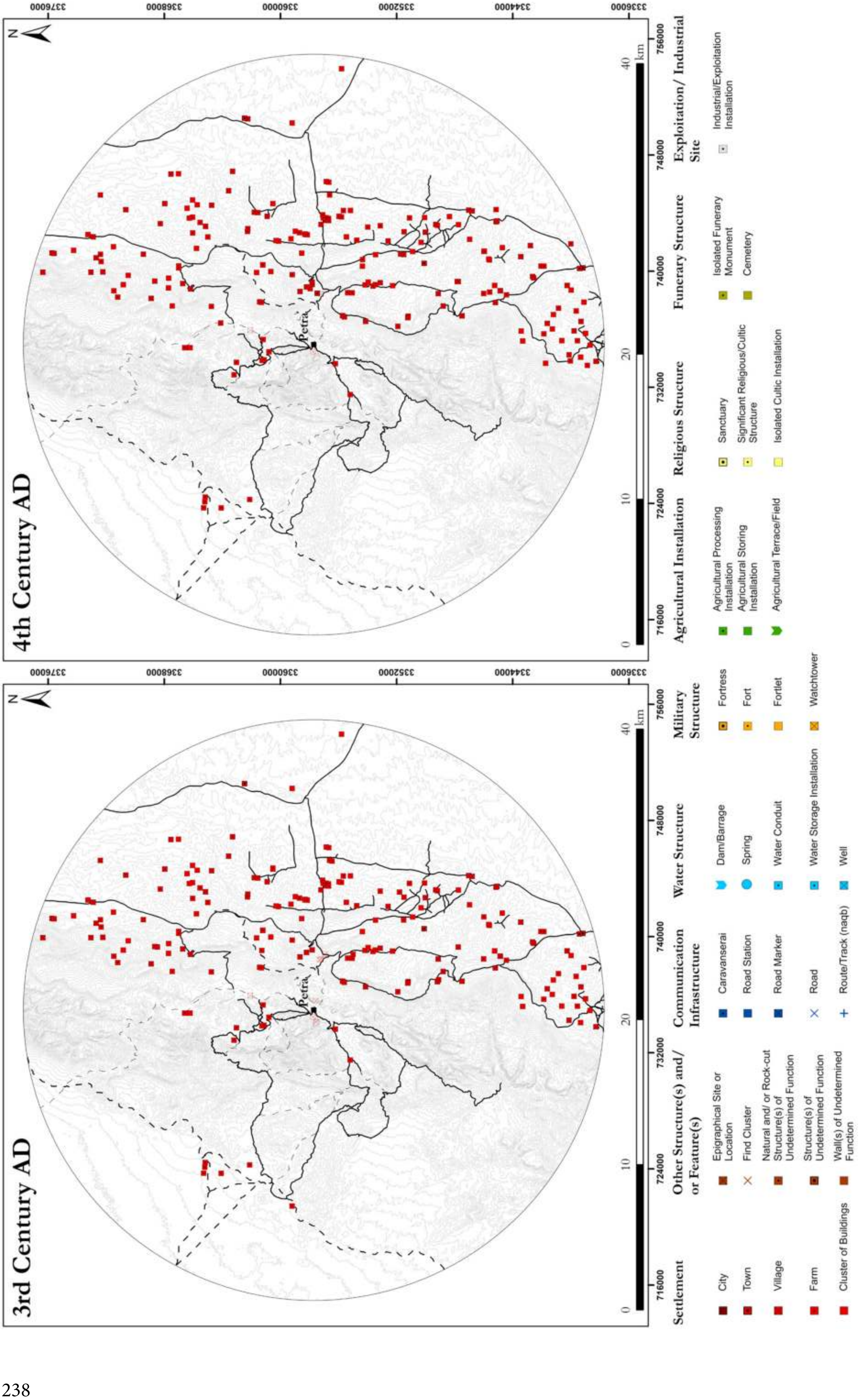


FIG. 167 Distribution map of all settlements dating to the 3rd and 4th century AD.

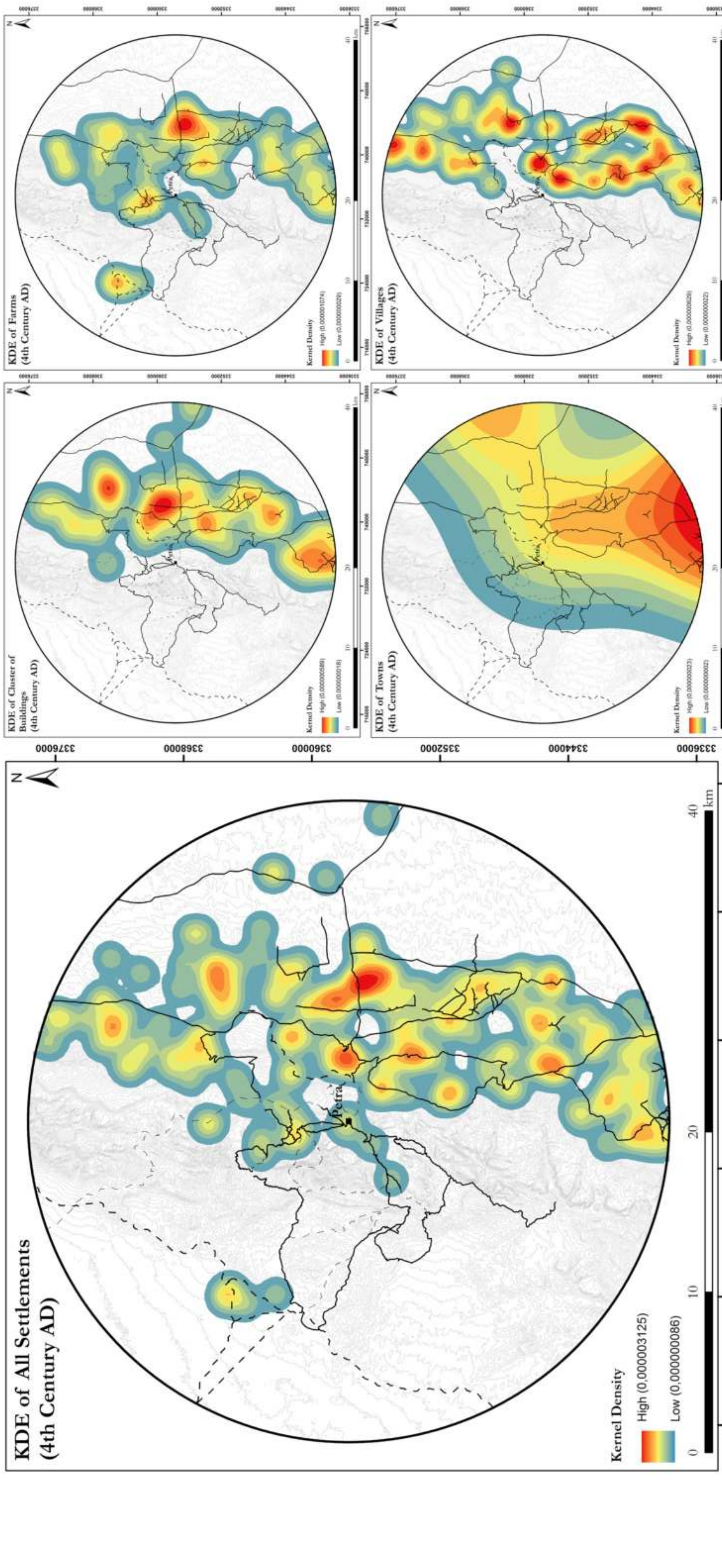


FIG. 168 Kernel density estimations of all settlements (left) and the individual subcategories of settlements dating to the 4th century AD.

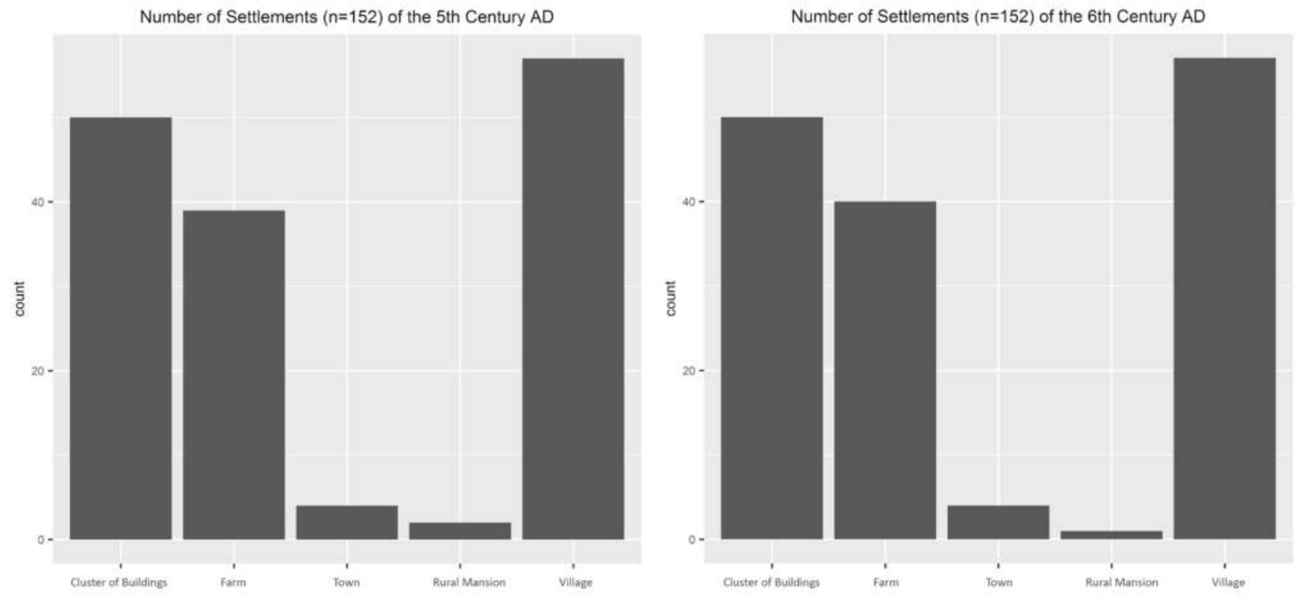


FIG. 169 Number of all settlements dating to the 5th and 6th century AD.

sites), despite the continuing increase of settlements (now 268 in total) (cf. FIGS. 161 and 163). The KDE nevertheless suggests a slight shift in the overall pattern, which now seems more exaggerated than in the previous century (cf. FIG. 162). The Pearson correlation test still does not indicate any significant spatial correlation to other archaeological sites (cf. TABLE 23).

In the 2nd century AD, the number of clusters of buildings begins to decrease slightly which stands in contrast to the slight overall increase of rural settlement at this period (70/270). Clusters of buildings are now only the third largest settlement type (cf. FIG. 167). This, together with the stark increase of farms, indicates a stronger focus on smaller settlement types. The observed decrease of clusters of buildings is also reflected in the KDE (cf. FIGS. 161 and 163). It shows that the overall pattern of the 1st centuries BC and AD remain the same, but the observed clusters are now less dense. The Pearson correlation test still does not suggest any significant spatial correlation to other archaeological sites (cf. TABLE 24).

The general decrease of settlements during the 3rd century AD is also evident for the clusters of buildings (59/201), which remain the third largest category of settlements (cf. FIGS. 165 and 167). The KDE now demonstrates an increasing eastern shift, most notably along the eastern high plateau (cf. FIG. 166). The observed clusters for the previous two centuries continue to grow increasingly less dense with a clear focus on the area northeast of Wadi Musa. The Pearson correlation test now indicates a strong spatial correlation to possible fortlets, indicating perhaps a possible security concern for the communities living in the evidenced clusters of buildings (cf. TABLE 25).

Together with the slight increase of settlements in general, the overall count of clusters of buildings also rises slightly (62/204) during the 4th century AD, remaining the third largest category of all settlements (cf. FIGS. 165 and 167). The KDE indicates that clusters of buildings now concentrate almost exclusively along the Jabal Shara escarpment and eastern high plateau (cf. FIG. 168). The observed clusters of the previous centuries continue to grow less dense, but there is a slight increase of clusters of buildings further east of Udruh.[785] The Pearson correlation test now suggests a strong spatial correlation to farms (in addition to the correlation to possible fortlets already observed for the 3rd century AD) (cf. TABLE 26). This indicates a gradual nucleation of clusters of buildings.

During the 5th century AD, the number of clusters of buildings continues to decrease (50/152) corresponding to the overall development of settlements in the study area (cf. FIGS. 169 and 171). The trend of the general pattern noted for the 4th century AD continues. This is supported by the KDE results (cf. FIG. 177). All clusters of buildings west of the Jabal Shara escarpment are now completely abandoned and there is an increased concentration of sites more eastwards. Although the clusters are generally less dense (because there are less sites), clear concentrations can now be observed around the extended areas

785 Note that some clusters of buildings situated east of Udruh were already occupied since the 1st century BC.

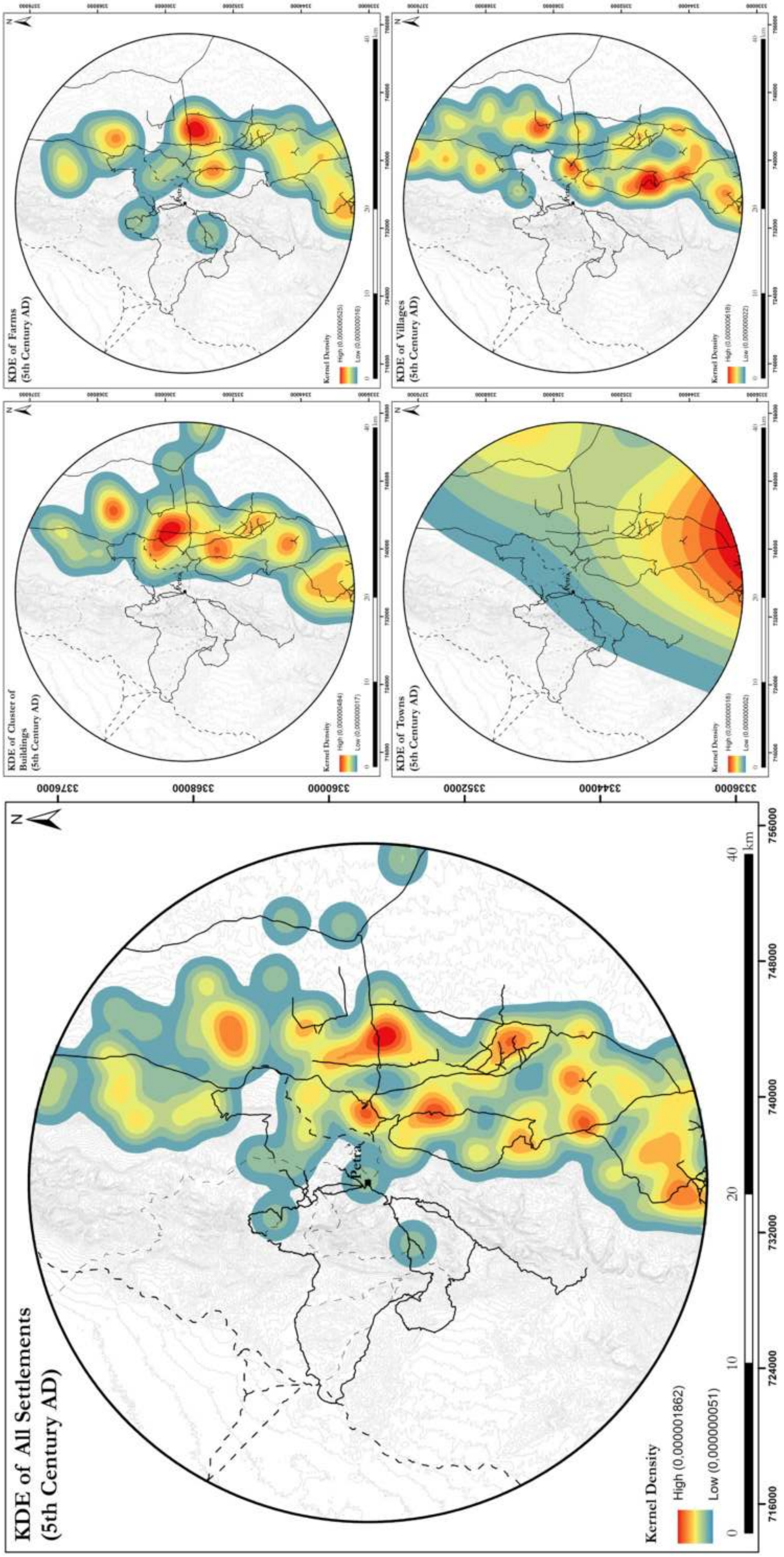


FIG. 170 Kernel density estimations of all settlements (left) and the individual subcategories of settlements dating to the 5th century AD.

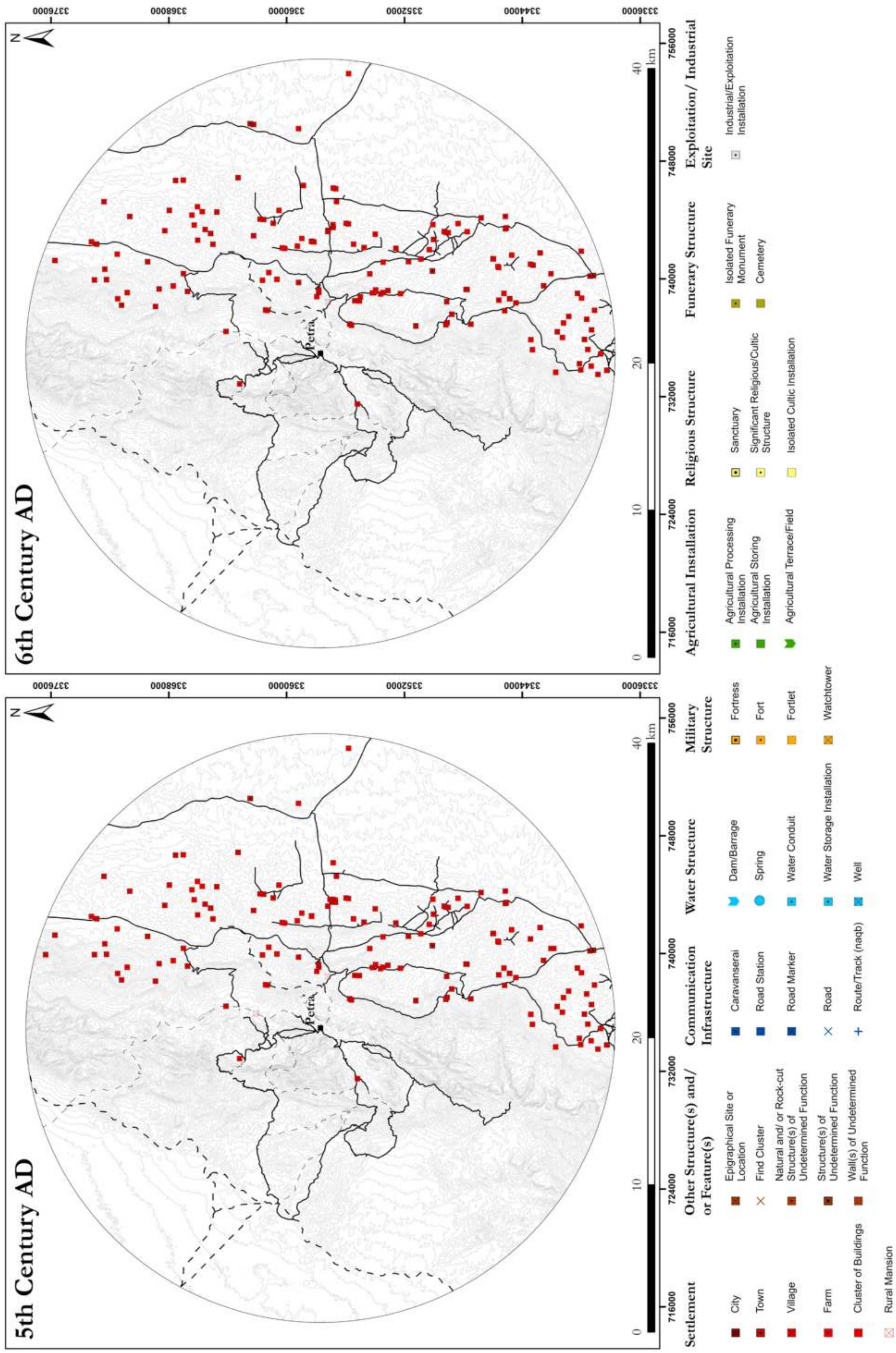


FIG. 171 Distribution map of all settlements dating to the 5th and 6th century AD.

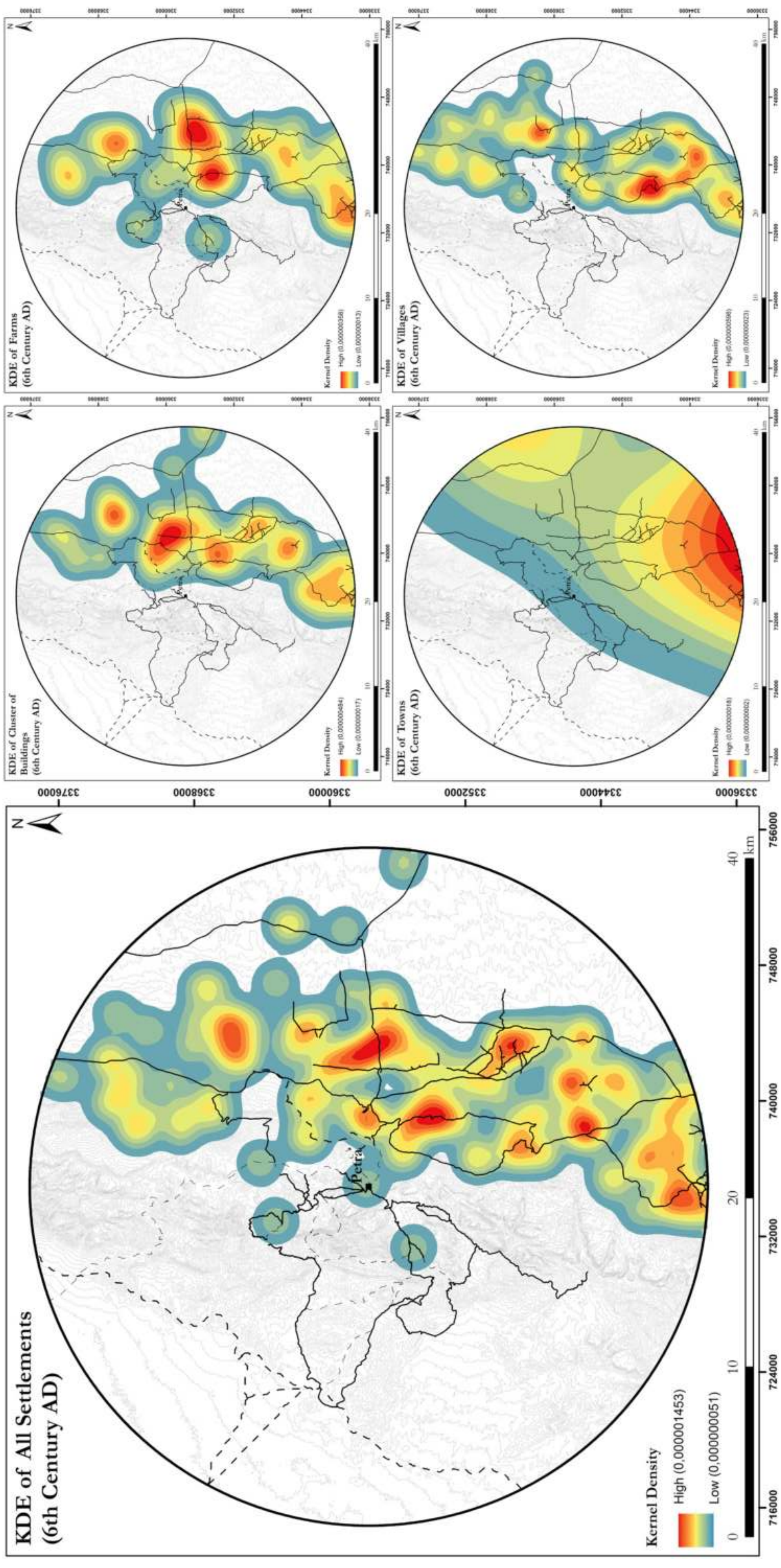


FIG. 172 Kernel density estimations of all settlements (left) and the individual subcategories of settlements dating to the 6th century AD.

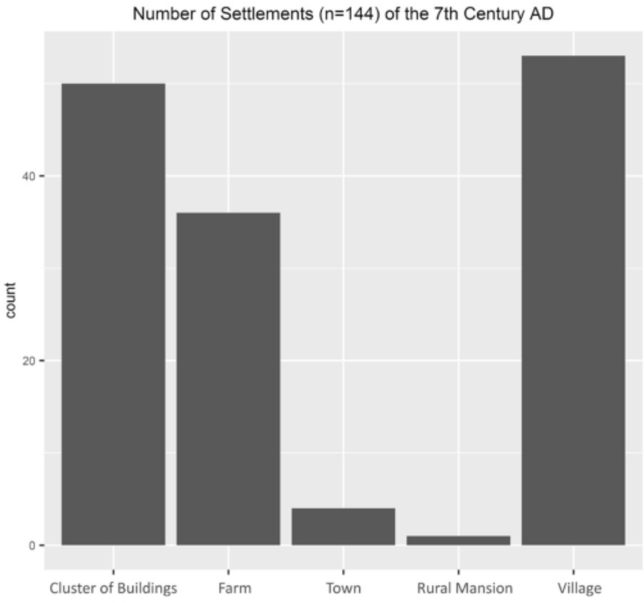


FIG. 173 Number of all settlements dating to the 7th century AD.

of Saddaqa and Fardakh as well as the region south-east of Bir Sarah, but most notably in the area north-east of Wadi Musa. The Pearson correlation test now suggests far stronger spatial correlations to other archaeological sites as well (cf. TABLE 27). These include road stations, possible fortlets, farms, natural and/or rock-cut structures of undetermined function as well as water storage installations. This further supports the claim that clusters of buildings are increasingly nucleating. The same observation can be made for the 6th century AD as well (cf. FIGS. 169, 171–172 and TABLE 28).[786]

Despite the increasing decline of settlements during the 7th century AD, the overall count of clusters of buildings remains stable (50/144) since the 5th century AD (cf. FIGS. 173 and 174), thus explaining the same KDE results as observed before (cf. FIG. 175). Reflecting the changing patterns of other contemporary archaeological sites, the Pearson correlation test now indicates strong correlations only to farms and structures of undetermined function (cf. TABLE 29). This further confirms that smaller settlements (i.e. farms) are nucleated around larger and medium-sized settlements such as clusters of buildings.

Farms

As for villages and cluster of buildings, the large number of identified farms does not allow a detailed archaeological discussion of the individual sites. This section therefore focuses on the statistical and landscape archaeological evaluation of the evidenced farms. However, M. Ladurner currently studies Nabataean farms in the Jabal Shara region in-depth.[787] To date, Ladurner has studied 12 structures along the Jabal Shara escarpment between Petra and Ras en-Naqb that she identifies either as farms or as hamlets.[788] Based on comparisons to Nabataean farms in central Jordan, specifically the area of the Wadi ath-Thamad, Ladurner characterizes Nabataean farms in the Petra region as large, single buildings with habitation and utilitarian quarters as well as installations for the processing of agricultural goods (such as threshing floors or olive presses). Structurally, farms are characterized as rectangular buildings with interior (possibly unroofed) courtyards, which are often situated on slopes.[789] These findings correspond well with the structures identified as farms in this study.

While all other farms evidenced in the Petraean hinterland were abandoned by the 5th century BC (cf. chapter 3), the farm at Abu Danna is apparently further occupied in the 4th century BC, but then also abandoned during the 3rd century BC (cf. FIGS. 152–153). In the 2nd century BC, the only farm evidenced in the Petraean hinterland is FJHP Site No. 128 (cf. FIG. 154).[790]

Corresponding to the explosive increase of rural settlements in the 1st century BC, the total count of farms (78/214) rises dramatically as well (cf. FIG. 159). Farms are the largest category of all evidenced settlements in the study area by this time. The KDE suggests a distribution mostly along the Jabal Shara escarpment, but with a clear cluster also further west in the Beidha/al-Begh'ah areas as well as in the al-Bitar area along the eastern high plateau (cf. FIG. 160). The Pearson correlation test shows no conspicuously strong spatial correlations to other archaeological sites (TABLE 11.8).[791]

During the 1st century AD the total amount of rural settlements continues to increase, which also applies

786 Instead of natural and/or rock-cut structures of undetermined function, the Pearson correlation test for clusters of buildings dating to the 5th century AD now indicates strong spatial correlations to structures of undetermined function (cf. TABLE 28).
787 Ladurner 2015.
788 Ladurner 2017.
789 Ladurner 2015, 44–45. On the Nabataean settlements in the Wadi ath-Thamad area, see Ladurner 2014; Ladurner 2013; Daviau et al. 2012 and Lykke – Ladurner 2011.
790 Silvonen et al. 2013, 387–388.
791 Moderate spatial correlations are suggested by the Pearson correlation test between farms and agricultural processing installations, clusters of buildings, rural mansions, natural and/or rock-cut structures of undetermined function and structures of undetermined function (cf. TABLE 22).

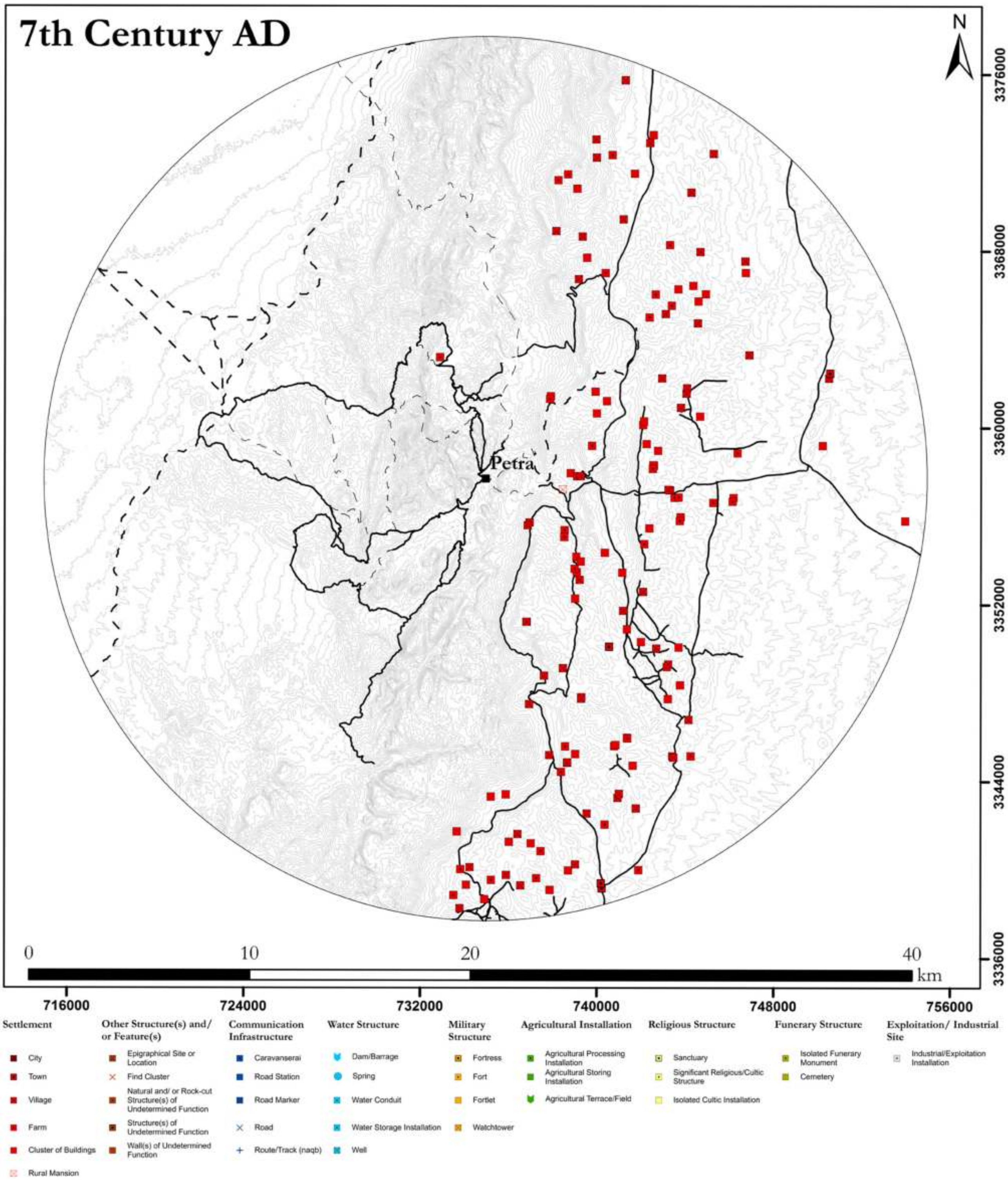


FIG. 174 Distribution map of all settlements dating to the 7th century AD.

to the evidenced farms (100/268) that are still the largest category of all settlements (cf. FIGS. 161 and 163). While farms are still largely distributed along the Jabal Shara escarpment, they are now spread more westwards as well – particularly north of Petra as well as in the Wadi Arabah south of Bir Madkhur. The KDE suggests that there is an even denser clustering of farms in the Beidha and al-Bitar areas than in the previous century (cf. FIG. 162). The Pearson correlation test suggests only a strong spatial correlation to water storage installations (cf. TABLE 23).

The observed upward trend continues into the 2nd century AD with a slight increase of farms (104/270) (cf. FIGS. 161 and 163). While the distribution pattern largely remains the same as for the previous century, an even denser clustering of farms can be observed in the Wadi Arabah, the Beidha area as well as around al-Bitar along the eastern high plateau.[792] The Pearson correlation test does not indicate any significant spatial correlations to other archaeological sites (cf. TABLE 24).

Although farms are still the largest category of all settlements (71/201) in the 3rd century AD, a significant decrease can be observed which relates to the overall development of rural settlements (cf. FIGS. 165 and 167). Farms in the Beidha area are gradually abandoned and the KDE suggests a shift further east along the Jabal Shara escarpment as well as along the eastern high plateau (cf. FIG. 166). There is now a clear clustering in the eastern al-Bitar area as well as in the Wadi Arabah. The Pearson correlation test indicates no significant spatial correlation to other archaeological sites (cf. TABLE 25).

In the 4th century AD, the slight decrease of farms continues (69/204), although they are still (only by a margin) the largest category of all settlements (cf. FIGS. 167 and 169). The KDE suggests a continuing eastward shift and abandonment of farms in the west (cf. FIGS. 168). The highest concentration of farms is still in the al-Bitar area and eastern high plateau. The Pearson correlation test now indicates strong spatial correlations to clusters of buildings, structures of undetermined function as well as water storage installations (cf. TABLE 26). This may indicate that farms are beginning to nucleate more around larger settlements (i. e. clusters of buildings).

By the 5th century AD, the decrease of farms continues dramatically (39/152) reflecting the overall development of rural settlements in this period (cf. FIGS. 169 and 171). Farms are now only the third largest category of settlements. Nearly all farms west of the Jabal Shara escarpment are abandoned and concentrate in the al-Bitar area instead (cf. FIG. 170). There are also clusters of farms between Saddaqa and Ayl. The Pearson correlation test now indicates strong spatial correlations to roads, cluster of buildings, natural and/or rock-cut structures of undetermined function and structures of undetermined function (cf. TABLE 27). This may suggest a continuing nucleation process of farms.

The overall number of farms remains stable for the 6th and 7th centuries AD, with only one additional farm evidenced (cf. FIGS. 169 and 173). Larger settlements such as clusters of buildings and villages now clearly dominate the rural settlement pattern for these periods. The KDE for the 6th century AD shows that the already observed eastern shift continues with clear clustering of farms in the al-Bitar area as well as the region immediately southeast of Wadi Musa (cf. FIG. 172). There are conspicuous (although less dense) clusters of farms in the extended area between Saddaqa and Ayl as well. The Pearson correlation test indicates strong spatial correlations between clusters of buildings (cf. TABLES 28 and 29). This may further support the hypothesis that farms are increasingly nucleating around larger settlements.[793] By the 7th century AD, all farms are situated between the Jabal Shara escarpment and Udruh (cf. FIG. 175). The only remaining site west of the Jabal Shara is Beidha.[794]

Rural Mansions

The generic term 'rural mansion' describes a large isolated structure that cannot be considered a simple farm. The most important structural characteristics of the presented rural mansions are their comparatively large size, good construction quality and often complex architectural design. Based on surface observations alone, a more distinct description in terms of the structure's function is difficult to offer. Excavation results are therefore particularly important for a more in-depth evaluation of this site type. Unsurprisingly, rural mansions are not evidenced in large numbers.

While the only possible Iron Age rural mansion at al-Muzayr'a is abandoned by the 1st century BC (cf. chapter 3), three new rural mansions are established during this period (cf. FIG. 159). These include the structures of al-Brayka (WMWS 1996 Site No. Bayda 18C), Umm Qussah and Seir al-Begh'er.[795]

Due to the extensive building activities in modern Wadi Musa, only a few wall lines, a ceramic water pipe as well as a large amount of Nabataean pottery dating to the 1st centuries BC and AD is known of al-Brayka.[796] While the site may have been part of a once substantial building, the paucity of archaeological evidence does not permit any functional identification.

For the presumed rural mansion of Umm Qussah at Beidha, archaeological evidence is abundant (FIG. 176).[797] In 2005, under the direction of Pierre and

792 For the sites in the Wadi Arabah, see Smith 2010, 75–76, 78 (BMP/CAS Site Nos. 3, 10, 12, 16, 19).

793 Strong spatial correlations can also be observed between farms and structures of undetermined function for the 6th century AD.

794 For a brief overview of Late Antique and Islamic Beidha, see e. g. Sinibaldi 2015 with further references.

795 Due to the limited number of evidenced rural mansions dating to the 1st century BC, KDEs or Pearson correlation tests are meaningless.

796 'Amr et al. 1998, 522–524.

797 Bikai et al. 2008.

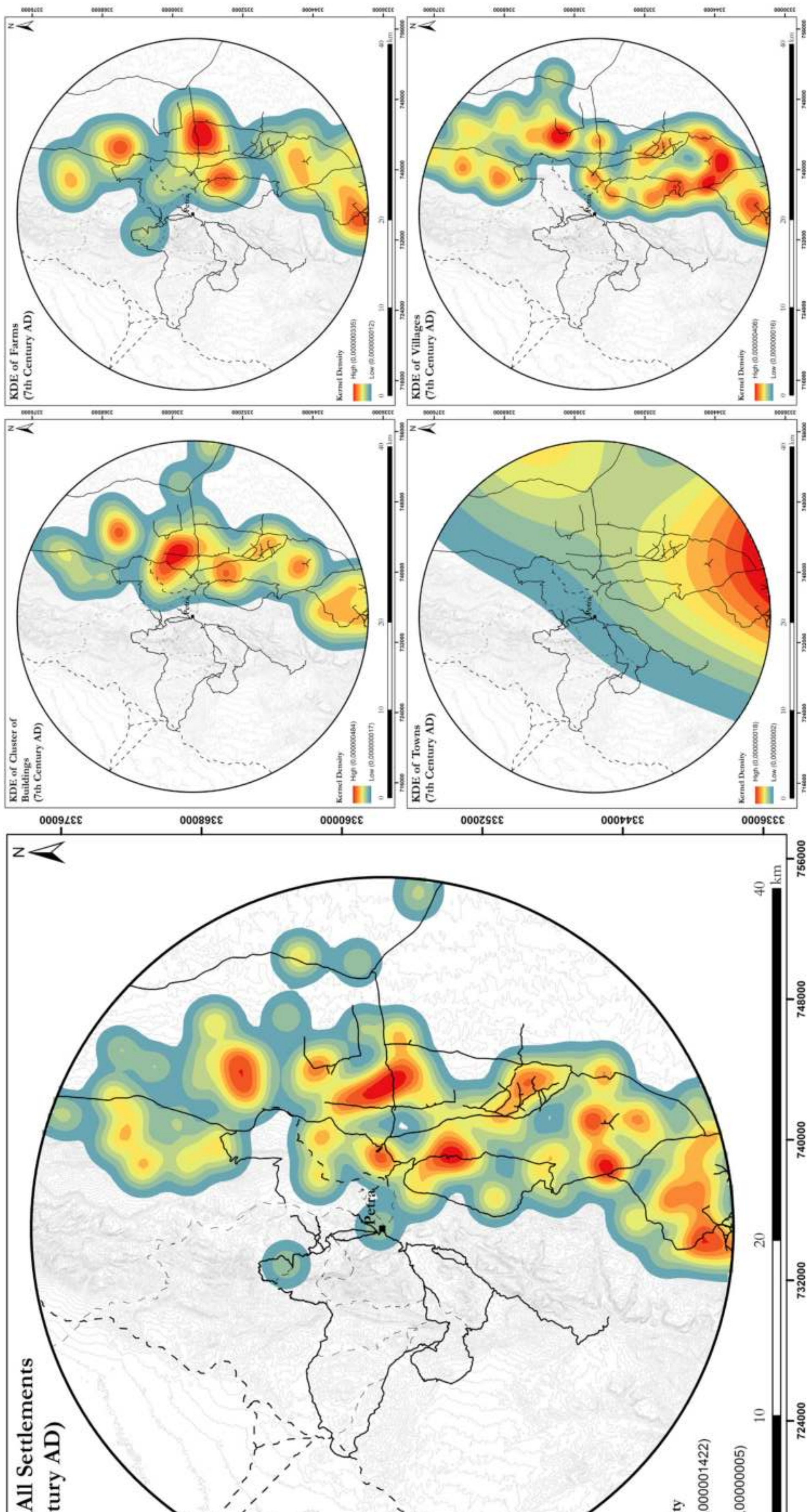


FIG. 175 Kernel density estimations of all settlements (left) and the individual subcategories of settlements dating to the 7th century AD.

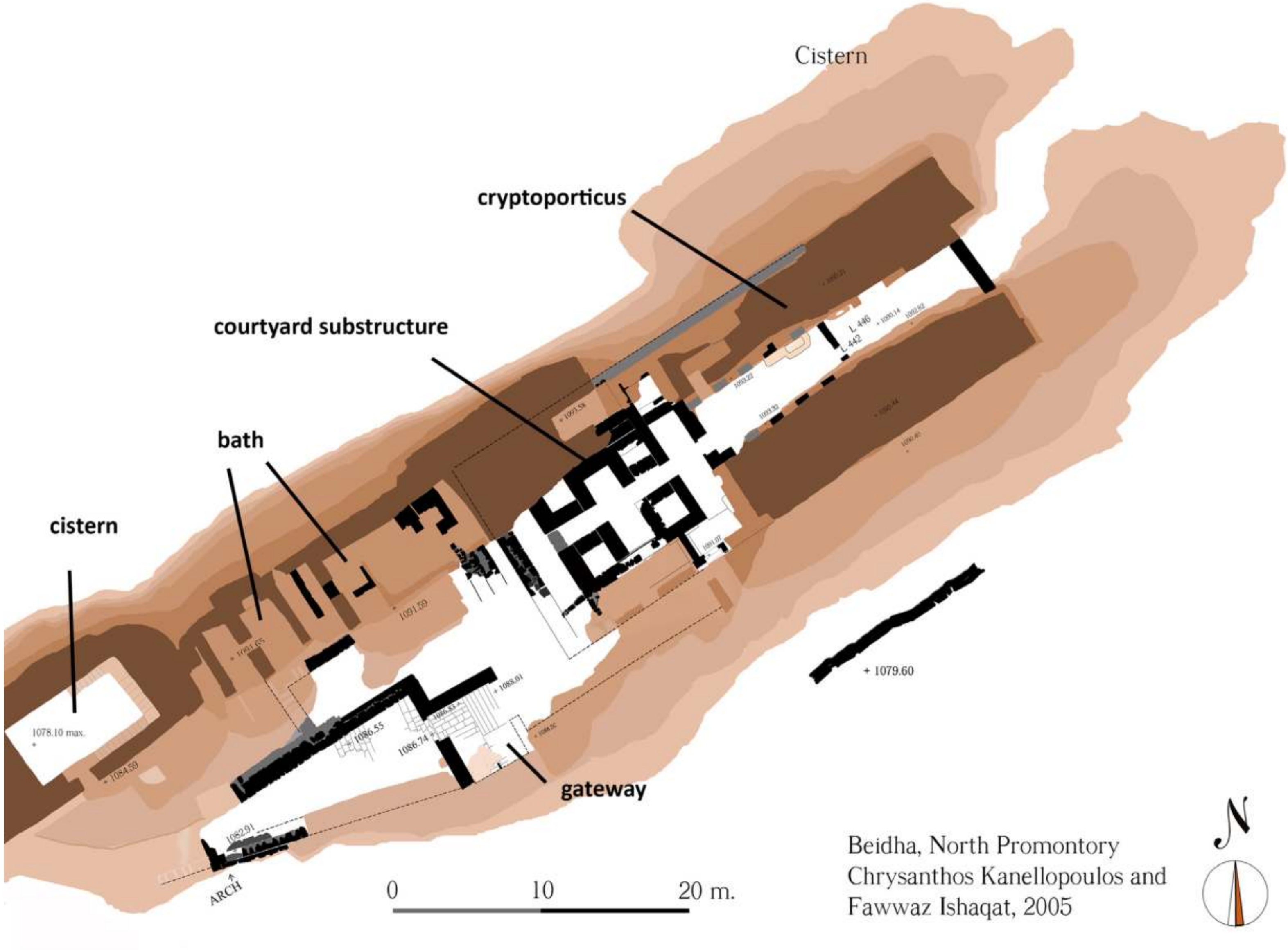


FIG. 176 Plan of the luxury structure of Umm Qussah at Beidha after Bikai et al. 2008, 468, fig. 2. Colored plan courtesy of C. Kanellopoulos.

Patricia Bikai as well as Barbara Porter, the *American Center of Oriental Research* (ACOR) uncovered substantial building remains on a rocky promontory (locally known as Umm Qussah) just outside the Siq al-Amti (Beidha). ACOR's research revealed a luxurious complex consisting of a monumental gateway, possible baths, a huge rock-cut cistern as well as an elevated courtyard and peristyle. Rock-cut wine presses were documented immediately adjacent to the main structure, suggesting that Umm Qussah was once within an extensive wine-growing area. This and the discovery of numerous architectural and decorative elements with Dionysian themes has led the excavators to term Umm Qussah the 'Dionysian hall.' The evidenced peristyle was interpreted as an *oecus* that may have served as a *triclinium* for the Nabataean king Malichos I (59/58–30 BC). This is based on stratified pottery material dating the construction of Umm Qussah to shortly after 50 BC, thus during the reign of Malichos I. As there is no material exceeding the last quarter of the 1st century BC, the excavators presume that the structure was occupied only briefly.[798] Whether Umm Qussah can truly be associated with the king himself, can certainly be discussed. The excavators base this hypothesis on the luxurious nature of Umm Qussah and the pottery dating, but there is no direct evidence associating Umm Qussah with the king.[799] Nevertheless, Umm Qussah was undoubtedly used by a member of a wealthy elite – if not the king, perhaps a local leader of the Beidha area – as the structure definitely served as a focal point in Beidha's immediate surroundings. The 'Dionysian' context and the postulated *triclinium* within the *oecus* clearly suggests that the structure served elite *convivium* purposes. As social gatherings often associated with the consumption of wine is arguably a fundamental feature of Nabataean culture (cf. chapters 8 and 9), Umm Qussah may have been a monumental gathering place for member(s) of the Nabatean elite. Although this elite cannot be further specified, it may be tentatively speculated that the structure could have belonged to members of a local elite of the Beidha area.

The contemporary luxurious structure of Seir al-Begh'er – better known as the 'Pond Temple' – is situated immediately west of the village of Ras Slaysil after a 450 m drop down Naqb Slaysil and Naqb Seir al-Begh'er (cf. chapter 6) (FIG. 177).[800] As the name suggests, the Pond Temple is mostly discussed as a religious structure. The site is characterized by a substantial amount of debris consisting of well-drafted sandstone ashlars and numerous architectural members including floral pediment pieces, metope and triglyph fragments as well as lavishly carved cornices and more. Large amounts of Nabataean fine ware dating to the 1st centuries BC and AD were observed in addition to marble *opus sectile* fragments as well as *pilae* and *tubuli* suggesting that the site may have had a heated bath system. This was possibly related to the name-giving pond immediately next to the structure. However, to date, no hydraulic installations could be identified to support this claim.

The building is undoubtedly of monumental character and the architectural elements documented by Lindner and his team could suggest a religious nature of the site. However, the interpretation as a Nabataean temple is founded solely "[…] *on the masonry and architectural pieces that were found, as well as the pottery fragments* […]" and on the fact that the structure is supposedly situated "[…] *at the crossroads of caravan routes.*"[801] The latter point that the presumed temple was situated along important routes is challenged here (cf. chapter 6). Due to the difficult terrain and the disadvantageous geological formation of the volcanic stone of the routes leading to Seir al-Begh'er (particularly Naqb Seir al-Begh'er, Naqb Slaysil as well as parts of Wadi as-Siyyagh), the structure was incredibly difficult to access. Naqb Slaysil and Naqb Seir al-Begh'er are undoubtedly among the most difficult routes evidenced so far in Petra's hinterland. If a structure of such architectural monumentality is to be interpreted as a temple, it would most definitely be far better accessible, as is the case of other Nabataean sanctuaries in the area (e. g. Sabra, Ras Hamra or Jabal Harun; cf. chapter 8). The inaccessibility of the site rather indicates a more private use. If so, Ben David's interpretation of Naqb Slaysil as a *via sacra* leading to the presumed 'Pond Temple' would have to be reconsidered.[802]

Arguably, were one to accept that the documented *pilae* and *tubuli* fragments are associated with a heated bathing system, parallels from other major Nabatean temples and sanctuaries such as at Khirbet edh-Darih, Sia in the Hawran, the Nabataean temple in Wadi Ramm, the bathing complex south of the *temenos* area at Sabra or the Qasr al-Bint in Petra, can certainly be found.[803] Further comparisons from Petra, how-

798 The chronology of Umm Qussah can certainly be further debated. Cf. e. g. Schmid 2017, 282.

799 If the sculpted heads of the structure's capitals can indeed be exclusively compared to the royal portrait of Obodas II as argued by Schmid 2017, 282, associating Umm Qussah with the Nabataean kings would seem more likely.

800 Lindner 2003a, 165–176; Lindner – Gunsam 1995a.

801 Lindner – Gunsam 1995a, 207. Also see Lindner 2003a, 170–174.

802 Ben David 2012, 21.

803 Specifically on the baths at Sabra: Tholbecq et al. 2016 and Fournet – Tholbecq 2015. On Dharih: Durand et al. 2018

FIG. 177 A–C: Overview of the monumental remains of the structure at Seir al-Begh'er (known as the 'Pond Temple') including building debris and hypocausts. D: Sketch plan of the site after Lindner – Gunsam 1995a, 202, fig. 3.

ever, can also be drawn to profane luxury architecture such as at the mansion of ez-Zantur, the bathing complex next to the *paradeisos* of the 'Great Temple' or the 'palatial' structures on Umm al-Biyara or Jabal al-Khubtah.[804] A spatially closer parallel is the 'Dionysian Hall' of Umm Qussah in Beidha, which also features heated baths.[805] The existence of a possible bathing system alone therefore cannot set the structure at Seir al-Begh'er in a religious context. Moreover, as Seir al-Begh'er has always been associated with the settlement of Ras Slaysil,[806] its identification as a temple would mean that Ras Slaysil would have had two religious structures: One small hilltop sanctuary above at ad-Dahunne Slaysil (cf. chapter 8) and one below at Seir al-Begh'er. While this is generally not impossible, it is curious that a small sanctuary would be in close vicinity to Ras Slaysil, while a significantly more monumental temple is situated below the settlement.[807] The comparisons to profane Nabataean luxury architecture therefore seem more convincing, thus allowing to tentatively interpret Seir al-Begh'er not as a religious structure, but as a luxurious rural mansion of a member of the Nabataean elite. Similar to Umm Qussah, this 'elite' cannot be further specified, but it may nevertheless be tentatively speculated that the structure could have belonged to members of a local elite of the Ras Slaysil area.

The number of evidenced of rural mansions rises in the 1st century AD corresponding to the overall increase of settlements during that period (cf. FIGS. 161 and 163). In addition to those described above, new possible rural mansions are constructed at JSS Site No. 055, WMWS 1996 Site No. Bayda 20, WMWS 1996 Site No. Wadi Musa 18B, WMWS 1996 Site No. Wadi Musa 18D, Maqbarat Wadi Musa (WMWS 1996 Site No. Wadi Musa 18E) as well as WMWS 1996 Site No. Wadi Musa 18F.[808] The KDE shows a clear cluster of urban villas in Wadi Musa (cf. FIG. 162), but the evidenced rural mansions seem to concentrate within a radius of less than 10 km around Petra.[809]

JSS Site No. 055 is described as a large debris of building remains standing up to 5 m high with smaller structures to its northeastern and western side.[810] The structure includes a possible cistern and is situated in a generally highly cultivated area. It may therefore be postulated that JSS Site No. 055 is a single rural mansion overlooking agricultural lands.[811]

WMWS 1996 Site No. Bayda 20 is situated in the eastern al-Begh'ah plain and is characterized by one larger rock-cut 'hall' and a smaller rock-cut room (FIG. 178).[812] The hall was accessed through a rock-cut doorway and shows equally measured rock-cut niches carved in the southern wall. These niches most likely served as foundations for the flooring of the second story, as there are indications for another rock-cut door above the doorway of the presumed first floor. In addition to rock-cut water channels and cisterns, there are several architectural blocks near the structure, including fragments of half columns.[813] WMWS 1996 Site No. Bayda 20 may therefore be referred to as a small, but presumably wealthy Nabataean rural mansion. Although speculative, it is possible that the site was associated with the production of agricultural goods in the al-Begh'ah area.

The important site of Shammasa is situated in the western al-Begh'ah area (FIG. 179).[814] Lindner and Gunsam refer to it as a 'fortified suburb' of Petra because the main site is located on a rocky promontory with several built structures on top, as well as an associated rock-cut wine press. The promontory is situated among an extensive agricultural area with an additional winepress and a large rock-cut cistern nearby. A small rock-cut cultic installation, probably for the veneration of the Nabataean main deity Dushara, is also associated with Shammasa.[815] This highlights the site's importance in the area. While it

and Durand 2015. For the comparisons drawn between Sia, the temple in Wadi Ramm and the Qasr al-Bint, see e.g. Villeneuve – al-Muheisen 2008, 1499. The interpretation of the structures south of the *temenos* of the Qasr al-Bint as baths has been challenged (Alpass 2013, 53 in reference to Zayadine 1987, 139).

804 On the baths on Jabal al-Khubtah: Fournet – Paridaens 2018 and 2017; Tholbecq et al. 2015 and 2014. On ez-Zantur: Kolb 2012. On Umm al-Biyara: Schmid et al. 2012. On the *paradeisos*: Bedal 2003.

805 Bikai et al. 2008, 467.

806 Alcock – Knodell 2012, 12; Lindner – Gunsam 1995a.

807 Cf. the situation at Sabra: While the baths may be associated with the sanctuary on the settlement's 'acropolis,' there is no clear indication that they were necessarily used for ritual purposes.

808 The hilltop structures on Umm al-Biyara and Jabal al-Khubtah could also be added here. However, as these sites are arguably more associated with urban Petra than with the city's hinterland, they are not further discussed.

809 The Pearson correlation test for rural mansions dating to the 1st century AD suggests a strong spatial relation to industrial/exploitation sites (cf. TABLE 23). This is probably explained by the close vicinity of the five 'villas' recorded in Wadi Musa to the ceramic production site of az-Zurraba.

810 Unpublished report kindly provided to the author by L. Tholbecq.

811 Based on the description of JSS 055, the structure seems too substantial to be considered as a simple farm.

812 'Amr – al-Momani 2001, 258; 'Amr et al. 1998, 511–512.

813 'Amr et al. 1998, 512.

814 Lindner – Gunsam 2002. Also cf. Vella et al. 2015, 225–226; Alcock – Knodell 2012, 11 and Knodell – Alcock 2011, 492.

815 Cf. Knodell et al. 2017, 657–659; Vella et al. 2015, 227–228.

FIG. 178 Views of the presumed rock-cut villa of Bayda 20. A: View of eastern and western room with horizontal carvings for second floor. View to west. B: View of entrance into western room. View to east. C: View of western room. D: Column drum in front of entrance.

cannot be specified who was responsible for Shammasa, it may nevertheless be tentatively hypothesized that the site was run by a member of a local Nabataean elite.

WMWS 1996 Site No. Wadi Musa 18B is situated in the center of the modern town of Wadi Musa and was cut during road construction.[816] The road-cut revealed a well-built, substantial building with plastered walls and a flagstone floor. This urban villa was supplied with water through a channel that was covered by stone slabs.

WMWS 1996 Site No. Wadi Musa 18D is reported as a Nabataean 'villa' with a rarely preserved mosaic floor of black and white geometric design. Nothing further is known of the villa, only that it had a cistern.[817] At Jabal az-Zuhur just north of the villa with the mosaic, another luxurious structure was revealed where a well-preserved wall painting in the second Pompeian style was discovered.[818]

Although significantly disturbed by recent robbing activity, Maqbarat Wadi Musa (WMWS 1996 Site No. Wadi Musa 18E) is described as an agglomeration of ashlar blocks and decorated architectural fragments with an abundant amount of associated Nabataean pottery finds. This suggests that a possible additional luxurious urban villa once stood at the site.[819]

WMWS 1996 Site No. Wadi Musa 18F is described as a once monumental urban villa in Wadi Musa that was cut by road construction as well.[820] The site is characterized by several substantial wall lines, fragments of painted wall plaster and a ceramic pipe feeding into the villa's baths.

The findings at Wadi Musa indicate a clear increase of wealth for the local Nabataean elite. It also

816 ʾAmr et al. 1998, 522, fig. 523. For further information on ʾAmr et al.'s rescue excavation of a Nabataean villa in Wadi Musa, see ʾAmr et al. 1997.
817 ʾAmr et al. 1998, 524. Cf. also ʾAmr – al-Momani 2001, 266, fig. 18.
818 Cf. ʾAmr – al-Momani 2001, 266, fig. 19.
819 ʾAmr et al. 1998, 524.
820 ʾAmr – al-Momani 2001, 267; ʾAmr et al. 1998, 525.

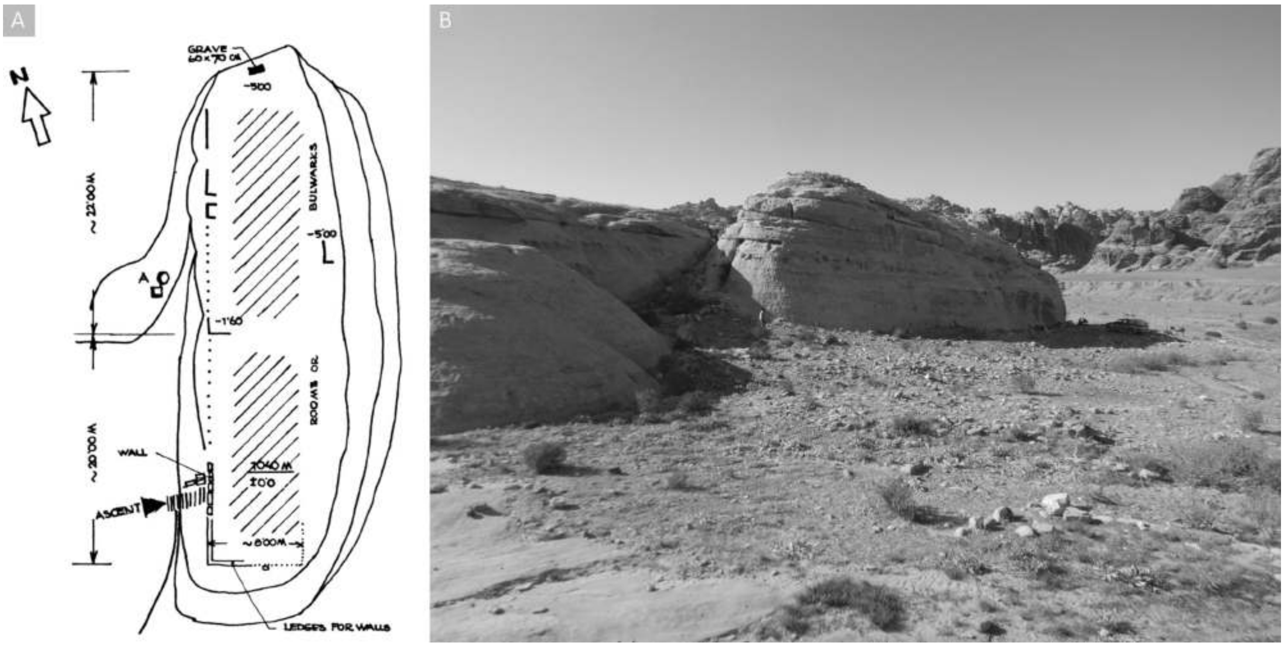


FIG. 179 The rocky promontory of Shammasa. A: Sketch plan after Lindner – Gunsam 2002, 228, fig. 7. B: View of Shammasa to northwest.

further underlines the underestimated importance of Wadi Musa in the Nabataean period.

While the 1st century AD records a peak of all evidenced rural mansions, this quickly declines by the 2nd century AD as evidenced by the abandonment of three rural mansions (JSS 055, al-Brayka and Umm Qussah) (cf. FIGS. 152, 153 and 164).[821] In the 3rd century AD, further rural mansions are abandoned corresponding to the general decline of rural settlements (cf. FIGS. 165, 167 and 166). The abandoned rural mansions are Seir al-Begh'er and WMWS 1996 Wadi Musa 18F. The Pearson correlation test indicates that there is a strong spatial correlation between the remaining rural mansions and agricultural terraces/fields (cf. TABLE 25). This trend continues in the 4th century AD when the only two remaining rural mansions are WMWS 1996 Bayda 20 and WMWS 1996 Wadi Musa 18D (cf. FIGS. 165, 167 and 168). The Pearson correlation test now suggests strong spatial correlations to agricultural processing installations as well, while the correlation to agricultural terraces/fields is now very strong (cf. TABLE 26).[822] The same observations can be made for the 5th century AD (cf. FIGS. 169, 171, 170 and TABLE 27). By the 6th century AD, the only rural mansion that seems to be occupied is WMWS 1996 Wadi Musa 18D (cf. FIGS. 173 and 174).[823]

821 The Pearson correlation test for rural mansions of the 2nd century AD shows the same results as for the 1st century AD (cf. TABLE 24).

822 Further significant correlations are also suggested to road stations, epigraphical sites and walls of undetermined function.

823 The Pearson correlation tests for the 6th and 7th century AD show no significant spatial correlation to other archaeological sites (cf. TABLES 28 and 29).

Chapter 6
The Communication Infrastructure

This chapter deals with all communication infrastructures evidenced in the Petraean hinterland from the Hellenistic to Byzantine periods. However, before presenting the relevant evidence, various 'best practice' approaches for researching ancient communication infrastructures in ancient desert landscapes are briefly introduced. These should be kept in mind when considering the presented evidence. This is then followed by a discussion of the different beasts of burden that were possibly exploited in the Petraean hinterland in antiquity. Subsequently, the archaeological evidence of all road- and/or route-related structures documented in the study area is presented, beginning with the critical discussion of the evidence pertaining to possible caravanserais in the study area. This is followed by the presentation of all smaller road- and/or route stations as well as a brief presentation of road/route markers. The next sections describe in detail the various roads and routes that are evidenced in the Petraean hinterland (FIG. 180). The definitions of the individual subcategories of all 'communication infrastructures' are given in chapter 2.

Ancient Communication Infrastructures in Desert Landscapes

When researching ancient roads and routes, the main question addresses their necessity: What purpose did roads and routes serve in antiquity? While this seems to be an obvious and simple question to answer, the explanations are manifold. One motivation was the creation of more optimal paths to connect sites and enhance local and regional social and economic networks. Road construction also enabled and facilitated the exploitation of natural resources. Another aim was to incorporate a particular site or wider region into a larger, supra-regional trade network in order to secure maximum economic stability and growth. Road systems extended strategic political, administrative and/or military control as well. Some ancient roads and routes have also shown to have had cultic/religious meaning. The reasoning behind the construction of roads and routes in antiquity could have also been all of the above, and consequently extremely difficult to determine distinctly.

The examination of roads and routes touches on a wide range of superordinate topics including trade, the exploitation and control of natural resources, administrative communication purposes and military operations.[824] The detailed study of ancient road use offers important insights into economic incentives, political aims, as well as technical achievements in terms of transportation technologies and the logistical and organizational abilities of ancient cultures.[825] Researching these various aspects, which very much depend on the specific regional and historical circumstances of the study area, brings various methodological challenges that necessitate interdisciplinary approaches.

While there are many archaeological studies of ancient roads and routes and their inherent value to the reconstruction of ancient landscapes, the objectives and methodological approaches vary significantly. To fully grasp the various aspects of ancient communication systems, a combination of multidisciplinary approaches can offer more information than that of a traditional archaeological perspective alone. Modern research of ancient roads and routes should therefore attempt to bridge the gap of disciplinary boundaries and utilize the advantages that the various approaches may bring to the table. This is particularly the case when dealing with desert landscapes.[826]

Traditionally, the study of ancient roads and routes only considers potential communication axes as connecting lines between two or more points. The evidence for ancient communication lines is often derived from indirect sources such as road- and route-related sites, travel accounts or historical sources, but the actual course of the road or route is often not verified in the field.[827] However, there are numerous, more di-

824 Riemer – Förster 2013, 34, 46–49; Adams 2001, 1; Casson 1994, 9.

825 Riemer – Förster 2013, 34.

826 Riemer – Förster 2013, 34; 19–58 defined a set of key issues that should be addressed when researching ancient communication systems.

827 For an overview of comprehensive investigations on ancient road systems in Europe and the East, see H. Lohmann, J. Wiesehöfer and M. Rathmann, 'Straßen', in: H. Cancik, H. Schneider, M. Landfester (eds.) Der Neue Pauly: doi:http://dx.doi.org/10.1163/1574-9347_dnp_e12225290 (last access 27.05.2020). Specifically for Near

1 : Possible course of the via nova Traiana from Petra to Nejel (after Brünnow and von Domaszewski 1904)
2 : Possible course of the via nova Traiana (Graf´s Central Route) (after Graf 1995)
3 :Possible course of the via nova Traiana (Graf´s Eastern Route) (after Graf 1995)
4 : Zharah Road (after Abudanh 2006)
5 : Du' aij Road (after Abudanh 2006)
6 : Basta - Udruh Road (after Graf 1995)
7 :Saddaqa - Basta Road (after Graf 1995)
8 :Darb ar-Rasif (after Graf 1995)
9 :Darb ar-Rasif (KHJ001, 002, 004, 008) (after Abudanh et al. 2015)
10: Siq (author)
11: Petra - Udruh Road (after Brünnow and von Domaszewski 1904)
12: Modern Udruh - Ma'an Road (satellite imagery)
13:Udurh - ad-Dosak Road (after Brünnow and von Domaszewski 1904)
14: Malghan Road (after Abudanh 2006)
15: en-Geb (author)
16: Naqb Namala (author)
17: Wadi Turkmaniye (author)
18: Wadi al-Mu'aysirah East (author)
19: Darb al-Lethie (author)
20: Wadi al-Ghurab (author)
21: Modern Beidha - King's Highway Road (author)
22: Naqb al-Farsh (author)
23: Naqb al-Aqab (author)
24: Naqb al-Asmar Sheiq an-Nisr (author)
25: Naqb Abu Mrerah
26: Naqb Slaysil (author)
27: Wadi Marwan (author)
28: Naqb Seir al-Begh'er/ Wadi as-Siyyagh (author)
29: Wadi al-Mu'aysirah West (author)
30: Wadi Musa (author)
31: Naqb al-Ghirbe (author)
32: Naqb Mistalgile (author)
33: Naqb as-Sto'e North (author)
34: Naqb as-Sto'e South (author)
35: Naqb ad-Dab'e (author)
36: Wadi Sabra (author)
37: Naqb ar-Risha'rish (author)
38: Naqb ad-Beidab (author)
39: Naqb Saqqara (author)
40: Naqb ar-Ruba'i (author)
41: Wadi Jawf Ahmar (author)
42: Umm Qamar (author)
43: LCP from Khirbet as-Faysif to Qaa' as-Sayideen (author)
44: LCP from Khirbet as-Faysif to Bir Madkhur (author)
45: LCP from Bir Madkhur via BMP/CAS Site Nr. 013 to Khirbet Qhuntera (author)
46: LCP from Khirbet as-Faysif to BMP/CAS Site Nr. 013 (author)
47: LCP from Khirbet as-Faysif to Kh. Umm Qhuntera (author)
48: LCP from Bir Madkhur to Faynan (author)

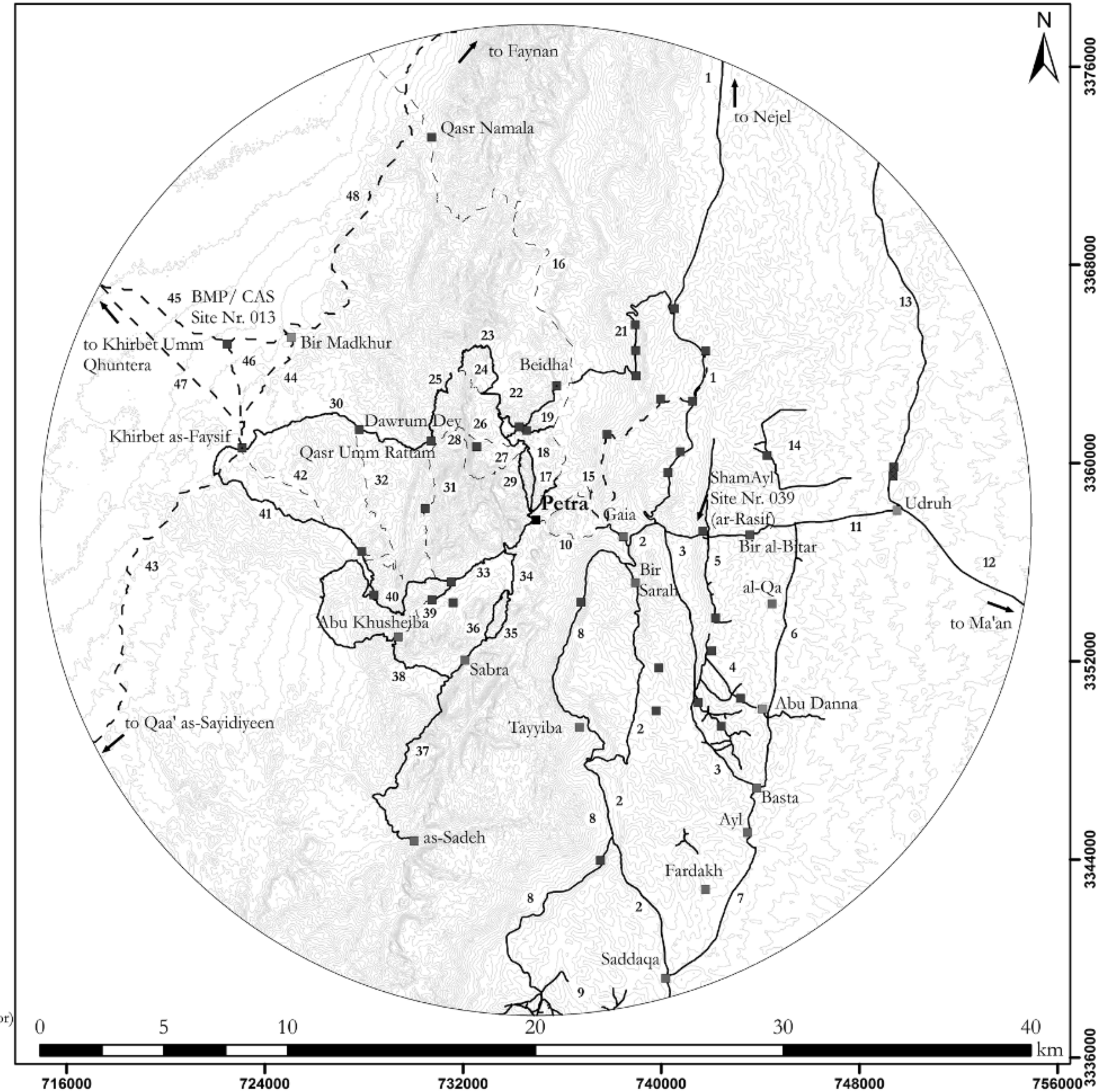


FIG. 180 Overview map of all archaeologically evidenced roads, routes and tracks in the Petra area with major road-related sites.

rect archaeological indicators that help to reconstruct them. These include the visible (mostly constructed) remains of the road/route itself, built landmarks or way points, road and route stations and other sites as well as archaeological objects that may have been discarded by ancient peoples along their way.[828] When possible, studies investigating ancient communication systems have therefore considered both the indirect, as well as more direct, archaeological, literary and historical sources together. Considering the importance of mobility and the travel process as a whole is also hampered by the general difficulties of grasping mobile peoples archaeologically.[829] It is nevertheless vital to recognize the significance of the travel process itself and to avoid the 'primacy of destination.'[830] Travel was a key part of ancient life, both in time and space, and should be considered as a dynamic alternative to "[…] *a sedentary way of life* [offering] *different experiences, and* [changing] *mindsets and perceptions.*"[831]

A major issue for the study of ancient roads and routes is the problem of defining the nature and character of particular communication lines. Giving an exact definition or distinction between roads and routes/tracks is not an easy task. Many definitions overlap and include similar functional and/or structural aspects.[832]

Any attempt to define the various means of land travel eventually leads to the question of their original purpose. With the introduction of herding, the need for easier and faster access to pasture called for a higher demand of specific trails and paths, and the impact of natural landscape conditions and overall travel time became increasingly important.[833] Eventually, more frequent traffic resulted in the infrastructural improvement of the established routes in terms of travel and transportation speed, security and comfort.[834] This process of 'formalisation of routes' is manifested in various ways.[835] The increasing formalization of routes eventually led to an entire communication network materialized in intersecting roads and routes/tracks.[836] Particularly in cases of dense networks, a generally defining feature of desert roads and routes is that they often bundle and intersect mostly in areas where difficult topographical conditions or particularly arid constraints prevail.[837]

Topographical preconditions have a major effect on the course of ancient roads and routes/tracks. This is particularly the case within mountainous desert areas, such the Petraean hinterland. Other environmental constraints are also important to consider. These include geological and soil typological conditions as well as the important aspect of seasonality and climate. Seasonal climatic conditions (warm/hot summers versus cooler and rainy winter months) have an immediate impact on when, and by which means, ancient roads and routes/tracks were accessible.[838]

Geographical distances are also immensely important for evaluating the significance of ancient roads and routes. Within a short distance, communication lines address daily logistical needs, but at a long distance they can often relate to "[…] *residential mobility, migration, or contacts and exchange with other people.*"[839] Travel time is often mentioned as measurement for distances. Instead of describing distances in units of lengths (e.g. kilometers or meters), many traditional travelers mention only the amount of time they needed to travel from A to B.[840] Ancient sources can also give information on the duration of travel.[841] Taking various factors such as travel speed, difficult terrain or the availability of natural resources into account, measuring distances in time is far more practical for the traveler who has to organize provisions, find over-night stops, manage potential animal herds and generally estimate the daily needs during the journey.[842]

Methodologically, the study of ancient communication systems is much embedded in larger landscape

Eastern examples, see the works on Achaemenid royal roads and itineraries of Briant 1997and 2001 as well as Graf 1994a.

828 Riemer – Förster 2013, 26.

829 Riemer – Förster 2013, 26. Cf. also Hauser 2006 as well as Bradley 1992.

830 Riemer – Förster 2013, 26; Cummings – Johnston 2006.

831 Riemer – Förster 2013, 27.

832 Cf. Köpp 2013, 107–132 and Köpp 2009. On the different types of Roman roads, see van Tilburg 2007, 7–9.

833 Riemer – Förster 2013, 28; Zboray 2013.

834 Cf. van Tilburg's brief account on the forerunners of Roman roads (van Tilburg 2007, 2–4). Also see Casson 1994, 21–58.

835 Zedeño – Stoffle 2003, 62–63: *"Heavily trafficked pathways were maintained and upgraded: stones, cairns, petroglyphs, trail-marker trees, stepping stones on canoe landings, rope and hand-and-foot rails, and wooden bridges were sometimes placed along land and water trails."*

836 Riemer – Förster 2013, 30.

837 Riemer – Förster 2013, 30. In the Petraean hinterland, cf. e.g. the 'intersection' at Dawrum Dey where Naqb al-Ghirbe, Naqb Abu Mrerah, Naqb Slaysil and the Wadi Musa meet (more below).

838 Riemer – Förster 2013, 30 claim that ancient desert roads should therefore be considered "[…] *as a unique type of environment for human behavior.*"

839 Riemer – Förster 2013, 31.

840 See Ben David 2007, 102, n. 15 for an exemplary list.

841 E.g. Plinys's and Strabo's accounts on the time needed for caravans to travel from southern Arabia to Aila and Gaza: Plin. HN 12, 32, 64 and Str.16, 4, 4.

842 Interestingly, information on distances that can be travelled by loaded Saharan camels is referred to in 'camel-days' (Riemer – Förster 2013, 31 and Lydon 2009, 220).

archaeological studies that contextualize site-based analyses in their larger environment. The study of 'off-site' evidence is particularly applicable to the research of ancient roads and routes since they enable further investigations into the areas between two sites along the way.[843] Traditionally, archaeology has been able to identify possible roads and routes by connecting various road- and/or route-related sites such as relay stations, trading posts, over-night stops, resting places or deposits for provisions.[844] However, the actual course sometimes differs significantly from the reconstructions based on archaeological evidence alone. Extensive field survey activities can attempt to re-track the routes on the ground, but identifying them in the field is highly dependent on the state of preservation and the changing environmental conditions. Supplementary to actual field survey are 'remote sensing methodologies,' i.e. the analysis of high resolution satellite imagery that can help to identify potential communication lines.[845] GIS-based investigations also offer useful tools for analyzing landscape conditions specific to particular roads and routes and are able to set them into a wider environmental context. GIS helps to identify and interpret structural remains associated with ancient roads and routes that may have impacted the general characteristic of their course as well. One very popular investigative method is the calculation of least-cost paths (LCPs) (cf. chapter 2). Without intensive ground-checking, however, these methods remain untested models. Field survey cannot be substituted by such analyses and must be of central focus to any study concerned with the research of ancient communication lines.[846] Ideally, both should be applied and compared in order to achieve optimal results.

Of particular interest for studies researching desert landscapes, is the aspect of *nomadism*. General theoretical discussions on mobility have identified two explicit modes of full nomadic lifestyles: Hunter-gatherer and pastoral nomadic societies.[847] This is important for discussing ancient roads and routes as the formalization of communication lines represents an organized form of mobility. Particularly mobile cycles of nomadic societies do not necessarily follow predefined roads and routes in the landscape. With good knowledge about their natural habitat and its natural constraints, limited water sources, vegetation spots and animal game, nomadic peoples greatly immersed themselves into, and were a fundamental part of, the natural landscape. The extreme natural conditions of desert landscapes forced mobile peoples to adapt quickly and appropriately. Important navigation skills therefore swiftly became a crucial ability in desert travel as losing one's way in a desert environment could end fatally. With increased aridity and limited water sources, desert landscapes are 'landscapes of scarcity and risks' and travelling across them required detailed knowledge of their settings and extraordinary organizational skills.[848]

Equally important for a comprehensive study of ancient roads and routes, is the evaluation of available historical sources. It is necessary to interpret relevant historical accounts on particular communication lines and their inherent value to the superordinate topics listed above, thus contextualizing communication networks in a wider historical framework. Although textual evidence concerning specific roads and routes are mostly limited, comparative historical analysis nevertheless may reveal promising insights into the socio-economic, political, administrative and military significance of communication networks.

In addition to traditional historical sources, ethnographic and ehtnohistorical/-archaeolgical studies can be of great supplementary value. Important ethnographic contributions to understanding the purposes and cultural meaningfulness of pre-modern roads and routes were presented by Alcock et al. and Snead.[849] Re-evaluating the accounts of earlier travelers may also reveal useful information on the practicality of traveling through the studied landscape.[850] On this basis, insights into the nature of ancient travel might be deduced. Modern ethnographic comparisons can yield important information on aspects of desert travel and offer further insights into modes

843 Riemer – Förster 2013, 31–32: these areas may contain "[…] *a number of interesting features await[ing] scholarly attention: visible tracks, objects lost by travelers, road signs, and petroglyphs.*"

844 Riemer – Förster 2013, 38–39 also distinguish so called 'portables', i.e. material evidence that ancient travelers lost or deliberately stored along their journey. A good example for such 'portables' is the vast amount of jars placed along the 'Abu Ballas Trail' in the Libyan Desert which served as water and food storages for the caravans (Förster 2013).

845 For an example from the western desert of Egypt, see Bubenzer – Bolten 2008.

846 If logistically possible, field activities should conduct intensive pedestrian surveys to fully grasp, experience and interact with the landscape. For this point, also see Riemer – Förster 2013, 35. For an insightful example on such an intensive pedestrian survey of ancient routes in the Libyan Desert, see Bergmann 2001, 367–460.

847 Riemer – Förster 2013, 33.

848 Riemer – Förster 2013, 33.

849 Alcock et al. 2012; Snead et al. 2009.

850 For an overview of early travelers and explorers to the Petra region, see e.g. Lewis 2003 and Llewellyn 2003. For a compilation of travel accounts in the western Sahara, see Lydon 2009.

of human adaptations to arid landscapes.[851] Ethnographic studies can also reveal interesting narratives associated with particular communication lines as well as journeys and/or particular places. Such narratives can play a significant role in reconstructing the so called 'mental map' of ancient desert travelers.[852] For example, Harding King's accounts of crossing the Libyan Desert in the early 20th century have revealed the importance of storytelling and tales for identifying lost or forgotten roads and routes.[853] Landscape narratives of traditional Bedouin give evidence to the significance of particular places and landscape features for the formation of tribal identities and the vast degree of local environmental knowledge.[854] While drawing direct lines between modern ethnographic observations and potential ancient behavior remains a disputed issue, there nevertheless seems to be ample grounds to assume some cultural continuity.[855]

In addition to textual evidence, epigraphical evidences, petroglyphs and rock-art are also majorly important for understating the functioning and cultural context of communication lines. These may appear at various significant places in the landscape including resting places, wind breaks or caves, prominent natural features such as rocks and hills, or built relay stations along ancient roads and routes.[856] Such epigraphic and pictorial evidence can yield important information on more 'personal' and social histories of roads and routes.[857] However, the purpose and meaning of such epigraphical and pictorial sources are multitude and can vary depending on context.

One of the primary aims in constructing roads and routes was to establish a logistically optimal communication infrastructure.[858] This is an important point considering the specifically difficult environmental conditions of desert landscapes, particularly concerning the availability of water and food.[859] Such logistical efforts highlight overall organizational oversight and should not be underestimated. These also include important navigation skills as well as local knowledge and the 'mental maps' of the landscape. While determining ancient wayfinding and navigation skills is difficult, the expedition of Aelius Gallus in 26/24 BC, who reportedly employed Nabataean guides to navigate him through the desert areas to the Sabaean kingdom in modern-day Yemen, emphasizes the significance of such 'mental maps.'[860]

There are archaeological remains suggesting infrastructural installations for navigating through the landscape: Road/route markers in form of stone cairns and others (more below) easily date back to prehistoric times and remained one of the most common navigation installations in desert landscapes until systematic mapping activities in the 19th and 20th centuries.[861]

Beasts of Burden: Donkeys, Camels and Horses

In desert landscapes, the use of animals as beasts of burden is often associated with caravan trade – most particularly with *camel* caravan trade. However, the three major beasts of burden in desert areas are donkeys, camels and horses.[862] Each animal has its own physical particularities, as well as advantages and disadvantages, in terms of transportation suitability affecting general travel speed and overall size of caravans. Independent of the particular animal, these various factors include the

> […] *physical state and condition* [of the animal]*; the weight of the load to be carried; the nature of the terrain crossed by the caravans; general climate and temperature; the*

851 For an ethnographic study following modern camel caravans from modern-day Chad to Libya, see Meerpohl 2013. On the nature of modern camel caravans in the Libyan Desert, see Bergmann 2001. Förster et al. 2013 also present an interesting contribution to the study of modern donkey caravans from Egypt to Darfur.

852 Riemer – Förster 2013, 37.

853 Harding King 1925.

854 For the Ma'aza Bedouin in the Eastern Desert of Egypt for example, Hobbs 2014; Hobbs 1990, 81–86 assembled such tales revealing such informative landscape narratives. For a similar assemblage of traditional tales on desert travel in Egypt's Western Desert, see Fakhry 1973 and 1974. An additional great source for accumulating such traditional narratives can be found in Maury's work between the Egyptian oases of Khraga and Dakhla (Maury 1979).

855 McCorriston's study on Iron Age Yemen also highlights the importance of places – mostly religious or ancestral funerary sites – for shaping tribal identities, attesting well to such cultural continuity (McCorriston 2013, 617–627).

856 Riemer – Förster 2013, 39.

857 Various case studies deal with such epigraphic and pictorial evidences. See e. g. Brusgaard 2019 and the contributions by Darnell 2013, Förster et al. 2013, Somaglino – Tallet 2013 and Bülow-Jacobsen 2013 in Riemer – Förster 2013.

858 Riemer – Förster 2013, 42.

859 Cf. Darnell 2013, Snape 2013 and Vetter et al. 2013 in Riemer – Förster 2013. Also consult Franzmeier 2008. Although the material evidence is mostly absent, one also has to take carry-on provision and water into account.

860 Str. 16, 4, 22–24; Hackl et al. 2003, 606–615. Although Strabo's accounts on the failed campaign of Aelius Gallus have to be considered critically (cf. Graf 2016; Sidebotham 1986), Nabataean involvement in the expedition was mostly due to their good knowledge of the caravan routes and tribal territories (Sidebotham 1986, 594–595).

861 Riemer – Förster 2013, 44.

862 Oxen are often referred to as important beasts of burden as well. However, since they are hardly attested for in the study area, they are excluded here.

overall distance to be covered and the duration of the journey; availability of water and food along the route; aimed travelling speed (including potential night marches); the possibility of longer resting periods in order to recover, etc.[863]

Acknowledging the various qualities of the different beasts has a major impact not only on the interpretation of the functionality of the various roads and routes/tracks, but also on the entire communication infrastructure of the Petraean hinterland. The following section therefore provides a brief overview on the qualities as well as the archaeological, epigraphical and historical evidence concerning the beasts used in the study area.

Donkeys

Particularly in desert landscapes, the domesticated donkey was the first beast of burden and the major animal used for transporting goods and people before it was substituted by the camel.[864] Studies on ancient caravan trade generally consider camel caravans only, as they are – particularly in the Western eye – the famous 'ships of the desert.'[865] Although the donkey's important key qualities for traversing across desert landscapes are recognized, its significance is often underestimated by the romantic perception of Arabian camel caravans. R. K. Power brought it nicely to the point:

The donkey is perhaps one of the most important, albeit neglected and misrepresented animals in history. Indeed, it may be said that everything that early man needed to take them from hunter-gatherers to settlements, and to great and complex civilisations, was carried on the backs of donkeys. Despite all the evidence, be it archaeological, ethnographical, or ecological, this animal's relentless work and almost inexplicable endurance over possibly 6000 years of domestication is overshadowed by one of the worst reputations in the animal world.[866]

While the modern perception of the donkey is often associated with its use as a pack animal, the idea of proper donkey caravans seems rather understated for the modern (Western) mind. Although desert travel is often closely linked to the imagination of large camel hoards roaming across the desert, donkey caravans were – and still are – an important feature of desert travel.[867] In Pharaonic Egypt, there is textual evidence suggesting the use of donkeys for means of transportation in larger caravans: There are references to the use of donkey caravans in the Old and Middle Kingdom encompassing between 100 and 1000 animals.[868] Also, the highly advanced trade networks within the Old Assyrian Empire would not have been possible without extensive use of donkey caravans, which comprised of up to 300 animals per caravan as well.[869]

Physically, the overall advantage of using donkeys for travelling across desert landscapes is their abilitiy to carry heavy loads over a long distance per day without requiring much water or fodder.[870] According to Köpp, the approximated carrying capacity of donkeys in temperate climates is c. 150 kg. However, the British Army manual from 1923 states that donkeys are only able to carry up to 50 kg at long distances.[871] An ethnographic study on modern donkey caravans in Sudan conducted by Förster, Riemer and Mahir confirms this weight.[872]

Depending on the general physical condition of the donkey, the distance of the journey (and travel time), as well as the overall load carried by the animal, modern-day studies from Sudan have shown that the average distance that can be travelled by a loaded donkey is approx. 35 km *per diem*.[873] In terms of water needs, the British Army recommended that donkeys should be watered every second day, but the ethnographic example from Sudan suggests that they can go three days without water.[874] An important point to

863 Förster et al. 2013, 212. Cf. Also Zohar – Erickson-Gini 2019, 4.

864 Magee 2015; Meerpohl 2013, 168; Riemer – Förster 2013, 36, 44–45; Somaglino – Tallet 2013. Old Assyrian texts also mention the use of mules. Derckson 2004, 257 states that the domestication of the wild-ass in modern-day Iraq took place at some point in the 4th millennium BC.

865 Riemer – Förster 2013, 45.

866 Power 2004, 131.

867 For modern examples of donkey caravans, see Förster et al. 2013.

868 Köpp 2013, 110 with further references. Dating as far back as the first dynasty, there is also very good textual, epigraphic and pictorial evidence from ancient Egypt suggesting that donkeys were not only important pack animals, but riding animals as well (Rossel et al. 2008 and Kahl 1994, 486). Köpp 2013, 110 and Peacock – Maxfield 2001, 297 state that donkeys were later used as draught animals for pulling quarry stones during the Graeco-Roman period. For more on travel and transportation in Egpyt during the Graeco-Roman periods, see Bülow-Jacobsen 2013 and 2006.

869 Derckson 2004, 255, 283.

870 Riemer – Förster 2013, 45.

871 Köpp 2013, 109; Peacock – Maxfield 2001, 297; Ohler 1988, 35. Rosen – Saidel 2010 mention that donkeys or mules can carry between 70 and 80 kg a day.

872 Förster et al. 2013, 200. However, discussing the presumed short lifespan of an Assyrian donkey Derckson 2004, 260, 278 claims that donkeys were often carrying too heavy loads of about 75 kg at average.

873 Riemer – Förster 2013, 31. Derckson 2004, 255 claims that a donkey caravan can cover an average distance of 25 km per day. The maximum distance can thus be roughly set at 35 km.

874 Numbers can vary as the travel rates of the particular animals are strongly dependent on various factors (Köpp 2013, 110; Peacock – Maxfield 2001, 296; Förster 2007, 5).

make is that due to the particular form of their hooves, donkeys perform very well in more mountainous regions and prefer harder, rocky ground over sandy soils.[875] This is particularly crucial for understanding ancient desert travel as the donkey's physical qualities allow them to take completely different roads and routes than camels (see below). This highlights the importance of the animal for desert travel in general, and offers more insights into the particular nature of the communication infrastructures evidenced within the Petraean hinterland.

There is only limited evidence for the use of donkeys in the Petra area. One textual reference on donkeys within the more general Nabataean context can be found in the 'Zenon Archive,' an ancient Greek papyrus discovered during illegal excavations of the Fayyum oasis in Egypt. The papyrus dates between 261 and 229 BC and is not only an important historical source on the Ptolemaic period in general, but is also one of the earliest textual references to the Nabataeans as a cultural group.[876] The name of the papyrus is based on the main author Zenon who served Apollonius, the finance administrator (διοκητής) of Ptolemais II since 261 BC and later was appointed to care for Apollonius' private estates near Philadelphia close to Madinat al-Fayyum.[877] After Zenon completed his services to Apollonius he remained in the area and continued to report on events and happenings in *koile Syria* (κοίλη συρία) under Ptolemaic rule.[878] One episode of the Zenon archive is particularly interesting in this context: Zenonpapyrus PSI 406, Col. I describes the misdealings of two official servants of Zenon who unlawfully profited by renting a female slave as a prostitute and for selling off their transportation animals.[879] These animals were one she-ass (ὄνος η θήλεια) and one onager (ὀνάγριος). Following Graf, these must have been considered an expensive and special donkey breed since the Tobiads also gave such animals as a gift to the Ptolemaic crown.[880] The fact that such animals were given away as a royal gift suggests their high value, therefore emphasizing the importance and standing of the donkey within the wider regional culture of the time.[881]

Another textual reference to donkeys is given by Strabo. Citing the Hellenistic geographer Agatharchides of Cnidus, he mentions that, in addition to camels and other wild and domesticated animals, mules (ἡμίονοι) were common to the immediate region around Aila (ancient Aqaba).[882] No further literary sources on the use of donkeys in the wider study area are known, but it is generally agreed that horses and onagers were well-known within the Nabataean realm ranging from the Hawran to the Gulf of Aqaba and the Negev desert.[883]

There is only limited archaeozoological evidence for beasts of burden from the Petra area, particularly from the more remote areas. The only (major) archaeozoological study conducted in Petra itself comes from the Swiss excavations of the domestic site of ez-Zantur.[884] Almost 10,000 animal remains were documented and studied in detail. However, with only 0,3 % evidenced, equids (undifferentiated between horse, donkey, mule) are particularly underrepresented.[885] Although donkey bones show some butchery marks, the low number of documented bones indicate that donkeys were not frequently eaten. This may suggest that they were primarily used as beasts of burden.[886]

Although there are only few known examples of donkey terracotta figurines, they nevertheless show "[…] *different types of tack than the horses, and depictions of being laden with bundles*."[887] Thus, while the direct evidence for the use of donkeys (and/or mules) within the Petraean hinterland and its wider cultural context seems limited, the comparative data from ancient Egypt, the ethnographic study from modern-day Sudan as well as the Assyrian references suggest the widespread use of donkeys as beasts of burden.[888]

Camels

The next most defining 'technological revolution' for desert travel was the domestication of the camel – or, more precisely for Arabia, the one-humped camel or

875 Riemer – Förster 2013, 30; Köpp 2013, 110; Ohler 1988, 35.
876 Hackl et al. 2003, 363.
877 Hackl et al. 2003, 363.
878 Hackl et al. 2003, 363.
879 For the entire episode, see Hackl et al. 2003, 364–365.
880 For specific mentioning of the she-ass and the onager, see Zenonpapyrus PSI 406, Col. I, 41–42. Hackl et al. 2003, 367; Graf 1990, 74. For more on the gift of the Tobiads, see Hauben 1984. There are different terms for donkeys. It appears that ὄνος is the normal donkey (undifferentiated gender), ὀνάγριος the wild, undomesticated (?) donkey (undifferentiated gender), while the ἡμίονος refers to the mule or half-ass (also undifferentiated gender).
881 Cf. Graf 1990, 74.
882 Graf 1994b, 267: Str.16, 4, 18.
883 Graf 1994b; Hyland 1990, 24–27; Negev 1986, 105–106.
884 Studer 2007.
885 Studer 2007, 259.
886 Studer 2007, 259.
887 Tuttle 2009, 186.
888 Without downplaying the significance of the camel – particularly in the Petra area – it is nevertheless important to recognize that at least regional trade and communication, was not conducted solely and exclusively on the backs of camels. The very likely possibility of the employment of other beasts of burden such as the donkey, particularly in areas difficult to access by the camel, must be expected.

dromedary.[889] The introduction of the camel as the major beast of burden for long-distance trade and military purposes had a major political, commercial, ecological and military impact on the Near East, and can only be paralleled by the introduction of the motorized vehicle in the early modern era.[890] Archaeozoological and pictorial evidence suggests that the dromedary was originally domesticated in South Arabia as early as the 3rd millennium BC and by the time the animal arrived in the Levant in the late second millennium BC, it was already fully domesticated.[891] This is also confirmed by textual sources. By the mid-9th century BC, a tribal leader named Gindibu owned 1000 camels and aided the local king of Damascus against the Assyrian ruler Shalmaneser III; a first account on the military use of camels. The Assyrian king Tiglah-Pileser III was apparently able to gain 30,000 camels after his successful battle against the 'Queen of the Arabs,' Samsi, in 733 BC.[892]

However, the camel is most famous as a beast of burden along the Arabian long-distance trade networks.[893] Biblical references to regular caravan trade between South Arabia and the Mediterranean Sea date camel-based caravan traffic as early as the 10th century BC.[894]

The camel is physically able to walk longer distances with less requirements for water and fodder than the donkey. Camels can go up to six times longer than donkeys without drinking. They are also able to carry twice the load and more. A male dromedary is able to carry loads weighing between 150–225 kg over long-distances and up to 500 kg over short distances.[895] However, the camel's ability to walk without water depends greatly on the physical fitness and age of the individual animal, day-to-day temperatures, its load, as well as the conditions of the road/route itself.[896] Meerpohl claims that camels can survive between 15–30 days without water in temperate climates. In the hot summer heat its endurance can be reduced to approx. 7–12 days.[897]

Due to their soft feet, camels prefer to walk on soft sandy soil and try to avoid hard rocky ground and therefore would choose significantly different roads/routes than donkeys.[898] The camels' feet are particularly sensible as they can develop extremely worn feet even when walking on soft sandy soil.[899]

889 Riemer – Förster 2013, 45. There are two genera of the camel: The more common *genus* to Arabia is the one-humped dromedary *(camelus dromedarius)*. The other – the two-humped Bactrian camel *(camelus bactrianus)* – mostly inhabits regions of the Far East. It is mostly claimed that the Bactrian camel was not known in ancient Arabia. However, discussing the Trajanic silver coin series depicting the two-humped camel on one side, Graf 2007 points out that the Bactrian camel was not only known, but also occasionally used in ancient Arabia. The use of the Bactrian camel was not only referred to in Neo-Assyrian texts (Graf 2007, 441–444), but there are also petroglyphs from Mesopotamia, the Hawran as well as in modern southern Jordan depicting two-humped camels (Graf 2007, 444–447). Particularly hybrids between dromedaries and Bactrian camels were desired as they were stronger and could endure longer distances (especially with reference to the Parthian habit of cross-breeding, see Graf 2007, 447). Although this does not negate the fact that the main camel *genus* was the dromedary, both the Bactrian as well as hybrids may have been wandering the Arabian deserts as well. As the famous ad-Deir relief at Petra suggests, one might even argue that the two-humped Bactrian and/or hybrid camel was a particular status symbol in the ancient Near East (cf. also Graf 2007, 441 and 448).

890 Köhler-Rollefson 1993, 180.

891 Rosen – Saidel 2010, 75, 76; Köhler-Rollefson 1993, 182–184. One of the first textural references on the use of camels in the region are the biblical accounts of the Midianites and Ishmaelites attacking rural settlements, although the historicity of these biblical accounts has been questioned (Rosen – Saidel 2010, 74). Additionally, depictions of camels on Assyrian reliefs showing them as both pack animals and being used for military purposes, as well as an abundant amount of camel bones found within major Assyrian settlements such as Tell Jemmeh immediately south of Gaza confirm the full domestication of the animal by the Iron Age (see Meerpohl 2013, 168; Riemer – Förster 2013; Rosen – Saidel 2010, 75). Further on the domestication of the camel in the Levant, see Magee 2015; Uerpmann – Uerpmann 2002.

892 Köhler-Rollefson 1993, 184; Ephal 1982. The proper use of camels within the cavalry was introduced by the Assyrians in the 7th century BC and later adopted by the Persians and Sassanians as well. See Rosen – Saidel 2010, 72; Köhler-Rollefson 1993, 184. Also see the passage in Hdt. 7, 69, 86; 184 mentioning that Arabian camel riders were incorporated in the Achaemenid armies (Hackl et al. 2003, 14). Nevertheless, textual sources mentioning the use of camels are rare and absent from the mid-second millennium BC Mari archive – the most comprehensive textual archive on ancient forms of nomadism in the Near East (Rosen – Saidel 2010, 75 referring to Matthews 1978, 68, no. 7).

893 The camel was also an important form of subsistence among desert pastoralists (Rosen – Saidel 2010, 73). It provided milk (products), meat as well as other secondary products such as water containers made of their skin, textiles or bones used as tent pegs. For an ancient reference on the use of camel skin for water containers, see Hdt. 3, 9, 1 and his accounts on the Persian king Cambyses' battle preparations against the Egyptian Pharao Amasis and how the native Arab population took control of his army's water management in the desert areas between Egypt and Arabia.

894 Köhler-Rollefson 1993, 184: See 1 Kings, 10 and the description of Queen Sheba's visit to King Solomon transporting her goods with camels.

895 Riemer – Förster 2013, 45; Rosen – Saidel 2010, 73. The two-humped Bactrian camel is able to carry loads of up to 270 kg a day over a distance between 30 and 40 km (Graf 2007, 447).

896 Meerpohl 2013, 183.

897 Meerpohl 2013, 183, 186.

898 Riemer – Förster 2013, 30; Gautier-Pilters – Dagg 1981, 79.

899 Meerpohl 2013, 179.

In extreme cases, it is necessary to improvise special camel shoes as is not only evidenced by modern-day caravans, but also documented by early travelers.[900] An important observation on camel walking behavior in the immediate Petraean hinterland is that camels generally avoid the sharp volcanic rock referred to by the local al-Bdul Bedouins as the *al-Somrah* – the dark stone – as it can easily cut the camels' feet, especially when walking on steep terrain.[901] This information is highly valuable for assessing the accessibility and general characterization of the various roads and routes/tracks in the study area. The average walking speed of camels is between 4,8 and 5,5 km/h. A slow trot can reach up to 8 km/h and galloping camels even 25 km/h.[902] At average, loaded Saharan camels can walk approx. 35 km per day.[903]

Although it is difficult to give any standard behavioral values, this offers a general 'rule of thumb' when assessing specific functionalities and practicalities concerning ancient roads and routes.

Within the Nabataean realm, the camel's significance as a beast of burden is abundantly evidenced by textual, epigraphical and pictorial sources as well as by ancient art.[904]

One of the earliest literary sources mentioning the use of camels by the Nabataeans comes from Strabo mentioning that camels were used instead of horses, as they were comparatively rare.[905] Based on the writings of Hieronymos of Cardia from the 4th century BC, Diodorus Sicilus states that some of the Nabataeans maintain camels, while others raise cattle which they keep in remote (desert) areas.[906] Plutarch mentions that during the Macedonian attempt to suppress the Nabataeans in 311 BC, Demetrios Poliorketes managed to take 700 camels from the Nabataeans as booty.[907] The use of the camel as a pack animal is often referred to in Strabo's description of the campaign of Aelius Gallus against the Sabaean kingdom.[908]

Describing how the Nabatean king Obodas I defeated the Hasmonaean ruler Alexander Iannaios near Gadara, Flavius Josephus reports that camels were used as a riding animal within the Nabatean army as well.[909] After the incorporation of the Nabatean realm into *Provincia Arabia*, it is well-attested that Nabataean units served in the imperial Roman army – including δρομεδάριοι.[910]

Graffiti along Egypt's coastal areas further attest to Nabataean caravan presence along the Red Sea ranging from the 1st century BC until the 3rd century AD.[911] Although only a transcription of the original text exists, one example is the Nabataean graffito dating to the second half of the 3rd century AD discovered at Abu Darag some 30 km south of modern Suez along the western coast of the Red Sea. This graffito is an important literary source for the continuance of Nabataean camel caravan trade in Egypt well into the Roman period.[912] Two other Nabataean inscriptions from Umm Jadhāyidh, situtated along the ancient road between Hegra and Petra, commemorate men and camels that travelled to Hegra and returned. At

900 For the modern-day version of the camel shoe (used innertubes from car tires), see e.g. Meerpohl 2013, 179. For an example from the late 19th century, Max Freiherr von Oppenheim mentions that leather was sown around the camels' feet for protection (von Oppenheim 1899, 219). K. Berghuijs is thanked for providing this reference.

901 Personal communication Suleiman Mohammed al-Bdul, April 2015. Cf. also Kennedy 2016a.

902 Meerpohl 2013, 176.

903 Riemer – Förster 2013, 3; Lydon 2009, 220. The weight of these carried loads are not specified. Rosen – Saidel 2010, 72 claim that they can walk between 60 and 90 km a day, with a maximum of 160 km in only 16 hours.

904 Cf. most recently Nehmé 2020.

905 Str. 16, 4, 26: "[…] *πρόβατα λευκότριχα, βόες μεγάλοι, ἵππων ἄφορος ἡ χώρα: κάμηλοι δὲ τὴν ὑπουργίαν ἀντ᾽ ἐκείνων παρέχονται.*"; Hackl et al. 2003, 615–617. Strabo also refers to the Nabataeans as camel herders in 16, 4, 2 based on the 3rd century BC accounts of Erathosthenes of Cyrene. Specifically on practical, domestic and utilitarian uses of the camel in Nabataea: Cf. Nehmé 2020, 207–211.

906 Diod. Sic. 19, 94, 4: *"τρέφουσι δ᾽ αὐτῶν οἱ μὲν καμήλους, οἱ δὲ πρόβατα, τὴν ἔρημον ἐπινέμοντες."* Interesting is the use of the verb τρέφειν, which can be translated as "to feed" or to "thicken." While Studer 2007, 251 translates the entire relevant passage as *"some of the Nabataeans keep camels, others sheep that they feed in the desert,"* the German translation provided by Hackl et al. 2003, 444–445 is: *"Einige von ihnen züchten Dromedare, andere Schafe, welche sie in der Wüste weiden lassen."* The German verb "züchten" is in fact closer to the literal translation of the Greek τρέφειν, perhaps suggesting active camel (and sheep) breeding by the Nabataeans, instead of merely "keeping" them.

907 Plut. Demtr. 7, 1; Hackl et al. 2003, 582.

908 Str.16, 4, 22–24; Hackl et al. 2003, 606–615.

909 Jos. Ant. Iud. 13, 374–375 and Jos. BI 1, 90, 4; Nehmé 2020, 221–222 and 2017, 143–148; Graf 2007 ; Hackl et al. 2003, 470, 538

910 However, the ethnic origins of Arabian troops within the Roman army are rarely stated. Cf. e.g. recently Speidel 2019, 59–60, 62 and Gatier 2018. Generally on the Roman recruitment of Nabataeans within the imperial army, see Graf 1994b. Spaul 1994, 104–105 comments that δρομεδάριοι were probably not very useful in battle and that there is no convincing evidence to suggest their active inclusion into fighting cavalry units. They were more likely employed for policing and controlling the desert areas (cf. chapter 7).

911 Hackl et al. 2003, 362.

912 Hackl et al. 2003, 361–362: Further attestations to Nabataean camel caravan trade are two *ostraca* found in the Egyptian Red Sea area that mention the regulation of trade goods. For ancient references to Nabataean camel caravan trade in general, see the accounts of Plin. HN 12, 63–65. Although Pliny does not directly mention the Nabateans, he nevertheless gives a detailed account on the transportation of incense from South Arabia to Gaza and how it was taxed by the various traders along the way.

Hegra, a group of Nabataean inscriptions associated with a *triclinium* and fraternal cultic society presumably mentions a caravan camel.[913]

Furthermore, dating to the 20th year of the reign of the Nabataean king Aretas IV (11/12 AD), a dedicatory inscription found in ancient Puteoli, Italy, mentions that two camels were sacrificed in the name of the Nabataean main deity Dushara.[914] The Nabataean commercial establishment in Puteoli is well-known and inscriptions refer to a temple commemorating Dushara that was presumably built during the reign of Malichos I (mid-1st century BC).[915] The reference to the two camels as sacrificial animals underlines the importance of the camel within Nabataean culture, even so far away from their home lands.[916]

The archaeozoological study of animal remains documented by the ez-Zantur excavations have shown that, after sheep and goat, the second most common species were male camels. However, only 4 % from the total percentage of the archaeozoological remains belonged to camels.[917] Butchery marks indicate that camel meat was consumed, but the overall paucity of the evidence does not suggest that the camel was eaten regularly. It rather supports the assumption that camels were primarily used as means of transportation.[918]

Nabataean art also bears witness to the significance of the camel within Nabataea. This is most clearly evidenced by terracotta representations of camels presumably used for private cultic purposes as well the famous camel relief in the Siq and the ad-Deir relief of Petra.[919]

Horses

There are only few historical sources on horses in Arabia before the Classical period and the absence of references to horses in the Mari archives has led to the assumption that they were not used in Arabia in the pre-Iron Age periods. However, the 18th century BC cuneiform tablets from Tell Leilan in northeast Syria mention that horses was used for military purposes.[920]

While horses are generally known for their speed (e.g. along the imperial road system of the Achaemenids[921]), they are physically not well equipped for traversing across difficult desert landscapes. While horses are able to carry loads of up to 170 kg, this can only be assumed for flat and easily manageable terrain.[922] In temperate climates, a traveler on horse back at normal walking pace can proceed between four and seven kilometers per hour and at full gallop a speed of up to 52 km/h. At average, it is possible to travel approx. 33 km/day on horseback.[923]

Strabo accounts for the limited use of horses by the Nabataeans stating that they preferred camels.[924] Other literary sources attest to the more representative status of horses within Nabataean culture. This is suggested by Flavius Josephus mentioning that the Nabataean king Malchos I presented horses as a gift to the Mac-

913 Nehmé 2020, 218–219.
914 Nehmé 2020, 213–215; Terpstra 2015; Hackl et al. 2003, 118; Roche 1996, 86–89.
915 Hackl et al. 2003, 118.
916 Actual camels were probably not sacrificed in Puteoli. The inscription most likely alludes to representative figurines instead (cf. Terpstra 2015, 81; Hackl et al. 2003, 118; Roche 1996, 88 and Glueck 1965, 379–380). However, the sacrifice of camels for ritual purposes can possibly be attested at the presumed monumental Nabatean *triclinium* at al-Qusayr, modern Saudi Arabia, where a deposit of most-likely camel bones was observed close to the site and therefore may have served for the ritual banquets at the presumed *triclinium* (Fiema et al. 2020). The great importance of the camel, particularly for the Nabataean kings, is also claimed by Milik, who states that the kings kept their camel (and horse) herds in the fertile steppes of northern Jordan and southern Syria during the winter months for grazing (Milik 1980). See also Hackl et al. 2003, 213.
917 Studer 2007, 258.
918 All archaeozoological material of camels and equids were mostly adult species (Studer 2007, 258, 268.). Apparently, this fits well with the expected age for beasts of burden (Studer 2007, 266 with reference to Köhler-Rollefson 1989). Cf. also Nehmé 2020, 208 in reference to Studer's archaeobotanical analyses of camel remains from Hegra, where camel was consumed only rarely in the earlier phases (pre-4th century AD) of the domestic quarters, while more in the Nabataean and Roman periods in the assemblages from the Roman fort.
919 From the c. 300 fragments of terracotta figurines discovered during the ez-Zantur excavations, about two thirds represent animals. Early finds dating to the first half of the 1st century BC already represent dromedaries with bridles giving evidence for the importance of the camel early on. Remarkably, these representations do not show dromedaries as beasts of burden, but rather as riding animals (Gorgerat 2012, 281). For more on Nabataean camel terracotta, see Tuttle 2009, 177–181; el-Khouri 2002 and Parlasca 1986. Cf. also Nehmé 2020, 215. On the dromedary relief in the Siq, see Nehmé 2020, 217; Seland 2017, 111; Graf 2007, 441, 448; Studer 2007, 258. On the ad-Deir relief depicting a two-humped Bactrian and/or hybrid camel, see Nehmé 2020, 212–213 and Graf 2007, 441, 448 with further references. Also consider the depiction of a dromedary on an early 2nd century AD shroud discovered in a tomb of the northern necropolis at Khirbet edh-Dharih and a small foot of a bronze camel statue discovered during the excavation of a tomb along the Jabal al-Khutbah in Petra (BD No. 779) (Nehmé 2020, 211–212 with further references).
920 Graf 1989, 393, n. 193.
921 Briant 2001; Graf 1994a.
922 Köpp 2013, 114, Tab.1; Ohler 1988, 35–36.
923 Köpp 2013, 114, Tab. 2; Junkelmann 1990, 46.
924 Str.16, 4, 26; Hackl et al. 2003, 615–617. However, Strabo contradicts himself by referring to the work of Agatharchides of Cnidus who in turn recounts the myth of Erythras, the eponym of the Red Sea, who supposedly led the horses of Arabia into Persia (see Graf 1994b, 267: Str.16, 4, 20).

cabean ruler Hyrkanos II.[925] Furthermore, the mid-3rd century BC epigram of Poseidippos of Pella states that a Nabataean king rode into battle on a horseback.[926]

Horses are generally well-attested archaeologically and pictorially throughout the Nabataean realm. Particularly the region of modern Amman (ancient Philadelphia) was supposedly well-known for its horses, which formed a large part of the Ptolemaic cavalry in Egypt.[927] North Arabian Thamudic inscriptions dating to the Hellenistic period refer to horses as well, and Nabataean-era Safaitic texts from the Hawran also give evidence for regional horse-breeding.[928]

Additionally, the frequent references to Nabataean cavalrymen, the *hipparchoi*, attest to the wide use of horses for military purposes in the Nabataean period.[929] This particular standing of horses within Nabataean culture is not only evidenced by literary sources, but also by the numerous terracotta horse figurines found at Nabataean sites.[930] For example, terracotta figurines of saddled horses were found both at Petra and a presumed Nabataean potter's workshop dump at Oboda in the Negev.[931] As for the camel figurines, horse terracottas discovered during the ez-Zantur excavations (dating to the last quarter of the 1st century BC), often depict weapons that do not suggest that the animals were used as beasts of burden, but rather for military purposes.[932] This is also supported by Tuttle's findings, claiming that the majority of horse figurines are depicted with 'tack,' i. e. "*the combined elements of the harnessing, saddlery, and decorations.*"[933] Furthermore, there are various petroglyphs depicting horses within a Nabataean context as exemplified by the rock-art discovered at Wadi Mukatteb in south Sinai, also indicating a more military use of horses.[934]

Only very little archaeozoological remains of horses were discovered by the ez-Zantur excavations.[935] These show no butchery marks, potentially indicating that horse was not part of the Nabataean diet.[936] It therefore seems more likely to assume that horses were generally not used as beasts of burden in the study area, but rather for more representative and/or military purposes.

Caravanserais

This study defines a caravanserai as a large isolated structure situated along major communication lines. It is characterized as a large, rectangular or square building with thick exterior walls with numerous interior room compartments arranged around a large, open courtyard. A caravanserai provided large groups of travelers lodging opportunities and had the capacity to hold caravan animals and to offer sufficient water and food supplies. Good examples of originally Nabataean caravanserais can be found in the Negev along the Petra–Gaza road at Moyat 'Awad and Sha'ar Ramon, which both measure c. 40 × 40 m.[937]

In the Petraean hinterland there are no structures that positively meet this study's criteria of a caravanserai, although there are six sites that are discussed as such by the various surveys: BS Site No. 014 (name unknown), Khirbet as-Faysif, a rectangular structure at Sabra, ShamAyl Site No. 112, Abudanh Survey Site No. 012 and Khirbet al-Hajareen.

Situated in the Siq al-Amti in the Beidha area immediately north of the luxurious Nabataean rural mansion of Umm Qussah (cf. chapter 5), Banning and

925 Studer 2007, 260; Jos. Ant. Iud. 15, 168 and 176; Hackl et al. 2003, 505–509, 617. Generally on the misleading details of Strabo's accounts on the Nabataeans, see Graf 1994b. Particularly on the contrasting literary evidence suggesting the (limited) use of horses by the Nabataeans, see Graf 1994b, 267.

926 P.Mil.Vogl. VIII, p. 309, Col. II 15–16. The epigram is fragmented and particularly the part referring to the potential use of horses was suggestively added by Hackl et al. 2003, 587 on the basis of metrical formalities. The fact that Poseidippos refers to the use of horses by a Nabataean king must therefore be considered critically. Also note the early mentioning of a Nabataean *basileios*.

927 Graf 1997, 281; Graf 1994b, 267; Hyland 1990, 24–27. Negev 1986, 105–106 particularly refers to the stables found in the Negev. On the inclusion of 'Nabataean' horses in the Ptolemaic army, see, MacDam 1992, 30; Hauben 1984 and Rostovtzeff 1922, 166–168.

928 Graf 1994b, 267; Graf 1989, 393, n. 193 for further references. Graf also suggests that the referenced horses from the Hawran may have made up a large part of the Nabataean cavalry, therefore contradicting assumptions that horses appeared only later in Arabia.

929 Hackl et al. 2003, 587; Graf 1994b, 282–290. See also Studer 2007, 260.

930 Gorgerat 2012, 281; Studer 2007, 259–261, 268; Bignasca 1993, 66. Stables are a well-known feature of originally Nabataean towns in the Negev such as Mampsis, Oboda (Avdat), Sobata and Rehovot-in-the-Negev (see Rosenthal-Heginbottom 2003, 26). However, it is questionable if the stables correspond to the original Nabatean phase of these settlements. They most likely date to the later Roman and/or Byzantine phases.

931 Negev 1986, 106; Horsfield – Horsfield 1942, no. 52, pl. XII; no. 250, pl. XXX; no. 449, pl. XLVI. Note that Negev 1986, 105 associates 'Nabataean' with the 1st century AD and further lists evidence of the use of horses in the region up to the 3rd century AD.

932 Gorgerat 2012, 281.

933 Tuttle 2009, 185.

934 Negev 1986, 106; Euting 1891, pl. 23.

935 Only three bone fragments were recorded.

936 Studer 2007, 259.

937 Erickson-Gini – Israel 2013, 28.

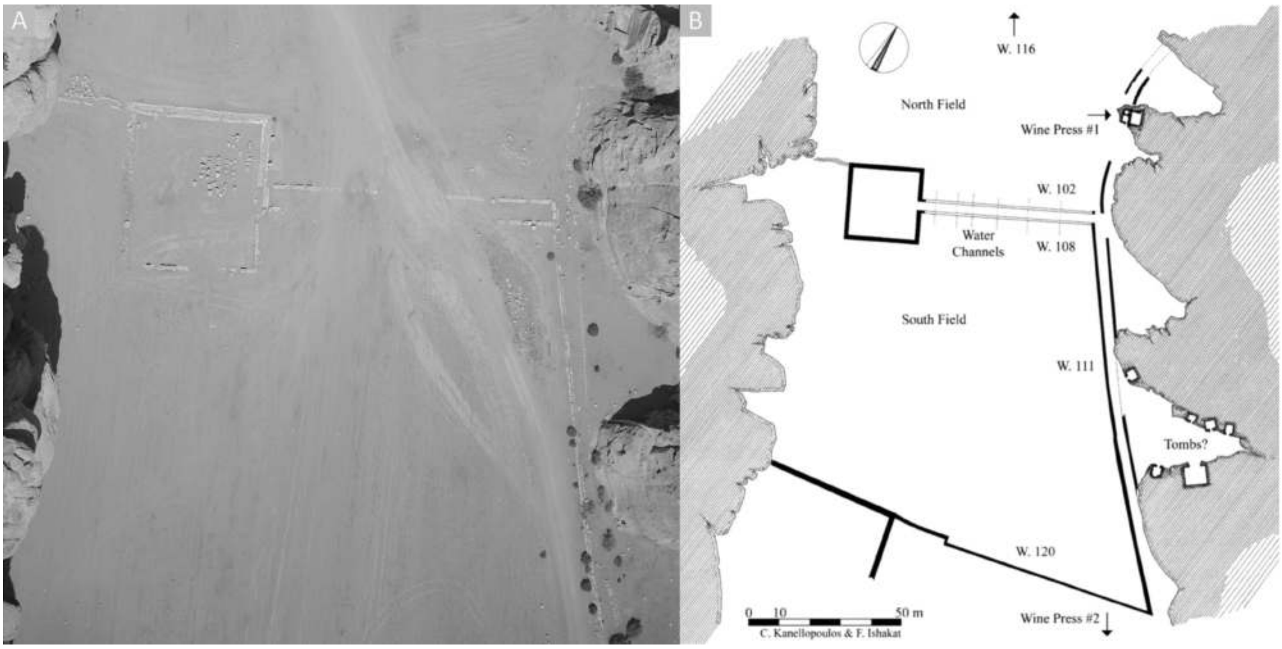


FIG. 181 Large rectangular structure in the Siq al-Amti (Beidha). A: Aerial view. Photo: APAAME. B: Plan after Bikai 2004, 440, fig. 12.

Köhler-Rollefson described BS Site No. 014 as a possible Nabataean caravanserai.[938] In 2003, the *Beidha Documentation Project* excavated the presumed caravanserai revealing a c. 24 × 24 m large open-air structure which was accessed by an elabarotely built walkway and was supplied with fresh water via built water channels leading directly into the central entrance of the structure (FIG. 181).[939] Ceramic finds date the structure roughly between the 1st and 4th centuries AD.[940] Although it remains difficult to assign a specific function to the excavated structure with certainty, its location near rock-cut wine presses suggest that the structure once stood in an extensive vineyard and is thus most likely related to the production and/or consumption of wine. Importantly, as a rock-cut *triclinium*, numerous Nabataean inscriptions and possible tombs were documented in a small gorge immediately east of the structure, it is now assumed that BS Site No. 014 had a ritual function. While this interpretation requires further verification, it is clear that the structure did not seve as a caravanserai.

During his extensive survey of the Wadi Arabah, A. M. Smith II discovered the site of Khirbet as-Faysif.[941] The site is located along the Petra–Gaza road following the important Naqb ar-Ruba'i route from the Jabal Harun area down the western escarpment into the Arabah. Once at Khirbet as-Faysif, it was also possible to proceed along the north-south roads in the Wadi Arabah either to Qaa' as-Sayidiyeen in the south or Bir Madkhur in the north. Smith therefore refers to the site as a 'caravan station.' In 2010, the site was partially excavated revealing a substantially built squarish structure (21 × 26 m) with interior rooms surrounding a possible courtyard (FIG. 182).[942] Although most of the unearthed rooms could not be further determined functionally, a possible kitchen area was excavated. Other smaller structures were noticed around Khirbet as-Faysif including a possible cemetery (cf. chapter 8) and a presumed dam. The site is located directly above the banks of Wadi Umm Qamar and small groves of bushes currently grow in its immediate vicinity. Therefore, potential caravan animals could have been provided with fodder and water.[943] Ceramic material from the excavations date Khirbet as-Faysif primarily to the 1st centuries BC and AD, but Late Roman material was also recorded. While the site is undoubtedly of great importance for the infrastructural connectivity of the Petraean hinterland, the current state of research does not permit to consider Khirbet as-Faysif as a proper caravanserai as formally defined in this study. Instead, the site will be further discussed as a 'road station.'

Recent investigations at Sabra documented a c. 23 × 12 m large structure immediately east of the

938 Banning – Köhler-Rollefson 1983, 381.
939 Bikai et al. 2008 and 2007; Bikai 2006; Bikai et al. 2005 as well as Bikai 2004.
940 Bikai 2004, 441.
941 Smith 2010, 37–39.
942 Smith 2018, 217; Hughes 2014; Smith 2010, 37–39.
943 Ben David 2013, 273; Smith 2005, 70.

FIG. 182 The important road station of Khirbet as-Faysif in the Wadi Arabah. A: View of the extent of the structure with the western escarpment in the background. B and C: Partly excavated casemate rooms.

Nabataean settlement along the lower banks of Wadi Sabra (cf. FIG. 273 and 278).[944] Although only few internal walls were observed, the surveyors postulate that the site served either as a caravanserai or fort if future archaeological investigations should confirm a large internal courtyard. While the identification as a fort is dismissed by this study (cf. chapter 7), the archaeological remains also do not permit to positively refer to the site as a caravanserai. Nevertheless, as Sabra undoubtedly functioned as an important infrastructural hub in the study area, it is likely that the structure served as a smaller road station.

ShamAyl Site No. 112 is situated along the eastern high plateau "[…] *in an isolated spot on the E side of a small wadi.*"[945] Measuring c. 22 × 21 m, the original surveyors describe the structure as an 'Ottoman-style building' consisting of six rooms, each with separate entrances. Building collapse was oberserved immediately around the structure including a possible 'corral and/or courtyard.' Although ShamAyl identify the site as a possible caravanserai, the archaeological information is too inconclusive as the structure may have equally served as a simple farm. No dating material was noted for this site.

Abudanh Survey Site No. 012, or Khirbet Du' aij, is situated along the so called 'Du' aij road,' most likely a major north-south running road near Udruh.[946] Presumably, Abudanh's identification of the structure as a caravanserai is based on its proximity to the Du' aij road. However, the site is described as

> […] *a large mound of about 50 m diameter indicat*[ing] *that a circular structure existed there. A square structure and two rainwater collecting cisterns were seen about 60 m to the south of the mound. The square structure could have been a guard and controlling outpost.*[947]

The described archaeological remains of Khirbet Du' aij are therefore not only too inconclusive to interpret the site as a caravanserai, it is too difficult to positively assign any function at all. Khirbet Du' aij is better classified under this study's 'structure(s) of undetermined function.'

Abudanh also discusses the c. 0,1 ha large site of Khirbet al-Hajareen located on a slope along the road

944 Tholbecq et al. 2016, 289–292 and Tholbecq 2015, 93–94.
945 MacDonald et al. 2016, 229.
946 Abudanh 2006, 102–104, 403–404.
947 Abudanh 2006, 103–104.

leading from Saddaqa to Basta along the eastern high plateau as either a possible 'security or military structure' or a caravanserai as it is characterized by internal room compartments arranged around a central courtyard (cf. FIG. 298, No. 16). ARNAS claims that the site had a potential military character, which is followed here as well.[948]

As this brief overview of possible caravanserais demonstrates, the available archaeological evidence is too inconclusive to positively identify larger caravanserais in the Petraean hinterland. There are, however, numerous smaller road and route stations which are presented in the following.

Road/Route Stations

This study has identified 34 structures as road/route stations (FIG. 183). These are defined as isolated structures situated along roads and/or routes serving as administrative control points or relay stations for resting and/or changing beasts of burden. They are considerably smaller than caravansearis and can be far more diversified in their structural layout. They probably provided only limited accommodation for travelers, although they may have offered water and food supplies. Many presumed military structures smaller than 0,1 ha, referred to in this study as possible 'fortlets,' are located along ancient roads and routes as well (cf. chapter 7). Due to the limited archaeological information, it is difficult to assign a purely military function of these sites and it is thus likely that they served more administrative purposes. Structures discussed here as fortlets, may therefore also be considered as possible road/route stations. The following section presents the archaeological evidence on the above-mentioned 34 structures that are defined here as road/route stations only. Their further archaeological context is discussed in more detail below.

Following the absence of all road/route stations from the 5th – 2nd centuries BC, a significant rise in the total number of evidenced road/route stations can be observed by the 1st century BC when there are 23 road/route stations recorded in the Petraean hinterland:

Situated along the 'Malghan road' along the eastern high plateau in the northeastern periphery of the study area, Abudanh documented the site of Malghan (Abudanh Survey No. 009) which is described as a 17 × 14 m large structure with an additional smaller structure in its interior measuring 4 × 4 m.[949]

The presumed road station of Umm Hilal (Abudanh Survey No. 145) is also situated on the eastern high plateau along the 'Zharah road.' The structure is described as a 20 × 15 m large building with six internal room compartments and a possible courtyard.[950]

Situated along the *via nova Traiana* south of Petra, ARNAS Site No. 041 (name unknown) is described as a possible 'road-station and/or watchtower' measuring c. 4,5 × 12 m.[951] An additional 6 × 5 m large structure and nearby springs were also observed.

Khirbet al-Mikwan (JSS Site No. 013) is located on the slopes of the Jabal Shara escarpment along a possible smaller route leading to the *via nova Traiana* in the east.[952]

ShamAyl Site No. 039 is located near the modern settlement of ar-Rajif at the intersection of the roads from Udruh, Wadi Musa and at-Tayyiba.[953] The site includes several features including "[…] *the footprints of structures that could have been associated with the roads.*"[954] No further archaeological information is available.

Khirbet al-Muharaq (ShamAyl Site No. 093) is situated on the eastern high plateau and is described as a c. 15 × 13 m large structure with two possible cisterns in the vicinity of a c. 2,5 m wide roadway. The original surveyors postulate that the site "[…] *could have had some administrative and/or service function related to the roadway.*"[955]

Khirbet Samra (ShamAyl Site No. 097) is a c. 31 × 16 m large structure built along the ancient road between Ayl and Wadi Musa. Internal divisions were observed as well as a c. 3 m wide 'corridor' running along the structure's western side. While the original surveyors identify the structure as a 'way station,' they also hypothesize that, due to the structure's size, it may have served as a possible temple.[956] This, however, seems rather far-stretched as no further archaeological information is provided.

ShamAyl Site No. 124 is a c. 20 × 17 m large structure situated along a 'farm road' near the settlement of Abu Danna in the far eastern periphery of the study area and is considered a possible 'way station.'[957]

948 MacDonald et al. 2012, 99.
949 Abudanh 2006, 402.
950 Abudanh 2006, 477.
951 MacDonald et al. 2012, 72.
952 Unpublished survey catalogue kindly provided to the author by L. Tholbecq. Cf. also Tholbecq 2013a and 2001b.
953 MacDonald et al. 2016, 158. The site was also recorded by the WMWS as Site No. 'Qa' 10' ('Amr et al. 1998, 543).
954 MacDonald et al. 2016, 158.
955 MacDonald et al. 2016, 213.
956 MacDonald et al. 2016, 216.
957 MacDonald et al. 2016, 240.

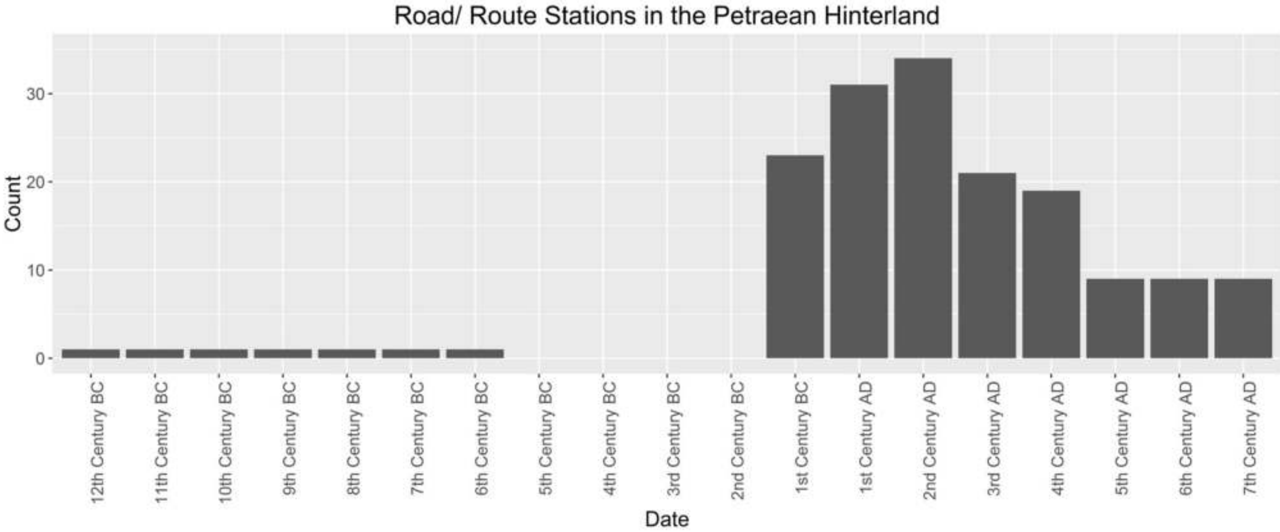


FIG. 183 Overall count of the road/route stations recorded in the Petraean hinterland from the 12th century BC to the 7th century AD.

ShamAyl Site No. 178 (name unknown) is a c. 20 × 20 m large structure with a possible courtyard situated along the modern road leading from Wadi Musa to Nejel, which most likely formed the ancient course of the *via nova Traiana*.[958] The surveyors are probably correct in identifying the site as a possible road station along the *via nova*.

ShamAyl Site No. 346 (name unknown) is situated at the intersection of the modern Wadi Musa-Shawbak and Beidha roads, which the original surveyors associated with the ancient course of the *via nova Traiana*.[959] The structure was built of roughly hewn limestone blocks and originally measured c. 37 × 31 m, but was cut by the modern 'Beidha road.'

ShamAyl Site No. 357 (name unknown) was also identified as a small road station along the modern road leading from the northern Jabal Shara escarpment area southwards to Beidha.[960] The structure was built of roughly cut limestone and chert blocks and measures c. 15 × 11 m.

Along the northern Jabal Shara escarpment, at Hauth al-Heleni, the PHSP recorded an elongated, c. 13 × 35 m large structure built of large limestone blocks (PHSP Site No. 074) along the way towards Shawbak which was possibly the ancient course of the *via nova Traiana* (FIG. 184).

Along the same road further south in the direction of Beidha, the PHSP documented another presumed road station at Sweitere (PHSP Site No. 088). The c. 10 × 12 m large structure was built of large roughly cut limestone blocks (cf. FIG. 184).

At the important Nabataean settlement of Ras Slaysil, a c. 25 × 28 m large structure built of local lime- and sandstone was documented by the PHSP on the southern slope of Wadi Slaysil on the way to the al-Begh'ah plain. The structure was tentatively interpreted as a possible route station (cf. FIG. 184).

PHSP Site No. 129 is located further south along the presumed ancient path of Wadi Siq al-Ghurab. It is a c. 4 × 5 m large structure built of local sandstone. As the structure is heavily filled by alluvial sands, its interpretation as a possible small route station must be considered critically (cf. FIG. 184).

The same applies to PHSP Site No. 126 situated along the route of Darb al-Lethie. Only the top wall layers of a c. 8 × 10 m large structure are visible (FIG. 185).

Situated along the route of Naqb al-Ghirbe leading from the foothills of Jabal Harun northwards to Dawrum Dey, the PHSP documented a small Nabataean-Roman route station (PHSP Site No. 109) which can be characterized as a c. 4 × 5 m structure built of irregularly cut sandstone boulders of varying sizes (cf. FIG. 185).

Situated only a few kilometers west of Ras Slaysil along the western escarpment, the only known structural remains at Dawrum Dey (PHSP Site No.111) include an aqueduct leading eastwards to the road station/fortlet of Qasr Umm Rattam as well as agricultural terraces known locally as the 'Roman Gardens' (cf. FIG. 185).[961] However, as Dawrum Dey forms an intersection of numerous important routes in the Pe-

958 MacDonald et al. 2016, 292.
959 MacDonald et al. 2016, 435.
960 MacDonald et al. 2016, 433.
961 Cf. the brief reference to Dawrum Dey in Russel 1995, 695, who spells the site 'Tur Imdai.' On the 'Roman Gardens,' see Gentelle 2009, 140–141.

FIG. 184 Exemplary road/route stations in the Petraean hinterland. A: Hauth al-Heleni (PHSP Site No. 074). B: Sweitere (PHSP Site No. 088). C: Ras Slaysil. D: Wadi Siq al Ghurab (PHSP Site No. 129).

tra area[962], it may also be discussed as a 'road station' or 'transshipment center.'[963]

Situated east of Dawrum Dey along the Wadi Musa, Qasr Umm Rattam was most likely constructed during the 1st century BC and was in continuous use until the 4th century AD (FIG. 186).[964] While the structure was characterized as an 'agricultural station' during its original Nabataean phase, the still fairly well-preserved structure or *qasr* was interpreted as a (Late) Roman administrative building that was constructed over its Nabataean predecessor.[965] A presumed watchtower situated on the adjacent wadi bed was associated with the *qasr* as well. Based on surface finds, it was also dated from the Nabatean period onwards.[966] Remarkable is the nine kilometer long Nabataean-Roman aqueduct presumably coming from the Amm Masemak spring at the eastern beginnings of Wadi Musa that fed a large reservoir at Umm Rattam with fresh water.[967]

Situated south of Qasr Umm Rattam along the route of Naqb ar-Ruba'i, the small route station of Seir Umm Qamar (PHSP Site No. 115) is characterized by two rectangular structures built of irregularly formed sandstone boulders. Agricultural terraces and three small burial cairns were probably associated with the site as well (cf. FIG. 213).

Along the route of Naqb Namala leading northwards from Petra to the Wadi Arabah, Qasr Namala (PHSP Site No. 025) is located southwest of the presumed ancient route. The rectangular structure measures c. 16 × 20 m and no internal divisions were observed (cf. FIG. 225).

BMP/CAS Site No. 013 (name unknown) is situated further west of Qasr Namala in the Wadi Arabah west-southwest of the Late Roman fort of Bir Madkhur. Smith reports that the structure measures c. 15 × 15 m with internal room compartments. The site was "[…] *possibly an important way-station at the intersection of a prominent north-south or east-west route* […]" through the Wadi Arabah.[968]

All road/route stations presumably dating to the 1st century BC are also evidenced for the 1st century AD. By then, eight further road/route stations are recorded raising the total count to 31:

Abudanh identified a possible road station on the hilltop of Ras al-Hatteh (Abudanh Survey No. 122) situated along the Wadi Musa-Basta road. The "considerable" structure was described as having four in-

962 These are Wadi Musa, Naqb Abu Mrerah and, by extension Naqb al-Aqab as well as Naqb al-Ghirbe and Naqb Slaysil.
963 Cf. Lindner et al. 2000.
964 Lindner et al. 2007, 247; Lindner et al. 2000, 535.
965 Lindner et al. 2000, 549–562. The agricultural nature of the Nabataean structure is presumed on the basis of agricultural terraces discovered in the vicinity of the site.
966 Lindner et al. 2000, 547–548.
967 Lindner et al. 2000, 554–560.
968 Smith 2010, 42.

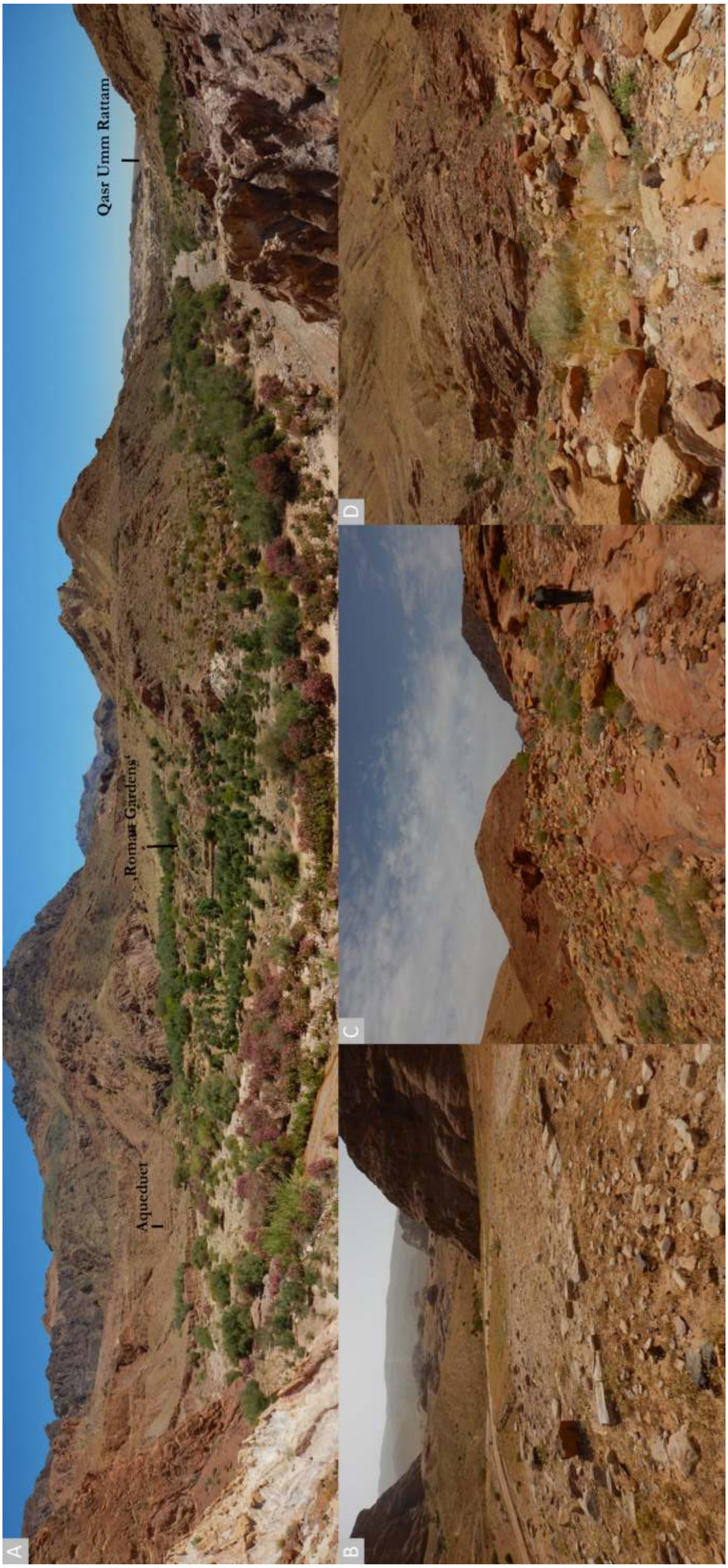


FIG. 185 Exemplary road/route stations in the Petraean hinterland. A: Panorama view of Dawrum Dey with the Nabataean-Roman aqueduct in the east running by the so called 'Roman Gardens' and ending at Qasr Umm Rattam further west along Wadi Musa. B: Darb al-Lethie (PHSP Site No. 126). B: Naqb al-Ghirbe (PHSP Site No. 109).

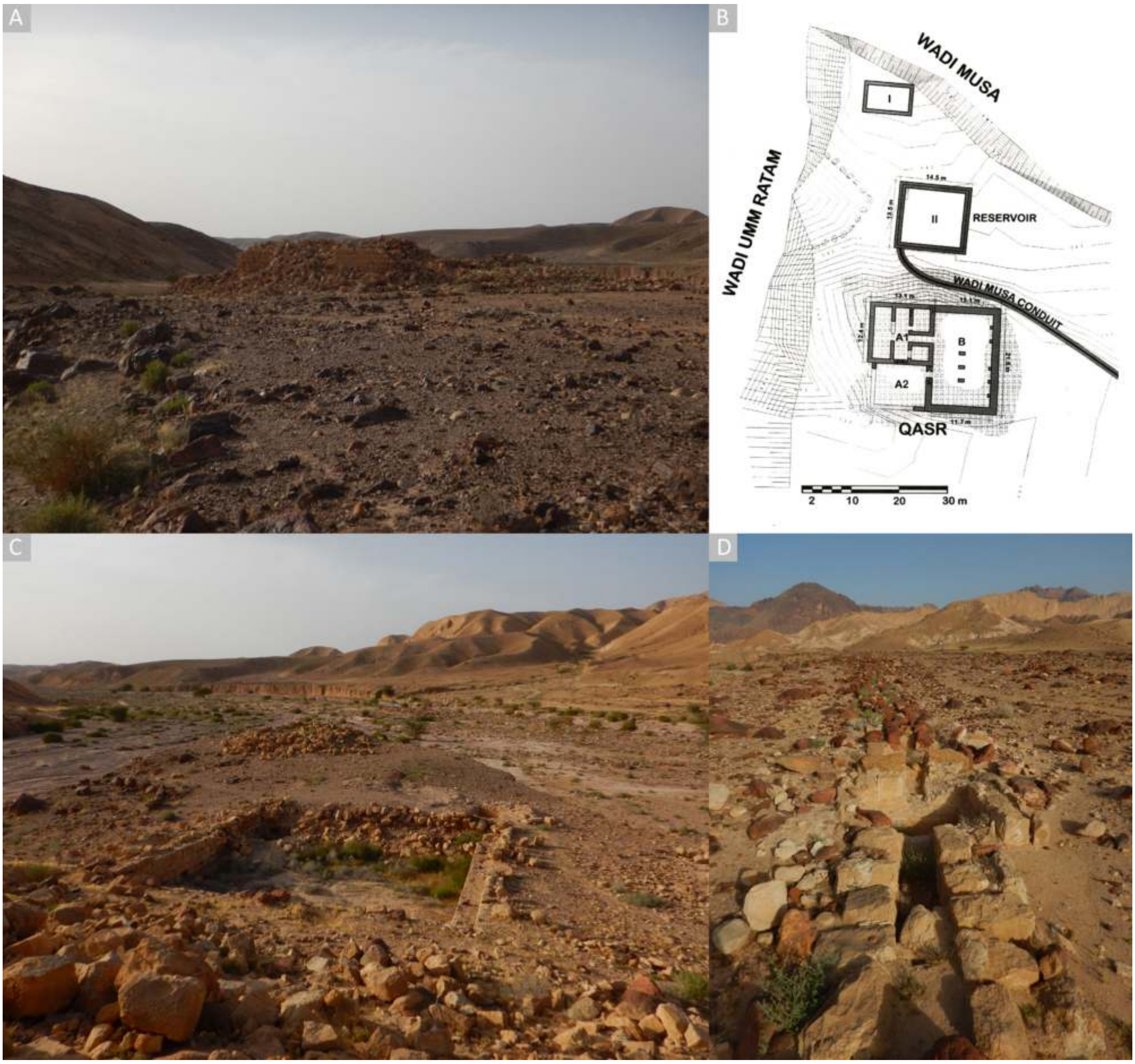


FIG. 186 View of Qasr Umm Rattam along the Wadi Musa. A: View of the main *qasr*. B: Site plan after Lindner et al. 2000, fig. 11. C: Reservoir. D: Aqueduct with settling tank.

ternal divisions and possible terracing walls were also associated with it.[969]

At Ras al-Mshubush (Abudanh Survey No. 156), Abudanh documented a 14,3 × 13 m large structure along the 'Zharah road' running along the eastern high plateau. A semi-circular structure encircling a c. 6 × 6 m square structure was observed immediately south of the presumed road station as well.[970]

Along the Jabal Shara escarpment, the JSS recorded a 20 × 10 m large structure at Khirbet Ras Umm Girrameh (JSS Site No. 018) along the modern Wadi Musa-Shawbak road (the ancient course of the *via nova Traiana*). The surveyjors also postulate that the site may have marked the northern departure point towards Beidha along the Wadi al-Mikwan.[971]

JSS Site No. 059 (name unknown) was documented along the same road and consists of three principle buildings built of large chert and limestone blocks.[972]

At al-Helain, the PHSP documented a possible road station along the way from the northern Jabal Shara escarpment to the Beidha area (PHSP Site No. 070). The site is a c. 18 × 20 m large rectangular structure built of large limestone ashlars on a slope

969 Abudanh 2006, 463.
970 Abudanh 2006, 484. The road station of Ras al-Mshubush should not be confused with the possible watchtower of Ras al-Mshubush (Abudanh Site No. 159).
971 Unpublished survey catalogue kindly provided to the author by L. Tholbecq.
972 Unpublished survey catalogue kindly provided to the author by L. Tholbecq.

FIG. 187 Exemplary road/route stations in the Petraean hinterland. A: al-Helain (PHSP Site No. 070). B: PHSP Site No. 023-ST030. C: Ras ad-Tah'i (PHSP Site No. 024-ST035. D: Janab Rashid (PHSP Site No. 029) with associated architectural fragments (E and F).

immediately east of the modern road leading southwest to the Beidha area. The structure has mostly collapsed, but clear wall lines can still be observed (FIG. 187).

Situated on a slope immediately north of the 'northern as-Sto'e route,' which runs along the al-Farasha plain southwest of Petra, the PHSP recorded a large, elongated structure measuring c. 30 × 45 m (PHSP Site No. 023-ST030).[973] The structure stretches over at least two terraces and is built of well-cut sandstone ashlars (cf. FIG. 187). The northern part of the structure may consist of casemate rooms. It is therefore likely that the site served as a possible road station.

In the southwestern part of the al-Farasha plain, before continuing to Sabra, the PHSP documented a disturbed structure made entirely of flat sandstone slabs at Janab Rashid (PHSP Site No. 029). The northern part of the site is almost circular with a rectangular structure in the south. The site was probably reused as a threshing floor, but many well-drafted sandstone ashlars, a fragment of a quarter column and a possible pilaster base were observed at the site (cf. FIG. 187). As it is also located at the eastern beginning of Naqb Saqqara, Janab Rashid may tentatively be considered as a possible route station.

Further along Naqb Saqqara, at Ras ad-Tah'i, the PHSP recorded a c. 6 × 8 m large structure (PHSP Site No. 024-ST035) built of medium-sized to large sandstone and limestone blocks. The site was therefore tentatively interpreted as a small route station (cf. FIG. 187).

While all documented road/route stations of the 1st centuries BC and AD are also evidenced for the 2nd century AD, by that time the total count of road/route stations reaches its peak (34 in total) with new sites now identified at Umm al-Futtus, Khirbet al-Hâj (JSS Site No. 053) as well as along the Naqb ar-Ruba'i route (FJHP Site No. Ext073/PHSP Site No. 086-ST078).

The 13 × 6 m large structure of Umm al-Futtus (Abudanh Site No. 107) is situated on the eastern high plateau along the 'Du' aij road' and may thus be considered a small station along the road.[974]

Situated along the western Jabal Shara escarpment, Khirbet al-Hâj (JSS Site No. 053) is described as a very well preserved site associated with the *via nova Traiana*. It can thus only be assumed that the site served as a road station.[975]

973 The FJHP may have already surveyed this site as FJHP Site No. S049.

974 Abudanh 2006, 455. The road station of Umm al-Futtus should not be confused with the possible watchtower of Umm al-Futtus (Abudanh Site No. 108).

975 Unpublished survey catalogue kindly provided to the author by L. Tholbecq.

FJHP Site No. Ext073/PHSP Site No. 086-ST078 is located along Naqb ar-Ruba'i shortly before reaching the Wadi Jawf Ahmar pass. Hidden from the main course of the route, the c. 6 × 8 m large structure is divided by at least two rooms and the walls still show remains of whitish plaster (cf. FIG. 210). While the majority of surface pottery dates to the Late Roman period, there is also evidence to suggest a late 1st to 2nd century AD date.[976] Typical Nabataean 45° tool marks were observed on the walls' ashlars as well.

After this peak of evidenced road/route stations during the 2nd century AD, a significant decline can be observed from the the 3rd century AD onwards. By that time the total count of road/route stations decreases to 20.[977] This decline continues during the 4th century AD with the supposed abandonment of Umm Hilal until this downward trend eventually stagnates by the 5th century AD when only nine road/route stations are still operational.[978] This remains unchanged until the 7th century AD.

Road/Route Markers

Road/route markers are all infrastructural installations needed for navigating along roads and routes. As no distinctions are made in terms of material, size or type, road/route markers can generally include *stelae*, inscribed or marked stones, simple sign posts, milestones, building ruins or cairns. [979] The importance of particular natural landmarks such as mountain ranges, hills, wadis, vegetation zones, specific sand dunes or even singular trees must also be acknowledged as significant road/route markers for navigating through desert landscapes.[980] However, these are almost impossible to identify archaeologically.

In the Petraean hinterland, only one road marker was identified as an individual archaeological site: ShamAyl Site No. 157. This site consists of six fragments of (uninscribed?) Roman milestones located east of the Udruh-Shawbak road and along the way to the possible military structure of Jabal al-Tahkeem (al 'Ashari).[981] These were already noticed by previous scholars who rightly claim that the milestones were not *in situ*.[982]

Abudanh and Driessen supposedly surveyed another milestone near Udruh which they vaguely date to the 2nd century AD.[983]

Since Thomsen's *Die römischen Meilensteine der Provinzen Syria, Arabia und Palaestina* from 1917, however, vast research along the *via nova Traiana* between Bostra and Aqaba revealed hundreds of milestones along the Roman road. Between Bostra and Petra alone, almost 200 milestones were documented.[984] Graf's survey of the southern segment of the *via nova Traiana* from Petra to Aqaba could add over 40 additional milestones with inscriptions dating from the Trajanic to the Constantinian period.[985]

Prior to the Roman period, milestones in the traditional Roman sense were not used. [986] However, as part of their study on the 'King's Highway' or Darb ar Rasif, Abudanh et al. noticed several standing stones along the southeastern section of a secondary road branching off the main course of the Darb ar-Rasif. These may have functioned as some sort of road markers.[987] Other 'standing stones' were also observed along minor roads that showed the way through agricultural fields.[988] Generally, stone piles or cairns (referred to as *alamats* by Zitteropf and Sidebotham) within desert landscapes signify a "[…] *developed stage in road travel, maintenance and control during ancient times*."[989] In the study area, the FJHP identified cairns and stone piles along a path crossing the al-Farasha plain immediately south of Petra and following the eastern side of the Wadi al-Waqit. While their possible multifunctionality (religious or commemorative purposes?) were acknowledged, they were discussed as possible landmarks for navigation purposes.[990] Similar interpretations were suggested for stone cairns in the Bir Madkhur area.[991]

976 Kouki et al. 2013a, 22; Smith 2010, 75.
977 The evidenced sites for the 3rd century AD are Malghan; Umm al-Futtus; Ras al-Hatteh; Umm Hilal; ARNAS Site No 041; Janab Rashid; PHSP Site No. 070, 074, Site039-ST60, Site086-ST078; ShamAylSite Nos. 033, 039, 093, 097, 124, 178, 346, 357; BMP/Cas Site 13 and Qasr Namala.
978 These stations are: Ras al-Hatteh (Abudanh Survey Site No. 122); ARNAS Site No. 041 (name unknown); PHSP Site No. 086-ST078; ShamAyl Site Nos. 033, 039, 093, 097, 124 and 178.
979 Cf. Riemer – Förster 2013, 40, 43–44 with further references.
980 Cf. e.g. Meerpohl 2013, 180 or Förster et al. 2013, 203–204.
981 Note that the possible military site is originally referred to by the original surveyors as "Jabal Mūsā al-Ash' arī."
982 Cf. e.g. Killick 1983a, 236 with further references.
983 The find corresponds to 'Udruh Survey Site I' as recorded in the Middle Eastern Geodatabase for Antiquities – Jordan (MEGAJordan): http://www.getty.edu/conservation/our_projects/field_projects/jordan/ (last access 28.05.2020). No further information was provided.
984 Graf 1995a, 241; Thomsen 1917, 34–57, No. 67–175.
985 Graf 1995a, 241.
986 Cf. e.g. Ben David 2012, 20.
987 Abudanh et al. 2015b, 162, 164.
988 According to Abudanh et al. 2015b, 164.
989 Riemer – Förster 2013, 44; Zitterkopf – Sidebotham 1989.
990 Ynnilä 2013, 263–264.
991 Smith 2018, 215.

Roads

The sections above gave a methodological and theoretical overview on how to comprehensively research ancient roads and routes and introduced the main beasts of burden that are of significance for this study. The following sections present the archaeologically evidenced roads and routes/tracks (naqb) in the Petra area. In total, this study systematically remapped 42 different roads and routes, which are discussed in detail (cf. FIG. 180). Adhering to the definitions of roads and routes/tracks (naqb) (cf. chapter 2), the following first describes the evidence of roads in geographical order from east to west. The various routes/tracks (naqb) are presented below.

Roads in the Petra Area – The Archaeological Evidence

Based on Class A survey results (cf. chapter 2), roads do not appear before the 1st century BC.[992] Dating roads archaeologically is difficult. While the available epigraphic and literary evidence for significant Roman roads offers solid dating evidence, many subsidiary roads cannot be easily dated. As Ben David points out, without additional epigraphic material (mostly derived from milestones) they can only be dated based on road-related structures or the built/paved sections of the roads themselves, which potentially can be dated by surface material or, ideally, by stratified archaeological evidence through excavation.[993]

Keeping this in mind, the most eastern road evidenced in the study area is ShamAyl Site No. 198.[994] From the western gate of Udruh, the road heads west towards Petra. Based on few surface pottery evidence, the surveyors very roughly date the road from the first half of the 1st century BC until the first half of the 7th century AD.[995] This road was already well-known since the first explorations of the area by Brünnow and von Domaszewski and was later restudied by Killick and others.[996] The course of the road mainly follows the course as mapped by Brünnow and von Domaszewski, which is now mostly overbuilt by the modern road connecting Petra with the Udruh area (FIG. 188).[997]Abudanh documented the remains of a three to five meter wide road near Qrah, which he could follow to a length of 2,5 kilometers. [998] This road heads towards Udruh in a southeastern direction and may either be an extension of another road leading to Malghan (Abudanh Survey Site No. 004)[999] or of a road west of Khirbet Maghair (Abudanh Survey Site No. 008). Khirbet Maghair is a rectangular structure of undetermined function associated with three caves. Abudanh interprets the site as a farmhouse dating to the 1st and 2nd centuries AD.[1000] From Khirbet Maghair, he traced the presumed road to a quarry site near Udruh (Abudanh Survey Site No. 028).[1001]

Taking up previous studies on the so-called 'Du' aij road,' Abudanh declares the road as one of the major north-south roads in the study area (FIG. 189).[1002] First documented at the functionally undetermined structure of Khirbet Du'aij (Abudanh Survey Site No. 012), the road is identified by curbstone walls and continues northwards in direction of 'Ain Nejel following the natural topography of the area.[1003] Crossing the important Petra-Udruh road, the Du'aij road continues its northern course just east of Jabal al-Qulaiah connecting other hilltop sites.[1004] It crosses the functionally undetermined structures at Khirbet al-Trabsieh (Abudanh Survey Site No. 025)[1005] and intersects a secondary road heading west, just northeast of Jabal al-Qulaiah.[1006]Another secondary road connected the presumed hamlet at al-Juri 1 (Abudanh Survey Site No. 088) and the presumed farm at al-Juri 2 (Abudanh Survey Site No. 092).[1007]

992 With the exeption of the Darb ar-Rasif that was one of the main roads in the Petra area during the Iron Age periods (cf. chapter 3).
993 Ben David 2012, 19. See also Smith 2005, 186.
994 MacDonald et al. 2016, 309. The surveyors mention that the coordinate information was given "[…] *from the point where the road intersects with D. Kennedy's 'Circle 5', that is, immediately S of the modern asphalt road from Udruh-Wadi Musa.*"
995 MacDonald et al. 2016, 309.
996 Graf 1997, 279; Graf 1995a, 242–244; Killick 1987, 173 and 175; Brünnow – von Domaszewski 1904, 100–102.
997 Brünnow – von Domaszewski 1904, Karte der Südlichen Belkâ & Edom, Blatt 3.
998 Abudanh 2006, 405: Site No. 014.
999 As the Malghan road does not consistently feature curbstones or other built features, this study tentatively interpreted the road rather as a route (cf. below). The course of Abudanh's Malghan road was georeferenced and re-mapped by the author on the basis of Abudanh 2006, figure 5.16, 328.
1000 Abudanh 2006, 402.
1001 Abudanh 2006, 405, 411.
1002 Abudanh 2006, 103. See Stein's investigations of the Du'aij road in Gregory – Kennedy 1985. The course of Abudanh's Du' aij road was georeferenced and re-mapped by the author on the basis of Abudanh 2006, figure 5.2, 314.
1003 Abudanh 2006, 102–104, 403–404. Abudanh 2006, 103–104 identifies Khirbet Du' aij as a possible caravanserai.
1004 Abudanh 2006, 102–104. Stein (cf. Gregory – Kennedy 1985, 341–342) assumed that this road represented the course of the *via nova Traiana,* which is correctly refuted by Abudanh.
1005 Abudanh 2006, 104, 410–411 identifies the site as a possible farmhouse.
1006 Abudanh 2006, 104.
1007 Abudanh 2006, 104–105.

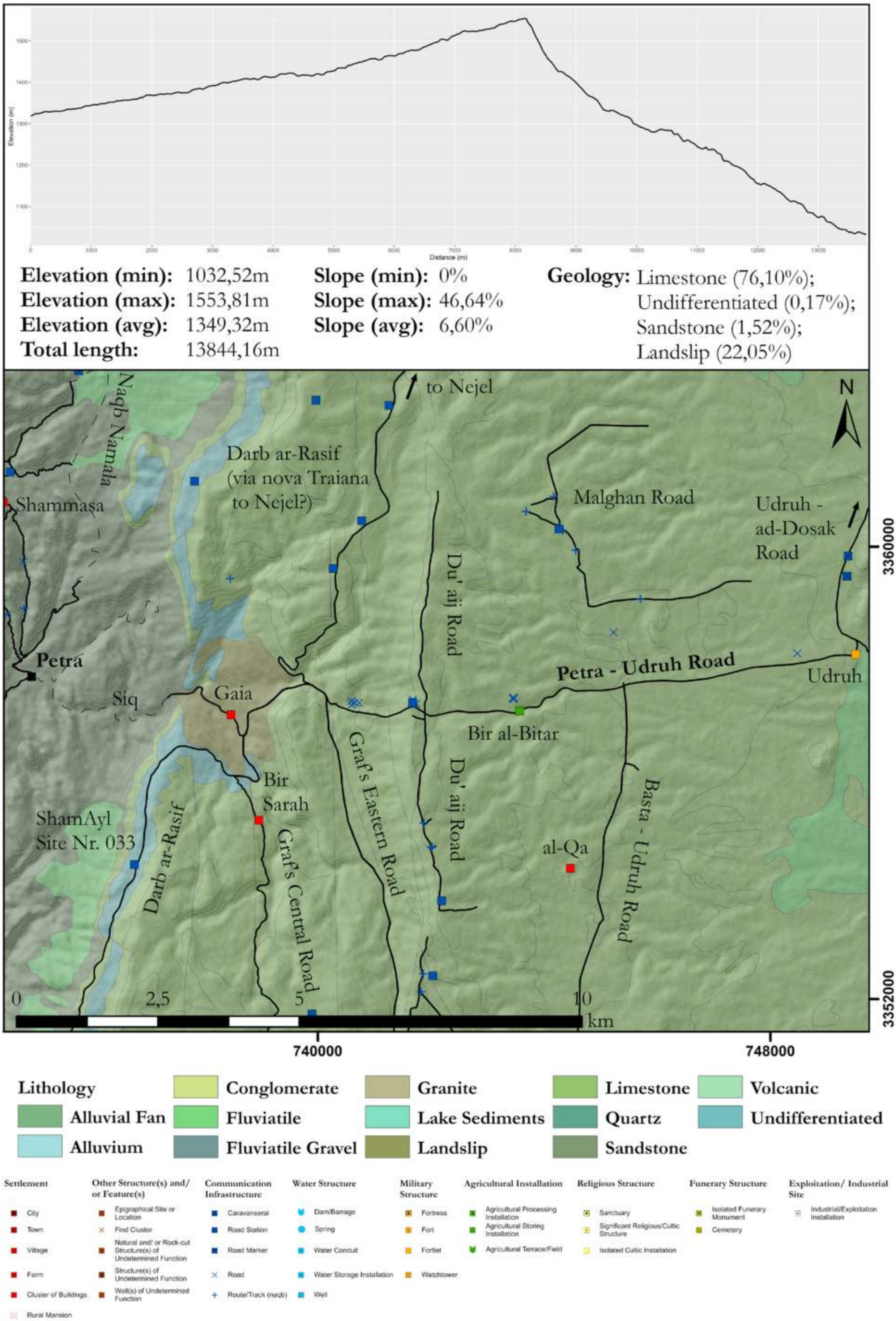


FIG. 188 The Petra-Udruh road as recorded by Brünnow and von Domaszewski with Abudanh's Malghan road to the north and Du'aij road to the west heading north.

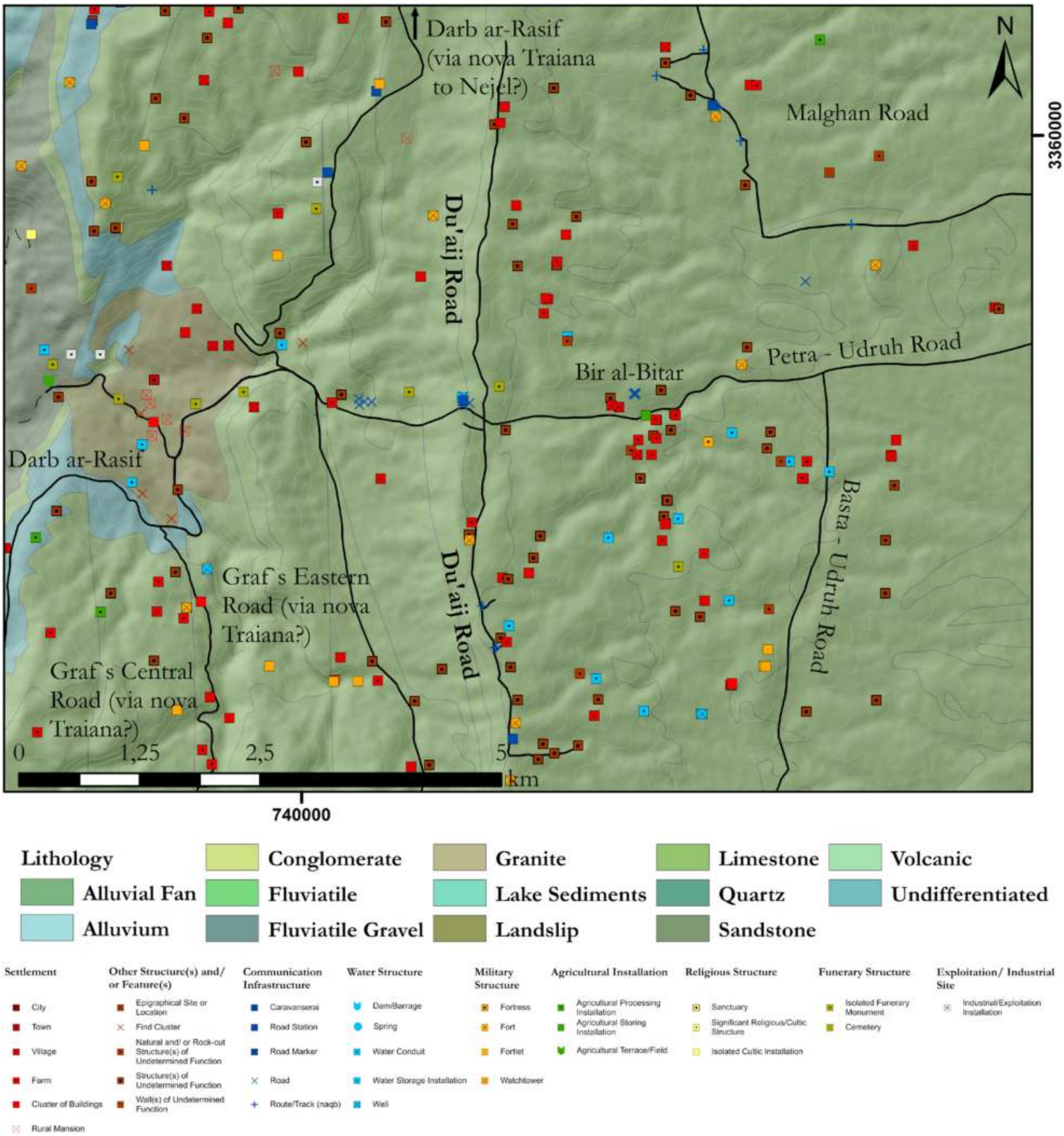


FIG. 189 Details of Abudanh's Du' aij road crossing the Petra-Udruh road and heading north towards 'Ain Nejel.

Abudanh also identified the so-called 'Zharah road' which can only be traced archaeologically along its southern course as it was heavily destroyed by the modern road leading from Wadi Musa to Basta (FIG. 190).[1008] Oriented northwest-southeast, the road connected Petra directly with Basta via various secondary roads branching off to other sites such as the road station at Ras al-Hatteh, (Abudanh Survey Site No. 122), the quarry site at Umm Hilal (Abudanh Survey Site No. 142), the presumed hamlet at Khirbet Abu Qumrah (Abudanh Survey Site No. 223) or the functionally undetermined structure at al-Dinarieh (Abudanh Survey Site No. 168).[1009]

The Zharah road also joins with other major roads in the Petra area, such as the 'Udruh-Basta road' that was wrongly assumed to be the course of the *via nova Traiana* from Basta passing a possible military structure at Khirbet al-'Ejami as well as Bir al-Bitar, al-Qa'

1008 Abudanh 2006, 105. The course of Abudanh's Zharah road was georeferenced and re-mapped by the author on the basis of Abudanh 2006, figure 5.3, 315.

1009 Abudanh 2006, 105–109. The Zharah road is 3–5 m wide, unpaved and marked by low curbstone walls (Abudanh 2006, 109–114).

(Rashid), the possible Roman fort at Abu Danna and eventually Udruh.[1010] Abudanh identified at least four secondary roads branching off the Zharah road as well. One heads southeast to Abu Danna passing the farm at Khirbet Umm al-Jarad, the ancient structures at Umm 'Areir 1 and 2 as well as Umm Hilal. This stretch is traditionally known as the *Tariq Umm Hilal* or the 'Umm Hilal road.'[1011]

Another north-south running road was identified by Abudanh further northeast of the Zharah road between Udruh and Wadi Musa, approaching the village site of Khirbet Malghan (Abudanh Survey Site No. 007) from the east-northeast.[1012] The so-called 'Malghan road' most likely headed southeast to Udruh as its curbstone walls could be traced just west of the quarry at Udruh (cf. FIG. 188).[1013] While the northeastern sections of the road could not be followed, Abudanh mentions evidence for it west of al-Jarba and stretches running parallel to the modern road connecting the (modern) Shawbak-Udruh and Shawbak-Wadi Musa roads.[1014] In a general southwestern direction, the road connects the functionally undetermined structure at Khirbet al-Qumaid (Abudanh Survey Site No. 010), the farm at Khirbet al-Zhaqiat (Abudanh Survey Site No. 003) and eventually intersects the Du'aij road.[1015]

In the immediate vicinity of Petra, one higher and one lower road were evidenced by WMWS 1996 Site No. Wadi Musa 24.[1016] Both roads could be "[…] *defined by layouts of chert stones*"[1017] running along a ridge south of WMWS 1996 Site No. Wadi Musa 23. This site is a structure of undetermined function, but the close vicinity to the roads may suggest a functional association with it. While only a short stretch of the higher road could be followed, the lower road was more clearly traceable.[1018] The latter was cut by numerous subsidiary tracks and the original surveyors hypothesized that it joined the at-Tayyiba road (see below) at ar-Rasif (WMWS 1996 Site No. Qa' 10).[1019] Based on scarce surface pottery material, the lower road was dated to the Nabataean period, although it may have been used in earlier and later periods.[1020]

According to the original surveyors, WMWS 1996 Site No. Qa' 10 may have been a junction between the Petra-Udruh road (cf. ShamAyl Site No. 198 above), the road from Wadi Musa (WMWS 1996 Site No. Wadi Musa 24), the Umm at-Tiran–Bir al-Bitar road (WMWS 1998 Site No. Qa' 11) and the 'at-Tayyiba road.'[1021] The Umm at-Tiran–Bir al-Bitar road could only be traced for 65 m by the WMWS, but the significant width of 4,20 m and the associated curb stones led the surveyors to date the road to the Nabataean-Roman period.[1022] They also assumed that the road once continued to ar-Rasif (WMWS 1996 Site No. Qa' 10).[1023]

Khirbet Umm at-Tiran (WMWS 1996 Site No. Qa' 6) is an extensive site consisting of three low hills with caves.[1024] The largest cave is on the northeastern hill and has "[…] *an arched entrance, rock-cut niches and a cistern inside, also built walls within the cave are showing robbers pits* […]." East of the second cave, there is a round 'well' which was fed by a ceramic water pipe from the west.[1025] The two other hills reportedly showed similar features. While the exact function of Khirbet Umm at-Tiran remains unclear, surface pottery dates the site between the Nabataean and the Byzantine period (1st to 5th centuries AD).[1026] Bir al-Bitar (WMWS 1996 Site No. 9) is a site featuring several structures of undetermined function. Surface pottery dates the site to the Iron Age II, Nabataean (1st and 2nd centuries AD) and Late Byzantine periods.[1027]

The 'Wadi Musa–at-Tayyiba road' runs immediately south of the modern reservoir of Wadi Musa, although large parts of the road were already disturbed when the WMWS surveyed it in 1996.[1028] A cave was reused as a cistern west of the Wadi Musa–at-Tayyiba road, which was illicitly excavated revealing pottery evidence that tentatively dates the cistern to the Nabataean, Roman as well as Late Roman and Early Byzantine periods.[1029] The Wadi Musa–at-Tayyiba road is known to be part of the so-called King's Highway or *Darb ar-Rasif*, which runs along the western escarpment of the Shara mountains between Petra and Qana (FIG. 191).[1030] Numerous Nabataean-Roman sites are evidenced along the Darb ar-Rasif including Khirbet Braq, 'Ain Amun, Mu' alaqa, Tayyiba, Qasr and Rujm

1010 Abudanh 2006, 114–115; Graf 1995a, 246; Killick 1987; Brünnow – von Domaszewski 1904, 465.
1011 Abudanh 2006, 41, 107.
1012 Abudanh 2006, 116.
1013 Abudanh 2006, 116–117.
1014 Abudanh 2006, 117.
1015 Abudanh 2006, 117.
1016 'Amr et al. 1998, 529; Graf 1992, 256.
1017 'Amr et al. 1998, 529.
1018 'Amr et al. 1998, 529.
1019 'Amr et al. 1998, 529.
1020 'Amr et al. 1998, 529.
1021 'Amr et al. 1998, 541. Abudanh notes that these roads actually met with the Du'aij road 200 m further east than presumed by 'Amr et al.
1022 'Amr – al-Momani 2001, 282.
1023 'Amr – al-Momani 2001, 282.
1024 'Amr et al. 1998, 541–542.
1025 'Amr et al. 1998, 541–542.
1026 'Amr et al. 1998, 542.
1027 'Amr et al. 1998, 543.
1028 'Amr et al. 1998, 541.
1029 'Amr et al. 1998, 541.
1030 Abudanh et al. 2015b, 159; Graf 1992, 258. The course

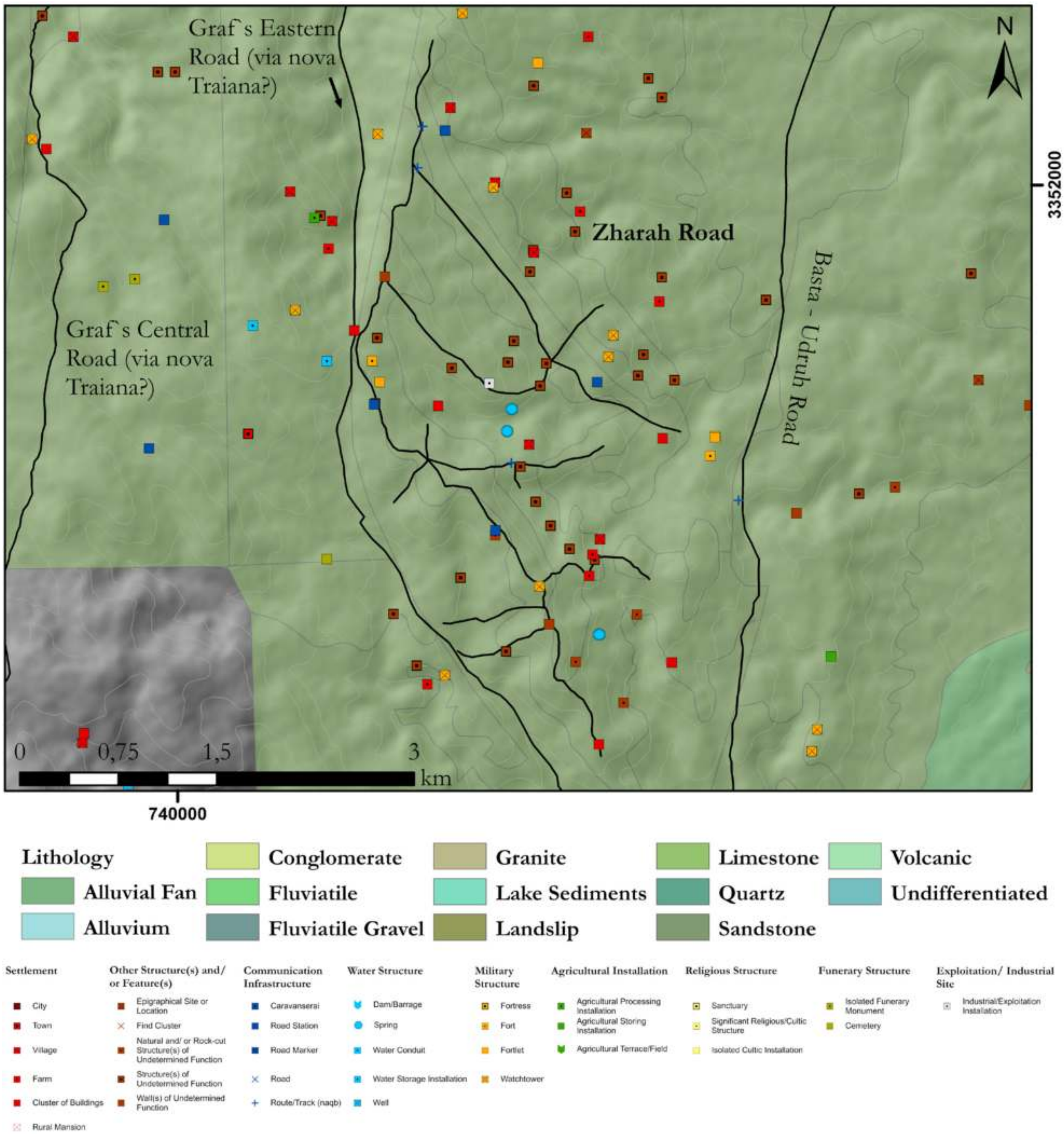


FIG. 190 Abudanh's Zharah road.

Tuliyeh and Khirbet as-Sa'ud.[1031] At Khirbet as-Sa'ud the Darb ar-Rasif forks off in southeastern direction towards Saddaqa, which is argued to be part of the *via nova Traiana*.[1032] However, from Khirbet as-Sa'ud the Darb ar-Rasif continues further south along the escarpment passing Qabir Shaker, Umm Tuliyeh, Ras ad-Dilagha, Birka and Baridiyeh before turning southeast to Qana where it meets the *via nova Traiana*.[1033] The most distinct stretch of the Darb ar-Rasif is west of Saddaqa between Qana and Ras ad-Dilagha showing low curbstone walls. [1034] The road was probably not paved. Milestones were not found along its course.[1035] Based on surface pottery collected at the related sites, the main phase of its utilization appears to be within the Nabataean-Roman periods. The Darb ar-Rasif may therefore have served as a viable alter-

of the Darb ar-Rasif was re-mapped by the author on the basis of Graf 1995a, 249, fig. 2 and 251–253 as well as satellite imagery.

1031 'Amr et al. 1998, 541; Graf 1992, 258. A later reuse of the road in Roman and Byzantine times is also attested.

1032 Graf 1995a, 248, fig.2, 252.

1033 Graf 1995a, 248, fig.2; 252.

1034 Graf 1995a, 254; Graf 1992, 258.

1035 Graf 1995a, 254.

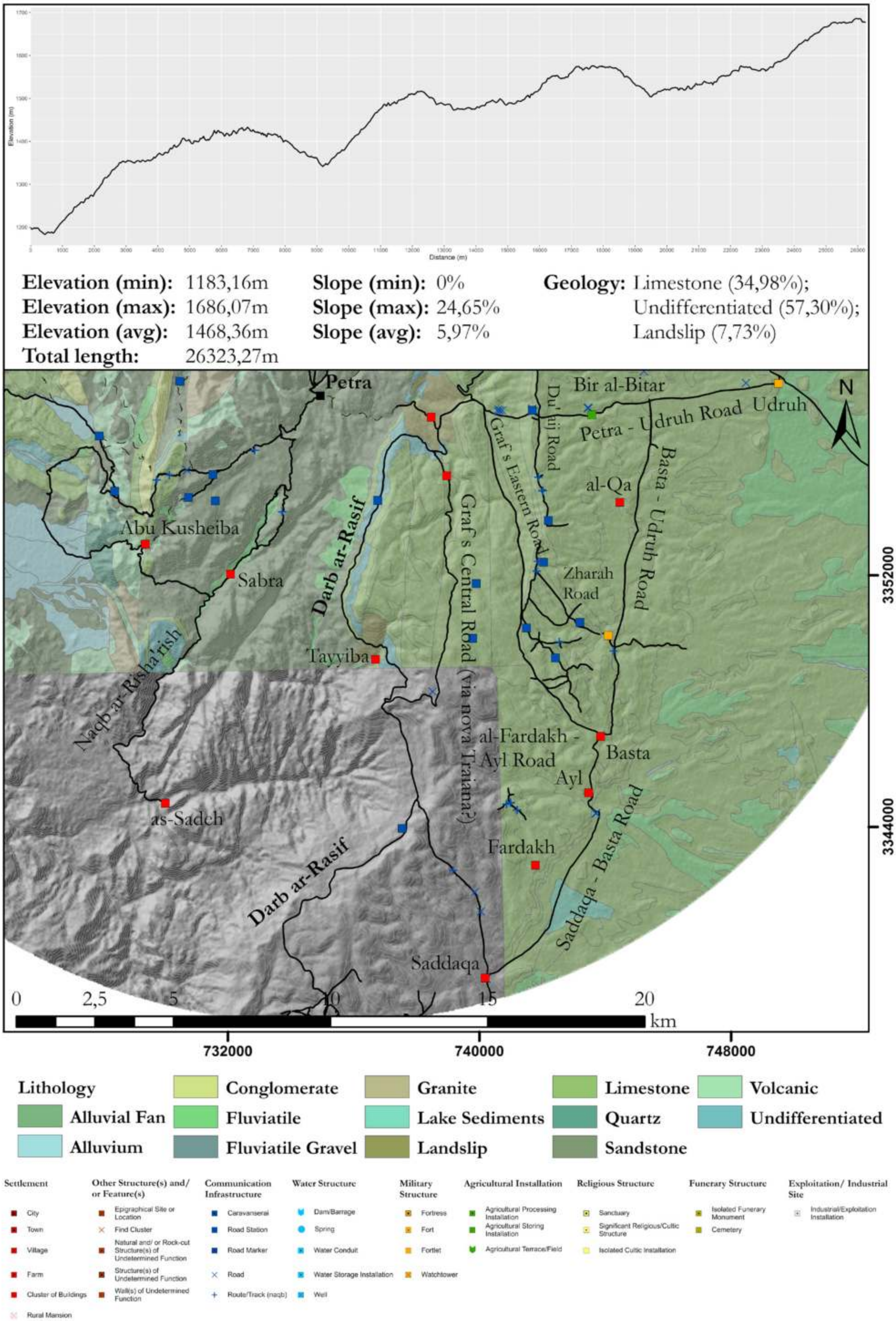


FIG. 191 Presumed course of the Darb ar-Rasif (King's Highway) from Wadi Musa (ancient Gaia) to Sadaqqa.

native to the *via nova Traiana* after its construction between 111 and 114 AD.[1036]

Based on presumably Roman period structures at at-Tayyiba and ar-Rajif, as well as a milestone found at the Roman fort of Gharandal, it is also possible that the Darb ar-Rasif descended westwards from Saddaqa through Dilagha and eventually to Gharandal in the Wadi Arabah.[1037]

While the Darb ar-Rasif was already quite extensively explored by past research, Abudanh et al. recently reevaluated the archaeological evidence and discovered 24 additional presumed roads immediately associated with the Darb ar-Rasif between ar-Rajif and Saddaqa, as well as in the area where the modern Petra-Aqaba road meets the modern Desert Highway.[1038] The newly discovered roads date between the Iron Age II, Nabataean, Roman and Byzantine periods.[1039] The results of this study highlight the significant infrastructural organization needed to connect such a vast geographical area, which the authors consider to be driven by a 'state-like' entity.[1040] The road network of the Darb ar-Rasif seemingly connects numerous settlements and together with the increasing settlement density through time, the road network also grew more complex. During the Iron Age II period, the authors advocate for the existence of a major road that facilitated transportation and traffic not only within the ancient Edomite realm, but also connecting it with other regions. This road can most likely be associated with the Darb ar-Rasif, therefore dating the road as far back as the Iron Age.[1041]

The project distinguished four types of roads and pathways: major primary roads, major secondary roads, minor secondary roads as well as minor secondary pathways.[1042] While major roads mainly have a north-south orientation following high and long ridges, major secondary roads diverge from the major road following contiguous ridges connecting the major roads with archaeological sites. Major roads have an average width of c. 6 m and are bordered by high walls and curbstones. The major secondary roads have a width of up to 4 m and their curbstone walls are lower than those of the major roads. Minor secondary roads are shorter and mostly link major secondary roads. They sometimes run between fields and are therefore most likely used by farmers. These have a maximal width of 3 m and low curbstone walls. In contrast to the above-mentioned road types, pathways are significantly slimmer and cut through tough terrain and difficult slopes that connect sites.[1043] None of the mentioned road types are paved.

Abudanh et al. concentrated their work mostly in areas south of this study's main area (cf. FIG. 180). The majority of the documented roads are therefore not discussed here. However, the overall results of Abudanh et al.'s study are nevertheless important. Only the very northern part of Abudanh et al.'s 'segment 1–5' falls within the study area (FIG. 192).[1044] In addition to the Darb ar-Rasif, only the secondary roads KHJ001, KHJ002, KHJ003 and KHJ005 are of concern for this discussion.[1045] Situated in the far southern limits of the study area, the major secondary road of KHJ001 branches off the main course of the Darb ar-Rasif and turns west-southwest at the functionally undefined site of Khirbet Munay'a (site KHS039).[1046] It first runs over gentle slopes before climbing a more hilly area passing by the primarily Iron Age village of Khirbet Ghurayra (KHS063) and ending at the functionally undetermined structure at Khirbet Rusays (site KHS064).[1047] From here a small, but walled pathway continues further southwest.

1036 Graf 1995a, 254; Bowersock 1971, 239.

1037 Graf 1995a, 254; Graf 1992, 258; Zayadine 1992, 225; Thomsen 1917, 59, No. 187. Although the milestone found at Gharandal does not yield any information on the direction of the marked road, it may rather be associated with the major north-south road in the Arabah that crossed the fort. Cf. e. g. Smith 2010, 92–105. It therefore does not seem very likely that the Darb ar-Rasif ran westwards from Saddaqa and the argument that Roman structures were identified at at-Tayyiba and ar-Rajif seems too weak an argument for suggesting otherwise.

1038 Abudanh et al. 2015b, 156, 184–185. Note Abudanh et al.'s slightly divergent definition of 'road' from the one given here.

1039 Abudanh et al. 2015b, 159, 186.

1040 Abudanh et al. 2015b, 186.

1041 Abudanh et al. 2015b, 186; Borstad 2008, 59–61; Zayadine 1992, 227–228.

1042 Abudanh et al. 2015b, 160. Abudanh et al.'s major primary and secondary roads as well as minor secondary roads fit the general definition for 'road' given in this study. What they define as 'pathways' is equivalent to this study's 'routes/tracks (naqb).' While such an elaborate differentiation of road types may have been useful for the detailed investigations conducted by Abudanh et al., such classifications call for a more detailed discussion on the purpose of and reason for these different road types. As the reasons for the construction and structural appearance of such various 'types' are manifold, it may be difficult to sustain such a hierarchy of road types. This study therefore discusses Abudanh et al.'s results simply as 'roads' without any further classifications.

1043 Abudanh et al. 2015b, 160.

1044 Abudanh et al. 2015b, 161, fig. 2.. N. 21 refers to another paper yet to be published, which shall cover the areas north of the ar-Rajif – Saddaqa junction.

1045 Abudanh et al. 2015b, 160–164. The course of Abudanh et al.'s secondary roads was georeferenced and re-mapped by the author on the basis of Abudanh et al. 2015b, 16, fig. 2.

1046 MacDonald et al. 2012, 60–61: KHS039 corresponds to ARNAS Site No. 031. MacDonald et al. either define the site as an 'agricultural village' or a 'defensive site' dating to the Iron Age I and II periods.

1047 Abudanh et al. 2015b, 160. On Khirbet Ghurayra, see MacDonald et al. 2012, 284–285, ARNAS Site No. 307; Hart 1988 and 1987b, 35–38. Khirbet Ghurayra also

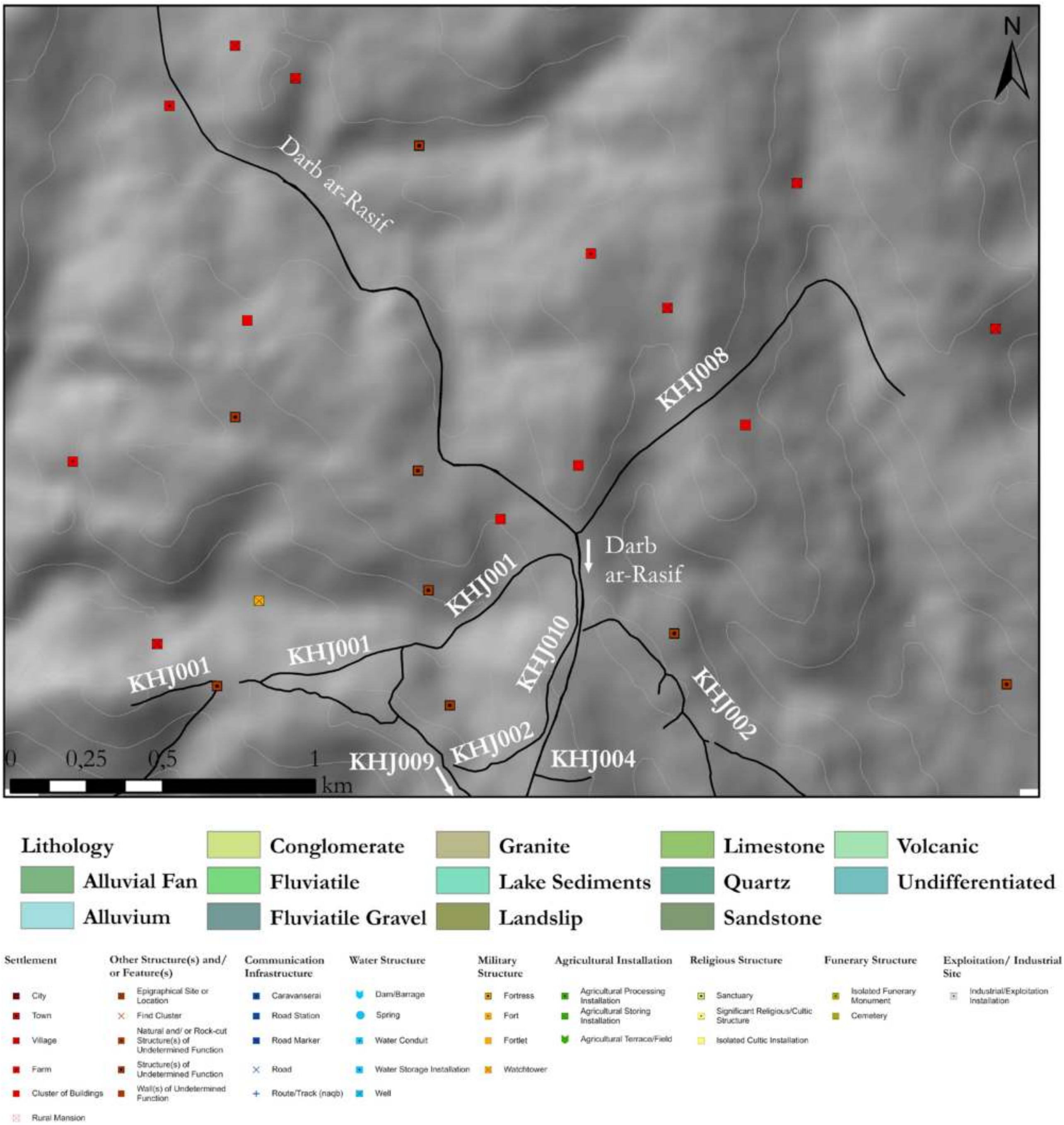


FIG. 192 Secondary roads in the study area branching off the main Darb ar-Rasif artery as recorded by Abudanh et al. 2015b.

Before KHJ001 reaches site KHS063, the minor secondary road KHJ005 diverges southeastwards from KHJ001 reaching site KHS065 and eventually intersects the main course of the Darb ar-Rasif.[1048] This road can also be reached by another minor secondary road branching off KJ001 from KHS063 in southeastern direction.[1049]

The longest major secondary road within the study area to run off the Darb ar-Rasif is KHJ002. Starting immediately southeast of Khirbet Munay'a (site KHS039), KHJ002 first proceeds southeast along low ridges, passing by the site of Ayn al-Jwiezat until it can no longer be traced after approximately 5 km just northwest of Dor (outside the study area).[1050] Several

revealed evidence for occupation during the Nabataean, Roman and Byzantine periods. On Khirbet Rusays, see MacDonald et al. 2012, 86–87, ARNAS Site No. 055. MacDonald et al. define the site as a fort or village and date it to the Iron Age II period.

1048 Abudanh et al. 2015b, 160. The point where KHJ005 should intersect with the Darb ar-Rasif is overbuilt by the modern King's Highway.

1049 Abudanh et al. 2015b, 160.

1050 Abudanh et al. 2015b, 161. The site of Dor appears to have standing stones were observed along this southeastern section of KHJ002, which may have functioned as road markers, thus potentially substantiating the significance of such secondary roads.[1051] Abudanh et al. mention numerous ancient field walls that border with the curbstone walls of KHJ002 as well.[1052] Many minor roads and pathways diverge off KHJ002 accessing the functionally undetermined sites of KHS001[1053] and KHS003.[1054] Although outside the study area, the southeastern continuation of KHJ002 and its diverging minor secondary roads and pathways furthermore connect KHS002[1055], the possible road station of site KHS004[1056] and the functionally undefined sites of KHS005[1057], KHS006, KHS007, KHS008, KHS009, KHS010, KHS077 as well as Khirbet al-Hudun (KHS077).[1058] Standing stones were evidenced in the vicinity of KHS004 which served as road markers showing the way through agricultural fields. This and the fact that some roads make unnatural turns to avoid fields have led Abudanh et al. to the assumption that the studied roads principally avoided fields in order to prevent the unnecessary loss of arable land.[1059] Continuing along the southeastern course of KHJ002, the road eventually intersects the Saddaqa road.[1060] Shortly after KHJ002 branches off towards Khirbet al-Hudun (KHS077) the road runs north-northeast until it cannot be traced any longer, approximately at the same level as KHS039.[1061]

Following the southern course of the main Darb ar-Rasif course from KHS039 and passing the two abovementioned secondary roads KHJ001 and KHJ002, KHJ003 turns further westwards ending at Khirbet Qaqe. This major secondary road avoids arable lands.[1062] Passing site KHS065, the last major secondary road to be discussed here (KHJ005) meets KHJ001 and runs northwest-southeast until it is cut by the course of the modern King's Highway further southeast.[1063] The core principle of major secondary roads branching off the main Darb ar-Rasif, from which minor secondary roads and pathways go off, was observed throughout the entire area between the ar-Rajif –Saddaqa junction and the meeting point between the modern Petra-Aqaba road and the Desert Highway.[1064] All road types seem to deliberately avoid arable lands and principally bypass agricultural fields. Seemingly, these are important factors to consider when researching the road network in the eastern uplands of the Petraean hinterland.[1065]

It is evident that the Darb ar-Rasif must have continued further north of Petra. Abudanh et al. state that the northern section of the road was already surveyed. As these results are yet to be published, the northern continuation of the Darb ar-Rasif can only be assumed to have had the same course as the modern road from Petra to ʾAin Nejel, thus the presumed course of the *via nova Traiana* as for the southern section of the Darb ar-Rasif (at least for the most parts).[1066]

Although there is no archaeological evidence for it, it seems likely that there was an east-west road or route connecting the Beidha area (and therefore Petra) with the major north-south roads on the eastern high plateau, most notably the Darb ar-Rasif. Brünnow and von Domaszewski mapped a direct route from ʾAin Nejel to the Beidha area, which then led directly to Petra, but this route must have cut through difficult terrain and severely descending slopes (FIG. 193).[1067] There is no further description of this route in their accounts. They only mention that previous explorers came from the Shawbak area directly to the now abandoned village of 'Dibdiba' (Dibidbi).[1068] Brünnow and

been a strategically important point of intersecting roads and routes, including the *via nova Traiana* as Graf 1995a, 255 also confirms.

1051 Abudanh et al. 2015b, 162, 164.

1052 Abudanh et al. 2015b, 162.

1053 Abudanh et al. 2015b, 162; MacDonald et al. 2012, 119–120: ARNAS Site No. 096. The site is defined as an 'agricultural village' dating to the Iron Age II, Nabataean and Roman periods.

1054 Without further definition.

1055 Without further definition.

1056 Abudanh et al. 2015b, 164 describe the site as "[…] *a small structure (10 × 6 m) located on the edge of KHJ002 and contiguous to its southern wall. Consisting of three units, it could have been a road station.*" No dating information was given.

1057 Abudanh et al. 2015b, 164; MacDonald et al. 2012, 89–90: ARNAS Site No. 059. The site is defined as a farm dating to the Iron Age II, Nabataean and Byzantine periods.

1058 According to Abudanh et al. 2015b, 164 site KHS077 corresponds to Khirbet al-Hudun. See also MacDonald et al. 2012, 96–97: ARNAS Site No. 069, which is defined as an 'agricultural village' dating to the Iron Age and 'Classical' periods. Site KHS007 is identified as a potential farmstead. Sites KHS006, KHS008, KHS009, KHS010, KHS078 were not further defined by Abundah et al.

1059 Abudanh et al. 2015b, 164.

1060 Abudanh et al. 2015b, 164.

1061 Abudanh et al. 2015b, 164.

1062 Abudanh et al. 2015b, 164. The function of Khirbet Qaqe is not further defined.

1063 Abudanh et al. 2015b, 164.

1064 Abudanh et al. 2015b.

1065 The FJHP has also shown that curbstones prevented trespassing of fields in the Jabal Harun area, thus confirming this assumption (Ynnilä 2013, 260).

1066 Abudanh et al. 2015b, 160, n. 21 mentions that the northern section is planned to be published. Although this should be considered critically, note that modern road planners commonly follow the course of pre-existing and potential ancient roads (Riemer – Förster 2013, 49).

1067 Brünnow – von Domaszewski 1904, Karte der Südlichen Belkâ & Edom, Blatt 3.

1068 Brünnow – von Domaszewski 1904, 414–415.

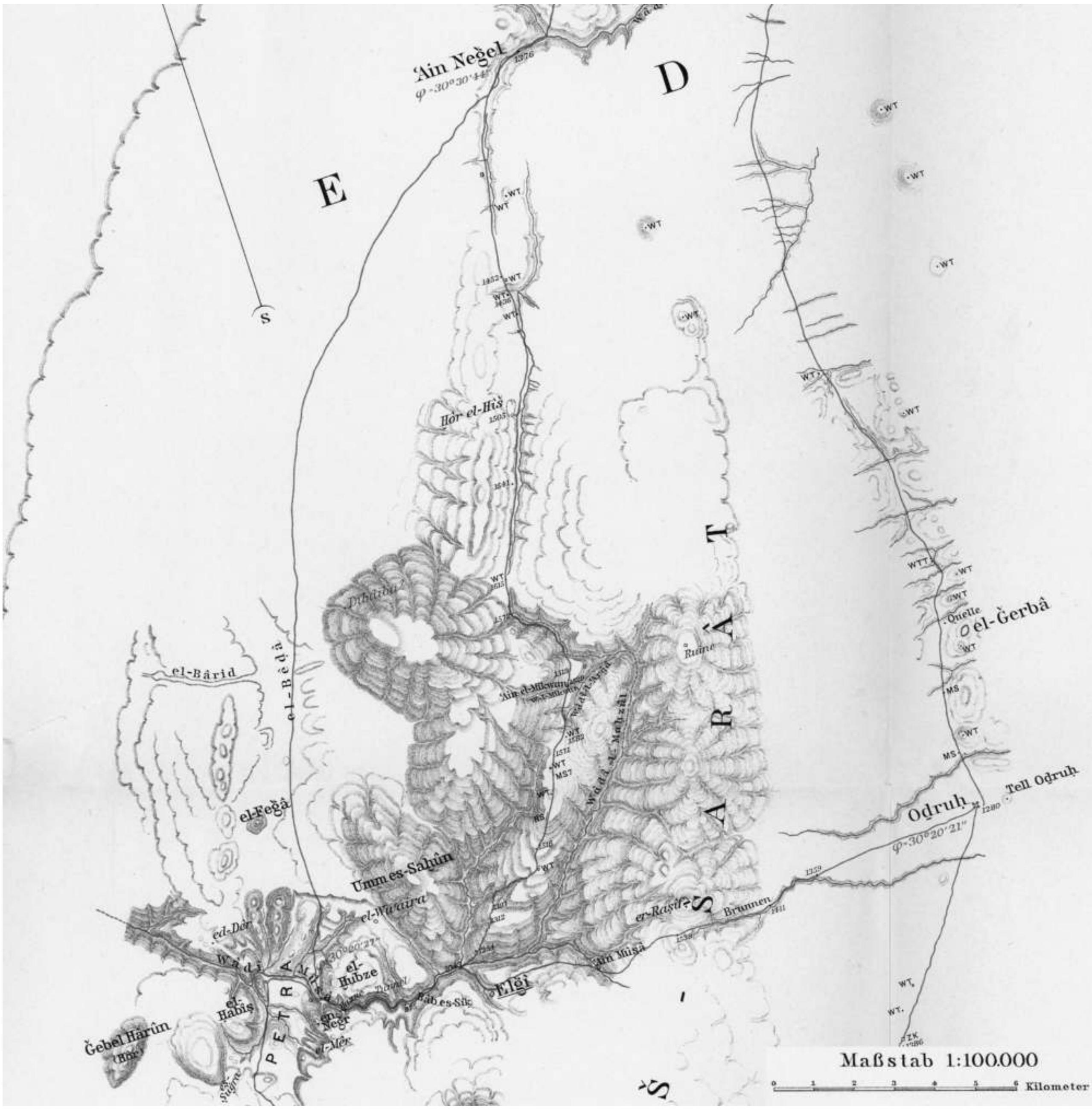


FIG. 193 Edited map detail of Brünnow – von Domaszewski 1904, Blatt 3 marking the road between the Beidha area and ʾAin Nejel.

Domaszewski admit that they have never seen the village and only refer back to earlier travelers.[1069] They therefore could only map the village approximately.[1070] The route that they marked from ʾAin Nejel to the Beidha area is therefore only a very approximate reconstruction of a route taken by earlier travelers and not by themselves. While the mapped route seems unlikely, a possible east-west connection between the Beidha area with one of the major eastern roads may have followed the same course as the modern road leading from Beidha to the King's Highway instead (FIG. 194). This road runs very close to the abandoned village of Dibidbi and may be a likely candidate for the actual route taken by earlier travelers.

In comparison to the east, archaeological evidence for roads in the western parts of the study area is rare. This is mostly due to the increasingly difficult terrain as one descends further through the western escarpment into the Wadi Arabah. The natural landscape does not allow for any major road constructions in

1069 Brünnow – von Domaszewski 1904, 415: *"Auf dem die nördliche Fortsetzung des Umm es-Sahûn bildenen Berge, östlich von el-Bêdâ, liegt das Dorf Dibdiba; wir haben es nicht gesehen und können die Lage nur ungefähr auf der Karte angeben."*

1070 Brünnow – von Domaszewski 1904, 415.

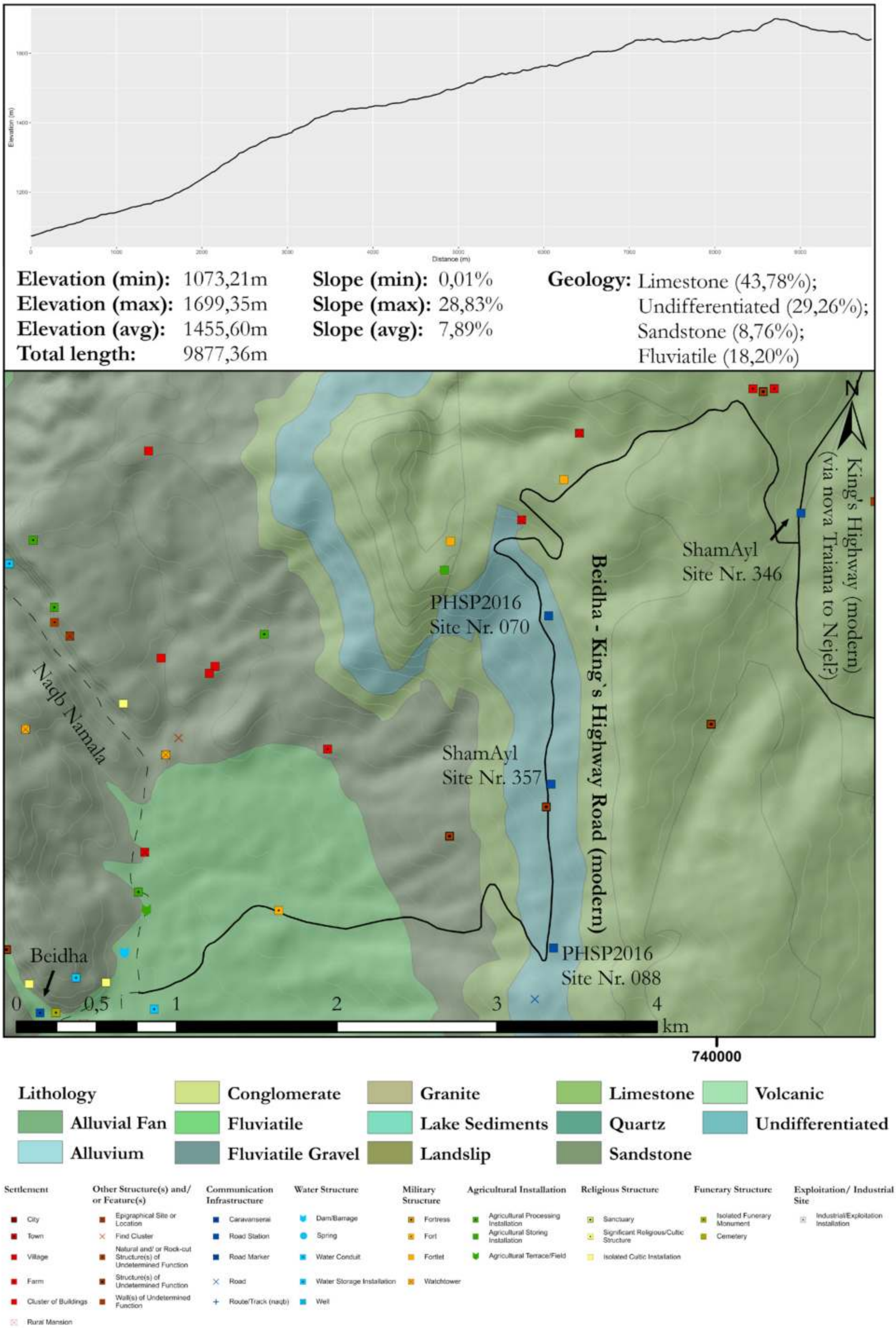


FIG. 194 Hypothetical road connecting the Beidha area immediately north of Petra with the Darb ar-Rasif. Road course based on modern road.

form of regular road widths, curbstone walls or even road pavements. Instead, the landscape conditions necessitate the use of a more complex web of smaller routes/tracks (naqb) as will be discussed below.

Before descending into the Wadi Arabah, the most western evidence for a road within the study area is FJHP Site No. S082.[1071] This road is only approximately 300 m long and 2–4 m wide and runs between the Wadi as-Saddat and Wadi al-Mahatta, in part still showing double-rowed curbstone walls as well as partial paving. The FJHP opened two small soundings revealing a 0,15 m thick layer of cobble bedding underneath the paving. There was no mentioning of dating material.[1072] However, two structures of undetermined function (FJHP Site No. S083 and S084) are immediately adjacent to the road. The surface pottery of FJHP Site No. S083 is dated to the second half of the 1st century AD.[1073] Although FJHP Site No. S082 follows the same course as the ancient routes FJHP Site No. S051 and S095 (cf. below), a contemporary date cannot be assumed for certain.[1074]

In the Wadi Arabah, the *Tabula Peutingeriana* possibly suggests another major Roman road from ancient Aila (Aqaba) to 'ad Diannam' and from there to Praesidio (Khirbet Khalde). This road is not to be confused with the *via nova Traiana*.[1075] From Khirbet al-Khalde, the road may have continued through the Wadi Muhtadi or Wadi Darba to the Roman outpost at Rujm Maqrah Hadid in the Arabah.[1076] From there, the road may have headed for Aila in the south or Yotvata in the north.[1077] The southern route back to Aila would have followed through Wadi Darba and then along the edge of the Dafiya Sabkha, passing by the ancient fort at Horvat/Mezad Dafit and the spring at Evrona/'Ain Dafiya before following the course of the *via nova Traiana* again.[1078] In addition to the northern route from Rujm Magrah Hadid to the Roman fort at Yotvata (ancient Osia or Bosia), another route headed more northeast towards the Nabataean site of Rujm Taba and further to the fort at Gharandal.[1079] In the sand plains of Gharandal, a paved section of a north-south running road was documented that leads towards the road station at Khirbet or Qaa' as-Sayidiyeen where anepigraphic milestones were found.[1080] From there, the sandy desert turns into the gravel *hamada* plains where paved roads were no longer necessary.[1081] Instead, various gravel routes continued northwards through the *hamada*, potentially passing important sites in Petra's western hinterland such as the Nabataean-Roman road stations at Qasr at-Tayyiba, BMP/CAS Site No. 013, Khirbet Umm Qunthera, Khirbet as-Faysif and the Roman fort at Bir Madkhur.[1082] There must have been at least one major north-south axis in the Wadi Arabah, such as the one evidenced archaeologically from Khirbet or Qaa' as-Sayidiyeen. This is attested in the literary sources. In his *Onomasticon* (early 4th century AD), Eusebius describes "[…] *a village Thamara, one day from the town of Mampsis on the road from Hebron to Aila, where now a garrison is located.*"[1083] By the time Eusebius completed his work, the *legio X Fretensis* was stationed at Aila and many other forts in the Arabah date around that time period as well.[1084] While the exact location of Thamara remains disputed, Smith convincingly points out that the passage in Eusebius' *Onomasticon* clearly suggests a north-south running road; potentially the one passing through Yotvata as portrayed above.[1085] This described section may have been associated with the transferal of the *legio X* from Jerusalem to Aila.[1086]

1071 Ynnilä 2013, 254; Silvonen et al. 2013, 371–372. Frösén et al. 2001, 389. The presumed road of FJHP S082 follows the course of Naqb ar-Ruba'i discussed below.
1072 Ynnilä 2013, 254; Silvonen et al. 2013, 372.
1073 Ynnilä 2013, 255; Silvonen et al. 2013, 372.
1074 Silvonen et al. 2013, 372, 377.
1075 Smith 2010, 94–95.
1076 Smith 2010, 96. 'Ad Dianam' is listed on the Peutinger map, but probably cannot be associated with Yotvata. This was more likely referred to as Costia (evidenced by the large Tetrachic inscription found at the site) or Osia (Bosia), a variant of Costia, as suggested by Late Roman milestones found immediately north of Yotvata (Smith 2010, 32; Eck 1992; Roll 1989). Cf. also Davies – Magness 2011 who suggest that the fort was not constructued before the mid-4th century AD. For a further discussion on the problematic issue of identifying 'ad Dianam' with Yotvata, see Smith 2010, 32, 94–95 and 2005, 186. The Peutinger map is so far the only source mentioning 'ad Dianam' and the depicted road course between 'ad Dianam' and 'Praesidio' may be erroneous as well as the inscription mentioning 'Costia' as the Tetrachic site name of Yotvata.
1077 Smith 2010, 95, 97, fig. 98; Smith 2005, 186.
1078 Smith 2010, 96; Smith 2005, 187. The fort at Horvat/Mezad Dafit dates to the Nabataean, Roman and Byzatine periods.
1079 Smith 2010, 92, 100; Smith 2005, 187.
1080 Smith 2010, 92; Smith 2005, 187. Smith also mentions that milestones dating to the late 3rd and early 4th centuries AD found approximately 15 kilometers north of Yotvata suggest a direct road connecting Yotvata with Gharandal. Another anepigraphic milestone was recorded at Bir Madkhur. See also Ben David 2007, 107, fig. 8 for the paved road.
1081 Ben David 2013, 273; Smith 2005, 186.
1082 Smith 2010, 100; Smith 2005, 187. This was evidenced by aerial photography.
1083 Smith 2010, 95.
1084 Smith 2010, 95.
1085 Smith 2010, 95–96.
1086 Contrary to Ben David 2007, 106–108.

While the archaeological evidence suggests a north-south axis in the eastern Wadi Arabah via Qaa' as-Sayidiyeen towards Bir Madkhur, Smith argues for a second north-south axis in the western Arabah as well. This route should head north from Yotvata, through Mezad Be'er Menuha, Moyet 'Awad, 'Ain Rahel, 'Ain Yehav and 'Ain Marseb before reaching Mezad Hazeva.[1087]

Importantly, the roads of the Arabah were met by numerous routes and pathways from the east – so-called *naqb* – that followed the wadis and gorges of the western escarpment eastwards into the Wadi Arabah.[1088] These are described below. The construction and maintenance of built roads in the Arabah was probably no easy task, explaining why the Arabah was mostly crossed via smaller routes/tracks better suitable for a more mobile population. Smith was able to document "[…] *a host of pathways and unpaved roadways that linked virtually all sites in the Wadi Araba together* […]."[1089] However, before elaborating on these important routes/tracks (naqb), the following first elaborates on the *via nova Traiana* in the Petraean hinterland as it was not covered extensively above.

The Via Nova Traiana in the Petraean Hinterland

The *via nova Traiana* is without doubt the most researched ancient road in the study area. Extending over 430 kilometers between *a finibus Syriae usque ad mare rubrum*, the *via nova Traiana* connected Bostra, the alleged 'capital' of the newly established *Provincia Arabia*, with the Red Sea port town of Aila.[1090] As papyri from Karanis dating to 107 AD mention that Roman legionaries stationed near Petra were quarrying stone near the former Nabataean capital, the construction of the road could have commenced as soon as that year.[1091] However, almost 200 milestones found between Bostra and Petra offer more secure epigraphical evidence and provide not only Trajan's titulary, but also the name of the governor of the new *Provincia Arabia* – Claudius Severus.[1092] The construction of the *via nova Traiana* must have therefore been completed at some point between 111 and 114 AD.[1093] With more than 40 datable milestones along the southern section of the *via nova Traiana*, D. Graf was able to show that the road was still managed in the Constantinian period.[1094]

Based on scattered finds of milestones and road-related archaeological sites, earlier scholars argued that the *via nova* bypassed Petra and argued that the city was connected to the *via nova* only by secondary roads heading east to Udruh, northeast to Shawbak and southeast to Saddaqa.[1095] However, the *Tabula Peutingeriana* shows only one major north-south running road, which is undoubtedly the *via nova Traiana*.[1096] Not only is Petra (*Petris*) listed as one of the stations along the road, it was most likely the original *caput viae* of the *via nova* and not Bostra.[1097] This is based on Roman milestones found near Bostra that state the distance back to Petra.[1098] Bauzou argues that Bostra did not take over the status as *caput viae* from

1087 Smith 2010, 101.

1088 Cf. also Smith 2010, 101; Smith 2005, 187–188: Wadi entrances were often equipped with towers to monitor animal and human traffic. Major forts such as Yotvata, Gharandal or Bir Madkhur were erected where the wadi systems offered good infrastructural connectivity within the Arabah and where water was available.

1089 Smith 2010, 92–94.

1090 Abudanh 2006, 118; Graf 1995a, 241; Graf 1992, 256. For a critical assessment of Bostra's status as provincial capital, see Fiema 2003 and 1988.

1091 Graf 1995a, 241; Youtie – Winter 1951, 21–23, no. 466, ll.

1092 Graf 1995a, 241.

1093 Graf 1995a, 241.

1094 Graf 1995a, 241.

1095 Graf 1995a, 242–243; Killick 1987, 174–175; Parker 1987a, 87; Glueck 1935, 70, 71, 75.

1096 Graf 1995a, 243.

1097 Graf 1995a, 242; Thomsen 1917, 36; Brünnow – von Domaszewski 1904, 312–317. As Graf points out, Weber 1976, 27 has noted that 'Petris' may have been added to the *Tabula Peutingeriana* at a later period. However, there is no doubt that the toponym 'Petris' was originally intended. While this does not affect the reconstruction of the course of the *via nova Traiana,* it should be noted that the grammatical form 'Petris' has not been previously discussed. The grammatical forms of toponyms listed in the *Tabula Peutingeriana* are frequently overseen when attempting to pinpoint sites with places mentioned on the map (Salway 2005, 120–122). In the case of 'Petris,' the form is either the ablative or locative plural form of 'Petra.' Therefore 'Petris' does not simply signify the place name, but should be translated as 'from Petra' (in contrast, cf. e. g. the nominative forms of 'Philadelphia,' 'Zadagatta' or 'Haila'). This may confirm the assumption that Petra served as a *caput viae* of the *via nova* as the toponyms listed in the Peutinger map are generally part of the phrase 'from X to Y, Z miles' (Salway 2005, 120). Cf. also Salway 2001, 22–28 and Dilke 1998, 114, note 1. However, the *Tabula Peutingeriana* also lists 'Bostris' instead of 'Bostra.' If Bauzou 1988 is correct in the assumption that Bostra replaced Petra as the *caput viae* in the last quarter of the 2nd century AD and the ablative or locative form as 'from X to Y' truly signifies a *caput viae,* the Peutinger map does not differentiate chronologically. It could therefore be argued that the map (if it is based on more than one copy of the original Roman *cursus publicus* map) shows both Petra *and* Bostra as *capita viae* of the *via nova,* however at different times. This issue will not solve the problem of identifying the *caput viae* of the *via nova* alone, but should be kept in mind for further discussions.

1098 Graf 1995a, 243, Brünnow – von Domaszewski 1904, 312–317; Thomsen 1917 No. 71, 87a and 90. Graf assumes that the milestones found along the Petra-Aila stretch of the *via nova* measure the distance back to Petra as well.

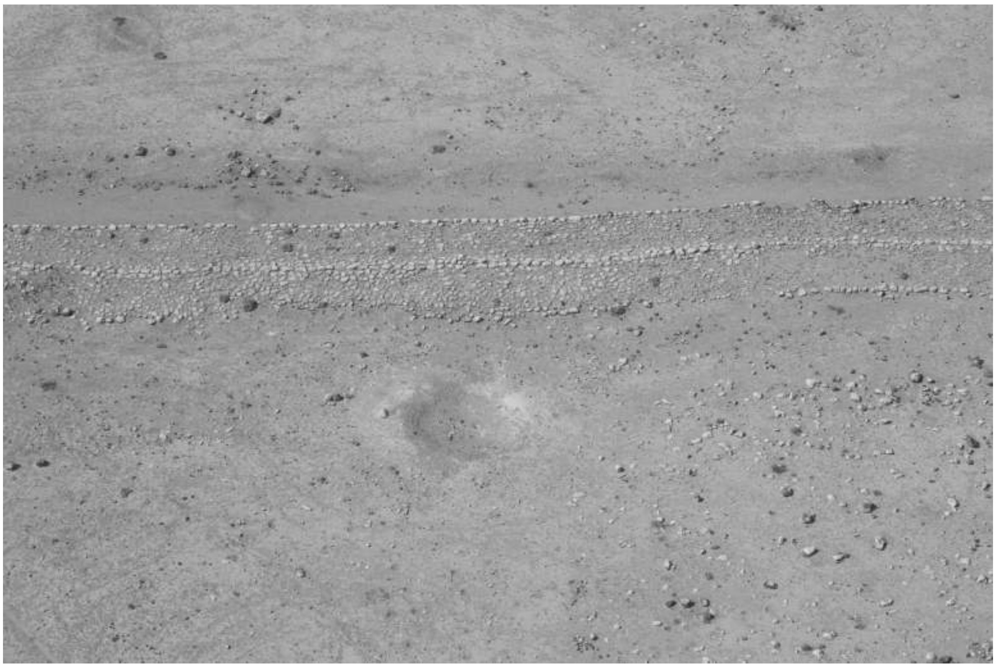


FIG. 195 Paved segment of the *via nova Traiana* near Umm al-Jimal (?). Photo: APAAME.

Petra until the last quarter of the 2nd century AD.[1099] This is corroborated by epigraphic evidence from milestones that date the completion of the Petra-Philadelphia (modern Amman) section of the *via nova* to 111 AD and the Bostra-Philadelphia section three years later to 114 AD.[1100]

Archaeologically, the remains of a paved Roman road evidenced immediately north of Petra and leading directly to the city may very well represent stretches of the *via nova Traiana*.[1101] Paved segments of this road and milestones found along its course pass through the modern village of al-Hai as well, situated only five kilometers northeast of Wadi Musa.[1102] Presumed Nabataean-Roman road stations along this segment were discovered at Sot Abu Uwaynah and Qasr al-Twaissi as well as potential guard posts or watchtowers at Mughar al-Kheil and Rujm 'Umeri.[1103] The paved segments of the road were about 5,5 m wide, showed clear curbstone walls and were centrally divided by a ridge (FIG. 195). These construction elements were featured in the same dimensions at the evidenced section of the *via nova* between Bostra and Philadelphia.[1104] The archaeological evidence therefore strongly suggests a direct link between Petra and the *via nova Traiana*.

According to the *Tabula Peutingeriana*, the next station south of Petra along the *via nova* is Zadagatta, which is identified with modern Saddaqa (FIG. 196).[1105] Based on milestones discovered between Petra to Saddaqa, Graf identified two major roads – one eastern and one central road.[1106] Both roads may have been the *via nova* as they were both used during the Roman period and have a length of approximately 27 km or 18 *milia passuum* (MP) as listed in the *Tabula Peutingeriana* for the *via nova*.[1107] As mentioned above, the Darb ar-Rasif (King's Highway) first runs more or less parallel to Graf's central course of the *via nova* and joins it immediately north of Khirbet Tuliyeh.[1108] While the *via nova* turns eastwards towards Saddaqa just after Khirbet as-Sa'ud, the Darb ar-Rasif continues straight south along the western escarpment of the Jabal Shara mountain ranges until it rejoins the *via nova* some kilometers south of Saddaqa at Qana.[1109]

Graf's 'eastern route' begins just southeast of Ain Musa following the Wadi Jammaleh until it reaches a Nabataean-Roman road-related structure at Umm

1099 Graf 1995a, 243; Bauzou 1988.
1100 Fiema 2003, 45; Graf 1995a, 243–244.
1101 Graf 1995a, 244.
1102 Graf 1995a, 244–245; Thomsen 1917 No. 169–171; Brünnow – von Domaszewski 1904, 101–102. These observations were confirmed in 1986 by the *Roman Road Project* directed by D. Graf.
1103 Graf 1995a, 245. Sot Abu Uwaynah supossedly measures approx. 22 × 10 m, Qasr al-Twaissi approx. 20 × 20 m. Mughar al-Kheil measured 3 m² and Rujm al-'Umeiri 6 m². Surface pottery at all sites range from the Nabataean, Roman and Byzantine periods.
1104 Graf 1995a, 245.
1105 Graf 1995a, 245.
1106 Graf 1995a, 247–252.
1107 Graf 1995a, 247.
1108 The course of Graf's central route was georeferenced and re-mapped by the author on the basis of Graf 1995a, 247 and 248, fig. 2 as well as 251–252 and satellite imagery.
1109 Graf 1995a, 247–248, fig. 2.

FIG. 196 Aerial view of Sadaqqa. Photo: APAAME.

Suwanneh after eight kilometers (FIG. 197).[1110] Continuing 4 km further south-southeast along the wadi it then passes the presumed Nabataean-Roman road station at Khirbet Bitahi before reaching the village of Basta (FIG. 198).[1111] The road then advances further southeast to the village of Ayl with its Roman fort where Glueck and Graf discovered milestones.[1112] At Ayl, a short stretch of only 200 m was also recorded by the WMWS in 1998 (WMWS 1998 Site No. Ayl 7).[1113] The paved road corresponds to another stretch of road located 300 m to the west and immediately north of the Ayl-Saddaqa road. Together with the evidence of a displaced milestone, the surveyors therefore suggest that the road of WMWS 1998 Site No. Ayl 7 is part of the *via nova Traiana*.[1114] Along the modern Ayl-Ma'an road, the WMWS also recorded a 2 km long stretch of a paved road with curbstones visible from a small brick factory just outside the modern town of Ayl.[1115] From Ayl, Graf's eastern route continues south passing the modern village of Fardakh. Abudanh's Ayl-Fardakh

1110 Graf 1995a, 247. Umm Suwaneh measures 12 × 9 m. Graf's eastern route corresponds well with Abudanh's 'Kafr Ass-ham road' (Abudanh 2006, 110–111). The course of Graf's eastern route was georeferenced and re-mapped by the author on the basis of Graf 1995a, 248, fig. 2 and 247–251 as well as satellite imagery.

1111 Graf 1995a, 247. Khirbet Bitahi consists of several structures on high ground overlooking the Wadi Jammaleh. One larger rectuangular structure measures 12 × 25 m and is situated to the north. Another irregularly shaped structure lies to the south measuring 15 × 20 m. Surface pottery dates the site to the Nabataean, Late Roman and Byzantine periods. On the road leading from Wadi Musa to Basta, see also Zayadine 1992, 227. The course of the *via nova Traiana* between Saddaqa and Basta was georeferenced and re-mapped by the author on the basis of Graf 1995a, 248, fig. 2 and 249 as well as satellite imagery. Graf also mentions a 'concentration of domestic structures' approx. 4–5 kilometers west of Basta at Tellet Omr. Based on surface pottery this site primarily dates to the Nabataean period, although the Roman and Byzantine periods were also represented.

1112 Graf 1995a, 249; Glueck 1935, 75 (No. 7). The milestone found and analyzed by Graf is a significant find as its painted text not only mentions the Roman emperors Maximinus Thrax and his son Maximus, but also the Roman governor of *Provincia Arabia* who served during the reign of both emperors. Most likely, these are either Pomponius Julianus (listed for 236 AD) or D. Simonius Proculus Julianus (listed between 237 and 238 AD). However Graf 1995a, 251 also recognizes the gaps in the governmental *fasti* for Arabia. Therefore, the named governor may have also been a previously unknown Julianus serving "[…] *under Augustorum duorum sometime between the Antonine dynasts and Gallienus*." For further discussions on the reading of the text of the Ayl milestone, see Graf 1995b.

1113 ʾAmr – al-Momani 2001, 275.

1114 ʾAmr – al-Momani 2001, 275; Graf 1995b, 418.

1115 ʾAmr – al-Momani 2001, 275–276.

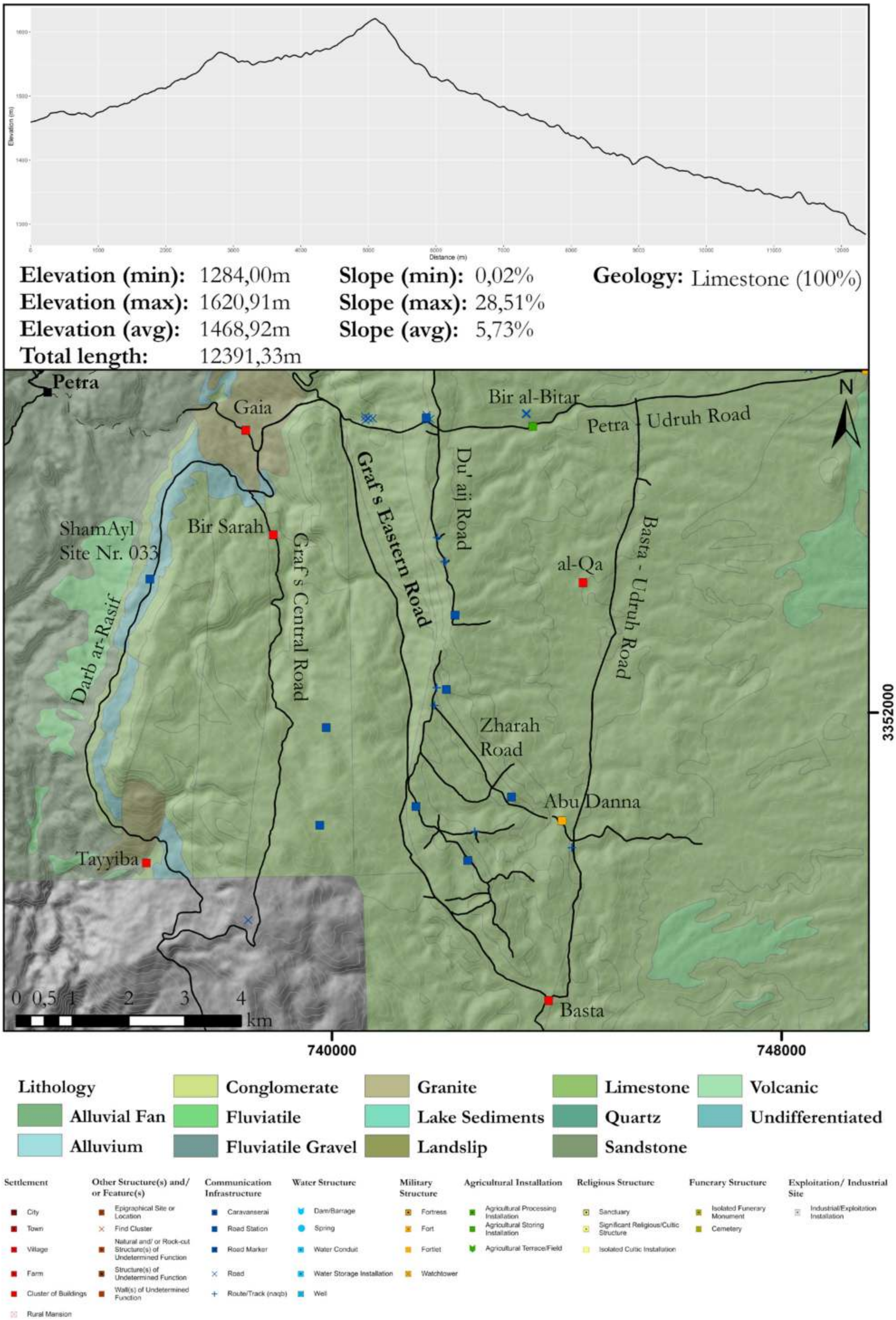


FIG. 197 Graf's eastern route.

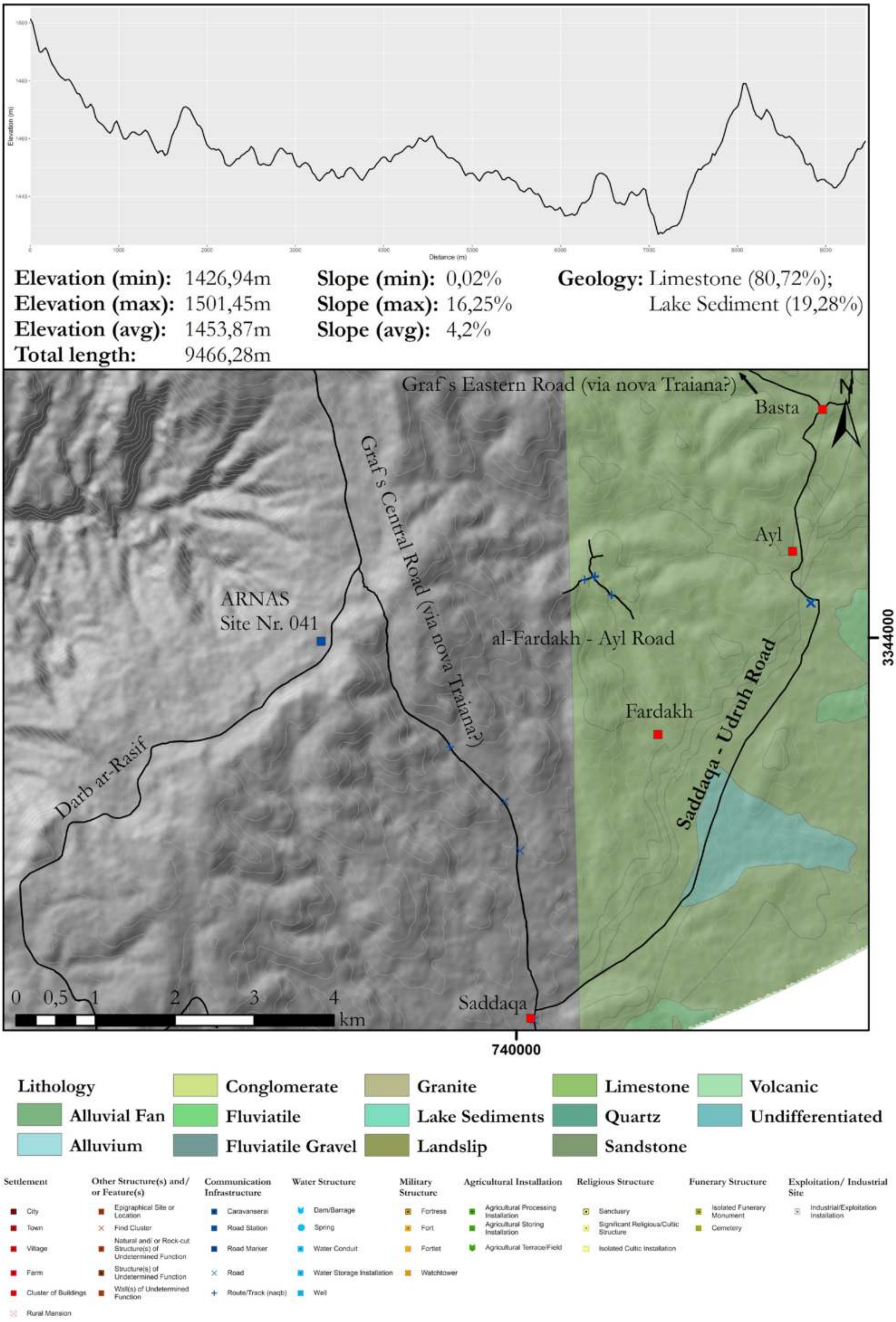


FIG. 198 Presumed course of the *via nova Traiana* between Saddaqa and Basta running through Fardakh and Ayl.

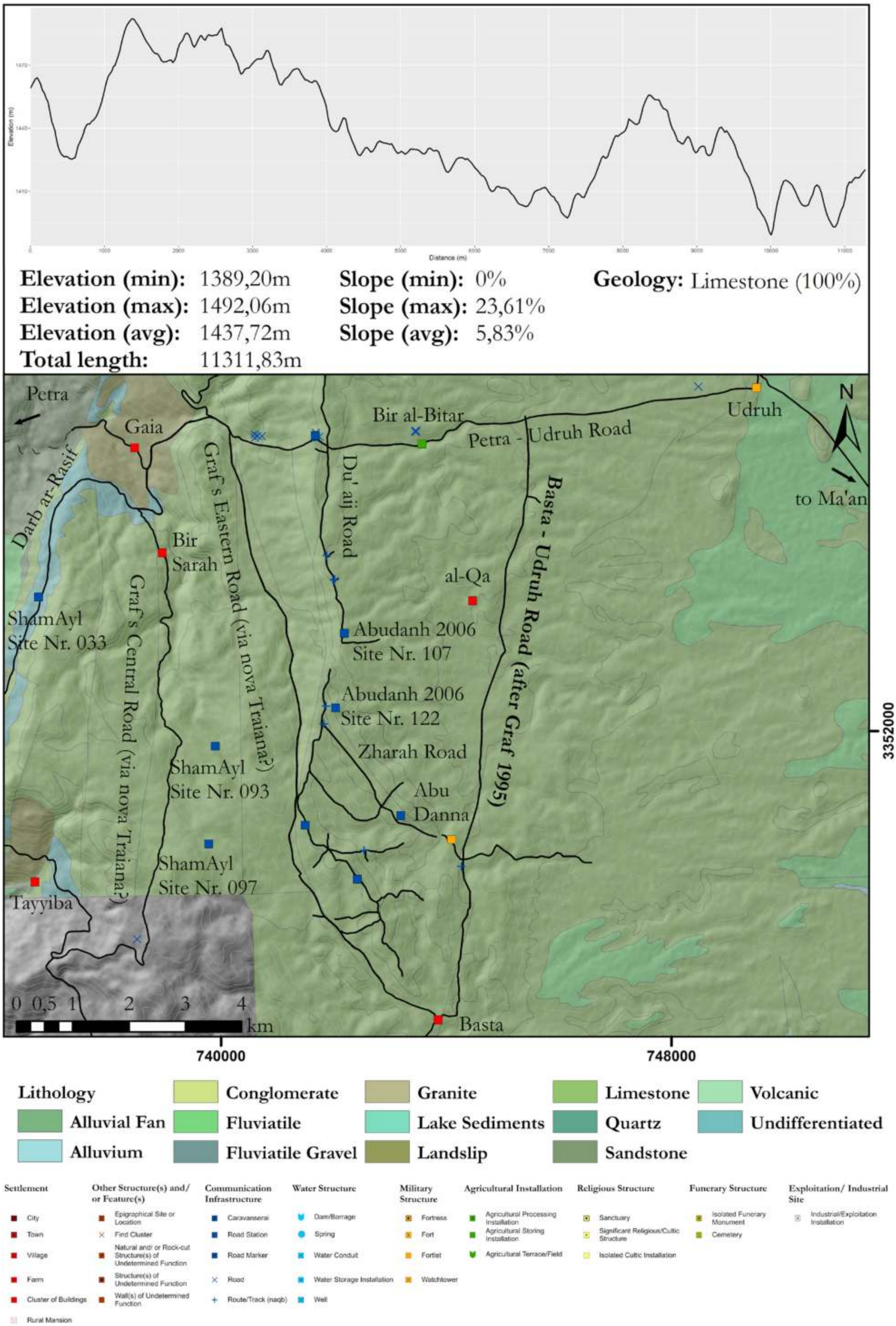


FIG. 199 Ancient road between Basta and Udruh.

road (cf. FIG. 198) adds additional archaeological evidence to the course of this road.[1116] Although Abudanh was only able to document a very short segment of this road northeast of Fardakh, it became evident that at least two secondary roads branched off from the main course. While the southern secondary road turns west-southwestwards towards the presumed fort at Khirbet al-Hajareen (Abudanh Survey Site No. 264), Abudanh claims that the northern secondary road may have continued northwestwards back to Basta.[1117] If Abudanh's assumption is correct, Basta would have been accessed by three roads.[1118] However, the identification of this road segment being part of the Ayl-Fardakh route seems unlikely as it runs over high ridges and steep slopes instead of passing through the more comfortable valley as the modern road does.

There is evidence of a large ancient settlement with surface pottery ranging from the Iron Age to the Byzantine periods immediately northwest of the modern village of Fardakh.[1119] On a hilltop southwest of the village there is a small Nabataean-Roman 'fort' overlooking the spring of 'Ain 'Uneiq as well. It is in visible contact with Rujm Saddaqa, the next station along the *via nova*.[1120]

From Basta, another road continues north to the forts at Abu Danna and Tell Abara as well as the village of al-Qa' (Rashid) and eventually even further north to Udruh and beyond (FIG. 199).[1121] Graf agrees with the observations of Brünnow and von Domaszewski that this route does not represent the course of the *via nova Traiana*.[1122] From Saddaqa, this northern route via Udruh measures 25 MP instead of the 18 MP to Petra listed in the *Tabula Peutingeriana*.[1123] The Peutinger map also indicates that the *via nova* passed through ancient Negla (modern 'Ain Nejel) north of Petra and not Udruh.[1124] The milestones found near Udruh supposedly marked only the east-west road passing through the fort at Khirbet Arja and connecting Udruh with the *via nova* further west.[1125] For Graf, the eastern Petra-Basta-Saddaqa route, or the so-called 'central route,' is therefore more viable for the course of the *via nova* (FIG. 200).[1126]

Graf's 'central route' leads from Petra to Saddaqa heading south over the eastern high plateau.[1127] The first station along this route is evidenced approximately 5 km south of Wadi Musa by an anepigraphic milestone found at Bir Sarah.[1128] From there, the road continues south passing the spring of 'Ain Hejn and the road-related site of Dhaha.[1129] It then continues further south passing the presumed forts at Khirbet Mirkab and Khirbet Diqah as well as the road-related structure at Bir Salman and the sites of Mijdal and Mudawrah, after which it eventually meets the modern at-Tayyiba-Ayl road.[1130]At a width between 4 and 4,5 m, segments of this road were paved and showed curbstone walls.[1131] Following the course of Wadi al-Rwaiha south

1116 Abudanh 2006, 115–116.

1117 Abudanh 2006, 115. Khirbet al-Hajareen supposedly dates to the Byzantine period.

1118 Abudanh 2006, 115–116.

1119 Graf 1995a, 251. Graf suspects a Persian origin in the name Fardakh, therefore arguing that the site could have been a station along the Achaemenid royal road system in the region.

1120 Graf 1995a, 251. Fardakh was even considered as the Byzantine *Pentakomia* (Abel 1938, 178, 407). However Graf argues that "[a] *nexus nearer to the settlement at Basta seems preferable, since it is surrounded by the fort and settlement at Ail to the S, Fardakh to the SW, the fort of Abu Danna to the E, and Tellet Omr to the N. It is at Basta that the roads from Petra and Udruh also converge, making it an attractive choice for the central location of the 'five villages.' However, since a bishop from Pentakomia is known, one would expect the remains of a Byzantine church in the area, but none has been reported.*" In his *Descriptio orbis romani* from 1054, George of Cyprus also mentions Pentakomia in the Petra area.

1121 Graf 1997, 279. This corresponds well with the course of Abudanh's Udruh–Basta road (Abudanh 2006, 112–115). The course of the Basta-Udruh road was georeferenced and re-mapped by the author on the basis of Graf 1995a, 248, fig. 2 and 247 as well as satellite imagery.

1122 Graf 1995a, 247; Brünnow – von Domaszewski 1904, 465.

1123 Brünnow – von Domaszewski 1904, 465. The distance from Saddaqa to Udruh varies depending on which route one takes. Following the modern road from Saddaqa through Fardakh and Ayl, then continuing west-northwest to the modern Ma'an-Shawbak road and then taking that road northwards to Udruh is indeed approx. 25 Roman miles (ca. 40 km) long. Taking the modern north-south road through Fardakh and Ayl, passing Abu Danna and Rashid (al-Qa') and then turning east on the modern Petra/Wadi Musa – Udruh road is only 27 km (ca. 18 Roman miles) long, therefore corresponding well with the 18 MP between Saddaqa and Petra stated on the *Tabula Peutingeriana*. However, as Graf 1997, 279 pointed out, the Udruh-Petra road was most likely not part of the *via nova Traiana,* but served merely as a branch connecting Udruh with the Trajanic road.

1124 Graf 1997, 279; Graf 1995a, 242–244; Brünnow – von Domaszewski 1904, 100–102.

1125 Graf 1997, 279. Graf also mentions a Roman villa along this road at Theman, only five Roman miles from Petra. According to Eus. On. 97,15–17, there was a *Romanorum militum praesidium* there.

1126 Graf 1995a, 247; Brünnow – von Domaszewski 1904, 465.

1127 Abudanh 2006, 544: Abudanh Survey Site No. 278; Graf 1995a, 252.

1128 Graf 1995a, 252. Glueck 1935, 77 No. 7 previously mentions two milestones at Bir Sarah.

1129 Graf 1995a, 252.

1130 Graf 1995a, 252. Khirbet Mirkab measures 17,5 m², Khirbet Diqah and Bir Salman 12 × 20 m. Surface pottery dates all sites between the Nabataean to Umayyad periods with a large concentration of Late Roman and Byzantine material.

1131 Graf 1995a, 252.

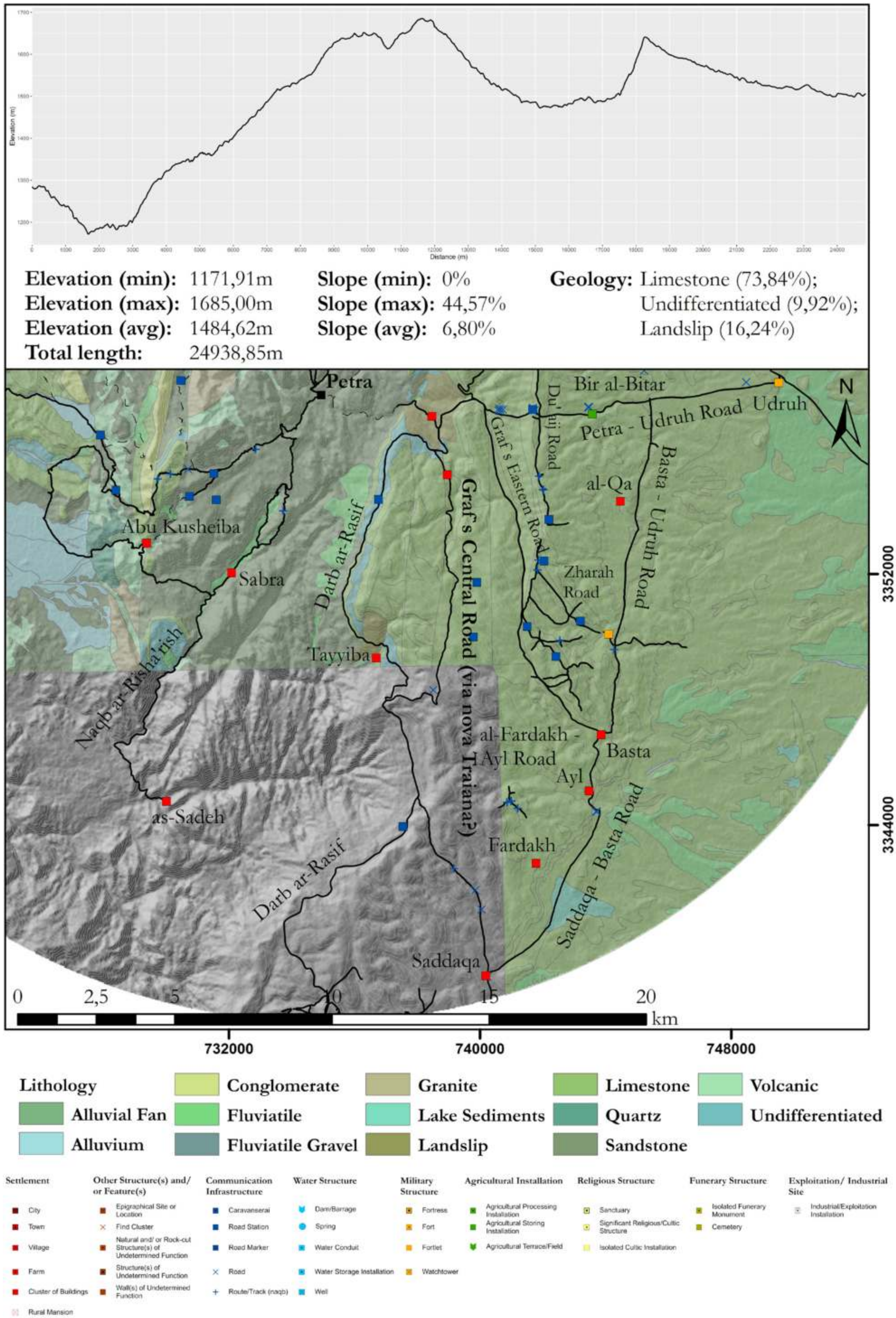


FIG. 200 Graf's central route and most likely candidate for the *via nova Traiana*.

of the modern at-Tayyiba–Ayl road, Graf's central road continues further south passing the road-related site of Beit Qadim, the fort at Qasr Tuliyah and another road-related structure at Khirbet as-Sa'ud.[1132] At Khirbet as-Sa'ud, the central route then turns southeast towards Saddaqa for approximately 6 km passing the Roman village of Khirbet al-Rawiha.[1133] Shortly before Saddaqa, sections of the over 6 m wide road were paved with clear curbstone walls.[1134] Based on the archaeological evidence and the corresponding length of the central route with the 18 MP stated in the *Tabula Peutingeriana*, Graf considers this route to be the best candidate for the course of the *via nova Traiana*.[1135] Between Khirbet Tuliyeh and Khirbet as-Sa'ud, the central route follows the same course as the Darb ar-Rasif, which continues further south along the western escarpment of the Jabal Shara to Qana.[1136]

While recognizing that Graf's central route corresponds to the 18 MP listed in the *Tabula Peutingeriana*, Abudanh et al. prefer Graf's *eastern* route as the true course of the *via nova*:[1137] First, they argue that the archaeological evidence of Graf's eastern route can be better characterized as a typical Roman road as it is more consistent in terms of width and overall layout. Second, although acknowledging the anepigraphic milestone documented along Graf's central road at Bir Sarah, the painted milestone discovered near Ayl mentioning the Late Roman emperor Maximinus Thrax and his son Maximus attests to the overall significane of the *eastern* road. The fort at Khirbet Ayl also suggests heightened military presence along the road. Third, Abudanh et al. claim that the road branching off at Khirbet as-Sa'ud westwards towards Saddaqa is not the *via nova Traiana*, but the Darb ar-Rasif. Fourth, numerous north-south running roads were evidenced in the vicinity of the Bir Sarah area where Graf's central road commences. These are most likely of pre-Roman date. It is also argued that the difficult terrain does not allow frequent traffic of caravans and/or troops.[1138] Fifth, it seems unlikely that the *via nova Traiana* would have bypassed the major settlements of Ayl and Fardakh which were already well incorporated into the infrastructural network of the Petra region in the pre-Roman periods (which, according to Abudanh et al, it did if accepting Graf's central road as the course of the *via nova*). Finally, Graf's central road does not bypass the numerous natural water sources (i. e. particularly springs) which are easily accessed when following his eastern route.

While the fact that only the c*entral* route corresponds to the 18 MP on the Peutinger Map needs to be further addressed, Abudanh et al. express convinging archaeological arguments to prefer Graf's eastern route as the course of the *via nova Traiana*.

To date, the northern course the *via nova* from Petra has only been studied by Fiema, who followed the road from ad-Dosaq through Rashadiyeh to Tuwaneh.[1139] According to the *Tabula Peutingeriana*, the next station from Petra in northern direction is Negla ('Ain Nejel), sitauted 22 MP (ca. 33 km) away.[1140] 'Ain Nejel lies in a flat valley and is described as an artificially widened spring which was probably walled in Roman times. On the eastern and western slopes directly above the spring are extensive structural remains.[1141] Glueck mentions that the Turkish road, now the modern course of the King's Highway, partly overbuilt the original Roman road.[1142] Following the course of Wadi Nejel southwest from 'Ain Nejel to Petra, Brünnow and von Domaszewksi mention a well-preserved section of the *via nova* in the wadi bed (FIG. 201).[1143] Continuing along the wadi in a south-southwestern direction there is another preserved section of the road with two possible watchtowers.[1144] Further along the wadi to the south, Brünnow and von Domaszewski describe five additional structures that they identify as watchtowers until the presumed *via nova* reaches a width between 5 and 6 m shortly before reaching the outcrop of Hor el-His.[1145] Immediately

1132 Abudanh 2006, 544; Graf 1995a, 252. Beit Qadim measures 11 × 13 m, Qasr Tuliyah 75 × 100 m and Khirbet al-Sa'ud 11 × 20 m. Surface pottery found at all sites range from the Iron Age, Nabataean and Byzantine periods. However, the Roman period was predominant.

1133 Abudanh 2006, 111–112; Graf 1995a, 252. Abudanh's 'Sadaqa road' represents the southern part of Graf's central route from Saddaqa.

1134 Graf 1995a, 252.

1135 Graf 1995a, 252.

1136 Abudanh 2006, 544; Graf 1995a, 252.

1137 Abudanh et al. 2016, 407–410.

1138 However, similar disadvantageous natural landscape conditions were also reported between Ayl and Fardakh along Graf's *easterm* route.

1139 Fiema 1997 and 1993.

1140 Glueck 1934, 76; Glueck 1935, 83, 96.

1141 Glueck 1934, 76; Brünnow – von Domaszewski 1904, 98 with references.

1142 Glueck 1935, 83. Modern road construction in remote desert areas poses a great threat to remains of ancient roads, as modern planners commonly follow the course of pre-existing and potential ancient roads (Riemer – Förster 2013, 49). It may thus be possible that Glueck's assumption that the modern King's Highway roughly follows the Roman road is correct. However, without direct archaeological evidence, this remains hypothetical.

1143 The presumed course of the Petra/Wadi Musa-'Ain Nejel road was georeferenced and re-mapped by the author on the basis of Brünnow – von Domaszewski 1904, 100–101 and Brünnow – von Domaszewski 1904, Karte der Südlichen Belkâ & Edom, Blatt 3 as well as satellite imagery.

1144 Brünnow – von Domaszewski 1904, 100.

1145 Brünnow – von Domaszewski 1904, 101.

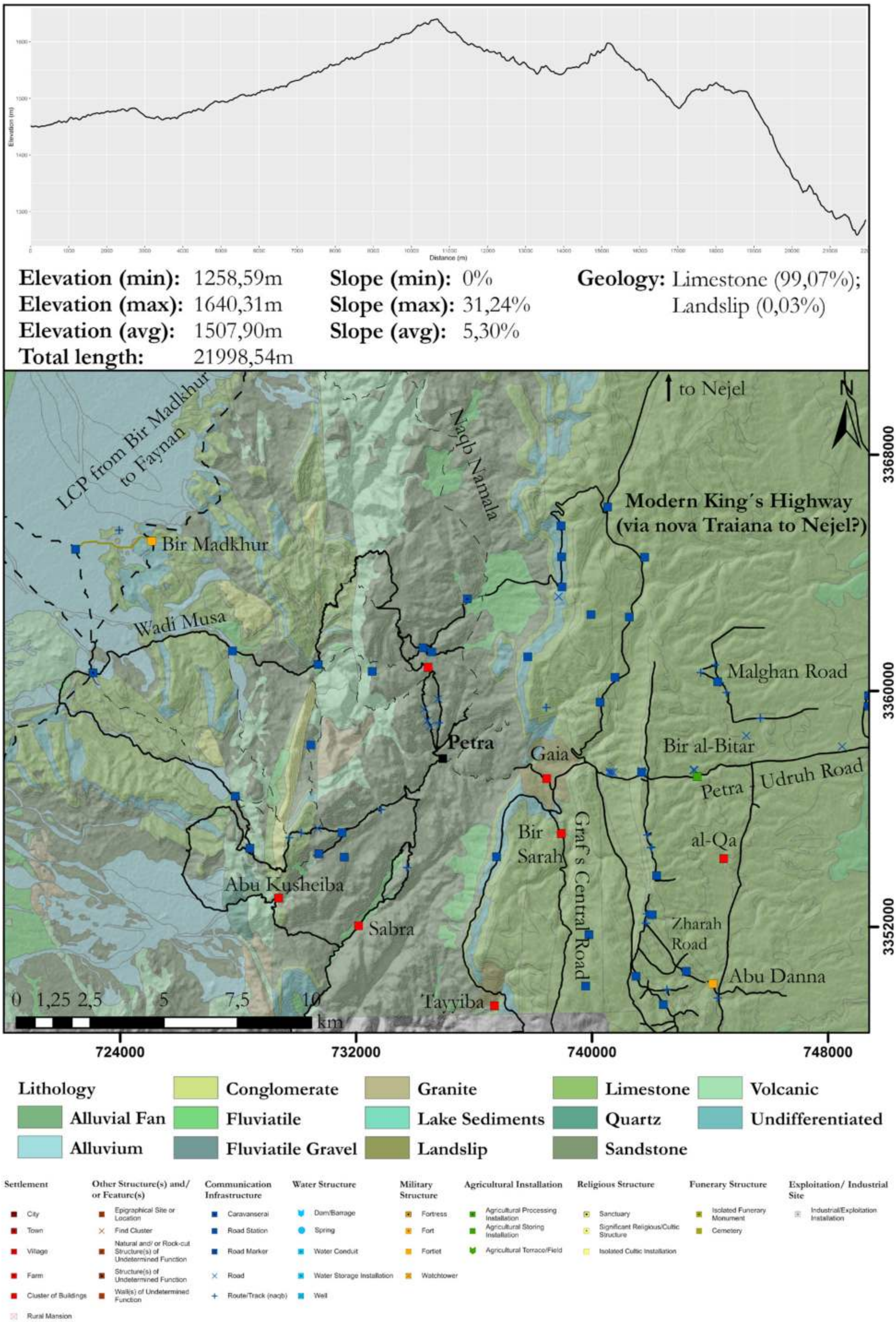


FIG. 201 Potential northern course of the Darb ar-Rasif and/or *via nova Traiana* from Petra/Wadi Musa to Nejel based on the descriptions of Brünnow and von Domaszewski 1904.

below Hor el-His, they documented more structural remains.[1146] Further south the road was supposedly well preserved and they recorded a structure that they identify as an 'intermediary fort.'[1147] Passing another structure approximately at the same level as 'Ain Dibidbi further west, the wadi turns southeast entering a steep canyon. The wadi curves through this gorge continuing again south and exits the canyon meeting the Wadi al-Arga.[1148] A larger structure, again a presumed 'intermediary fort,' was documented where the two wadis meet. Here, one anepigraphic milestone was discovered (9 MP from Petra).[1149] Only "five minutes further southwest," the road reaches the spring of 'Ain al-Mikwan, where two groups of milestones were recorded (8 MP from Petra) in addition to a small structure. The first group of milestones was still buried under soil and therefore not further distinguished. One of the other group, however, showed traces of an inscription in cursive lettering.[1150] From here the road continues further along the Wadi al-Arga until it discharges into the Wadi al-Mahzul passing another structure and then descending along a ridge just west of the Wadi al-Mahzul further south. At this point the road is 5 m wide.[1151] Further along this course, fragments of milestone(s) were recorded (7 MP from Petra).[1152] From here the road then continues further southwest and after passing at least three structures, it finally converges with the Wadi Musa.[1153] Due to the abundance of archaeological material discovered by Brünnow and von Domaszewski, it is likely that this road was the former course of the *via nova Traiana* leading north to 'Ain Nejel (Negla) from the immediate Petra area.

Although not directly related to the *via nova Traiana*, but nevertheless important in the context of potential infrastructural changes in the Petraean hinterland after the Roman annexation in 106 AD, is the scholarly debate on a potential Roman-Byzantine *via militaris* that was arguably constructed along the eastern Arabian frontier.

Specific scholarly debates concerned the presumed course of the *via militaris* between Ziza near Amman and Udruh in the Petra region.[1154] It was assumed that the possible military road connected various military structures, most notably Qasr Bshir, Lejjun, Jurf al-Darawish and Da' janiyeh as well as civilian settlements along the outer *limes Arabicus*.[1155] This is based on anepigraphic milestones discovered at various forts along the c. 150 km long stretch from Amman to Udruh, therefore arguably giving evidence for an outer eastern *via militaris* running mostly parallel to the *via nova Traiana*.[1156] Although the milestones give no precise date, the related archaeological sites mostly date to the late 3rd and 4th centuries AD.[1157] There is no archaeological evidence that confirms the existence of the road itself and it is therefore assumed that, if it existed, it was unpaved.[1158] Prior to the results of Parker's *Limes Arabicus Project* from 1980 to 1989 and the investigations of Graf and others between 1994 and 1995, the argument for a *via militaris* was entirely based on related sites.[1159] Graf therefore surveyed key areas associated with the possible road starting from the Madaba plains in northern Jordan and ending in the Ma'an/Udruh region in the south.[1160] Their specific results within the Petraean hinterland have shown that the archaeological evidence for a possible *via militaris* is based merely on two isolated milestones found between Jarba and Udruh approx. 20 km east of Petra.[1161] As it is generally agreed that the *via nova Traiana* did not pass through Udruh, it was argued

1146 Brünnow – von Domaszewski 1904, 101.
1147 Brünnow – von Domaszewski 1904, 101.
1148 Brünnow – von Domaszewski 1904, 101.
1149 Thomsen 1917, 56, No. 169; Brünnow – von Domaszewski 1904, 101 with references.
1150 Thomsen 1917, 56, No. 170; Brünnow – von Domaszewski 1904, 101 with references.
1151 Brünnow – von Domaszewski 1904, 101.
1152 Thomsen 1917, 56, No. 171; Brünnow – von Domaszewski 1904, 101–102 with references. Three fragments of a potential milestone were found. However, not only was the reading difficult, it was also unclear whether the fragments belonged to a single milestone. According to Thomsen, fragment (a) reads "[…] *n* […] *Iulianum* […] [A]*ntoniniana* […]", fragment (b) "[…] *[proco]ns(ul) per* […] *[Alli?]um Sec[undum]* […]" and the cursive fragment (c) (CIL III 14149[8]) "[…] *ne.pos* […] *erur* […] *X* […]." Brünnow – von Domaszewski also consider it as a potential fragment of an altar.
1153 Brünnow – von Domaszewski 1904, 102.
1154 Findlater 2002, 140–141; Graf 1997, 271.
1155 Findlater 2002, 138, 140; Graf 1997, 271; Parker 1986, 39; Brünnow – von Domaszewski 1904, 1–103. Findlater raises doubts for the identification of Jurf al-Darawish as a military structure: *"However, it must be pointed out that there are no obvious military features apparent in its layout. The thickness of walls noted by Brünnow and v. Domaszewski (1905: 14) at 1.7 m which may suggest a military feature, were considered by DAS to be a confusion with internal features. Thus, the 'fort' at Jurf ed-Darwish may correspond to a courtyard layout as the function can be interpreted in many ways. In fact, the only association with a military feature is its proximity to a 'military road' that supposedly led to the fort of Dajaniya and then to the fortress/town of Udruh*" (Findlater 2002, 140).
1156 Parker 2006; Findlater 2002, 140; Graf 1997, 272; Parker 1986, 126; Isaac 1990, 228; Isaac 1984, 191.
1157 Ynnilä 2013, 253; Parker 2006; Graf 1997.
1158 Findlater 2002, 140; Graf 1997, 272.
1159 Parker 2006; Graf 1997, 273–274. Graf 1997, 272 specifies the road-related sites to be "[…] *forts, mansiones, caravanserais, guardposts, and signal stations* […]."
1160 Graf 1997, 274–280.
1161 Findlater 2002, 140; Graf 1997, 279.

that the documented milestones most likely marked a secondary road from Jarba to the fort at Khirbet Arja and from there connected with the *via nova*. However, there is no evidence to suggest that this road necessarily served military purposes.[1162]

As Parker's *Limes Arabicus Survey* did not consider the forts at Tell Abara and Abu Danna along the section of the *via nova Traiana* between Udruh and Basta, "[...] *an external fortified defensive north-south line between Da'jāniyeh and Ma'ān*" was proposed.[1163] Including the Roman-Byzantine fort at Jabal Tahuna, Graf claims that the actual cluster of forts is along a southeastern axis between Udruh and Ma'an with several large reservoirs and associated large building remains that suggest an extensive agricultural exploitation of the area. He claims that the agricultural zone was therefore extended further into the eastern desert during the Byzantine period.[1164] Whether the other investigated areas in the Madaba plains, the Kerak or Shawbak regions support the idea of associating the various military structures along the eastern frontier with agricultural installations requires further research, the argument for a militarized zone and therefore the existence of a *via militaris* is questionable.[1165] The few milestones found along the presumed course do not allow a reconstruction of a continuous road between Ziza and the Udruh region and the surveyed military structures are irregularly distributed between 10 and 35 km from each other, which does not speak for a rigidly structured defensive line against potential enemy intrusions.[1166] Nevertheless, based on a reevaluation of the 16th century AD fort of Qal'at Unaiza south of the Wadi al-Hasa/Jurf al-Darawish area that revealed a previous Roman/Byzantine phase, Findlater argues that there was a formal Roman route east of the *via nova Traiana*. However, this road is not associated with Da' janiyeh or Udruh and therefore cannot be characterized as a *via militaris*.[1167]

While it was first understood that the eastern frontier of the *limes Arabicus* was a militarized frontier zone to counter raids of nomadic tribes from the eastern deserts and a *via militaris* was constructed to facilitate troop movements along the frontier, Graf suggests to explore other possibilities such as economic or commercial incentives.[1168] The apparent tendency to further exploit marginal territories agriculturally by establishing estates in frontier zones during the Late Roman and Byzantine periods may explain the construction of military structures along the eastern Arabian border.[1169] This association of military structures with larger issues concerning water management and agricultural exploitation was also observed in the vicinity of Admatha.[1170] As the discussed military structures may have served various functions and the evidence does not support a continuous *via militaris*, current research avoids a too militaristic interpretation of the late Roman/Byzantine Arabian frontier.[1171]

Routes/Tracks (Naqb)

A. Smith documented numerous passes along wadi courses leading from the Petra area down to the Wadi Arabah.[1172] These routes/tracks (naqb) follow the natural topography of the area and meet with the larger north-south running roads in the Arabah and eventually lead further west through the Negev desert to the ancient port of Gaza. In contrast to the roads in the eastern uplands, the discussed routes/tracks (naqb) rarely show constructed sections and only in strategic locations or in parts where the natural conditions necessitated it.[1173] Although not paved, the *naqb* could be stabilized by route-side dry stone walls delineating

1162 Graf 1997, 279.
1163 Graf 1997, 270; Fiema 1995, 263–266. Findlater 2002, 140 also states that the DAS recorded two further sites 5 km south of Jurf al-Darawish.
1164 Graf 1997, 279–280.
1165 A general eastern shift of military structures and civilian settlements within the eastern provinces can be observed since the Diocletianic period and is not restricted to Arabia (Graf 1997, 280; MacMullen 1963, 121–123).
1166 Graf 1997, 280.
1167 Findlater 2002, 140–141.
1168 Graf 1997, 280; Parker 1989, 499.
1169 Graf 1997, 280–281; Findlater 2002, 141, 143–144; Delmaire 1989, 679–682; Kehoe 1988, 200–221; Crawford 1976, 54. For example, Byzantine sources often refer to *Saltus Geraiticus* in the Negev where the *equites Thamudeni Illyricani* and *equites promoti Illyricani* were garrisoned (Graf 1997, 281; Tsafrir et al. 1994, 132–133 and the *Notitia Dignitatum:* Not. Dign. Or. 34, 19 and 22). *Salton Hieratikon* is also mentioned by Byzantine geographers in the vicinity of Petra, which is suspected to be Khirbet Megdes in the forests of the Jabal Shara, which "[...] *may be a sacred area in the immediate vicinity of Petra once associated with the royal dynasty of Nabataea before being acquired by Rome*" (Graf 1997, 281). More on the suspected temple estate of Salton Hieratikon, see George of Cyprus, *Descriptio orbis Romani* and Honigmann 1939, 43–44. Findlater 2002, 141 and 144 agrees that such military structures were more associated with guarenteeing water supply to the area. He also proposes a possible defensive structure for the presumed imperial estate identified by DAS at Khirbet al-Bir (Findlater 2002, 143–144).
1170 Findlater 2002, 141; Gregory – Kennedy 1985, 295–301.
1171 Findlater 2002, 138, 143; Graf 1997, 281.
1172 Smith 2010, 95–103. See also Ynnilä 2013, 253.
1173 Ynnilä 2013, 253.

FIG. 202 Route-side wall of Naqb ad-Dab'e leading to Sabra. View to the southwest.

the course of the route as, for example, can be nicely observed along Naqb ad-Dab'e (FIG. 202).[1174] These smaller routes/tracks were part of a local or regional communication network as well as the well-known Petra–Gaza road, which was centrally important for Nabataean supraregional trade and has been a major focus of previous research.[1175] In addition to the more general course of the Petra–Gaza road, recent studies were concerned with the individual routes and tracks that connected Petra with its western hinterland.[1176] To date, C. Ben David's listing of the major passes from Petra to the Wadi Arabah is the most recent contribution to the infrastructural connectivity of Petra's western hinterland by smaller routes and tracks. Some are part of the larger network that connected Petra with Mediterranean trade.[1177]

When researching these routes, their dependency on the difficult natural landscape conditions becomes apparent. Petra's extreme physical landscape strongly affects the distribution of archaeological sites and impacts the nature of archaeological features. This can be best exemplified with the various routes/tracks leading from Petra to the Wadi Arabah and descending very severe slopes and difficult geological formations.[1178] The western border of the 'central plateau' (cf. chapter 1) highlights this observation particularly well. Starting from the Jabal Harun area and continuing further north, a strikingly dark strip of volcanic stone coincides with descending slopes of 45 % and more. Not only does the topography pose natural limitations for traversing across this area, the volcanic stone brings great challenges as well. This vol-

1174 However, the FJHP opened two small soundings at the upper beginning of Naqb ar-Ruba'i revealing a cobblestone bedding of the route (Ynnilä 2013, 254). Further west, on the way to the Wadi Arabah, a small stretch of Naqb ar-Ruba'i was paved with irregularly formed limestone slabs as well (Ynnilä 2013, 256 and Lindner 2003a, 60–61, fig. 10).

1175 Erickson-Gini – Israel 2013; Ben David 2013; Ben David 2012.

1176 Ben David 2013; Ben David 2012, 21–22; Ynnilä 2013.

1177 Ben David 2013, 273–277.

1178 Kennedy 2016a, 144–145.

canic *al-Somrah* with its sharp and thin layers make it extremely difficult – and in parts dangerous – to cross even on foot (cf. above).[1179] Donkeys and mules can walk the al-Somrah, but only with great difficulty. For camels and their soft feet, it is impossible. Such observations of natural landscape conditions must be considered when discussing trade routes in the Petra area as they greatly impact the nature and functionality of the discussed routes.

Expanding on the work of Ben David and others, unless otherwise noted, the author walked and mapped all major passes connecting Petra with its western hinterland in order to trace the exact course of the routes and to evaluate their significance for the infrastructural connectivity of the Petra region (cf. FIG. 180).[1180] By such field-based landscape archaeological analysis, it was possible to distinguish two route classes with different qualities (see below). The following description of the routes is structured geographically, starting with those leading south-southwest from Petra and descending to the Wadi Arabah. From there, the descriptions continue northeast and gradually ascend the slopes back up to the central plateau, discussing the routes leading to Petra from the north and east as well.

Petra's Southern Access via the as-Sto'e and al-Farasha Plain – The Northern and Southern as-Sto'e Routes

There are numerous ways to leave the urban limits of Petra and head south-southwest across the as-Sto'e plain and to the al-Farasha area south of Jabal Harun. The most straightforward route is the modern way, which is referred to as the 'northern as-Sto'e route' crossing Wadi Kharubeh along the southern skirts of Umm al-Biyara and the presumed religious structure on the hilltop of Ras Hamra (FIG. 203).[1181] Further south and already ascending moderate slopes to the northern as-Sto'e plain, there is evidence of approximately 2–4 m wide rock-cut roads (FIG. 204) similar to those observed by the Petra Routes Project (PRP) in Wadi al-Mu'aysirah East and Wadi al-Mu'aysirah West (see below).[1182]After crossing through the region of al-Haie, this northern as-Sto'e route reaches Ras Suleiman where a southern route branches off. This 'southern as-Sto'e route' continues south along the southern part of the as-Sto'e and al-Farasha plains. Just south of Ras Suleiman it passes the small *triclinium* complex of FJHP Site No. Ext063, some water-related structures, two small cemeteries (concentration of shaft graves) as well as the important sanctuary of Jabal Numayr before passing Ras Sabra and eventually reaching Ras ad-Dab'e.[1183] The southern as-Sto'e route has a total length of 4,17 km, follows a comfortable average slope value of 6,99 % and to 73,73 % crosses sandstone, thus offering one of the best walking conditions in the region (FIG. 205).[1184]

From Ras Suleiman, the northern as-Sto'e route continues westwards along the Wadi al-Waqit and passes the small Isis sanctuary on the way to Jabal Harun (*Darb an-Nabi Harun*). It also passes at least three isolated funerary monuments, some water-related structures and several structures of undetermined function before the route forks at the southeastern foot of Jabal Harun. One branch of the northern as-Sto'e route heads southwestward towards Naqb Saqqara (see below). The other continues west-northwestwards to Ras al-Ghirbe and the access up to Jabal Harun. At this intersection, FJHP Site No. 128 has been identified as a possible farm with a presumed watchtower (FJHP Site No. S132). However, FJHP Site No. 128 may also be interpreted as a possible route station along the northern as-Sto'e route.[1185] In either case, the entire stretch of the route is under good visible control from possible military structures in the area, most notably FJHP Site No. S132 and

1179 Kennedy 2016a, 141–142. Again, note von Oppenheim's description of leather 'camel shoes' when crossing Jordan's northeastern basalt desert (von Oppenheim 1899, 219).

1180 In total, 27 of the described routes/tracks (naqb) were walked by the author. All routes were mapped with a hand-held GPS device with a 3 m precision.

1181 Cf. Parcak – Tuttle 2016 and Hübner 2002. Ynnilä 2013, 258 discusses the good possibility that the modern track of the northern as-Sto'e route may well have been used in antiquity as well.

1182 Berenfeld et al. 2016, 85–87; Ynnilä 2013, 258–259; Ben David 2007, 103–104; Hertell 2002. At the crossing of Wadi al-Waqit, there are small square depressions carved into the sandstone rock surface immediately next to the road. While it has been argued that such depressions may have once held torches or poles, Ynnilä 2013, 258 proposes that they may have been slots for "[…] *post-holes for a wooden turnpike or for another structure to control traffic and close the road when needed.*"

1183 In order to reach Sabra from Petra, Zayadine 1992, 226 mentions three routes: The first route basically follows the course of the northern as-Sto'e route. The second is mostly equivalent to the southern as-Sto'e route. Zayadine's third route apparently left Bir Huweimel via Ras Suleiman and then followed Wadi Maqtal ad-Dikh until Ras al-Bitahi. The latter route could not be confirmed in the field and therefore was not mapped.

1184 Ynnilä 2013, 257 also states that sandstone formations are good for pedestrian travel.

1185 Kouki et al. 2013a, 235–237; Silvonen et al. 2013, 388: The identification of FJHP Site No. S128 is based on a *mortarium* found on-site as well as various agricultural fields and barrages in the al-Farasha region indicating local food production at the site.

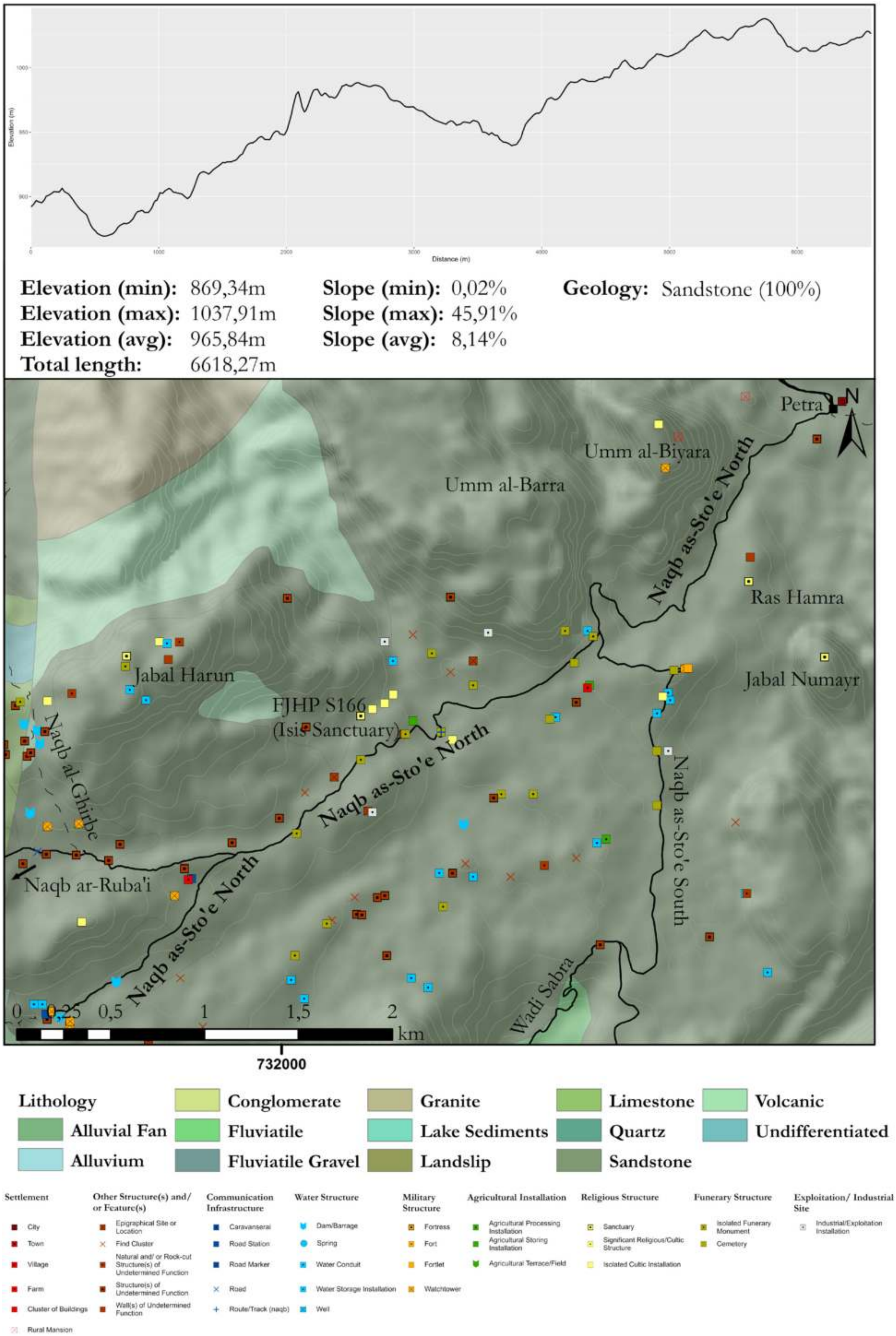


FIG. 203 The course of the northern as-Sto'e route south of Petra with elevation profile and the covered geological formations (in %).

FIG. 204 Rock-cut road and associated *nephesh* leading from the northern as-Sto'e route northeastwards to Petra. Ras Hamra in the background.

PHSP Site 016-ST026 at Ras Suleiman. Although the maximal slope value of the northern as-Sto'e route lies at 45,91 %, at a total length of 6,62 km it follows an average slope value of 8,14 % which is easily manageable. The route runs along sandstone, which is one of the best geological formations for traversing through the region.[1186]

The Western Descent to the Wadi Arabah via Naqb ar-Ruba'i and Wadi Jawf Ahmar/ Umm Qamar

Following the northwestern branch of the northern as-Sto'e route to the foothills of Jabal Harun at over 1100 m a.s.l., the most straightforward way to the Wadi Arabah is either to continue north down Naqb al-Ghirbe (see below) or to head west down Naqb ar-Ruba'i, before continuing further via Wadi Jawf Ahmar and/or the Umm Qamar pass (FIG. 206).[1187] The FJHP has identified and documented this ancient path as FJHP Site No. S051.[1188] The site is a 450 m long wall following the Wadi al-Mahatta to the saddle of al-Manatir where it meets Naqb ar-Rubai'i before it descends to the Wadi Arabah.[1189] At al-Manatir, FJHP Site No. S095 gives evidence to a 485 m long stretch of the east-west running path with a 160 m long wall showing the course of the route. Building remains adjacent to the route date to the Nabataean, Roman and Byzantine periods.[1190] Passing al-Manatir further westwards and instead of continuing the steep slopes of Naqb Mistalgile (see below) in western direction,

1186 The FJHP documented other paths in the as-Sto'e and al-Farasha region such as the 'Darb al-Magraba,' or 'Naqb al-Manatir,' but these were probably of local use only (Ynnilä 2013, 262–263).

1187 Contrary to Ben David 2007, 106 who states that Naqb ar-Ruba'i "[…] *does not lead west and definitely not northwest toward 'Avdat and Gaza.*"

1188 Ynnilä 2013, 253–254, 256.

1189 Silvonen et al. 2013, 363; Ben David 2007, 104; Frösén et al. 2001, 389; Frösén et al. 2000, 418; Brünnow – von Domaszewski 1904, 427–428; Lindner 1992b; Zayadine 1992 and 1985.

1190 Silvonen et al. 2013, 377; Frösén et al. 2001, 389.

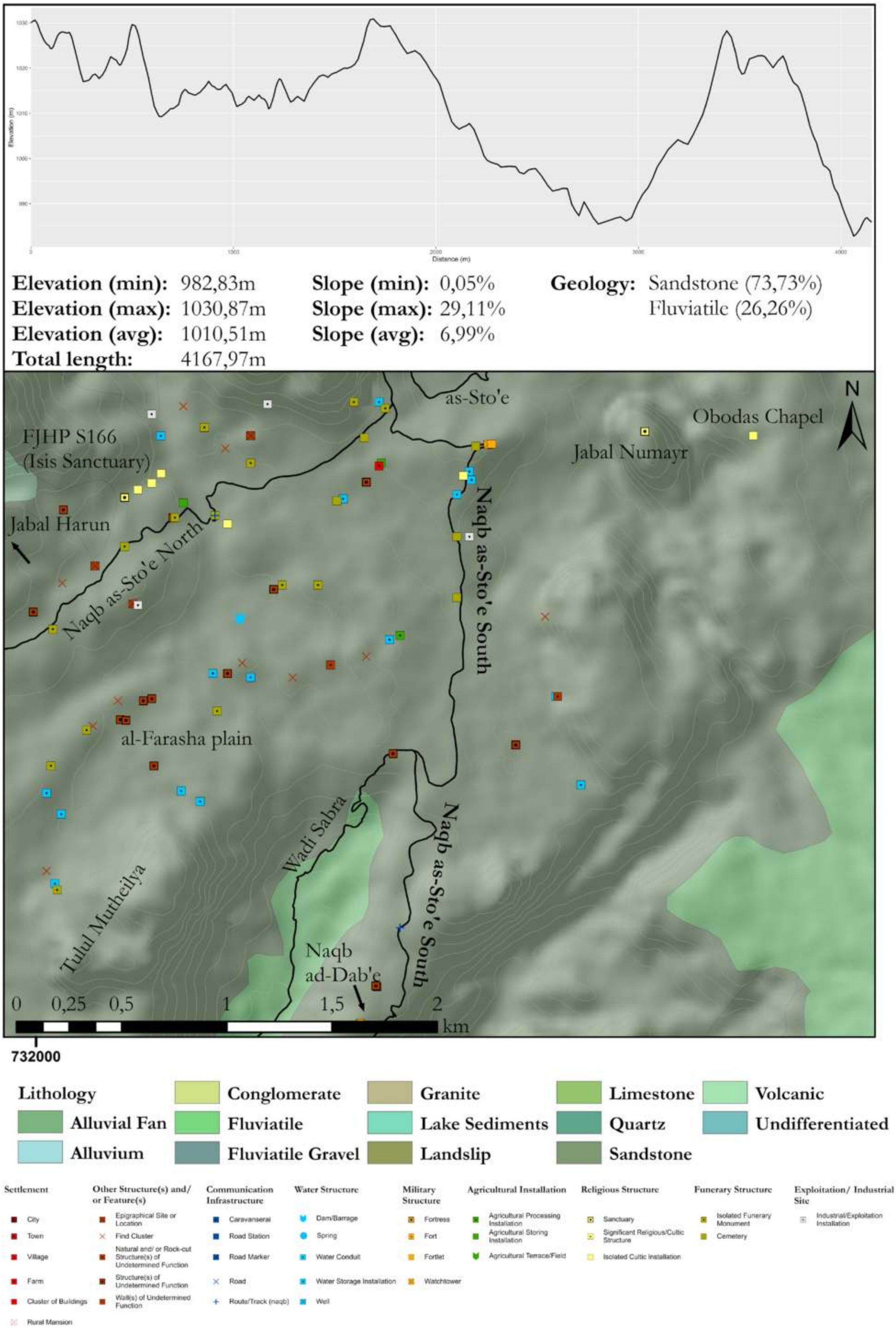


FIG. 205 The course of the southern as-Sto'e route south of Petra with elevation profile and the covered geological formations (in %).

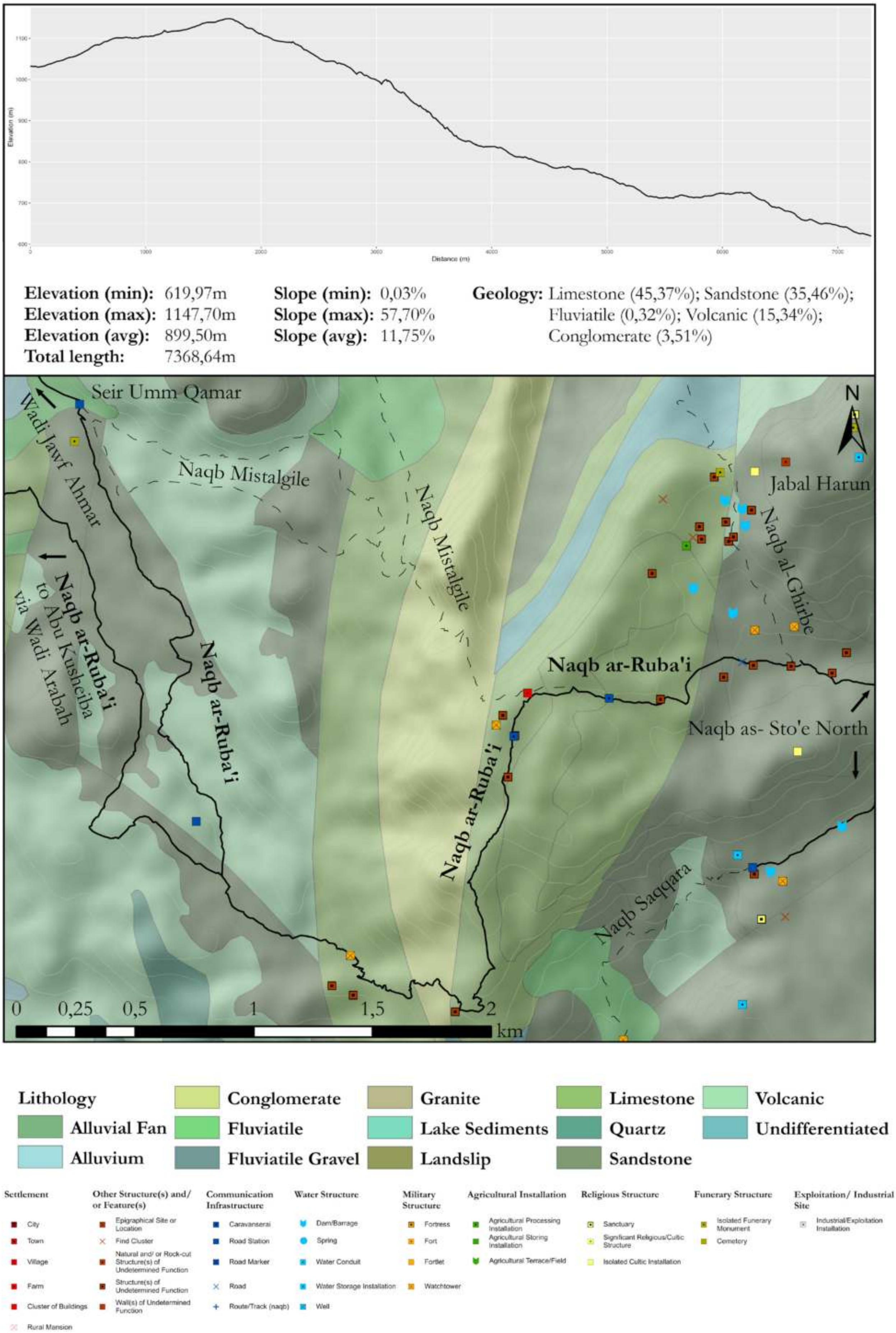


FIG. 206 The course of Naqb ar-Ruba'i with elevation profile and the covered geological formations (in %).

FIG. 207 View of Rujm Ruba'i.

Naqb ar-Ruba'i turns south at the presumed 1st–2nd century AD farm of FJHP Site No. S049. It passes the 1st–2nd century AD watchtower of Rujm ar-Ruba'i (FJHP Site No. S54, FIG. 207) and continues its southern course coming across at least two structures of undetermined function such as FJHP Site No. S56. Several smaller sites of undetermined function such as FJHP Site No. S53, S83 and S84 as well as the presumed cairn of FJHP Site No. S87 follow the course of the road as well.[1191] Naqb ar-Ruba'i was therefore in good visual contact to and from surrounding archaeological sites, which was possibly an important aspect in terms of security measures and potential taxation purposes.[1192] The route continues smoothly in a southern direction over a limestone formation until reaching yet another structure of undetermined function (FJHP Site No. Ext072) after approx. 1,6 km. This structure was already noticed by M. Lindner and may have been a small relay station (FIG. 208).[1193]

The route continues west-northwest, perfectly following the smooth transition from the limestone to the conglomerate formation for a few hundred meters. Running over limestone again, Naqb ar-Ruba'i crosses a functionally undetermined structure (FJHP Site No. Ext075). Continuing the route further, a very short and highly eroded section is paved by irregularly formed limestone boulders (FIG. 209). No secure dating can be suggested for the paving.[1194] According to the FJHP, another structure of undetermined function (FJHP Site No. Ext073) is located just 100 m northwest of FJHP Site No. Ext075. This structure is far more substantially built than FJHP Site No. Ext075 and is hidden from the

1191 Ynnilä 2013, 255. Based on their location along the road and proximity to larger sites, Ynnilä tentatively suggests that these smaller sites may have functioned as small look-out posts.

1192 Ynnilä 2013, 255.

1193 Ben David 2007, 104; Lindner 2003a, 64; Lindner et al. 2000, 542; Lindner 1989, 86. In addition to the surface pottery found by the FJHP ranging from the 1st century BC to the 1st century AD, Ben David noticed a Nabataean coin at FJHP Site No. Ext072 as well (personal communication C. Ben David, April 2015).

1194 Ynnilä 2013, 156; Lindner 2003a, 66–72. Up until this point, the course of Naqb ar-Ruba'i is also confirmed by Ben David 2013, 277; 2012, 21 and 2007, 102–106.

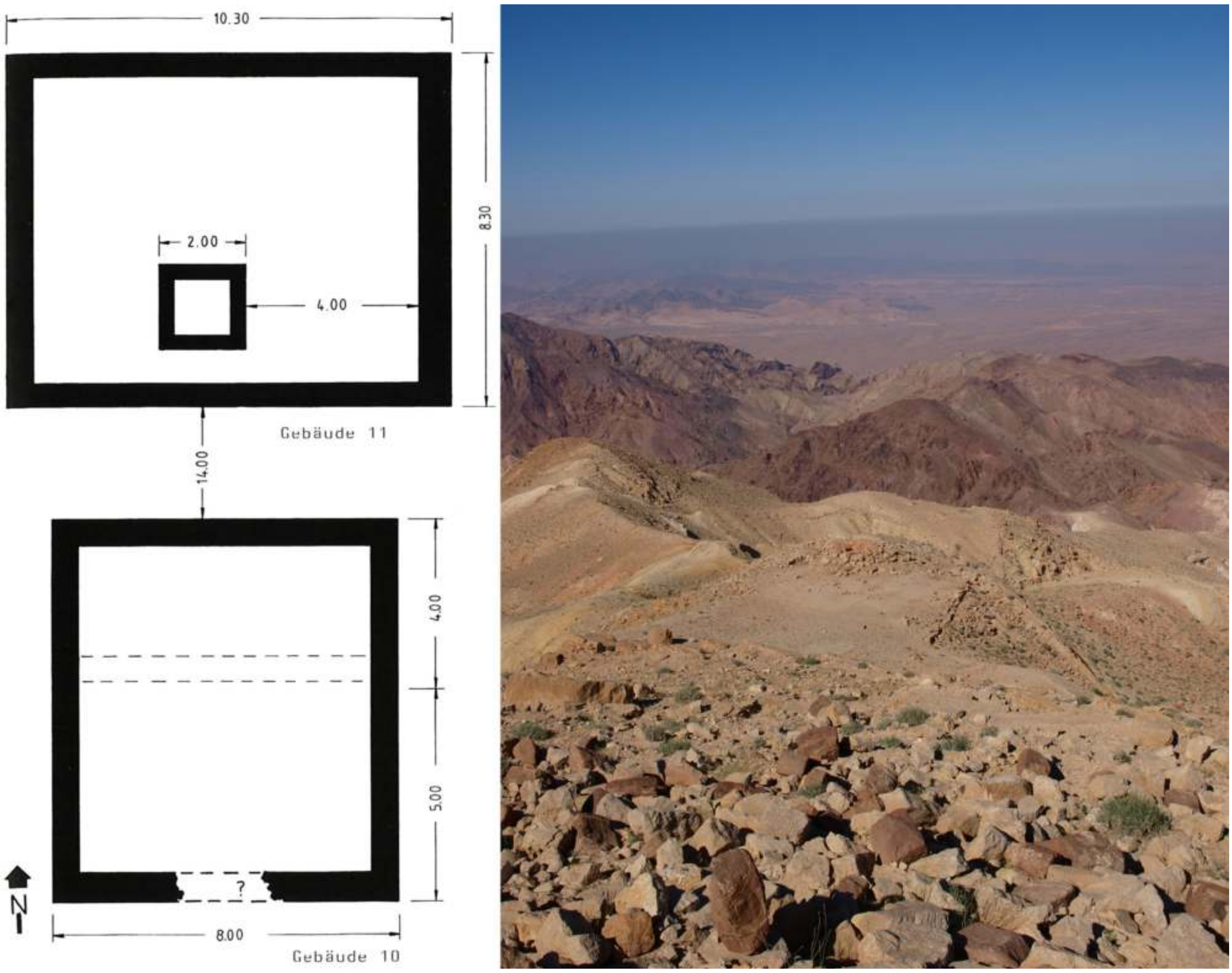


FIG. 208 FJHP Site No. Ext072 with site plan after Lindner 2003a, 71, Abb. 36.

course of the route.[1195] While the FJHP located the site immediately next to FJHP Site No. Ext075, the PHSP maps the site at least one kilometer further northwest along the course of Naqb ar-Ruba'i (cf. FIG. 206).[1196] The majority of surface pottery dates to the Late Roman period, but there is also evidence to suggest a late 1st to 2nd century AD date.[1197] The structure may be interpreted as a route station (FIG. 210).

From there, the route continues further downslope in northern direction through the volcanic al-Somrah for about two kilometers. Further along, Naqb ar-Ruba'i eventually leaves the al-Somrah again and returns to sandstone before it reaches the southern end of the Jawf Ahmar plain and the beginning of the Wadi Jawf Ahmar pass. From the Wadi al-Mahatta at the foothills of Jabal Harun at an elevation of 1147,70 m a. s. l., Naqb ar-Ruba'i has a total length of 7,37 km ending at 619,97 m a. s. l. (cf. FIG. 206). Although the maximal slope value reaches 57,70 %, the route follows an average slope value of 11,75 %, which is easily manageable. It also follows five different geological formations. The majority of the route follows limestone (45,37 %) and sandstone (35,46 %) – the best geological formations for travelling in the Petra region.[1198] Naqb ar-Ruba'i avoids the difficult al-Somrah when possible, but is forced to pass through it for about one kilometer (total coverage of 15,34 %). The sections passing through conglomerate (3,51 %) and fluviatile (0,32 %) formations are negligible. Importantly, the fact that it perfectly follows the transition between the conglomerate and limestone along its upper part, demonstrates how strongly the natural landscape conditions determined

1195 The PHSP recorded the structure as PHSP Site No. 086-ST078. Immediately south of the site, the PHSP also noticed some architectural fragments (PHSP Site No. 085) along the way.

1196 The author verified the position of the site in the field.

1197 Kouki et al. 2013a, 22; Smith 2010, 75.

1198 This is also confirmed by Zayadine 1992, 226 as well as the accounts of Sultan Baybar (Zayadine 1985). Jarvis 1940 reports that the naqb was passed by both camels and horses as well.

FIG. 209 Paved segment of Naqb ar-Ruba'i.

the course of Naqb ar-Ruba'i.[1199] Not only do the favorable environmental conditions and the abundance of archaeological sites along Naqb ar-Ruba'i attest the great significance of the route, it was still frequently used in later historical periods as well: In the 13th century AD Sultan Baybar travelled along Naqb ar-Ruab'i on his way from Cairo to Karak reaching Petra in only five days.[1200] Zayadine claims that the most direct way to Sinai from the Petra area is via Naqb ar-Ruba'i.[1201] The route was also travelled and described by various western travelers on their way from the southern Wadi Arabah to the Petra valley, attesting to its importance in the modern era as well.[1202]

Together with C. Ben David, the author attempted to survey a possible route from Naqb ar-Ruba'i to Abu Khusheiba (FIG. 211). Following Naqb ar-Ruba'i about 800 m down from the presumed road station of FJHP Site No. Ext073/PHSP Site No. 086-ST078 shortly before the route continues northwards through the al-Somrah, another route was followed that runs further northwestwards. It continues through the sandstone formation before it turns northwards after approx. 800 m. For about 1,7 km the route runs parallel to the main course of Naqb ar-Ruba'i before taking a sharp western turn after transitioning from the sandstone to a limestone formation. Keeping mainly to the limestone while briefly crossing through fluviatile and undifferentiated formations, the route continues for approx. 2 km before heading south to reach the alluvial plain of the Arabah after about 1,8 km. It crosses the alluvium for c. 2,5 km in a southwestern direction until Jabal Abu Khusheiba. After 2,3 km through Wadi Abu Khusheiba, the route reaches the ancient settlement of Abu Khusheiba. From there, Sabra can be reached via the southern route of Naqb ad-Beidab. Naqb Saqqara leads northeastwards back up to the al-Farasha plain at the foothills of Jabal Harun. Although not part of this 'Naqb ar-Ruba'i–Abu Khusheiba route,' the larger north-south running routes of the Arabah can be easily reached from Abu Khusheiba through Wadi Abu Khusheiba.

While no archaeological sites were noticed along the Naqb ar-Ruba'i–Abu Khusheiba route, parts of the route were characterized by small terraced tracks, similar to those observed along other ancient routes such as Naqb ad-Dab'e. The Naqb ar-Ruba'i–Abu Khusheiba route has a total length of 11,25 km starting at 782,16 m a. s. l. when leaving the main Naqb ar-Ruba'i course

1199 Many thanks are owed to C. Ben David for initially pointing this out.
1200 Ynnilä 2013, 253; Zayadine 1992, 225–226 and 1985, 162–167.
1201 Zayadine 1992, 225.
1202 See Ben David 2007, 102 for an exemplary list. The central significance of the route is also confirmed by previous archaeological research along the naqb (cf. e. g. Ben David 2013, 2012 and 2007; Ynnilä 2013; Lindner et al. 2000; Zayadine 1985).

FIG. 210 FJHP Site No. Ext073 (PHSP Site No. 086-ST078) along Naqb ar-Ruba'i.

and reaching its lowest elevation in the alluvium of the Arabah at 509,31 m a. s. l. (cf. FIG. 211). With an average slope value of 7,71 % the topographic conditions are easy to manage. In total, the route crosses seven different geological formations. With a coverage of 28,46 %, sandstone is the most represented formation, followed by alluvium (22,94 % coverage), which also offers reasonable walking conditions.

However, the main and most straightforward course to the Arabah from the al-Farasha plain via Naqb ar-Ruba'i does not follow this route to Abu Khusheiba, but continues northwestwards via Wadi Jawf Ahmar (FIG. 212).[1203] The end of Naqb ar-Ruba'i and the beginning of the Wadi Jawf Ahmar pass is marked by the small, but important road station site of Seir Umm Qamar (PHSP Site No. 115).[1204] Dating to the 1st century AD, the site consists of two rectangular structures built of irregularly formed sandstone boulders and at least two larger field walls presumably used for agricultural terracing. Small burial cairns (PHSP Site No. 164) are located on an outcrop immediately south of Seir Umm Qamar. Surface pottery suggests a rough date between the 1st century BC and 2nd century AD.[1205] In addition to Naqb ar-Ruba'i and Wadi Jawf Ahmar, the two western branches of Naqb Mistagile converge at Seir Umm Qamar as well (FIG. 213). Although the site is not large, it seems to have played a significant infrastructural role in the region.

From Seir Umm Qamar, the most straightforward way to head down to the Wadi Arabah is crossing the Jawf Ahmar alluvial plain in northwestern direction and continuing through the actual *wadi* Jawf Ahmar.[1206] The Wadi Jawf Ahmar pass crosses the plain for about 2 km until it intersects with the more direct, but also slightly more difficult, Umm Qamar pass to the important Nabataean-Roman road station of Khirbet as-Fay-

1203 Ben David 2013, 277. Ben David 2012, 21 confirms this assumption by referring to Colonel Newcomb's regional map from 1915 which shows a track leading from Naqb ar-Ruab'i to Khirbet as-Faysif (Levin et al. 2010, 7–8).

1204 Note Ben David's beginning of the Umm Qamar route: *"We found the head of the camel pass [of Umm Qamar] that leaves the wide road of Naqb ar-Ruba'i and descends north-west to the Qamar Valley"* (Ben David 2012, 21).

1205 The dating of both Seir Umm Qamar as well as the burials is based on surface pottery collected by the PHSP.

1206 Ben David 2012, 21 refers to this route as 'Naqb Umm Qamar.'

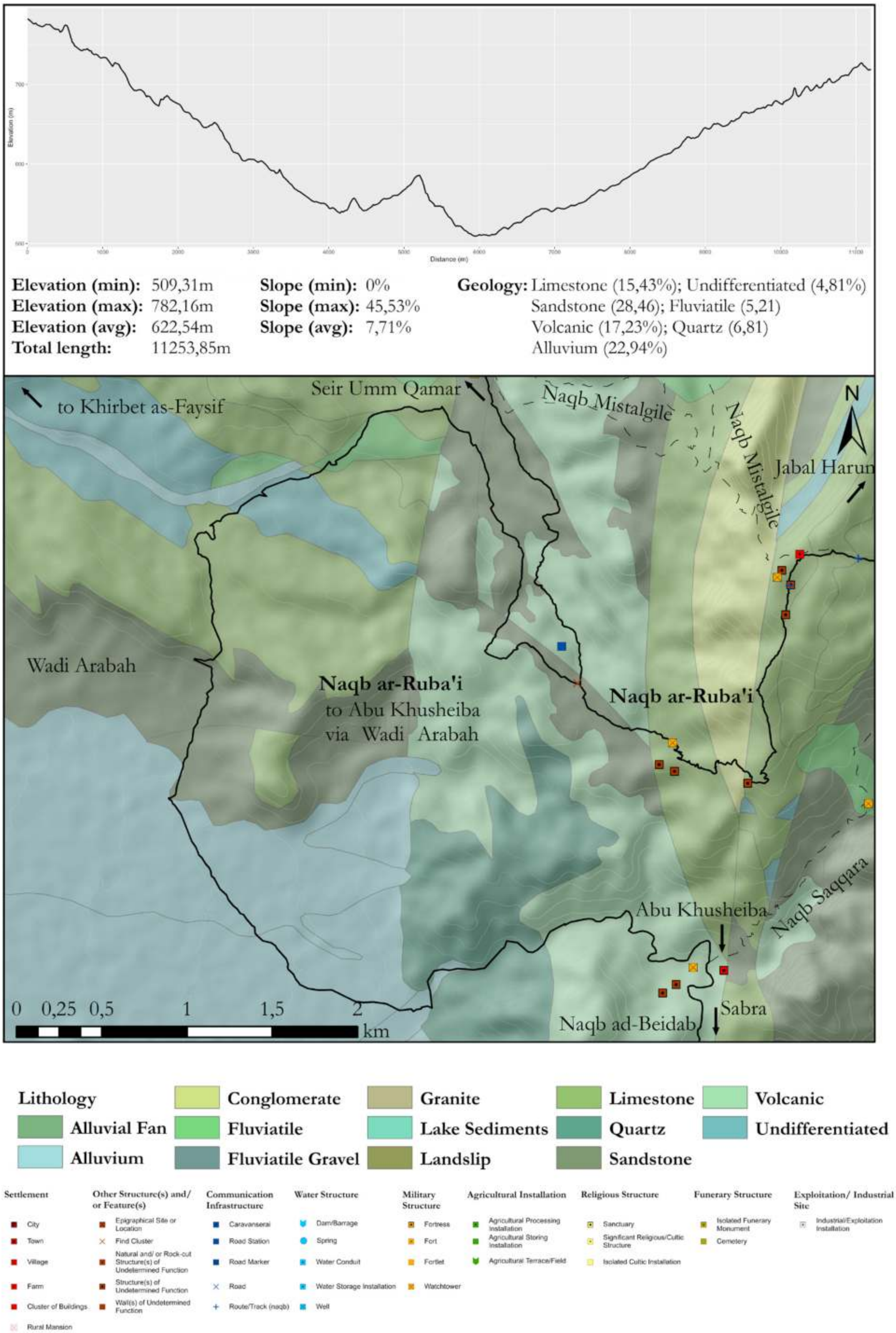


FIG. 211 Presumed route from Naqb ar-Ruba'i to Abu Khusheiba via Wadi Arabah with elevation profile and the covered geological formations (in %).

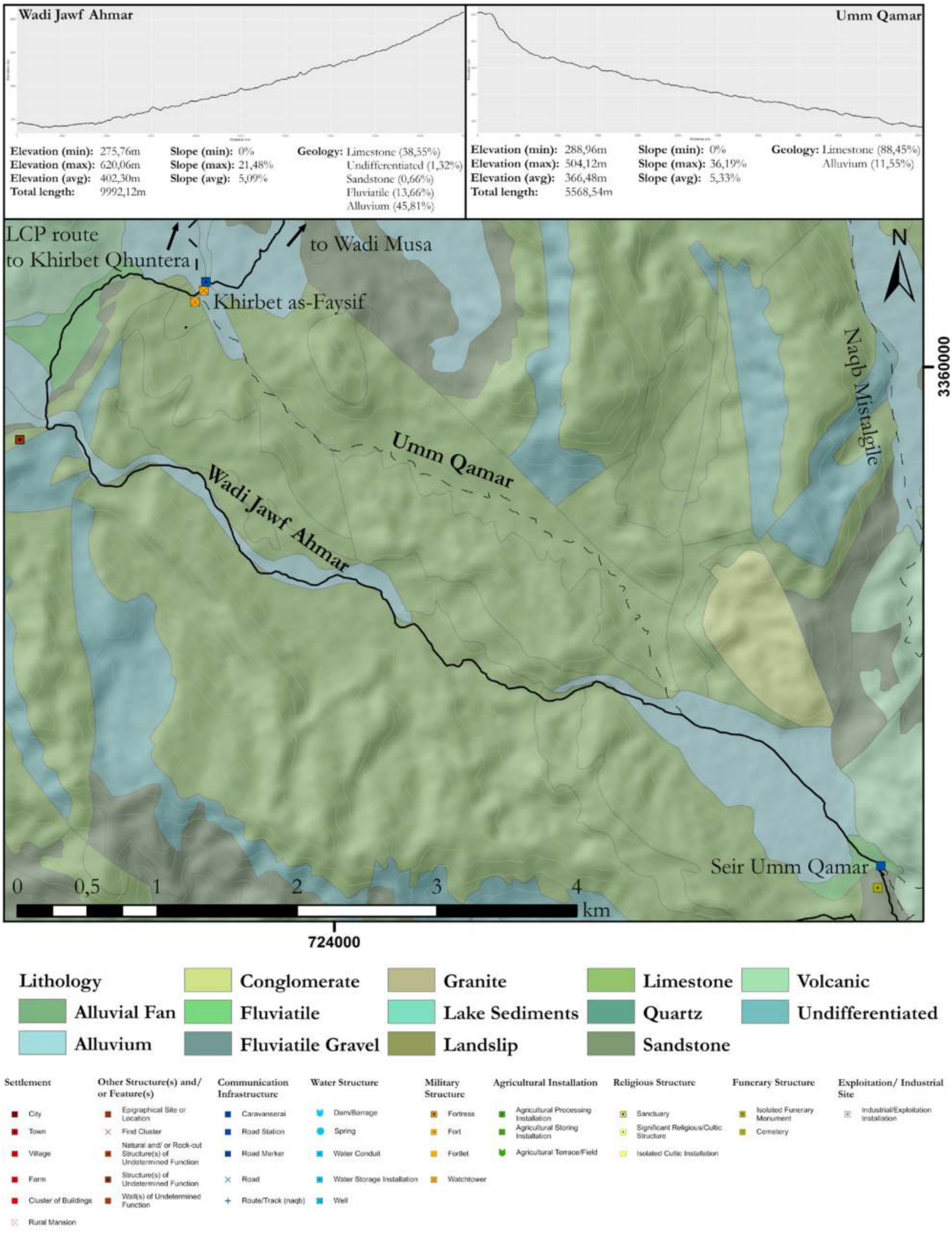


FIG. 212 The course of the Wadi Jawf Ahmar and Umm Qamar pass with elevation profile and the covered geological formations (in %).

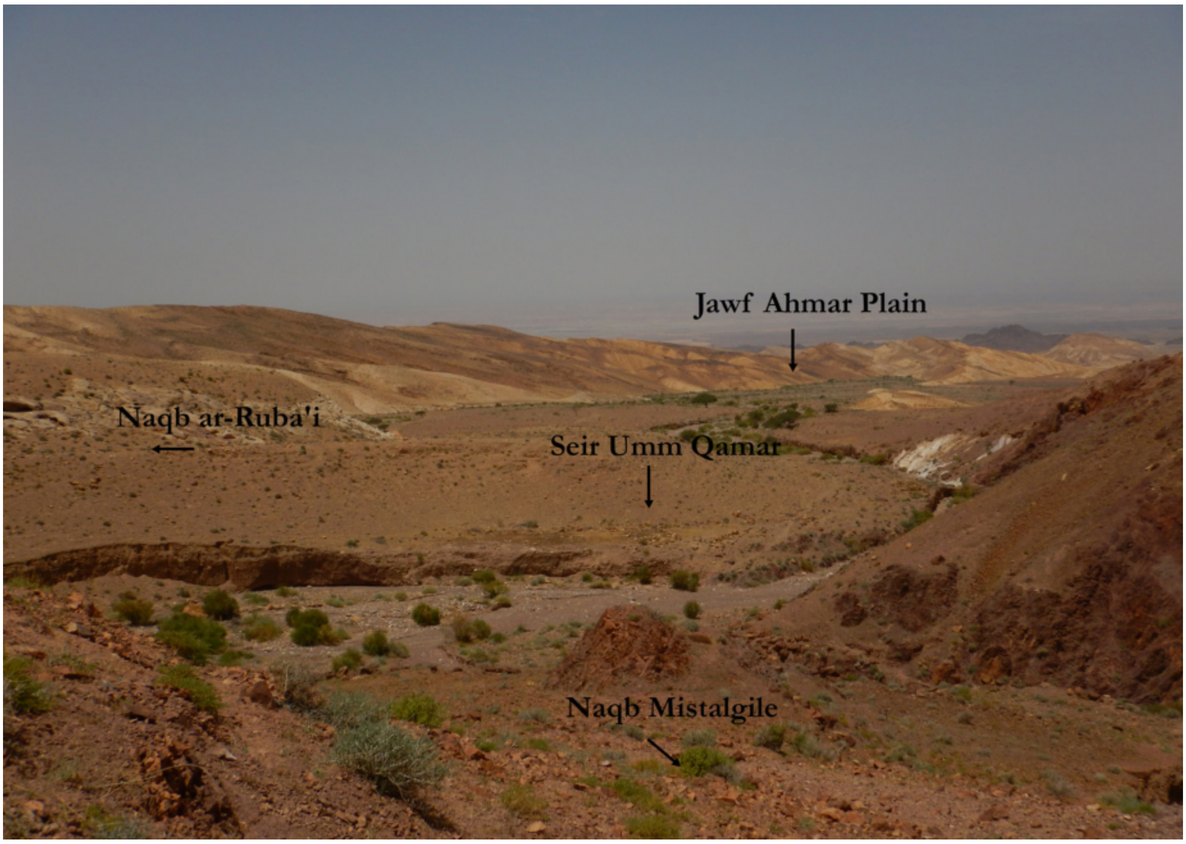


FIG. 213 Overview of the important road station of Seir Umm Qamar at the junction of Naqb ar-Ruba'i, the Wadi Jawf Ahmar pass and Naqb Mistalgile. Photo taken from Naqb Mistalgile. View to the west.

FIG. 214 The Umm Qamar pass seen from the Wadi Jawf Ahmar plain. View to the northwest.

sif in the Arabah.[1207] After the crossing with the Umm Qamar pass, one continues further along the Wadi Jawf Ahmar in northwestern direction for approximately six kilometers before reaching the alluvium of the open Arabah. Once in the open, the route continues northwards through alluvium and fluviatile until reaching the road station of Khirbet as-Faysif after approx. two kilometers. The Wadi Jawf Ahmar pass has a total length of nearly ten kilometers starting at a height of 620,06 m a. s. l. and reaching Khirbet as-Faysif at 275,76 m a. s. l.. Although the maximum slope value is 21,48 %, the pass comfortably follows an average slope value of 5,09 %. It also follows one of the most convenient geological formations for traversing through the region: 45,81 % of the pass is through alluvial plains and 38,55 % through limestone. In terms of the topographical and geological conditions, the most convenient way down from the al-Farasha plain to the Wadi Arabah – more specifically to Khirbet as-Faysif –, is therefore via Naqb ar-Ruba'i and the Wadi Jawf Ahmar pass.

Although it is more difficult to pass the route with camels than by donkey or on foot, the Umm Qamar pass offers an even more direct way to Khirbet as-Faysif from its intersection with the Wadi Jawf Ahmar pass (cf. FIGS. 212 and 214).[1208] At a total length of 5,57 km the Umm Qamar pass heads northwest towards Khirbet as-Faysif from the Jawf Ahmar plain through Wadi Umm Qamar. The average slope value lies at 5,33 % and it exclusively crosses limestone (88,45 % coverage) until it reaches the open alluvial plain of the Arabah (11,55 % coverage). While the wadi is often very narrow and therefore difficult for large animal traffic, the pass is unproblematic for smaller caravans of mules or donkeys.

The way via Naqb ar-Ruba'i, Wadi Jawf Ahmar and/or the Umm Qamar pass to Khirbet as-Faysif is one of the most significant routes in the Petra region.[1209] It is part of the Petra–Gaza road which continues to Khirbet Umm Qhuntera and then further to Moyat 'Awad in the Negev desert.[1210] As the Petra–Gaza road was the major east-west connection between Petra and the Mediterranean, the next section will briefly elaborate on the continuation of the road from Khirbet as-Faysif.

The Petra–Gaza Road

Nabataean control of the Negev desert and important trade routes to the Mediterranean was already challenged by the Ptolemies in the Hellenistic period as early as the 3rd century BC.[1211] However, the real threat to the regional Nabataean hegemony came from the Hasmoneans in Judaea, most exemplified by the sack of Gaza by Alexander Iannaios in 99 BC.[1212] The Hasmoneans gradually expanded their control of the Negev by constructing a series of forts such as Horvat Ma'agurah or Nessana along the road connecting Elusa with Sinai.[1213] Through negotiations with Hyrcanos II, the Nabataeans regained the Negev by 65 BC, which was important to maintain control over the inland trade routes.[1214] Potentially reacting to the increase of Roman inland and sea trade from Egypt, the Nabataeans followed a new and more direct road connecting Petra with the Mediterranean. Pliny states that the main caravan route from southern Arabia to Gaza passed 65 caravanserais and road stations offering opportunities to rest along the way.[1215]

After descending Wadi Jawf Ahmar and/or the Umm Qamar pass from Naqb ar-Ruba'i and reaching Khirbet as-Faysif, the most direct way to reach Gaza from Petra, was to continue from Khirbet as-Faysif to Khirbet Umm Qhuntera being the last Nabataean-Roman road station on Jordanian soil (FIG. 215). [1216] The ancient route then continues through the Negev highlands reaching elevations of over 800 m a. s. l. and passes through the famous Ramon Crater, "[…] *a deep erosion cirque, 40 km in length whose northern wall rises to a dramatic 400–500 m within a space of a mere 5 km*" (FIG. 216).[1217] Despite these environmental constraints, numerous road stations were constructed along the road including Moyat 'Awad, Horvat Qazra, Har Massa, Mezad Neqarot, Sha' ar Ramon ('En Saharonim), Ma' ale Mahmal, Grafon, Oboda (Avdat), Horvat Ma' agurah, Elusa and finally ancient Gaza.[1218]

1207 Cf. Ben David 2012, 21. Numerous modern stone circles for tent structures and other evidence for modern camp sites were noted while crossing the Jawf Ahmar plain. It is likely that this was also the case in antiquity, but there is no direct archaeological evidence to support this claim.

1208 Information provided by local Bedouin guides through the region.

1209 Ynnilä 2013, 253; Ben David 2013 and 2012; Zayadine 1992, 225–226 and 1985, 162–167.

1210 Ben David 2013, 273; Smith 2010, 98 and 2005, 70–71.

1211 Erickson-Gini 2007, 91.

1212 Erickson-Gini – Israel 2013, 25; Jos. Ant. Iud. 13, 13, 2.

1213 Erickson-Gini – Israel 2013, 25.

1214 Erickson-Gini – Israel 2013, 25. Jos. Ant. Iud. 14, 1, 14.

1215 Erickson-Gini – Israel 2013, 25; Jos. Ant. Iud. 12, 32, 63–65.

1216 Although the passage to Gaza is commonly referred to as the Petra–Gaza or 'Incense *road*,' the course fits this study's definition of routes/tracks (naqb). See e. g. Erickson-Gini – Israel 2013, 50; Ben David 2012; Smith 2010 and 2005.

1217 Erickson-Gini – Israel 2013, 25.

1218 Cf. Erickson-Gini – Israel 2013; Ben David 2012. Most of these sites were excavated by R. Cohen: Erickson-Gini – Israel 2013, 30; Cohen 1982. Among the excavated sites are: Moyat 'Awad, Horvat Qazra, Har Massa, Mezad Neqa-

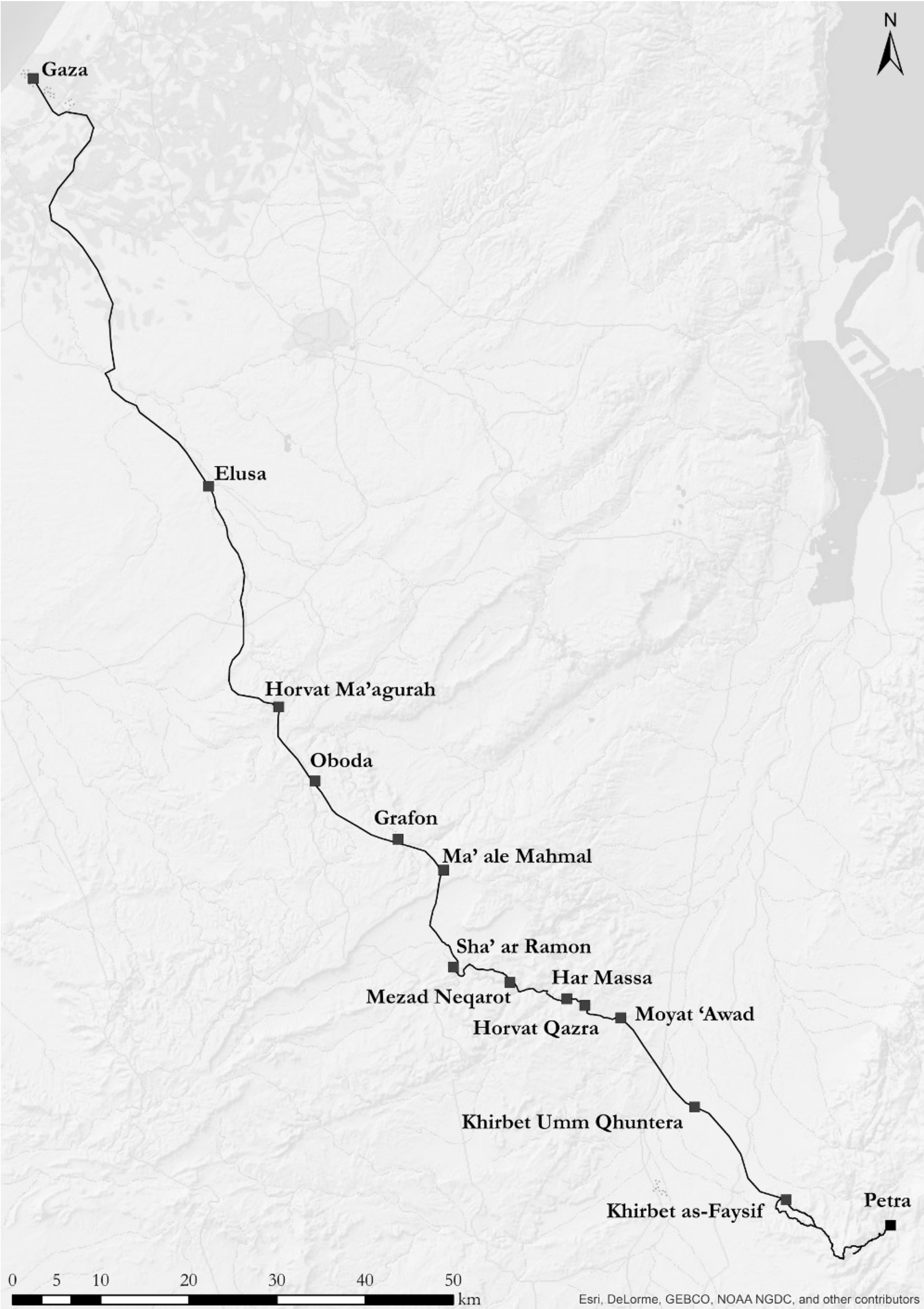


FIG. 215 The Petra-Gaza road.

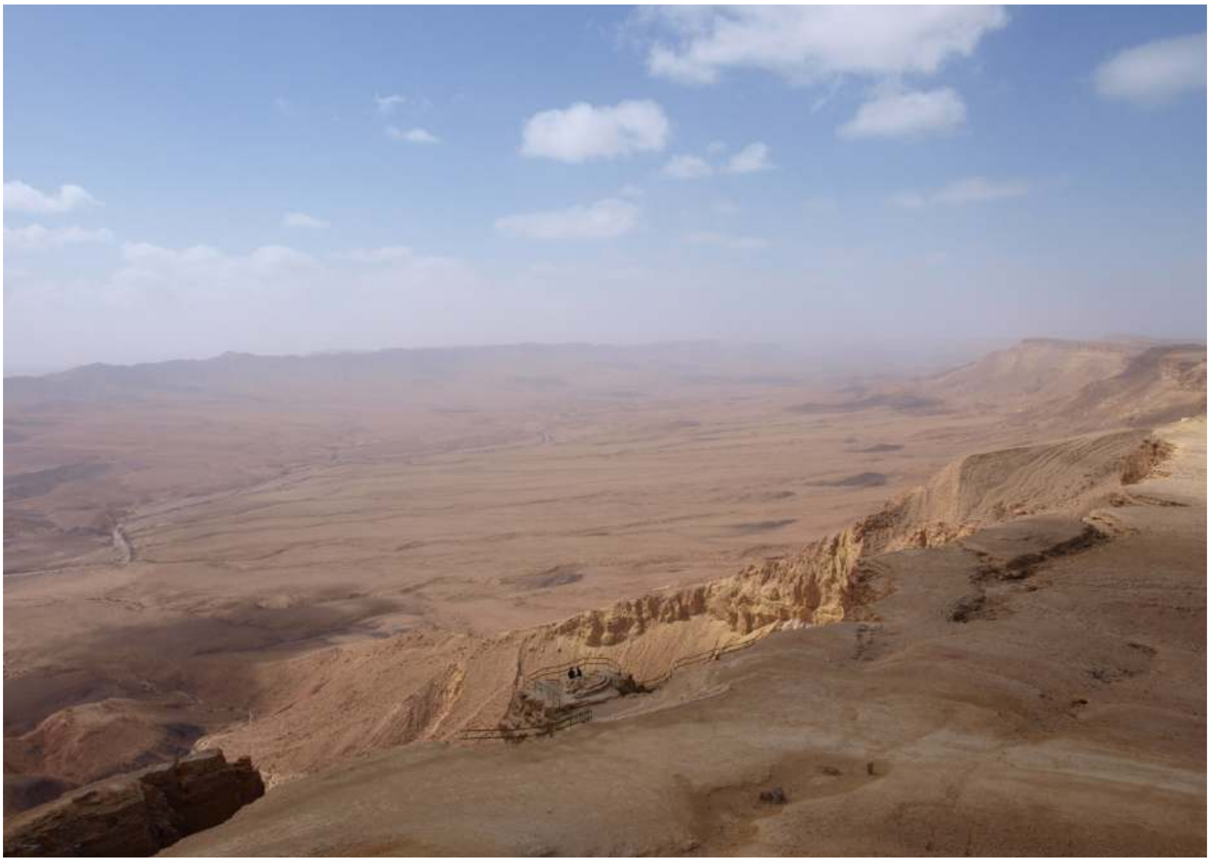


FIG. 216 The Ramon Crater seen from the western Negev highlands. View to southeast.

FIG. 217 View of Moyat ʾAwad with the caravanserai and fort.

Adding to the presumed Iron Age course of the Petra-Gaza road (cf. chapter 3), the Nabataeans supposedly followed the new route through the Ramon Crater towards the end of the 1st century BC. It runs along the northwestern face of the crater, known today as the 'Mahmal Pass,' and connected important 1st century BC sites such Moyat 'Awad and Oboda.[1219]

To provide a better understanding of Nabataean infrastructural efforts to maintain the Petra–Gaza road (and therefore highlighting the general logistical and organizational level of the Nabataeans), the following provides a more detailed description of the Nabataean Petra–Gaza road, continuing the accounts from Khirbet as-Faysif where the section above ended.[1220]

Due to time issues and practical reasons the author was not able to validate possible routes from Khirbet as-Faysif to Khirbet Umm Qhuntera in the field.[1221] However, A. Smith, who surveyed the site of Khirbet Umm Qhuntera extensively, suggests several possible ways through the alluvial plain of the Arabah.[1222] In order to simulate at least one possible way connecting the two sites, a GIS-based least-cost path (LCP) was modeled (cf. FIG. 180).[1223] According to the LCP, the most comfortable route from Khirbet as-Faysif circumvents the dominant mount of Jabal Somra at-Tayyiba to the west and crosses straight through the alluvium heading for Khirbet Umm Qhuntera in northwestern direction. The total length of this route is 9,69 km and has an average slope value of only 2,52 %. The route offers one of the best walking conditions in the region.

From Khirbet Umm Qhuntera, the next stop along the Petra–Gaza road is Moyat 'Awad. As the modern Israeli–Jordanian border crosses between Khirbet Umm Qhuntera and Moyat 'Awad, another LCP route was calculated to model the best possible connection between the two sites. This LCP route runs through the alluvial plains of the Arabah and, as the proposed Khirbet as-Faysif–Khirbet Umm Qhuntera route, offers one of the best walking conditions in the area.

At Moyat 'Awad the Nabataeans erected a substantial site consisting of a fort and a large caravanserai, as well as associated agricultural fields (FIG. 217).[1224] It was supplied with fresh spring water. The site has three occupation phases. The squarish fort, situated on a hilltop overlooking the road, dates as far back as the 3rd century BC.[1225] Excavations within the fort revealed an olive press and other utilitarian finds. The large amount of Nabataean pottery, most notably *unguentaria*, as well as the existence of agricultural terraces has led to the assumption that oils were produced locally (cf. chapter 4).[1226]

The caravanserai lies in the plain below the fort. It was presumably constructed during the reign of Aretas IV (9 BC-40 AD), and could have placed 20–30 camels within its courtyard.[1227] In a later, post-annexation phase, it was equipped with a small bathhouse as well.[1228] A third structure was built on a hilltop opposite the fort and was used for industrial purposes as suggested by the existence of kilns.[1229] Moyat 'Awad was abandoned during the first half of the 3rd century AD.[1230]

From Moyat 'Awad, the Petra–Gaza route continues through the Negev desert leaving the alluvium of the Arabah and ascending into a more mountainous region again. The next stop along the route is the Nabataean-Roman road station of Horvat Qazra, a small structure with an associated courtyard presumably added in the Severan period (FIG. 218).[1231] Situated on a steep ridge, it was supplied with water from a cistern far below the site.[1232] A small shrine for the veneration of a *baetylus* lies directly along the route opposite the site (FIG. 219).[1233] From Horvat Qazra, the route continues to the small rectangular site of Har Massa on the way to Mezad Neqarot. Har Massa dates to the post-annexation period.[1234]

Mezad Neqarot consists of at least four structures. A large building with a presumed courtyard dates be-

rot, Sha' ar Ramon, Ma' ale Mahmal as well as Horvat Ma' agurah. Cf. Zohar – Erickson-Gini 2019, 4, 11 and 15 for a discussion of possible routes between Elusa and Gaza.

1219 Erickson-Gini – Israel 2013, 26–28; Erickson-Gini 2007, 91, 93; Schmid 2001, 374.

1220 Cf. the elaborate GIS-based least-cost path calculations presented recently in Zohar – Erickson-Gini 2019.

1221 However, the autor did walk and map the Petra–Gaza road from Moyat 'Awad to Sha' ar Ramon. Many thanks are owed to T. Erickson-Gini and E. Aladjem for their much appreciated support.

1222 Smith 2010, 95–102.

1223 Cf. Zohar – Erickson-Gini 2019, 9–11 for more complex LCP calculations (including the provision of relevant natural landscape factors) between Petra and Oboda that model most cost-effective routes in terms of energy expenditure and travel time.

1224 Erickson-Gini – Israel 2013, 28; Erickson-Gini 2007, 93.

1225 Erickson-Gini – Israel 2013, 44; Erickson-Gini 2007, 93. A similar plan can be found at 'En Rahel further to the north.

1226 Erickson-Gini – Israel 2013, 46–48; Erickson-Gini 2007, 93.

1227 Erickson-Gini – Israel 2013, 44. The caravanserai at Sha' ar Ramon has a similar plan.

1228 Erickson-Gini – Israel 2013, 46.

1229 Erickson-Gini – Israel 2013, 44–45.

1230 Erickson-Gini – Israel 2013, 41. The latest numismatic finds date to the era of Elagabalus.

1231 Erickson-Gini – Israel 2013, 28; Ben David 2012, 19.

1232 Erickson-Gini – Israel 2013, 42.

1233 Erickson-Gini – Israel 2013, 44.

1234 Erickson-Gini – Israel 2013, 41. Presumably, Har Massa was reoccupied in the 4th century AD. There are no water related-structures near Har Massa. The road between

FIG. 218 Horvat Qazra along the Petra-Gaza road.

tween the 1st – 3rd centuries AD (FIG. 220). Its original Nabataean function seems to have served domestic/civilian purposes.[1235] A small 'tower fort' was also constructed near the site in the second half of the 2nd century AD[1236] as well as an associated roofed Nabataean cistern for storing fresh water.[1237] The site was abandoned in the first half of the 3rd century AD.[1238]

The next station along the Petra–Gaza road is Sha' ar Ramon, a large square building with an internal courtyard and casemate rooms dating between the mid-1st and 3rd century AD (FIG. 221).[1239] After the Roman annexation in 106 AD, the caravanserai was equipped with a large baking oven as well as bathtubs.[1240] Although Cohen's excavations revealed that the main phase dates as early as the 1st century BC, a Roman bilingual *stela* was discovered within the nearby necropolis mentioning the *cohors VI Hispanorum* thus providing evidence for a later (late 2nd–early 3rd century AD) presence of Roman troops along the Petra–Gaza road.[1241] Similar to other sites along the road, Sha' ar Ramon was abandoned after the first quarter of the 3rd century AD, although some rooms seem to have been in use until the end of the 3rd century.[1242]

In addition to milestones discovered along the road between Sha' ar Ramon and Oboda, the small

Horvat Qazra and Mezad Neqarot is accompanied by several aniconic *baetyli* (Erickson-Gini – Israel 2013, 44).

1235 Ben David 2012, 19.

1236 Erickson-Gini 2007, 94. The latest material dates to the first half of the 3rd century AD.

1237 Erickson-Gini – Israel 2013, 28: Ben David 2012, 19. The structure is interpreted as a fort and supposedly dates to the Severan period. The cistern is supposed to be Nabataean and it is assumed that previous Nabataean structures were later overbuilt (Erickson-Gini – Israel 2013, 42, 50).

1238 Erickson-Gini – Israel 2013, 41.

1239 Erickson-Gini 2007, 94.

1240 Erickson-Gini – Israel 2013, 39; Erickson-Gini 2007, 94.

1241 Erickson-Gini – Israel 2013, 39–41; Erickson-Gini 2007, 91; Figueras 1992, 178.

1242 Erickson-Gini – Israel 2013, 41 give the precise date of 222 AD without further explanation. Erickson-Gini 2007, 94 refers to a coin of Gallienus (253–268 AD) found directly above the bedrock foundation of the rooms.

FIG. 219 Small shrine with *baetylus* at Horvat Qazra.

Severan period fortlet of Ma' ale Mahmal was erected on top of a previous Nabataean structure dating to the mid-1st century AD to guard the passage.[1243] It had an associated courtyard and cistern similar to the one known at Mezad Neqarot.[1244] The same is true for Grafon, the next stop along the way to Oboda.[1245] While Ma' ale Mahmal was abandoned by the first half of the 2nd century AD, it may have been reused in the late 3rd and 4th century AD.[1246] Grafon was still in use until the early 5th century AD.[1247]

Meshel and Tsafrir intensively surveyed the road section between Sha' ar Ramon and Oboda. Oboda belongs to the earliest Nabataean sites in the Negev dating to the second half of the 1st century BC.[1248] Soon after the death of Obodas II (62–58 BC), a temple was erected at the site honoring a Zeus Obodas.[1249] A Roman fort was erected at the site in the Diocletianic period.[1250] Meshel and Tsafrir's discovery of Roman milestones and the results of test excavations at both Sha' ar Ramon and Oboda suggest the heavy presence of Roman army units in Severan and Diocletianic times.[1251] Oboda was destroyed by an earthquake in the early 7th century AD.[1252]

From Oboda, the route continues to Horvat Ma' agurah which is situated along the way to Elusa on a strategic highpoint overlooking the road. Excavations by Meshel and Cohen revealed a large Nabataean caravanserai equipped with a large cistern dating to the 2nd century BC. The site belongs to the earliest examples of Nabataean caravanserais known to date.[1253] A smaller square structure was constructured in the middle of the caravanserai's courtyard and identified as a fort due to the structure's characteristic corner towers (FIG. 222).[1254] Ceramic evidence dates the fort to the Early Hasmonean-Late Hellenistic period, presumably after the Hasmonean conquest of the Negev in 99 BC.[1255] The Hasmonean fort at Horvat Ma' agurah (as well as the presumed fort at Nessana) confirms

1243 Erickson-Gini – Israel 2013, 28, 41, 50; Ben David 2012, 19; Erickson-Gini 2007, 94. Cf. also more recently Zohar – Erickson-Gini 2019, 14–15.
1244 Erickson-Gini – Israel 2013, 28, 44.
1245 Erickson-Gini – Israel 2013, 28.
1246 Erickson-Gini 2007, 94.
1247 Erickson-Gini – Israel 2013, 41.
1248 Erickson-Gini 2007, 91.
1249 Erickson-Gini – Israel 2013, 39; Erickson-Gini 2007, 92.
1250 Erickson-Gini – Israel 2013, 41. Fabian 2005, VI postulates that the fort dates immediately after the annexation.
1251 Erickson-Gini – Israel 2013, 29; Erickson-Gini 2007, 92; Meshel – Tsafrir 1975 and Meshel 1974.
1252 Erickson-Gini 2007, 92.
1253 Erickson-Gini – Israel 2013, 34. The section of the road between Oboda and Elusa was confirmed by the discovery of Roman milestones.
1254 Erickson-Gini – Israel 2013, 34; Erickson-Gini 2007, 94.
1255 Erickson-Gini – Israel 2013, 35–36. One of the mentioned towers descended into a small room with a heatable bathtub. This may be interpreted as a *mikveh,* thus affirming the Hasmonean date of the fort (Erickson-Gini – Israel 2013, 38).

FIG. 220 Mezad Neqarot along the Petra-Gaza road. View to the west.

the assumption that the Hasmoneans gained control over access to Mediterranean trade at Gaza.[1256] However, only a few decades after the Hasmonean sack of Gaza in 99 BC, Hyrcanos II returned the territories in the Negev to the Nabataeans after he received Nabataean military support against Aristobulos.[1257] Hereafter, the Nabataeans established permanent settlements at Elusa, Oboda as well as Nessana and maintained regional control until the Roman annexation in 106 AD.[1258] Cohen dated the latest phase of Horvat Ma' agurah to the Early Byzantine period, which was confirmed by late 3rd and 4th century AD numismatic finds at the site.[1259]

Some of the sites along the Petra–Gaza road date to the Nabataean, while others to the Roman periods.[1260] All road-related sites were in use during Roman rule of the region.[1261] Until the first half of the 3rd century AD, the Petra–Gaza road continued to be the main connection between Petra and the Mediterranean.[1262] Roman military presence in the Diocletianic period, as evidenced by Oboda and Sha' ar Ramon as well as the erection of milestones along the road, suggests the eventually unsuccessful attempt to reboost caravan trade between Petra and the Mediterranean.[1263] The increased military presence may be associated with Diocletian's shift of the *legio X Fretensis*

1256 Erickson-Gini – Israel 2013, 39. It is possible that during this period the Nabataeans expanded further south from Petra establishing important sites such as Humeima (ancient Hawara) as well as northwards towards the Hawran.
1257 Erickson-Gini – Israel 2013, 39.
1258 Erickson-Gini – Israel 2013, 39.
1259 Erickson-Gini 2007, 94; Cohen 1982. However, Erickson-Gini – Israel 2013, 35 mention a "[…] *complete lack of Roman or Byzantine artificats in the fort* […]."
1260 Ben David 2012, 20–21.
1261 Erickson-Gini – Israel 2013, 29.
1262 Erickson-Gini 2007, 93.
1263 Erickson-Gini – Israel 2013, 41; Ben David 2012, 20; Erickson-Gini 2007, 97. The milestones are anepigraphic and show no signs of painted inscriptions. The dating of the milestones is thus based entirely on archaeological structures related to the Petra–Gaza road (Ben David 2012, 20). Erickson-Gini tentatively associates this decline in trade activties through the Negev with regional epidemics that may have caused temporary and/or permanent abandonment of sites along the Petra–Gaza road and in the entire Negev (Erickson-Gini 2007, 92, particularly n. 7).

FIG. 221 The caravanserai of Sha' ar Ramon along the Petra-Gaza road. View to northeast.

FIG. 222 View of the Hasmonean fort within the Nabataean caravanserai at Horvat Ma' agurah. View to northwest.

from Jerusalem to Aila (Aqaba) as stated by Eusebius.[1264] By the Diocletianic period, Ben David claims that from Moyat 'Awad, the route did not continue further east towards Petra, but headed south to Yahel in the Arabah and from there further along the Wadi Arabah to Aila where the *legio X Fretensis* was stationed.[1265] In the 4th century AD, the Petra–Gaza road was still in occasional use, although it had lost its function of a major road between the Mediterranean and the Petra region already by the mid-3rd century AD.[1266] The road's signifance declined completely in later periods.

The section above described the Petra–Gaza road leading from the al-Farasha plain below Jabal Harun

1264 Erickson-Gini – Israel 2013, 41; Erickson-Gini 2007, 97; Eus. On. 6, 17–20, 8, 1–3.

1265 Ben David 2007, 108; Fiema 2003, 49–50.

1266 Erickson-Gini – Israel 2013, 41. Cf. e.g. the finds of Sha' ar Ramon. Also see Rothenberg 1962.

and descending into the Wadi Arabah via Naqb ar-Ruba'i, the Wadi Jawf Ahmar and/or the Umm Qamar pass to the Nabataean-Roman road station of Khirbet as-Faysif and further to Khirbet Umm Qhuntera.[1267] The natural landscape conditions of these routes are well suited for larger caravan passings, particularly for camels. Considering that these routes cross through a region characterized by severe slopes of 45 % and more, they follow the easiest slope values: The average slope values of all routes range between 2,52 % and 11,75 %. Within this particular landscape, these are low values offering good conditions for animal and human travel. In addition, the largest geological coverage of all four routes are either limestone or alluvium. The difficult volcanic al-Somrah is avoided when possible.

Importantly, this course of the Petra–Gaza road goes against older proposals that suggest the road followed through Beidha via Naqb Namala to the north, passing Bir Madkhur as well as (presumably) BMP/CAS Site No. 13 and from there to Khribet Qhuntera.[1268] While there was probably never *the* Petra–Gaza road, the more advantageous natural landscape conditions suggest that the routes described above offer the best conditions for camel, donkey and human travel through the region and that they may have formed the most important course of the Petra–Gaza road. While it is argued that Naqb Namala did not form the main course of the Petra–Gaza road, the route was nevertheless an important communication axis. The following sections will therefore resume the description of the archaeologically evidenced routes of the Petraean hinterland, beginning with Naqb Namala.

Naqb Namala

Scholars previously proposed that the most straightforward way from Petra to the Negev desert was pass the *quadriburgium* at Bir Madkhur through Naqb Namala.[1269] From Bir Madkhur, Smith argues that the Petra–Gaza road potentially continued to the Nabataean-Roman road station of BMP/CAS Site No. 13 and then further to Khirbet Umm Qhuntera.[1270] While it was argued above that Naqb Namala was not the most straightforward way to the Negev from the Petra area, it still is a major northward running route that provided important additional access to the Arabah. With a total length of over 28 km, Naqb Namala can be described as one of the longest routes in the Petra region running along a north-south axis from the immediate vicinity of Petra and eventually turning westwards down to the Arabah (FIG. 223). The beginning of the route is marked at the modern road connecting Beidha and Umm Sayhoun, just before the modern access way to Petra via Wadi Turkmaniye.[1271] From this point, it follows the course of the modern Namala pass through Beidha, Siq Amm al-Alda and the ad-Thankia region. After 11 km, the route leaves its northern course after the ad-Thankia plain at Ras al-Siq Amm al-Alda heading westwards down to the Arabah mostly through the volcanic al-Somrah (FIG. 224).[1272] While direct archaeological evidence for the ancient course of the route is overbuilt by the modern road, numerous archaeological sites along the way suggest that the path of the ancient route is most likely similar to the modern road. For example, shortly before its westward turn at Ras al-Siq Amm al-Alda, the route is overseen by a possible Nabataean-Roman watchtower just east of the modern road at Babul Baja. After approx. 4 km from Babul Baja, it then passes the Neolithic village of Shkarat Musa'id (PHSP Site No. 007), which also showed evidence of use in the Nabataean period.[1273]

After Shkarat Musa'id, the route continues northwestwards down the severe slopes of the al-Somrah in a zig-zag-like pattern. After approx. 8 km it then reaches the Nabataean-Roman route station of Qasr Namala (PHSHP2016 Site No. 025) situated just southwest of the modern road (FIG. 225). The route leaves the al-Somrah at Qasr Namala and arrives at the open fluviatile and gravel plain of the Arabah 1,8 km further northwestwards from the route station. Continuing in northwestern direction, Naqb Namala then meets with one of the major north-south running routes in the Arabah connecting Bir Madkhur

1267 Cf. Ben David 2013, 277.

1268 Ben David 2013, 273 and 2012, 21; Smith 2010, 101; Glueck 1934.

1269 Smith 2010, 101.

1270 BMP/CAS Site No. 013 lies "[…] *at the intersection of a prominent north-south or east-west route through the valley*" (Smith 2010, 42–43).

1271 As mapped in this study, Naqb Namala follows the modern road that was constructed in 1979 (Ben David 2007, 102; Zayadine 1992, 217). The course of Wadi Turkmaniye was also taken as the potential northern access to Petra in antiquity. This route is just over two kilometers long and has an average slope value of 9,05 %. It runs completely over sandstone offering one of the best travelling conditions in the region.

1272 For more details on the various regions passed by Naqb Namala, see Zayadine 1992, 217–223.

1273 It may thus be hypothesized that Naqb Namala preceded the Nabataean period. The PHSP collected some Nabataean surface ceramics on a small sandstone promontory nearby. Cf. also 'Phase V' resprenting the Nabataean/Roman phase of Shkarat Musa'id as claimed by the excavators (Kinzel 2018, 94). For more on the Neolithic village, see e. g. Kinzel 2018 and Kaliszan et al. 2002.

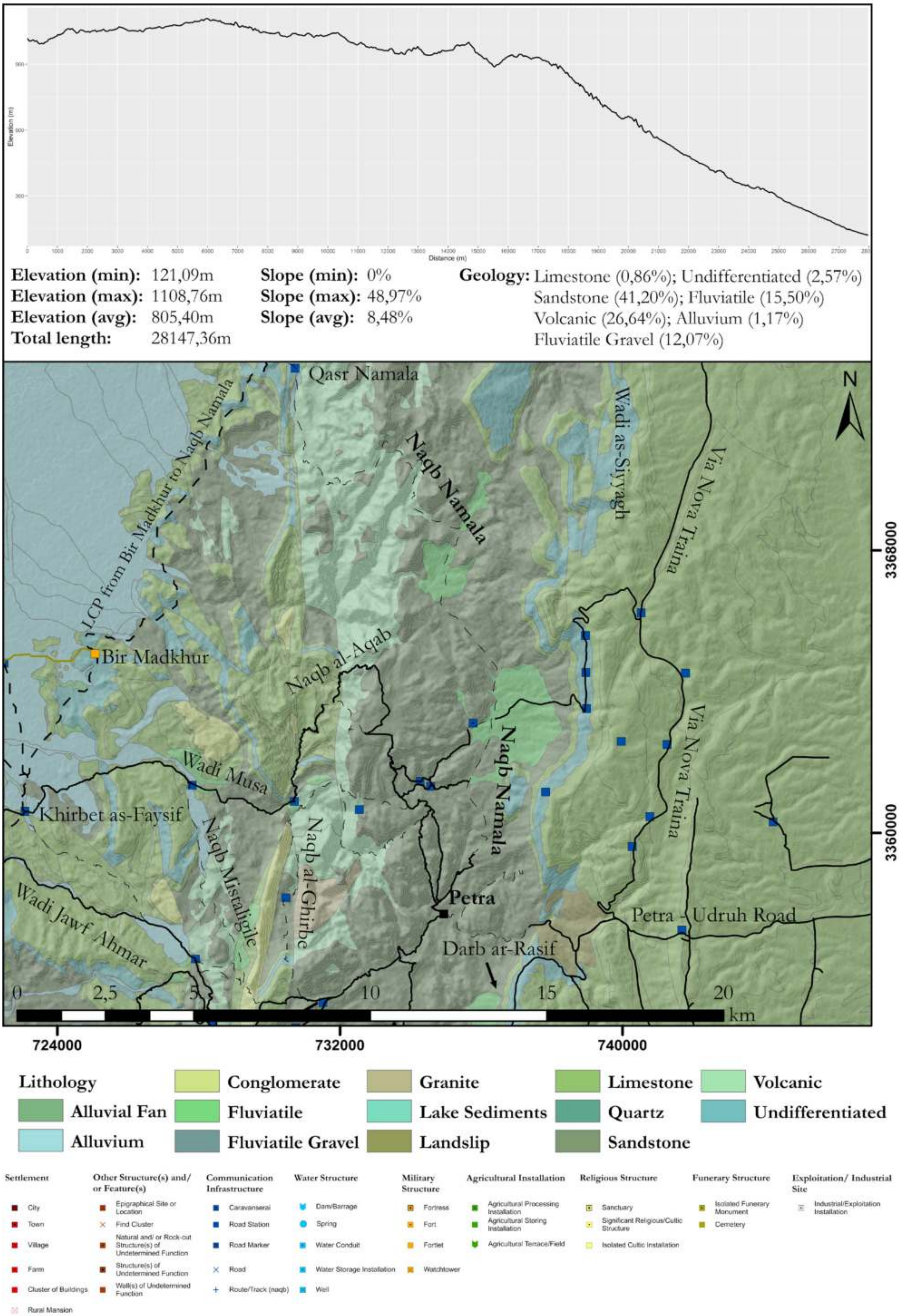


FIG. 223 Major route-related sites and the course of Naqb Namala with elevation profile and the covered geological formations (in %).

FIG. 224 Modern dirt road along Naqb Namala crossing through the difficult volcanic al-Somrah. View of the Arabah in the west.

FIG. 225 The route station of Qasr Namala along Naqb Namala. View to the north.

with Faynan (Phaino) and continues further northwestwards to SAAS Site No. 330.[1274]

Not only is Naqb Namala one of the longest routes in the study area, it also covers the largest elevation difference: Starting at 1108,76 m a.s.l. it ends in the Arabah at only 121,09 m a.s.l.. The route has an average slope value of 8,48 %. While this offers comfortable walking conditions, the route's largest geological coverage is the al-Somrah (26,64 %) between Shkarat Musa'id and Qasr Namala. Contrary to previous assumptions, this does not allow easy access for large camel caravans.[1275] The route is better suited for donkey, mules and human traffic.[1276] The natural landscape conditions do not favor Naqb Namala as the main course of the Petra–Gaza road. This was already noted by G. Horsfield and A. Conway in the first half of the 20th century, who claimed that Naqb Namala was too strenuous and therefore not the most straightforward way to the Negev from the Petra area:

> *The shorter passage to the sea-coast from El Bared, by the Namala Pass, the ancient trade route to Gaza, is not favoured, as the going is rough, with practically no food or water. We went down it for four hours. The track leads through a wide wadi at first, but when it reaches the porphoritic* [i.e. volcanic] *region it winds in and out amongst great fallen porphyry blocks. We found the remains of a camel, and there were fresh droppings on the track; so that it is used, but not very much, for small numbers who want to get through quickly.*[1277]

Nevertheless, the north-south roads in the Arabah offer a good connection between Naqb Namala and the course of the Petra–Gaza road as suggested above. One possible north-south GIS-based LCP route in the Arabah, connecting Naqb Namala with Bir Madkhur, Khirbet as-Faysif and Qasr at-Tayyiba was calculated (cf. FIG. 180).[1278] Eventually leading to Faynan (Phaino), this north-south road crosses Naqb Namala shortly after it enters the open fluviatile plain of the Arabah.[1279] The north-south route then continues southwards for 14,61 km until it reaches Bir Madkhur. While the largest geological formation covered by the road is undifferentiated (38,25 % coverage), the road mostly runs over sandstone (19,75 %) and limestone (15,13 %). The rest is alluvial or fluviatile plain. The route runs from 436,37 m a.s.l. to 281,60 m a.s.l. and follows an average slope value of 11,10 %. The walking conditions are therefore optimal. From Bir Madkhur, the road continues straight south for six kilometers to Khirbet as-Faysif, meeting in part with the calculated LCP-route from Khirbet as-Faysif to Khirbet Umm Qhuntera (see above). Generally maintaining elevations between 253,60 and 273,68 m a.s.l., the route has an average slope value of 4,27 %. While the largest geological formation is undifferentiated (40,29 % coverage), the road also runs over limestone (16,12 %) and sandstone (9,89 %). From Khirbet as-Faysif, the north-south road then continues southwestwards crossing Qasr at-Tayyiba after approx. 3,5 km, and then further south towards Qaa' as-Sayidiyeen. The route runs along elevation values of c. 300 m a.s.l. with an average slope value of 4,81 %. While the largest geological formation is undifferentiated (29,21 % coverage), the road also runs over sandstone (27,48 %), limestone (21,73 %) and alluvium (15,83 %).

There also appears to have been an east-west connection between Bir Madkhur and the late Roman road station of BMP/CAS Site No. 013. This route is crossed by the north-south running Arabah road, which is evidenced archaeologically by BMP/CAS Site No. 006 at this point. This site is a 3,20 m wide stretch of an unpaved route oriented north-south and a possible milestone was found in its vicinity.[1280] The east-west connection between Bir Madkhur and BMP/CAS Site No. 013 is approx. three kilometers long with an average slope value of 3,1 % (cf. FIG. 205). The route runs mostly over alluvium (55,26 %). It is also possible to reach Khirbet Umm Qhuntera from BMP/CAS Site No. 013. This approx. six kilometer long route remains between 178,87 and 218,50 m a.s.l. with an average slope value of 2,39 % and runs completely over alluvium.

Therefore, the major north-south routes in the Arabah provided an important connection between the main course of the Petra–Gaza road and Naqb Namala. From the crossing point with Naqb Namala, these north-south routes run south passing through Bir Madkhur, Khirbet as-Faysif, Qasr at-Tayyiba and eventually further south to Qaa' as-Sayidiyeen. Bir Madkhur is therefore located at an important intersection. From there, the east-west running route connects the road

1274 Smith 2010, 98, figure 99.
1275 Cf. e.g. Ben David 2013, 274 and 2007, 102 who describes Naqb Namala as a camel track.
1276 Local Bedouins confirmed the author that Naqb Namala is not a good route for camel-based travel.
1277 Horsfield – Conway 1930, 383.
1278 Ben David 2013, 274 mentions that, with an overnight stop at the springs of Buweirdeh, it is possible to reach Moyat 'Awad from Naqb Namala. Based on his analysis of topographical maps and satellite imagery, he suggests that the way from Bir Madkhur to Moyat 'Awad would be to follow the alluvial plain south of Wadi Musa between Wadi Umm Mitla and Wadi Dabat (Ben David 2013, 275).
1279 Ben David 2013, 277 confirms that Naqb Namala mainly served to connect with northern parts of the Wadi Arabah.
1280 Smith 2010, 78.

station of BMP/CAS Site No. 013 with Khirbet Umm Qhuntera and thus the main course of the Petra–Gaza road through the Negev as presented above.

However, the natural landscape conditions of Naqb Namala do not offer good conditions for large-scale camel-based caravan activities. While Naqb Namala may certainly have served as an important secondary arm of the Petra–Gaza road for mainly donkey and/or mule-based trade, the main course of the Petra–Gaza road seems to have been via Naqb ar-Ruba'i and the Wadi Jawf Ahmar/Umm Qamar pass. Nevertheless, this does not downplay the general significance of the route for the Petra region.[1281] Although the regional landscape conditions are generally disadvantageous (in this case i. e. particularly the topographical and geological conditions on the way to the Arabah), the infrastructural connectivity of the Petraean hinterland is heavily reliant on a web of secondary routes that eventually feed into main communication lines. One of these important secondary routes is Naqb Namala. The next section therefore elaborates on other alternative routes connecting the Wadi Arabah with the immediate Petra area.

Alternative Routes from the Wadi Arabah through the Wadi Musa

Another important route connecting the eastern Petraean hinterland with the north-south running Arabah route and therefore enabling access to major local infrastructural hubs, is the Wadi Musa (FIG. 226). Approximately 3,5 km northeast from Khirbet as-Faysif, the Wadi Musa opens into the wide alluvial plain of the Arabah. The general direction of the Wadi Musa is east-west. It has a total length of approx. 6,3 km until converging with the Wadi ad-Dulaiya to the south of Dawrum Dey.[1282] The wadi runs between 276,16 and 467,80 m a. s. l. and has an average slope value of 5,32 %. The main geological formations along the course of the wadi are limestone (30,13 %), sandstone (28,12 %) and alluvium (24,45 %), thus offering some of the best walking conditions in the region.[1283] Approximately six kilometers from Khirbet as-Faysif, the next route station along the Wadi Musa is Qasr Umm Rattam.[1284] This site is not only significant due to its impressive structural remains, reservoir and aqueduct coming from the spring of Amm Massemak further east along the Wadi Musa (cf. FIG. 186), but also because it is an important meeting point between the Wadi Musa and Naqb Mistalgile heading southwards up the eastern highlands and meeting Naqb ar-Ruba'i near Rujm Ruba'i.[1285]

The total length of Naqb Mistaligile (FIG. 227) is 8,4 km. While the first seven kilometers from Qasr Umm Rattam feature relatively low slope values (averaging at 8,24 %), much of the route runs over the volcanic al-Somrah (34,41 % coverage). Two branches of the main route then divert into northwestern direction and meet at the Nabataean-Roman route station of Seir Umm Qamar, where Naqb ar-Ruba'i and Wadi Jawf Ahmar converge as well (see above). These two routes probably served as a short-cut to the main course of the Petra–Gaza road mainly for pedestrian and donkey/mule traffic, as both cross severe slopes between 25 % and 45 % and mostly run through the difficult al-Somrah. Although the last 1,5 km of the main course of Naqb Mistalgile mainly covers conglomerate (69,10 %), it mostly passes through very severe slopes (averaging at 21,57 %), which makes it impossible for camels to pass and even for pedestrians extremely difficult (FIG. 228).[1286] In order to facilitate limited travel along this upper part of Naqb Mistalgile, up to 30 flagstone steps were constructed that zigzag up to the top.[1287] Reaching the southern beginning of Naqb Mistalgile immediately west of the al-Farasha plain, the FJHP recorded two sites (FJHP Site No. S112 and S118) which Ynnilä interprets as potential lookout posts.[1288] Despite the difficult environmental conditions of Naqb Mistalgile, this is an important secondary route for donkey/mule and pedestrian traffic that leads from the al-Farasha plain below Jabal Harun to Qasr Umm Rattam. Loosely translated, the meaning of the route is "the path of

1281 Cf. Ben David 2007, 102.

1282 The total length of Wadi Musa was measured from Khirbet as-Faysif. Note that the Wadi Musa continues further eastwards until the volcanic cliffs of Ras Slaysil merging into the Wadi as-Siyyagh. However, the *route* Wadi Musa only refers to the section until Dawrum Day. Routes further east are referred to as Naqb Slaysil, Naqb Seir al-Begh' er, Wadi Marwan and Wadi as-Siyyagh.

1283 Cf. also Ben David 2012, 21 and 2007; Lindner et al. 2000 stating that Wadi Musa is well-passable for camels.

1284 Approximately 2,5 km from the point where the wadi opens into the alluvial plain of the Wadi Arabah. Ben David 2013, 275 confirms the pass along Wadi Musa to Umm Rattam. He also notes that approx. one kilometer west of Umm Rattam, there is a route leaving Wadi Musa in northwestern direction, which eventually reaches Bir Madkhur after three kilometers. This is part of the *Bīr Madhkūr Incense Route Project's* (BMIRP) 'Wadi ad-Dlayih Trail' connecting Bir Madkhur with the immediate Petra area via Jabal Harun (Smith 2018, 222–224, 233, fig. 12; Smith – Kay 2018, 137–139; 138, fig. 9).

1285 Cf. also Ben David 2013, 277.

1286 Zayadine 1992, 226 mentions the great difficulties his donkey had when passing Naqb Mistalgile in the spring of 1984.

1287 Ynnilä 2013, 257.

1288 Ynnilä 2013, 256.

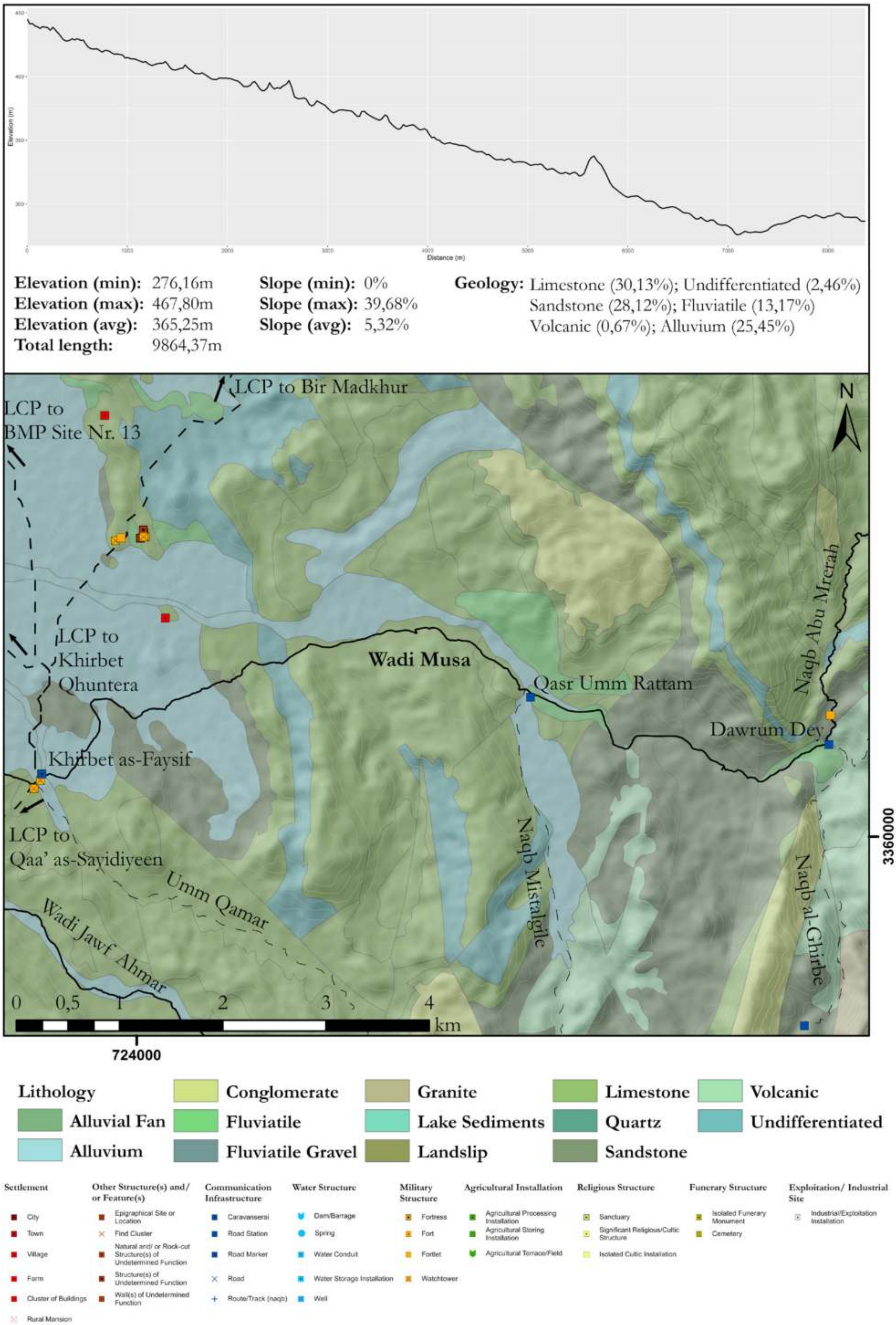


FIG. 226 The course of the Wadi Musa with elevation profile and the covered geological formations (in %).

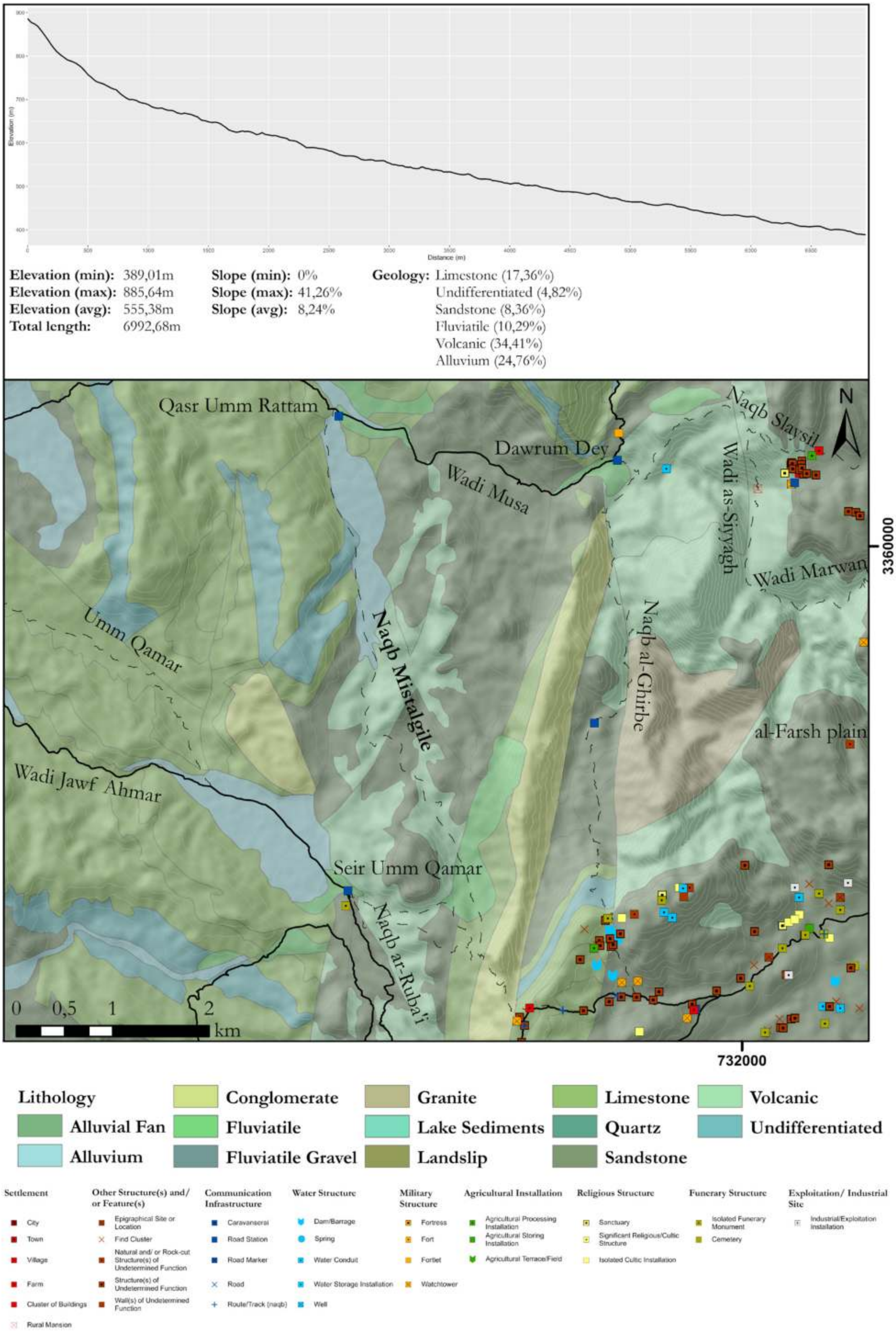


FIG. 227 The course of Naqb Mistalgile with elevation profile and the covered geological formations (in %).

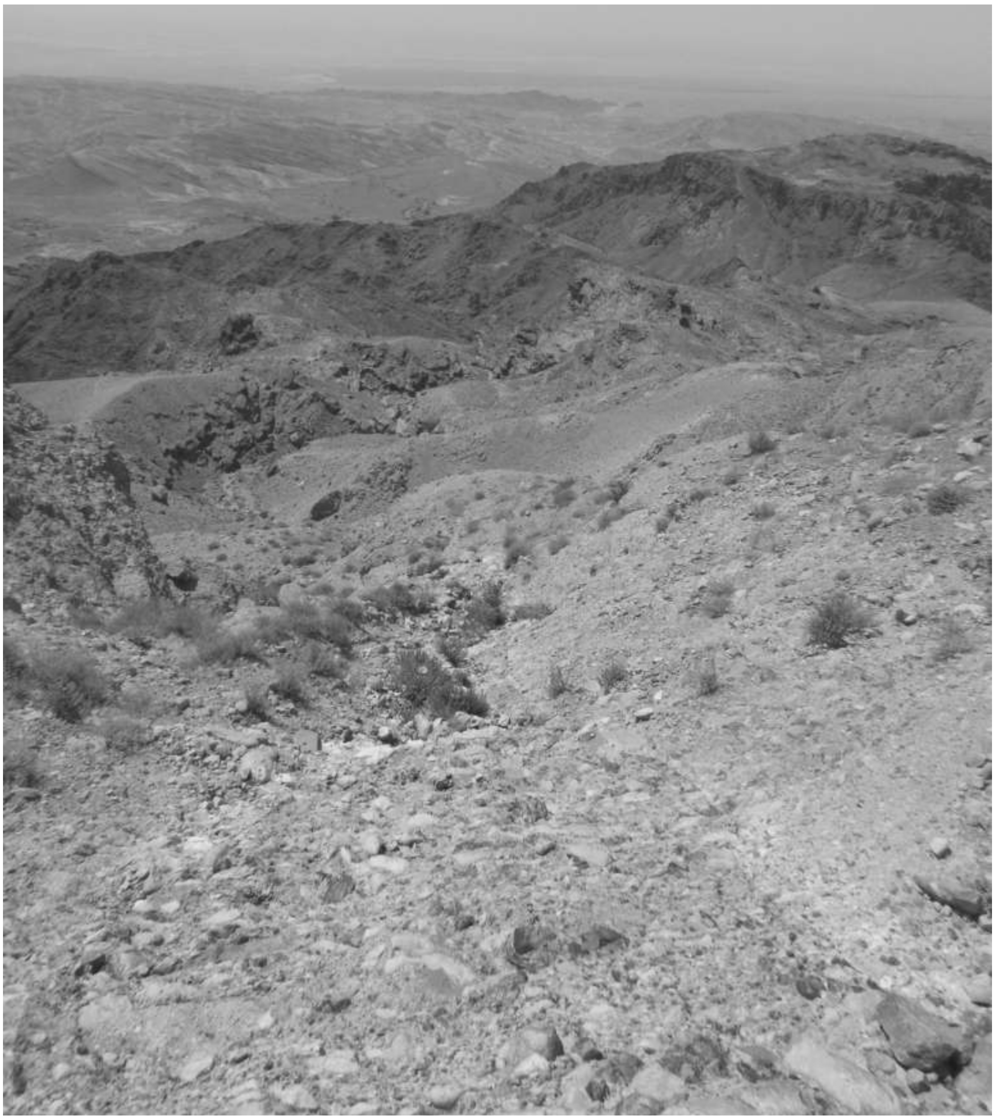


FIG. 228 Descent of Naqb Mistalgile with the Jawf Ahmar plain and Wadi Arabah in the background. View to the west.

the one who hurries."[1289] As the name suggests, but also based on the overall unfavorable environmental and topographical conditions, the route may very well have served for quick communication purposes.

Continuing approx. 3,5 km further east along the Wadi Musa, one reaches the site of Dawrum Dey again (cf. above). Although not as structurally impressive as Qasr Umm Rattam, Dawrum Day is an important infrastructural hub for the Petraean hinterland as it forms a meeting point of four ancient routes of different quality: Wadi Musa, Naqb al-Ghirbe, Naqb Slaysil and Naqb Abu Mrerah.

Naqb al-Ghirbe is 7,67 km long starting from Ras al-Ghirbe at the foothills of Jabal Harun at an elevation of 1110,35 m a.s.l. and ending at Dawrum Dey at 469,30 m a.s.l. (FIG. 229). The general orientation is north-south. With an average slope value of 13,01 % it does not pass through too difficult topography, but large parts of the route run through the al-Somrah (37,23 coverage) making it in parts difficult for camels to pass. After its first descent from Ras al-Ghirbe at the northwestern foothills of Jabal Harun, where FJHP Site No. S25 is situated and Ynnilä presumes to be a caravan campsite[1290], the route zigzags in northern direction (FIG. 230) passing several structures of undetermined function including stone circles (PHSP Site No. 108) and terraces. The stone circles may be interpreted as the remains of a possible camp site. Continuing further south along the route and after approx. 3,6 km from Ras al-Ghirbe, Naqb al-Ghirbe passes a small Nabataean-Roman relay station (PHSP Site No. 109). Dawrum Dey is reached after another 3,5 km further north.

Naqb Slaysil is the east-west connection between Dawrum Dey and the important settlement of Ras

1289 Cf. Ben David 2013, 277.

1290 Ynnilä 2013, 256. Naqb al-Ghirbe is most likely equivalent to Ynnilä's 'Naqb 'Uqayriba.'

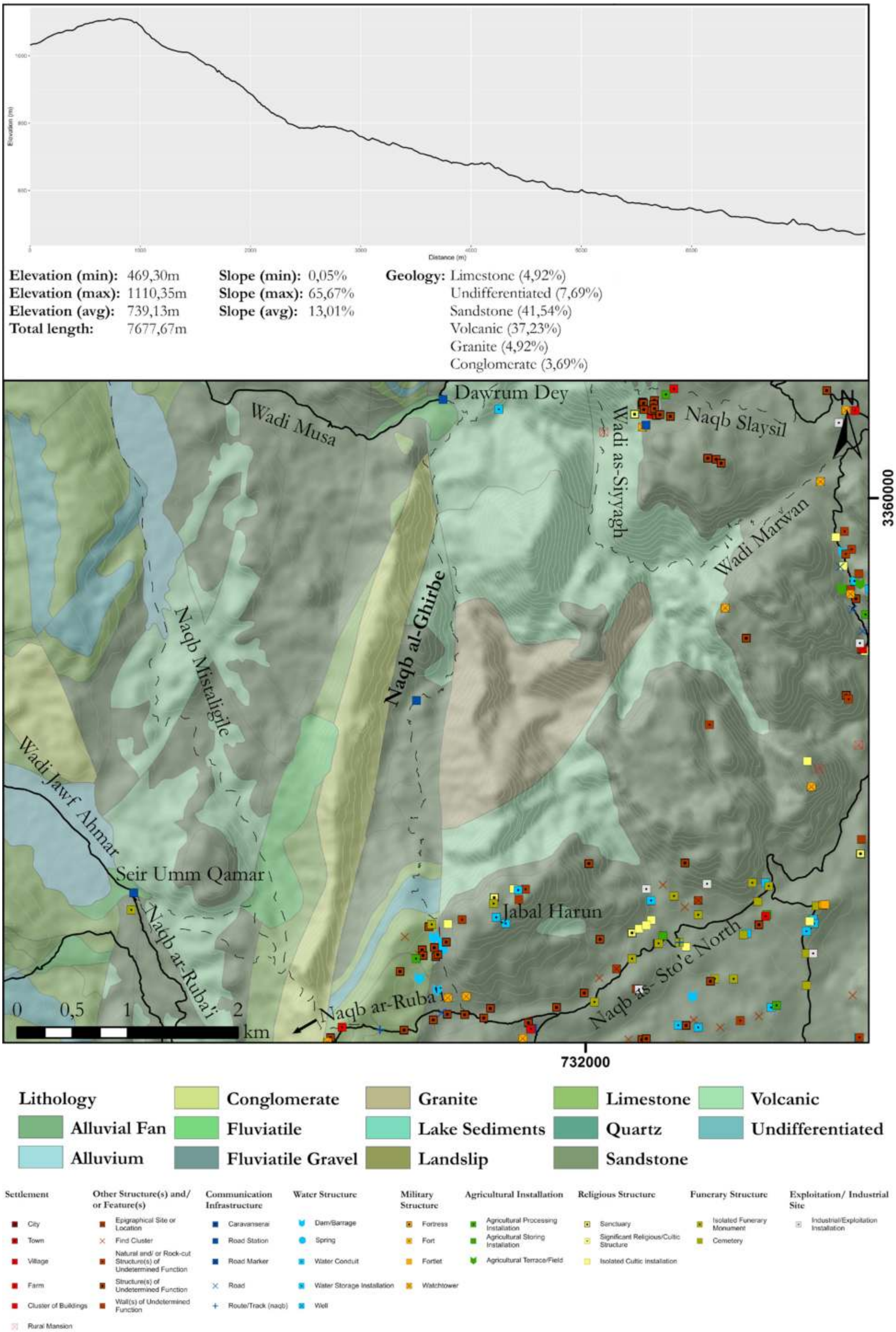


FIG. 229 The course of Naqb al-Ghirbe with elevation profile and the covered geological formations (in %).

FIG. 230 Naqb al-Ghirbe descending northwestwards from Ras al-Ghirbe.

Slaysil 400 m higher on the al-Somrah edge and overlooking the Wadi Musa to the west (FIG. 231).[1291] As one of the most difficult routes in the entire study area, Naqb Slaysil is traditionally known to run from Ras Slaysil westwards to Dawrum Dey having a total length of approx. 2,5 km.[1292] However, this study also refers to a possible track passing through the plain of Ras Slaysil eastwards until it meets Naqb al-Farsh (see below) as a part of Naqb Slaysil, thus giving the route a total length of approx. 5 km. Starting at just over 1000 m a. s. l. at Ras Slaysil, the route ends at 462,68 m a. s. l. at Dawrum Dey. With the longer length of 5 km, Naqb Slaysil has an average slope value of 21,41 %. It runs along sandstone (34,74 % coverage) and the volcanic al-Somrah (64,79 % coverage). While these landscape factors already seem unfavorable, considering the traditional course of Naqb Slaysil only, i. e. starting from Ras Slaysil and immediately descending to Dawrum Dey, the environmental conditions are even more severe: This part of Naqb Slaysil has a maximal slope value of 86,67 % averaging at 28,07 %.[1293] More importantly, this stretch of the route runs entirely over volcanic stone. Therefore, the combination of steep slope values and the volcanic al-Somrah makes it impossible for camels to pass. Donkeys and/or mules can use this route, but it is extremely difficult even for them (FIG. 232). However, the zig-zagging course of the upper part of the route renders passage easier and the way was once stabilized by dry terrace walls.[1294] While Kloner argued that Naqb Slaysil formed the main route from the Petra area towards the Arabah, it is clearly a locally used route for connecting Ras Slaysil with Dawrum Dey and then further through Wadi Musa towards the Arabah.[1295]

Naqb Seir al-Begh'er eventually meets with Naqb Slaysil approx. 800 m from Ras Slaysil, which leads down to the presumed rural mansion of Seir al-Begh'er (cf. chapter 5) (FIG. 233).

1291 Confirmed by Ben David 2013, 276.
1292 Cf. also Kennedy 2016a, 144–146; Ben David 2013, 276: "[…] *it is one of the most difficult donkey trails to negotiate in the region.*"
1293 See also Kennedy 2016a.
1294 Ben David 2013.
1295 Ben David 2012, 21; Kloner 1996, 127–134.

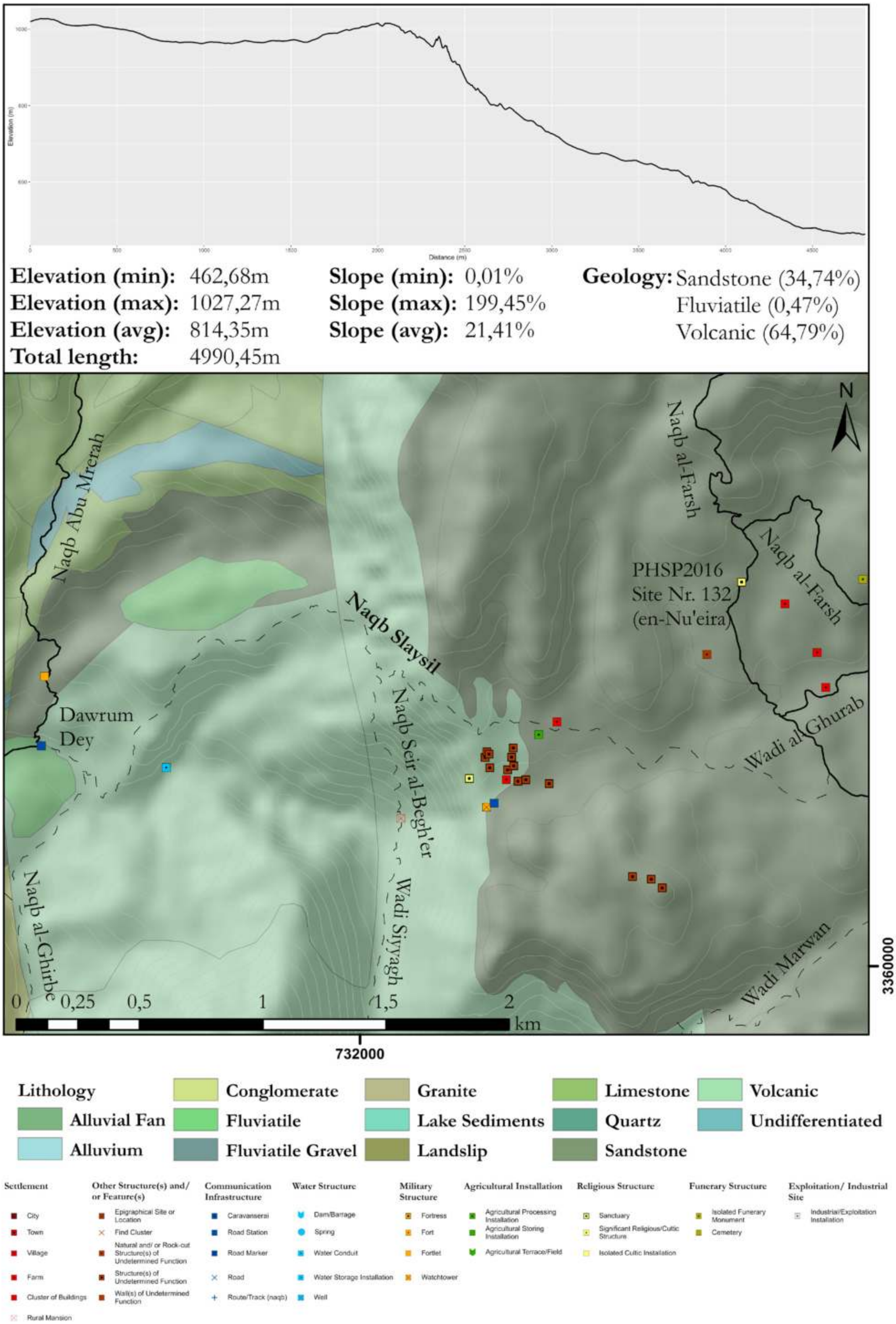


FIG. 231 The course of Naqb Slaysil with elevation profile and the covered geological formations (in %).

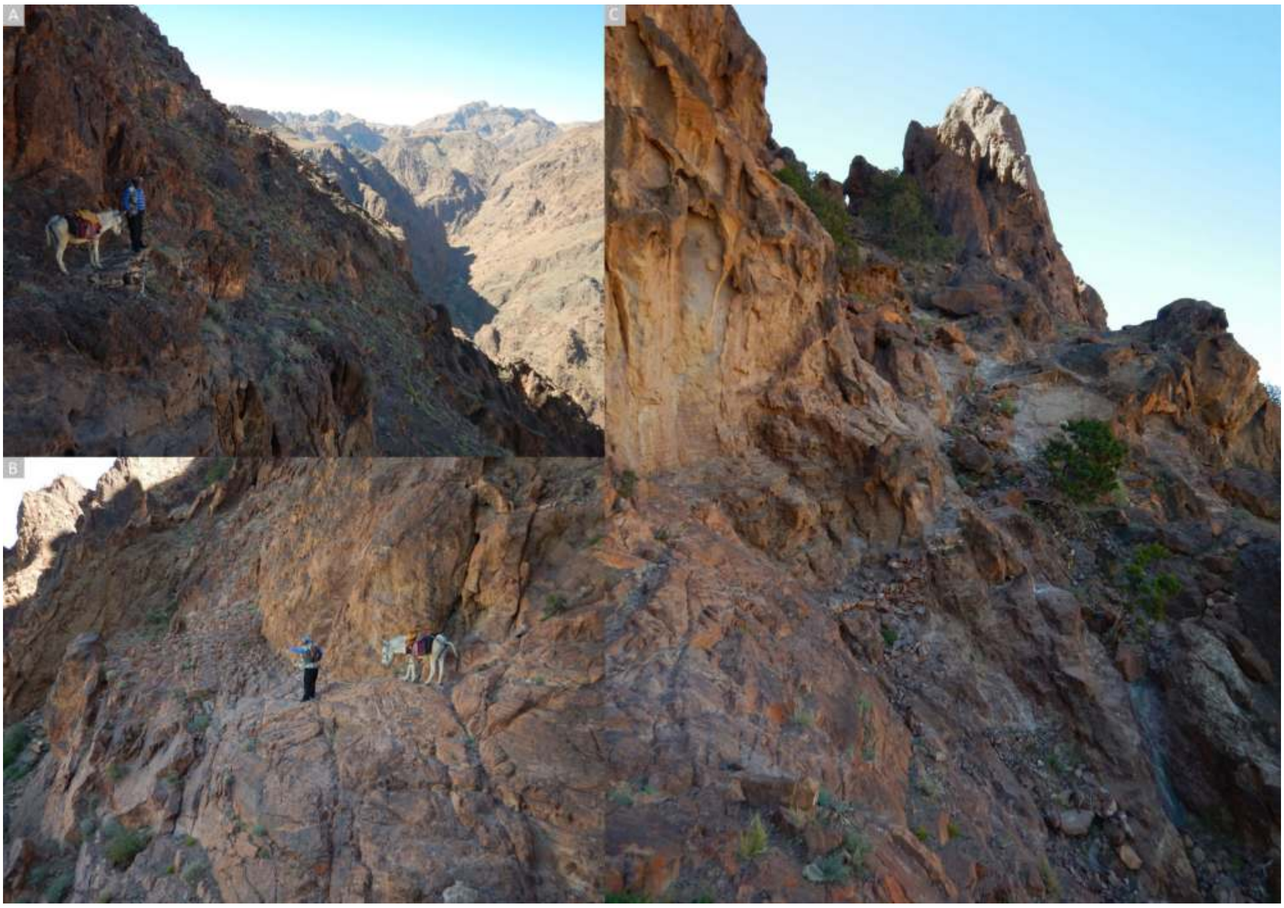


FIG. 232 A and B: The difficult descent of Naqb Slaysil along the volcanic al-Somrah. C: Remains of terracing walls along the naqb.

While Naqb Seir al-Begh'er is just about one kilometer long, it shares the natural landscape features of Naqb Slaysil, although even steeper. This naqb can only be used by pedestrians, donkeys and/or mules.[1296] At Seir al-Begh'er one can proceed further south along the Wadi as-Siyyagh for 1,8 km before heading eastwards along Wadi Marwan for approx. 3 km. This leads directly to the northern foothills of Jabal ed-Deir, thus back to the outskirts of Petra. However, these routes feature relatively high slope values as well and mostly run over volcanic stone. Most likely, the routes along Wadi Marwan and Wadi as-Siyyagh were therefore not heavily traveled. There may have been a possible pass from Seir al-Begh'er continuing westwards along the Wadi as-Siyyagh coming across the spring of Amm Massemak and eventually leading to Dawrum Dey, but the present topography does not allow easy passage and involves partial climbing.

The Northern Routes from the Wadi Musa to the al-Farsh and al-Begh'ah Plains to Petra via Wadi al-Mu'aysirah, East and West

While following Naqb Slaysil may be the most direct way to reach the immediate Petra area from the Wadi Musa, it is also the most difficult route – particularly for camel caravans.[1297] This only highlights the importance of Naqb Abu Mrerah as it is the only route where natural conditions allow camels to pass from the Wadi Musa to the Petra area (FIG. 234).[1298] Heading north from Dawrum Dey, Naqb Abu Mrerah connects with Naqb al-Aqab before continuing through the western escarpment to the al-Farsh plain in the east from where it is comparatively easy to enter the Petra valley. Naqb Abu Mrerah has a total length of just under 4 km and features average slope values of 12,29 %. It mostly runs over limestone (71,60 %), followed by sandstone

1296 Ben David 2013, 276 and 2012, 21 claims that Naqb Seir al-Begh'er (considered as part of Naqb Slaysil) may be a *via sacra,* assuming one accepts the interpretation of the so called 'Pond Temple' as an actual temple as proposed by Lindner 2003a, 170–174; Lindner – Gunsam 1995a. Cf. chapter 5.

1297 Cf. Kennedy 2016a, 144–146; Ben David 2013, 275–276 and contrary to Kloner 1996, 129–132.

1298 On Naqb Abu Mrerah, see also Ben David 2013, 275–276.

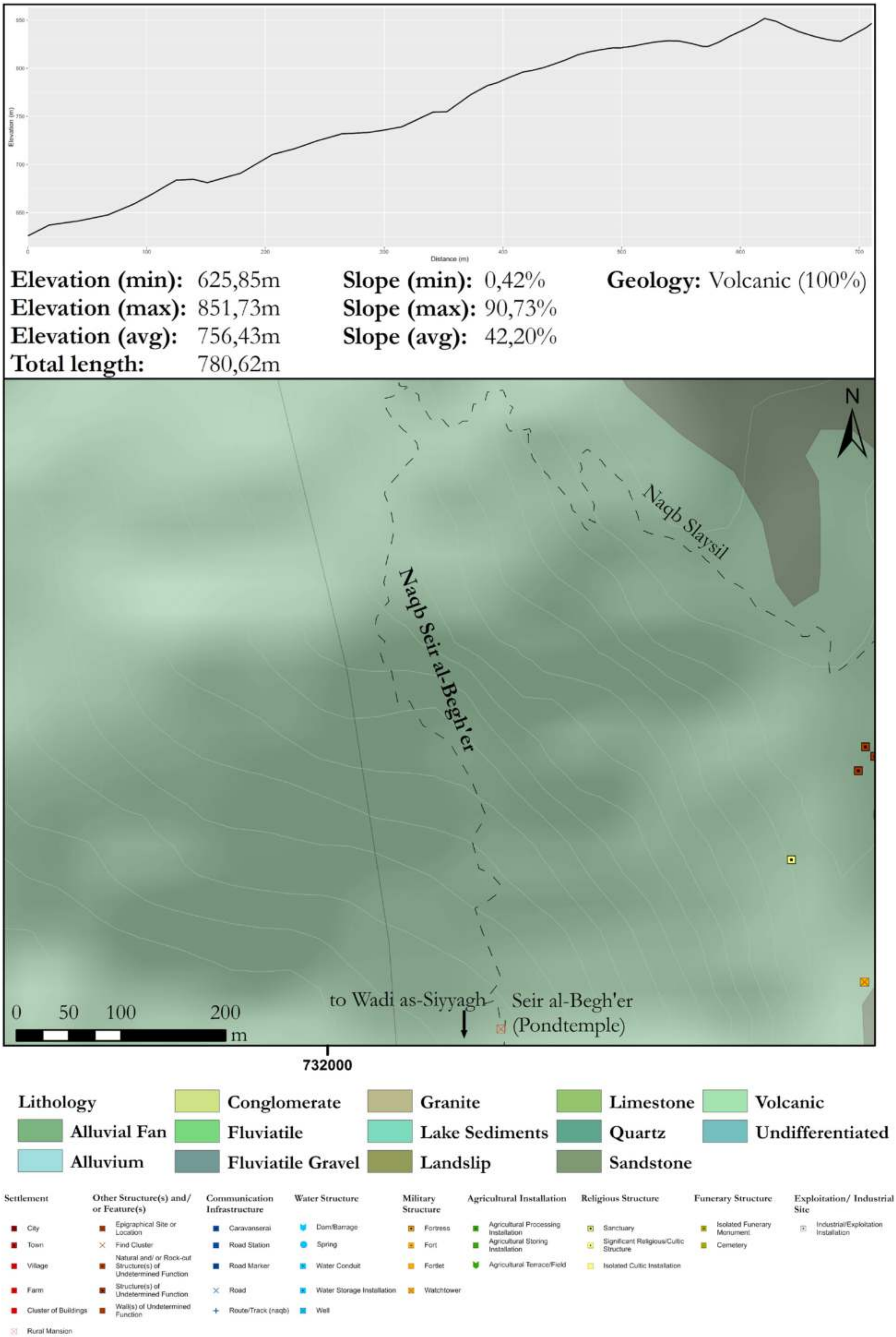


FIG. 233 The course of Naqb Seir al-Begh'er with elevation profile and the covered geological formations (in %).

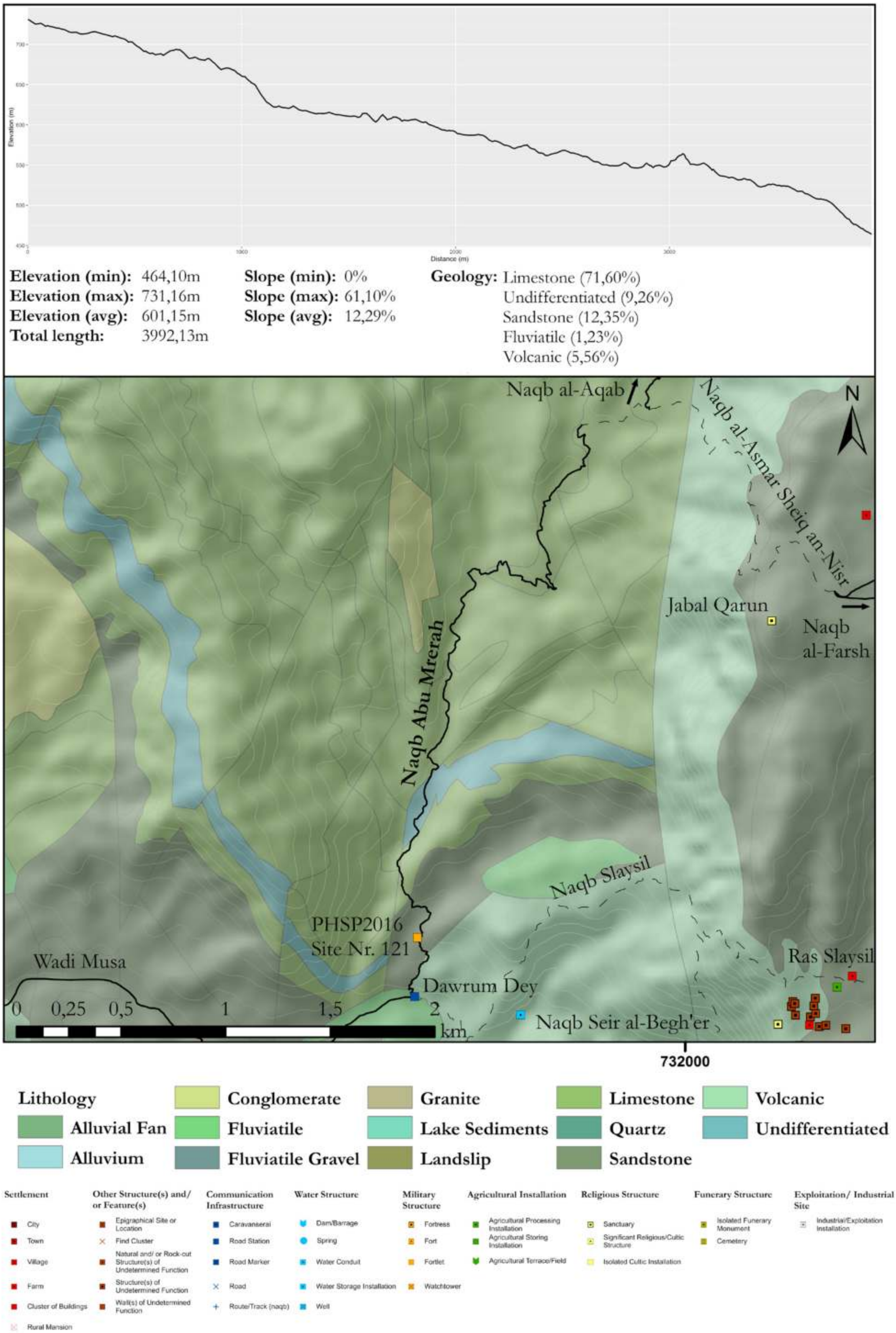


FIG. 234 The course of Naqb Abu Mrerah with elevation profile and the covered geological formations (in %).

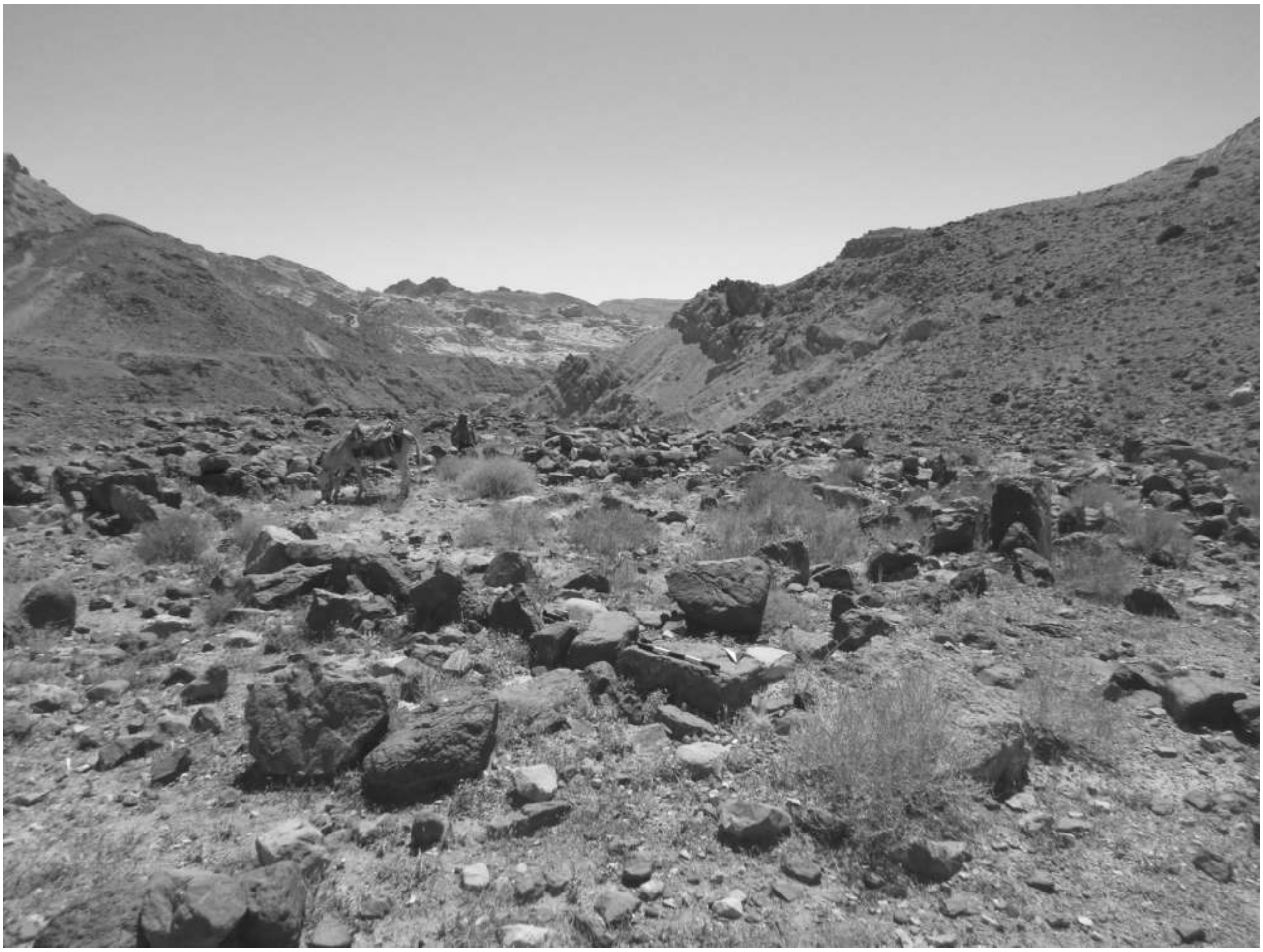


FIG. 235 Presumed Nabataean-Roman fortlet of Seil Abu Mrerah along Naqb Abu Mrerah. Dawrum Dey in the background to the south.

(12,35 %). Compared to Naqb Slaysil, only 5,56 % of the route passes over volcanic stone. The natural conditions are therefore significantly more favorable for both pedestrian and animal passage. About one kilometer from Dawrum Dey, Naqb Abu Mrerah approaches the presumed Nabataean-Roman fortlet/road station at Seil Abu Mrerah[1299] (PHSP Site No. 121) (FIG. 235). The PHSP also recorded several structures of undetermined function (PHSP Site No. 122) a few hundred meters further along. These may represent an ancient campsite. Proceeding further, the route encounters a presumed watchtower (PHSP Site No. 123) after approx. 2,3 km. No dating material was noticed on the surface, but as it lies well within the visibility field of other military structures in the immediate vicinity that date to the first centuries BC and AD (cf. chapter 7). Only a few hundred meters further, at least two circular stone enclosures were observed in the wadi bed below the actual naqb as well as one possible grave site on the ridge immediately along the route (PHSP Site No. 124). Another conglomeration of several structures of undetermined function (PHSP Site No. 125) appear a few hundred meters further along, which may also represent an ancient camp site.[1300] Just after PHSP Site No. 125, Naqb Abu Mrerah intersects with Naqb al-Aqab and Naqb al-Asmar Sheiq an-Nisr. While Naqb al-Aqab continues the northern course, Naqb al-Asmar Sheiq an-Nisr cuts directly through the al-Somrah in an eastern direction, zig-zagging its way up to the al-Farsh plain at the foothills of Jabal Qarun and the presumed sanctuary on top of the hill (PHSP Site No. 054) (cf. chapter 8) (FIG. 236). Naqb al-Asmar Sheiq an-Nisr has a total length of 2,70 km starting around 765 m a.s.l. and ending at 114,84 m a.s.l. on the al-Farsh plain where it joins with Naqb al-Aqab and Naqb al-Farsh (see below) (FIG. 237).

Like Naqb Slaysil, a large portion of the route runs over volcanic stone (36,84 %) where it features

1299 This structure is presumably also meant by Ben David 2013, 275 describing that "[…] *about 300 meters north of Wadi Musa there is a 12 × 12 meter structure with a scatter of ceramic material dating from the first to third centuries AD.*"

1300 The area between PHSP Site No. 124 and 125 is also referred to as 'al-Hammade al-Somrah.'

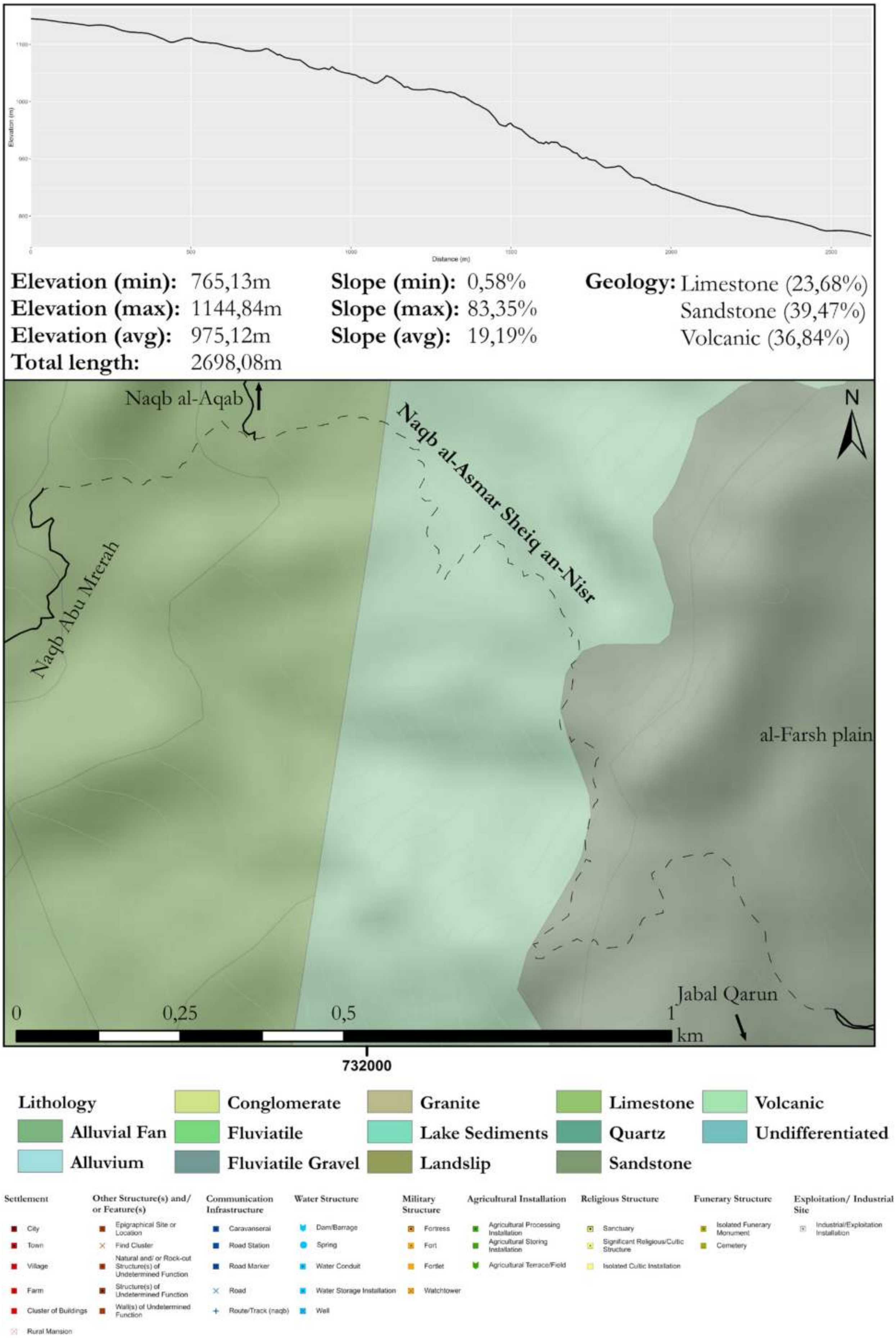


FIG. 236 The course of Naqb al-Asmar Sheiq an-Nisr with elevation profile and the covered geological formations (in %).

FIG. 237 View from the intersection with Naqb Abu Mrerah and Naqb al-Aqab to the steep ascent of Naqb al-Asmar Sheiq an-Nisr through the volcanic al-Somrah.

its highest slope value of over 83 % (the average slope value being 19,19 %) as well. However, once the naqb reaches the al-Farsh plain at Jabal Qarun the slope values are relatively low and the route continues over limestone (23,68 %) and sandstone (39,47 %). While these parts of Naqb al-Asmar Sheiq an-Nisr are well-suited for animal and pedestrian travel, the western parts cutting through the steep slopes of the al-Somrah are particularly difficult for camels. Naqb al-Asmar Sheiq an-Nisr must therefore be considered a secondary route for donkeys, mules and pedestrian use only.

The main camel pass from Dawrum Dey and Naqb Abu Mreah continues instead via Naqb al-Aqab (FIG. 238):[1301] This naqb has a total length of 5,36 km and has an average slope value of 11,30 %, which is comparatively low. Leaving the intersection with Naqb Abu Mrerah and Naqb al-Asmar Sheiq an-Nisr, Naqb al-Aqab continues further north for approx. 1,1 km, crossing the gentle and moderate limestone slopes before heading east-northeast through the al-Somrah for approx. 1,4 km. It reaches the al-Farsh plain about two kilometers further north than Naqb al-Asmar Sheiq an-Nisr. It then heads southward for approximately 2,8 km until intersecting with Naqb al-Asmar Sheiq an-Nisr and Naqb al-Farsh just a few hundred meters northeast of Jabal Qarun. Approx. 900 m after Naqb al-Aqab reaches the al-Farsh plain, the route crosses PHSP Site No. 050-ST 077. This is a collapsed, irregularly shaped wall built around a natural depression at the foothills of a large sandstone outcrop, possibly serving as some sort of temporary shelter.[1302] Although no features were noticed on top of this outcrop, the traveler nevertheless enjoys an excellent view over Naqb al-Aqab, with Ras Namala to the north, the Wadi Arabah to the west, Jabal Qarun

1301 Due to time issues, Naqb al-Aqab was not walked by the author. Instead, the hand-held GPS device was given to Suleiman Mohammed al-Bdul, the local guide, who could trace it while the author mapped Naqb al-Asmar Sheiq an-Nisr. Ben David 2013, 275 confirms the general course of Naqb al-Aqab.

1302 Few surface sherds suggest a tentative dating of the site to the 1st century AD.

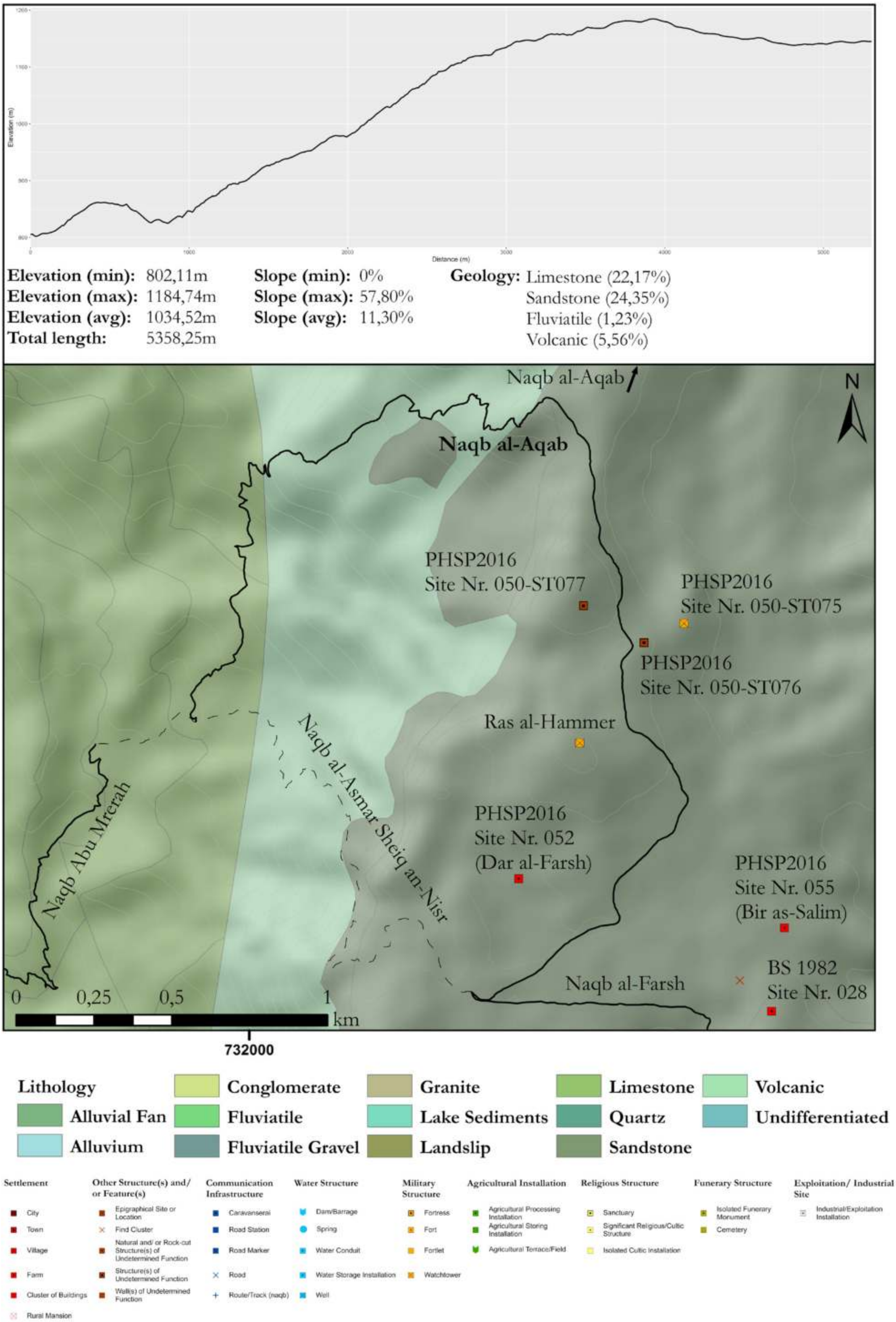


FIG. 238 The course of Naqb al-Aqab with elevation profile and the covered geological formations (in %).

FIG. 239 Possible watchtower at Ras al-Hamm'er overlooking the al-Farsh plain.

to the south and the entire al-Farsh plain to the east. Continuing a few hundred meters further south along Naqb al-Aqab, the PHSP documented a heavily disturbed squarish structure measuring ca. 2,5 m × 2 m (PHSP Site No. 050-ST076) as well. This may have functioned as a small shelter or relay station along Naqb al-Aqab.[1303] A small squarish structure is located approx. 150 m further northeast. This may be associated with the presumed relay station and interpreted as a signaling post or small watchtower overviewing the al-Farsh plain (PHSP Site No. 050-ST075).[1304] It is in good visual contact with the more substantially built watchtower of PHSP Site No. 051 at Ras al-Hamm'er, situated only 500 m further south from PHSP Site No. 050-ST076 (FIG. 239). From Ras al-Hamm' er, the presumed farm of PHSP Site No. 052, approx. 500 m further south-southwest, as well as the sanctuary on top of Jabal Qarun are also well visible. Additionally, a direct route possibly crossed the al-Farsh plain in an eastern direction from Ras al-Hamm'er, connecting two possible farms (BS Site No. 016 and 018), one possible camp site (BS Site No. 017) and one rock carving site. This may have led to Siq al-Amti (Beidha).[1305]

From the intersection of Naqb al-Asmar Sheiq an-Nisr and Naqb al-Aqab just south of PHSP Site No. 052, Naqb al-Farsh leads southwards back to the Beidha plain and the immediate surroundings of Petra (FIG. 240). With a total length of approx. 4,5 km, Naqb al-Farsh is one of the most comfortable routes to pass in the Petra region (FIG. 241). It has an average slope value of 9,43 % and runs completely over sandstone. Approximately 2,3 km after leaving the intersection with Naqb al-Asmar Sheiq an-Nisr and Naqb al-Aqab, Naqb al-Farsh arrives at the sanctuary of en-Nu'eira (PHSP Site No. 132) (cf. chapter 8). Immediately north of the sanctuary, Wadi Siq al-Ghurab North (FIG. 242) connects Naqb al-Farsh with Siq al-Amti (Beidha) and eventually Naqb Namala.[1306] After approx. one kilometer south of en-Nu'eira, Naqb al-Farsh passes three Nabataean-Roman farms before crossing Wadi al-Ghurab South.[1307] From the Wadi al-Ghurab South intersection, the naqb then heads slightly southeast, joining the eastern beginning of Naqb Slaysil (beginning of Wadi Slaysil) after approx. one kilometer. From there, the route turns eastwards passing two structures of undetermined function (PHSP Site No. 094 and 095) before reaching the site of Shammasa in the al-Begh'ah

1303 Few surface sherds suggest a tentative dating of the site to the 1st century AD.
1304 No surface material was noticed at this structure.
1305 However, this was not systematically researched and requires further verification in the field. For more information on the sites along the presumed route to Siq al-Amti, see Banning – Köhler-Rollefson 1983, 381.
1306 See also Zayadine 1992, 223–224.
1307 The presumed farm sites are BS Site No. 004 (Banning – Köhler-Rollefson 1983, 379), PHSP Site No. 073 (Hauth al-Heleni) and PHSP Site No. 011-ST024.

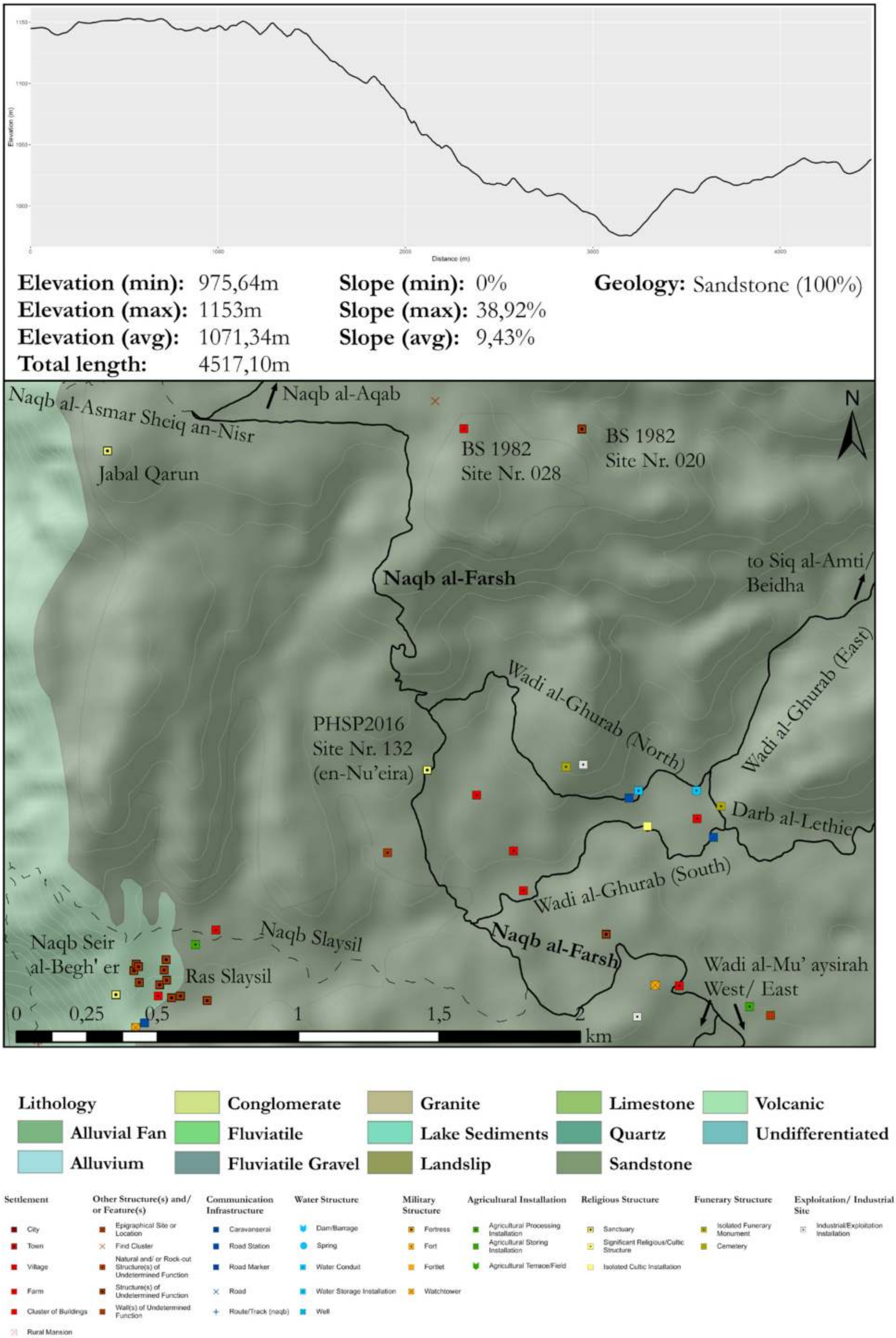


FIG. 240 The course of Naqb al-Farsh with elevation profile and the covered geological formations (in %).

FIG. 241 The easy crossing of the al-Farsh plain via Naqb al-Farsh.

plain (cf. FIG. 179). At Shammasa (cf. chapter 5), Naqb al-Farsh meets with the Wadi al-Mu'aysirah East and Wadi al-Mu'aysirah West routes, which were intensively surveyed by the *Petra Routes Project* (PRP).[1308] Wadi al-Mu'aysirah West (FIG. 243) has a total length of approx. four kilometers and follows the small canyon south-southwest of Shammasa. It runs completely over sandstone with an average slope value of 11,57 %.[1309]

Following the route south from Shammasa, it crosses Wadi Marwan after c. 800 m, which heads down the wadi in a south-western direction eventually meeting with the Wadi as-Siyyagh below. Some 500 m further along Wadi al-Mu'aysirah West, the route passes the rectangular structure of PHSP Site No. 005-ST020 to the west, which may have served as a Nabataean-Roman watchtower as it provides an excellent view over the Wadi Marwan and the entire al-Begh'ah plain with Shammasa to the north. Another 700 m along Wadi al-Mu'aysirah West, PHSP Site No. 005-ST021 is situated immediately west of the route. This site describes an already well-known rock-cut *stibadium* complex (cf. chapter 8), which marks the beginning of a wider rock-cut route (FIG. 244).[1310] From this point, the rock-cut route can be traced along the entire course of Wadi al-Mu'aysirah West. Immediately after the *stibadium*, PHSP Site No. 043 is situated somewhat elevated along the eastern edges of the sandstone cliffs that form the eastern limits of the canyon of Wadi al-Mu'aysirah West. While this site is hidden from the main course of the route, it nevertheless holds good visual control of any activities below. The site consists of six holes carved in the sandstone surface, which most likely served as peg-holes for a temporary, tent-like installation (cf. chapter 4).[1311]

Shortly after PHSP Site No. 043, Wadi al-Mu'aysirah West could have been temporarily blocked

1308 Generally on the PRP, see Berenfeld et al. 2016 and Rojas – Berenfeld 2012.

1309 Note that the maximal slope value of 118,73 % of Wadi al-Mu'aysirah West is unrealistically high. This may be due to some marginal error while tracking the route in the field. The high maximal slope value therefore also explains the high average slope value. In reality, the slope values of the route are much smaller.

1310 Tholbecq 2018, 22–24. Cf. also Berenfeld et al. 2016 although the PRP does not mention the *stibadium*.

1311 Kennedy 2016a, 147–150.

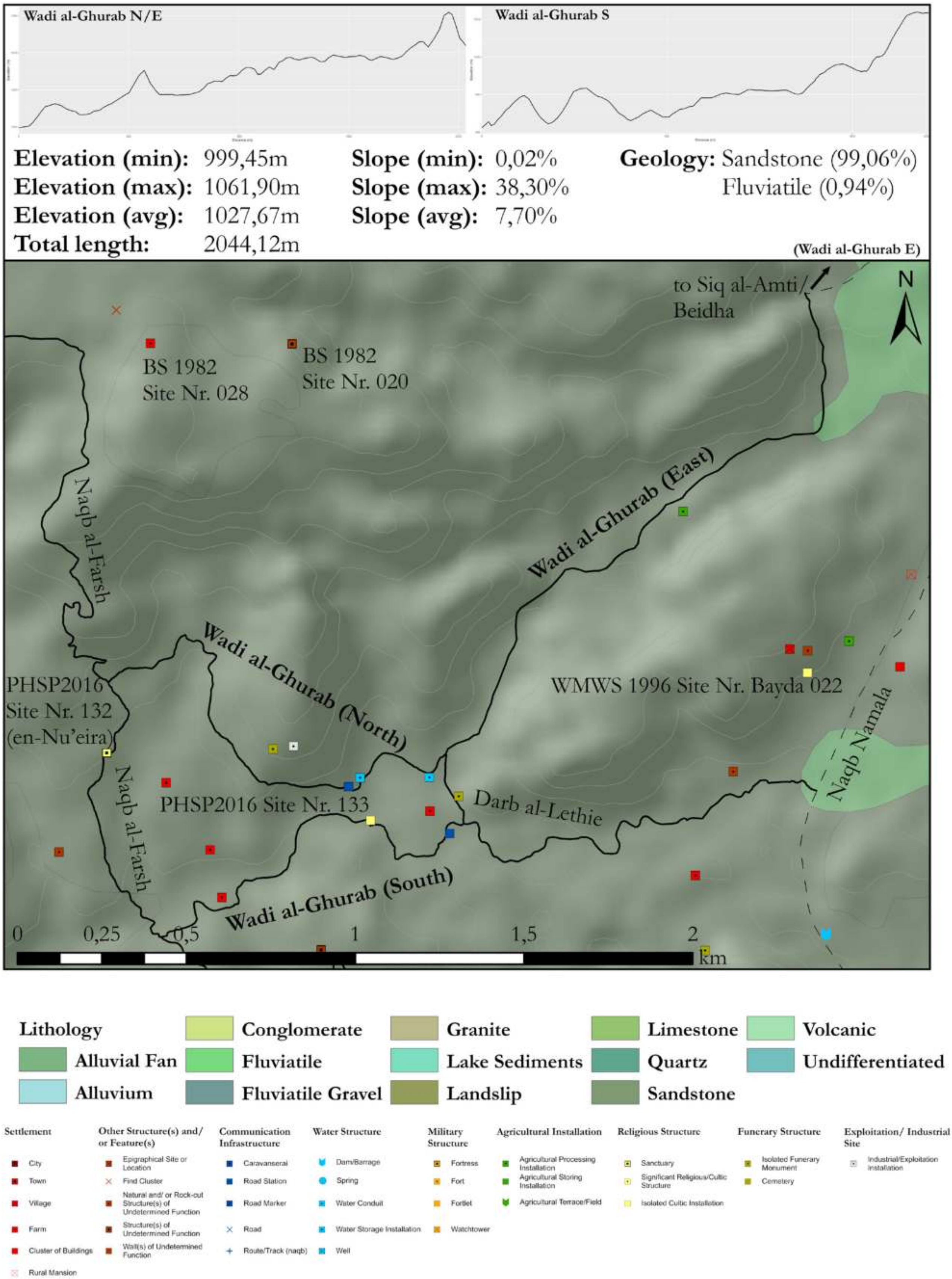


FIG. 242 The course of Wadi Siq al-Ghurab North, East and South with elevation profiles and the covered geological formations (in %).

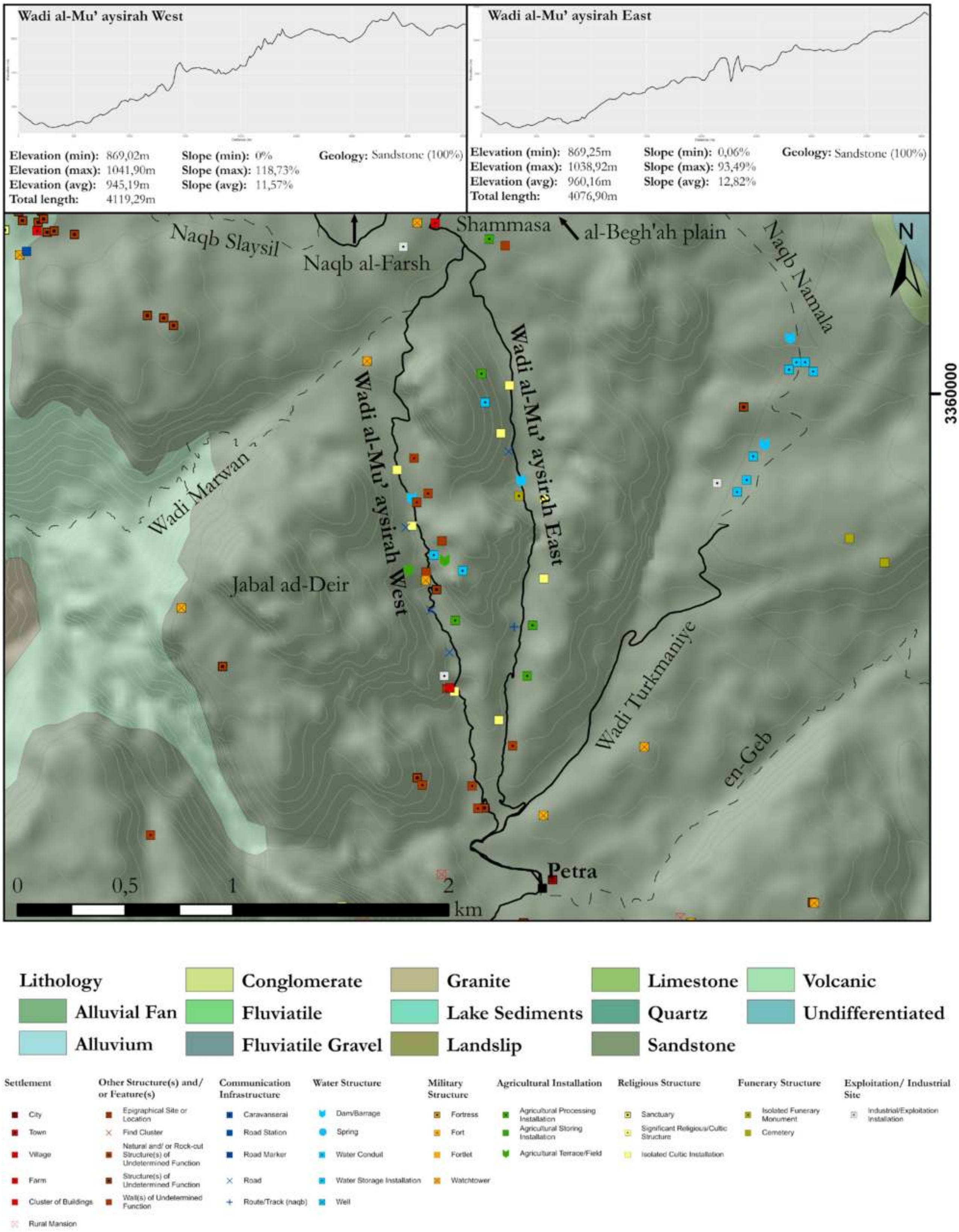


FIG. 243 The course of Wadi al-Mu'aysirah East and West with elevation profiles and the covered geological formations (in %).

FIG. 244 Rock-cut *stibadium* along Wadi al-Mu'aysirah West.

by a massive wall (PHSP Site No. 043-ST070) that closed the course of the route (FIG. 245). While only the eastern remains of the collapsed wall are still visible, traces of rock-cut 'steps' can be observed on the other side of the canyon (only about 1,5 m wide at this point).[1312] These could have served as a supporting surface for built sections of the wall over the wadi. A functionally undetermined structure is situated on a slightly higher sandstone outcrop immediately to the north-west of the wall, accessible by a series of rock-cut steps. Several built structures with Nabataean-Roman surface pottery were noticed directly to the south of the wall as well.[1313] The function of these structures remains unclear. According to Berenfeld et al., these structures and the wall itself belong to a larger agricultural area in this part of Wadi al-Mu'aysirah West characterized by several retaining walls for maintaining agricultural terraces.[1314] The wall is considered to be the most massive terracing wall in the area, built for redirecting water through channels and cisterns towards the agricultural terraces north and south of the wall.[1315] However, if the wall should indeed be a terrace wall, this would have impeded travel along Wadi al-Mu'aysirah West significantly, forcing by-passers to temporarily leave the wadi bed and continue along high ground to the west. This would mean that Wadi al-Mu'aysirah West did not serve larger caravans, but functioned as a small-scale and local communication route between Petra and the al-Begh'ah plain. In any case, Wadi al-Mu'aysirah West continues south for another two kilometers until it reaches the northern wadi bed of the Wadi Musa in Petra's city center, immediately opposite the Qasr al-Bint at the functionally undetermined structure of PHSP Site No. 057.

As Wadi al-Mu'aysirah West, Wadi al-Mu'aysirah East runs through a small canyon along the western foothills of Jabal ad-Deir from Shammasa to Petra's city center (cf. FIG. 243). It is also approx. four kilom-

1312 This dry wall is constructed by irregularly shaped sandstone ashlars and is approx. three meters wide and two meters high.

1313 Surface pottery finds range from the 1st to the 4th centuries AD.

1314 Berenfeld et al. 2016, 90–92.

1315 Berenfeld et al. 2016, 90–91.

FIG. 245 Massive wall of PHSP Site No. 043-ST070 potentially blocking off Wadi al-Mu'aysirah West and serving as an agricultural terrace/dam wall.

eters long, with an average slope value of 12,82 % and runs completely over sandstone.[1316] The PRP surveyed a significant number of sites along its course. These include water structures (water channels and cisterns), agricultural installations (agricultural terraces and wine presses),[1317] rock-cut tomb facades,[1318] isolated cultic installations such as *baetyli* and *nephesh*, epigraphical sites[1319] and small quarries, as well as natural and/or rock-cut structures of undetermined function (mostly caves, which may have been used for domestic purposes). The formal analysis of the natural landscape factors of both Wadi al-Mu'aysirah East and West may seem favorable for larger camel traffic, but both wadis grow steeper and in parts also very narrow, therefore only allowing pedestrian, goat, sheep, donkeys and/or mules to pass.[1320] While both routes certainly had a secular function, the fact that Wadi al-Mu'aysirah East and West pass various cultic installations has led to the suggestion that the routes served as processional ways for locals as well.[1321]

The Southern Routes from Petra via the as-Sto'e and al-Farasha Plains to Sabra and Abu Khusheiba

After entering the urban limits of Petra from the north and continuing south-southwest towards Sabra and Abu Khusheiba, the ancient traveler passed through the as-Sto'e and al-Farasha plains via the northern and southern as-Sto'e routes (cf. above). Proceeding through the southern as-Sto'e route, the descent down Wadi Sabra (FIG. 246) begins at Ras Sabra

1316 As with Wadi al-Mu'aysirah West, note that the maximal slope value of 93,49 % of Wadi al-Mu'aysirah East is unrealistically high. This may be due to some marginal error while tracking the route in the field. The high maximal slope value therefore also explains the high average slope value. In reality, the slope values of the route are much smaller.

1317 Berenfeld et al. 2016, 87–94.

1318 Berenfeld et al. 2016, 94.

1319 Berenfeld et al. 2016, 95–100.

1320 Cf. also Berenfeld et al. 2016, 87.

1321 Berenfeld et al. 2016; Ynnilä 2013, 265; Rojas – Berenfeld 2012, 155. On the cultic installations along Wadi al-Mu'aysirah East and West, see chapter 8.

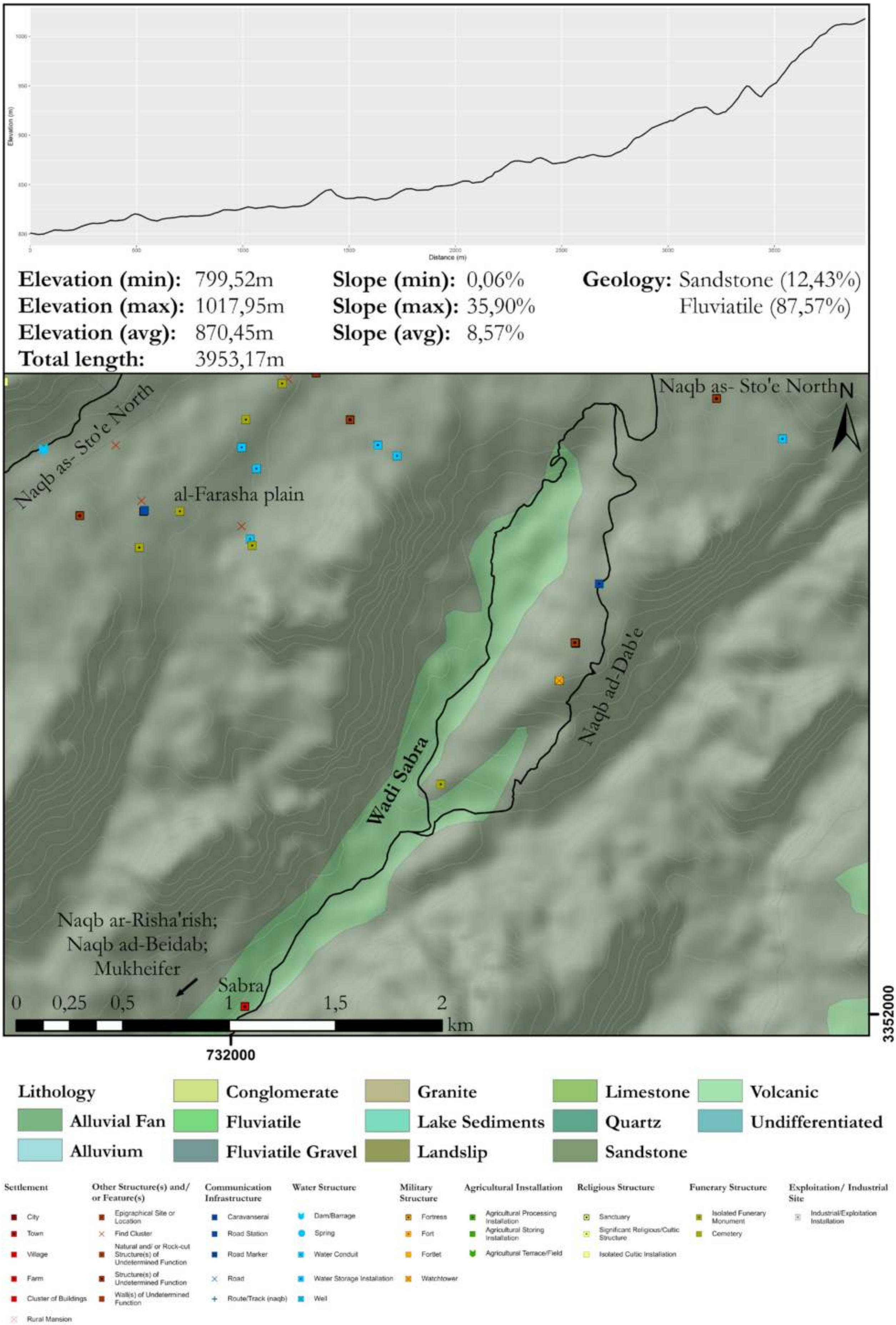


FIG. 246 The course of Wadi Sabra with elevation profile and the covered geological formations (in %).

FIG. 247 View of the descent of Wadi Sabra. View to the southwest.

and the heavily collapsed structure of undetermined function PHSP Site No. 017. A large amount of Nabataean-Roman surface pottery was noticed at the site and its location at the intersection between the southern as-Sto'e route and Wadi Sabra may suggest that the structure was once a small relay station. From there, Wadi Sabra begins its descent towards Sabra at 1017,95 m a. s. l..[1322] The wadi follows the natural topography with an average slope value of 8,57 % in southwestern direction before reaching Sabra after approximately four kilometers at c. 800 m a. s. l. (FIG. 247). As the route follows the natural course of the wadi, it mainly runs over fluviatile soils (87,57 % coverage). The remaining parts of the route cover sandstone. Such natural landscape conditions favor all modes of travel – including that of camel caravans. In addition to occasional walls potentially forming part of the ancient route, no significant archaeological features were noticed along the route instead of PHSP Site Nos. 038-ST047 and ST048. After passing through Wadi Sabra for approx. 2,3 km from Ras Sabra, PHSP Site No. 038-ST047 is situated high above the eastern wadi bed on a sandstone ridge with an excellent view over the entire wadi. The same applies to PHSP Site No. 038-ST048, which is located immediately opposite of PHSP Site No. 038-ST047 on the western ridge. PHSP Site No. 038-ST047 (FIG. 248) is a heavily disturbed, cairn-like structure consisting of numerous sandstone and quartz blocks of irregular form and size. In contrast, PHSP Site No. 038-ST048 is more rectangular, although this structure is also heavily disturbed and wall features are barely noticeable. Surface pottery tentatively dates both structures to the Nabataean-Roman periods and due to their strategic position overlooking the entire Wadi Sabra, they may be interpreted as watchtowers or signaling posts. However, as no plan can be discerned for PHSP Site No. 038-ST047 and due to its cairn-like character, it seems more likely to consider it as a burial site.

Instead of taking the direct way to Sabra from the al-Farasha plain via Wadi Sabra, an alternative route continues the branch of the southern as-Sto'e route

1322 Ben David 2012, 21. At some sections Wadi Sabra reaches a width of 4 m.

FIG. 248 Possible burial site of PHSP Site No. 038-ST047 on a high ridge along Wadi Sabra.

for ca. 1,5 km further south from Ras Sabra. Shortly before passing the presumed watchtower of PHSP Site No. 018-ST027 on the ad-Dab'e plateau above, Naqb ad-Dab'e (FIG. 249) continues the south-southwestern descent and meets with Wadi Sabra just south of PHSP Site No. 038-ST048. The total length of Naqb ad-Dab'e is only 1,5 km, but the route still shows well-preserved walls that delineate the course of the naqb (cf. FIG. 202). The average slope value is 15,95 % and the majority of the route passes over sandstone. The rest is fluviatile. Naqb ad-Dab'e was therefore suitable for all travel modes as well.

From Sabra, the Wadi Sabra continues along its south-southwestern course.[1323] Approximately one kilometer southwest of Sabra, Naqb ad-Beidab crosses over steep slopes and runs in west-northwestern direction connecting Sabra with Abu Khusheiba (FIG. 250).[1324] The total length of Naqb ad-Beidab is approx. 3,8 km with average slope values of 12,49 %. It runs mostly over sandstone (66,27 % of total coverage). Although the second most frequented geological formation is the volcanic al-Somrah (25,90 % coverage), the overall advantageous natural landscape conditions suggests that Naqb ad-Beidab was suited for camel-based travel and therefore most likely served as a local connecting route between Sabra and Abu Khusheiba.[1325] Once at Abu Khusheiba, it is possible to reach the wider alluvial plain of the Arabah through Wadi Abu Kusheiba.[1326] From there it is easy to connect with the Umm Qamar or Wadi Jawf Ahmar pass to the north, which eventually led to Khirbet as-Faysif.

The most direct way to reach Abu Khusheiba from the immediate Petra region is to descend Wadi Abu Khusheiba from the east, starting from the southern branch of the northern as-Sto'e route just south of Jabal al-Farasha. Traditionally, it was assumed that the main

1323 From the point south of Sabra, the continued southern route is referred to as Naqb ar-Risha'rish.

1324 The author could not validate Naqb ad-Beidab in the field. The course of this route is based on information provided by local guides and the analysis of satellite imagery.

1325 Naqb ad-Beidab could have served for transporting copper from Umm al-'Amad between Abu Khusheiba and Sabra as copper slags were observed at both sites (Lindner 2003a, 91–98).

1326 According to Zayadine 1992, 226, Abu Khusheiba served as a larger relay station between the copper mines of Umm al-'Amad and Petra.

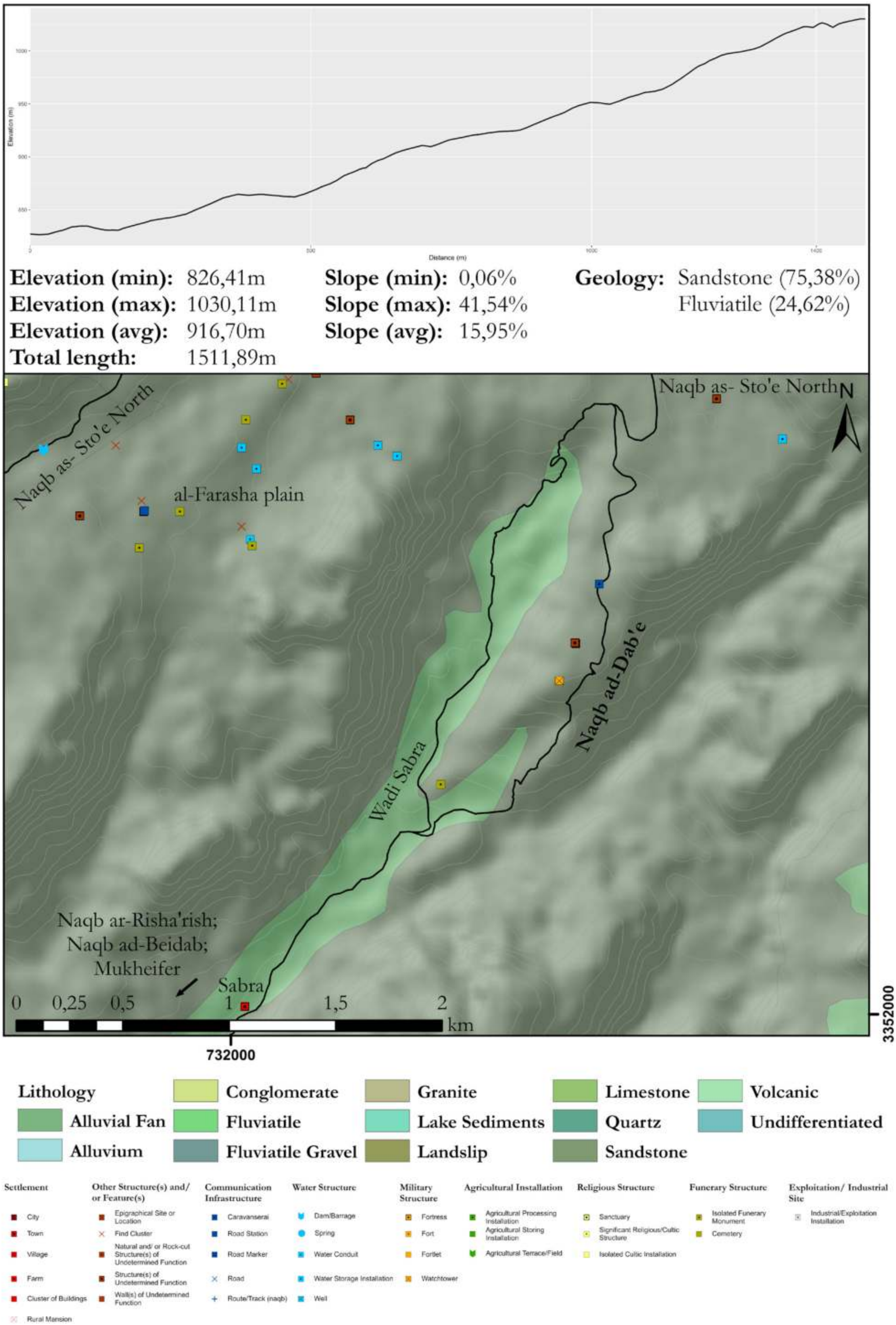


FIG. 249 The course of Naqb ad-Dab'e with elevation profile and the covered geological formations (in %).

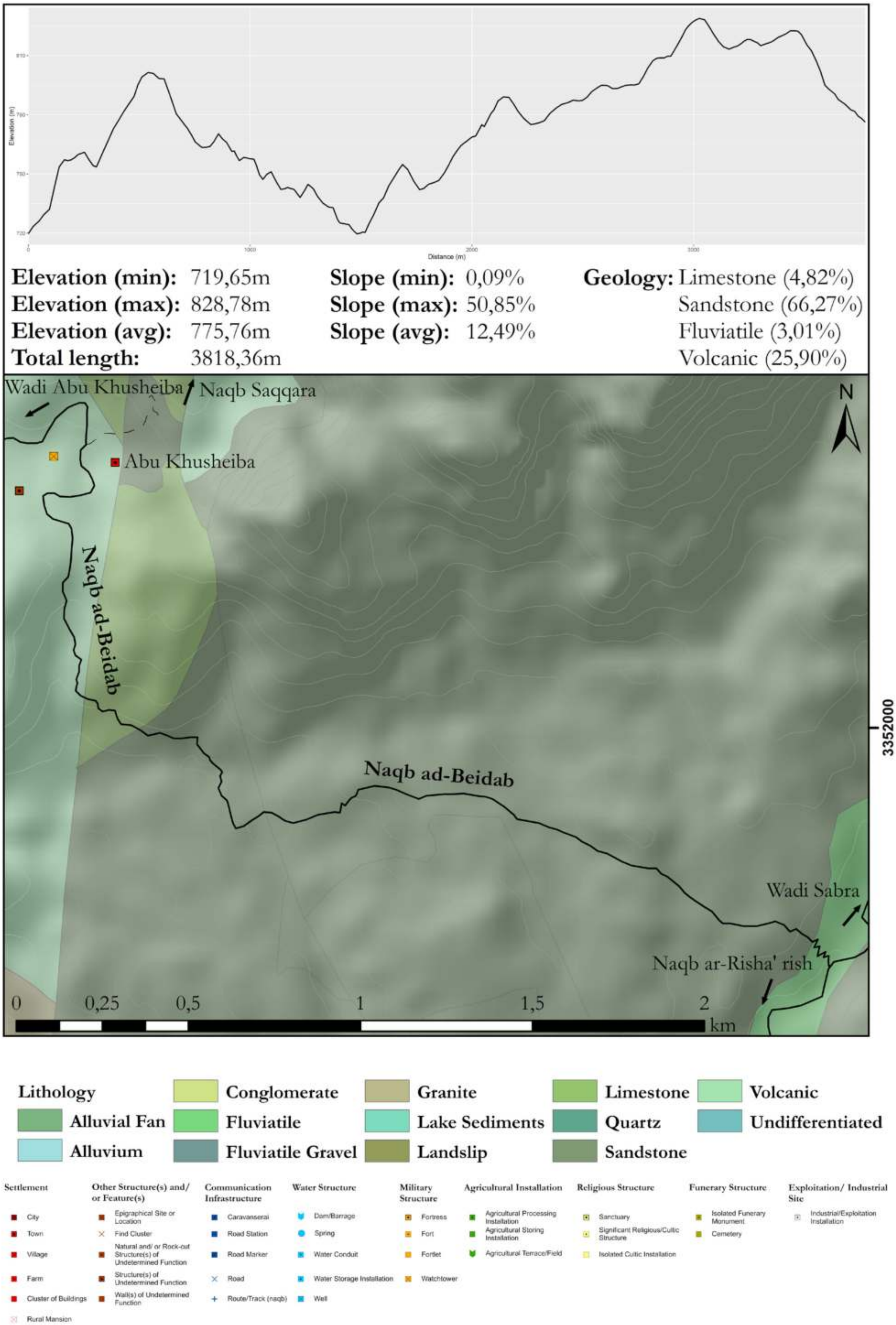


FIG. 250 The course of Naqb ad-Beidab with elevation profile and the covered geological formations (in %).

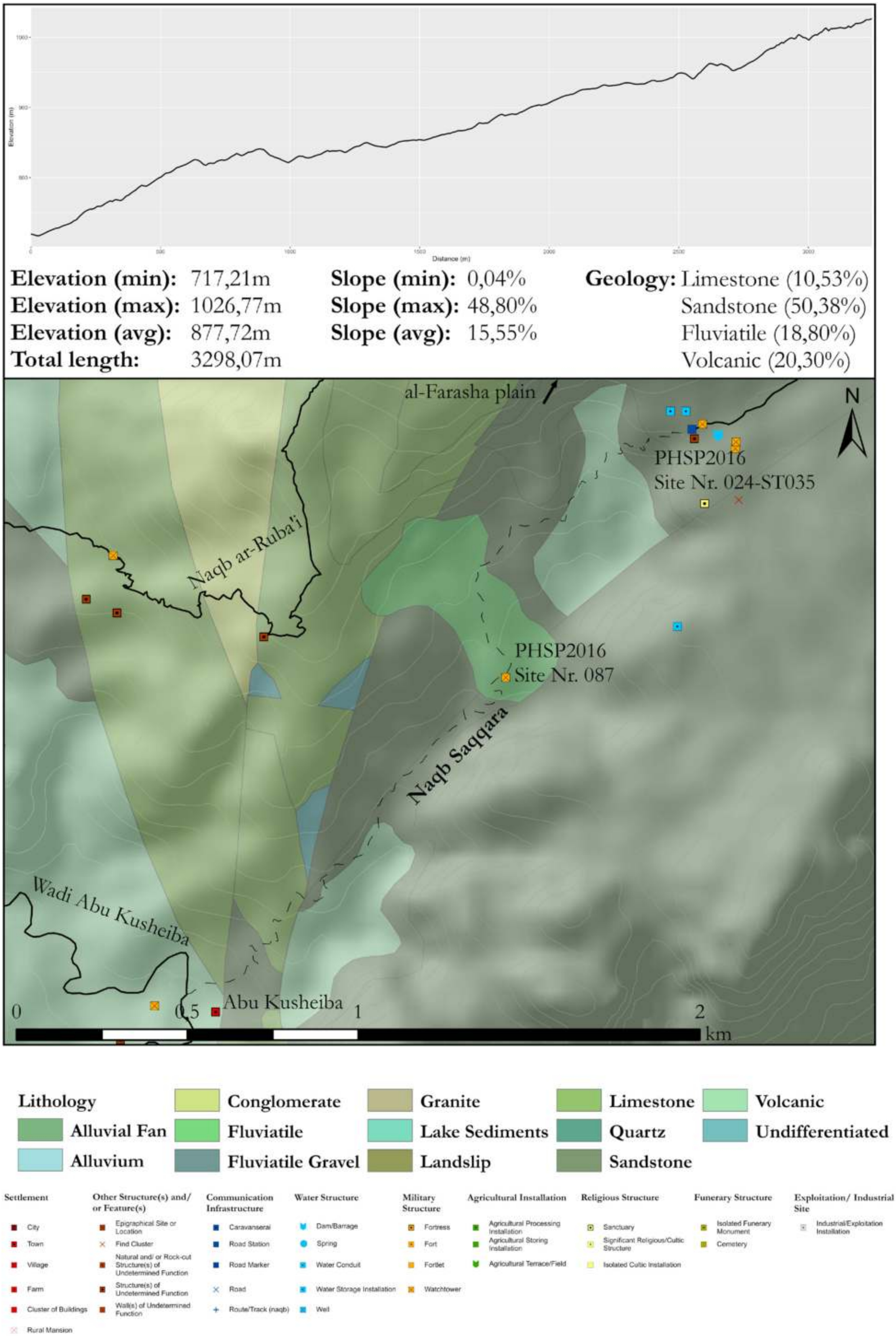


FIG. 251 The course of Naqb Saqqara with elevation profile and the covered geological formations (in %).

FIG. 252 Naqb Saqqara leading from Abu Khusheiba up to the al-Farasha plain. View to the west.

route descending westwards from Petra was via Wadi Abu Khusheiba.[1327] This approx. 3,3 km long route is commonly known as Naqb Saqqara and follows the natural course of the wadi (FIGS. 251 and 252). Singular dry-stone walls running slightly higher than the actual wadi bed still delineate the presumed course of the route. This route has an average slope value of 15,55 % and mostly runs over sandstone (50,38 % total coverage).[1328] However, 20,30 % of the route crosses the al-Somrah. Naqb Saqqara therefore does not qualify as a major camel route, but was potentially used primarily as a donkey and/or mule track. Ynnilä mentions a junction of three routes at the top of Wadi Saqqara: one being Naqb Saqqara itself, the second a route back towards Petra (referred to as Wadi ʾIyal ʾId, which must correspond to the southern branch of the northern as-Stoʾe route), and another route passing the western foothills of Jabal Harun.[1329] The latter is most likely the stretch of the northern as-Stoʾe route leading to Ras al-Ghirbe.

Finally, there is another route that continues from Wadi Sabra connecting Sabra with the more extended hinterland to the south. This route is referred to as Naqb ar-Rishaʾ rish which eventually connected Sabra with the Nabataean settlement of as-Sadeh, c. 11 km further south (FIG. 253).[1330] The route has an average slope value of 10,52 % and runs predominantly over sandstone (48,21 %) and fluviatile (38,97 %). It may therefore be assumed that Naqb ar-Rishaʾ rish is well suited for larger camel-based travel. To date, Naqb ar-Rishaʾrish is the only route that connected Sabra with the south, which is of major infrastructural impor-

1327 Ynnilä 2013, 255; Ben David 2007, 104–106; Lindner 2003a, 63–65 and 1992b, 266; Zayadine 1992, 225–226; Jarvis 1940, 139.

1328 Ben David 2007, 108 confirms the passage from Abu Khusheiba to the al-Farasha plain via Naqb Saqqara. However, he also notes that the naqb is one of the most comfortable routes based on a presumed vertical ascent of only 300 m. He is most likely referring to a different course of Naqb Saqqara.

1329 Ynnilä 2013, 263.

1330 The author could not validate Naqb ar-Rishaʾrish in the field. The course of this route is based on information provided by local guides and the analysis of satellite imagery. This may explain potential errors in the reconstruction of the exact course of the route. Also note that the southern half does not show any geological information as the required geological map of the region was not available to this study (cf. chapter 2). Geological information could therefore only be extracted along the first 4,2 km of Naqb ar-Rishaʾrish.

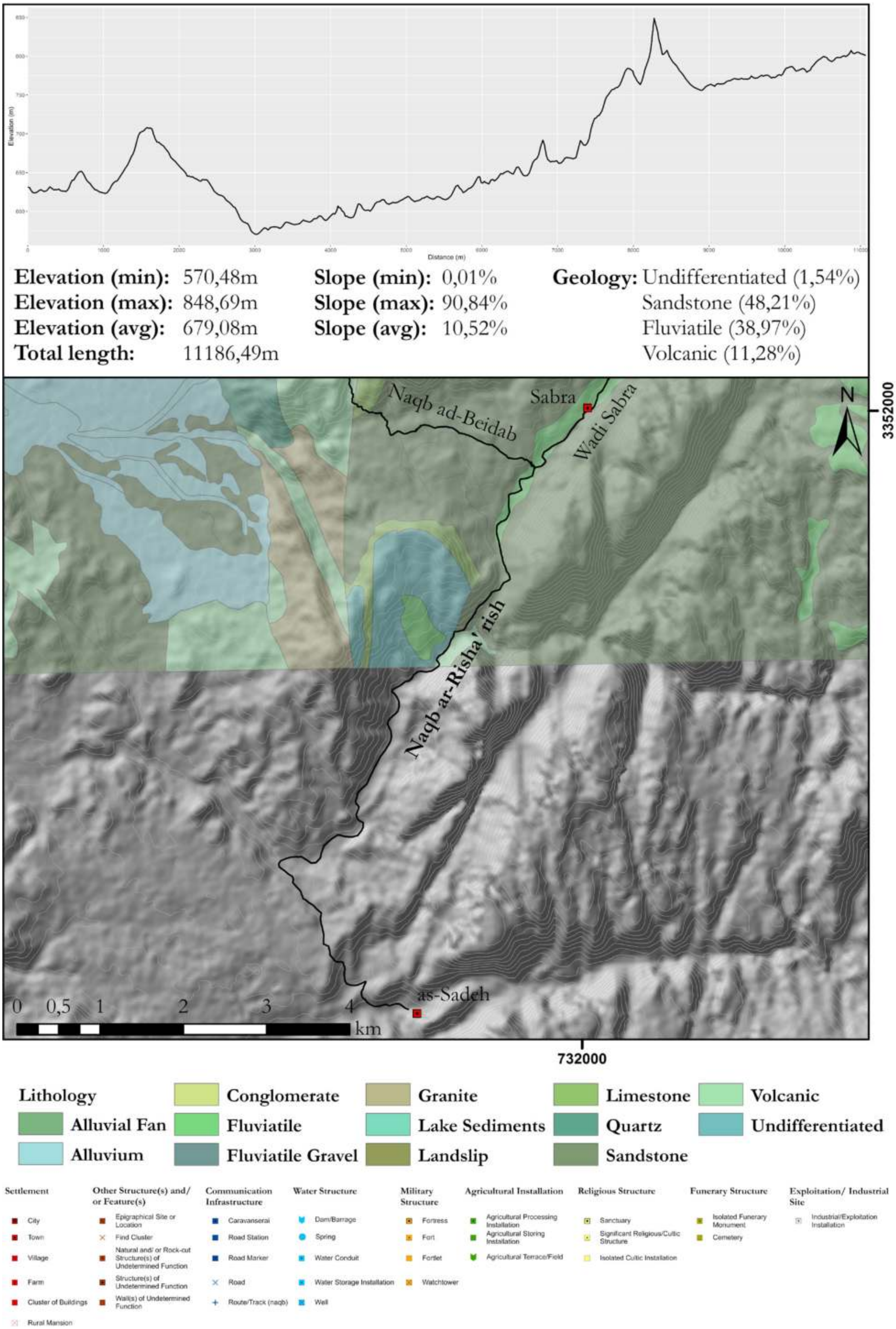


FIG. 253 The course of Naqb ar-Risha' rish with elevation profile and the covered geological formations (in %).

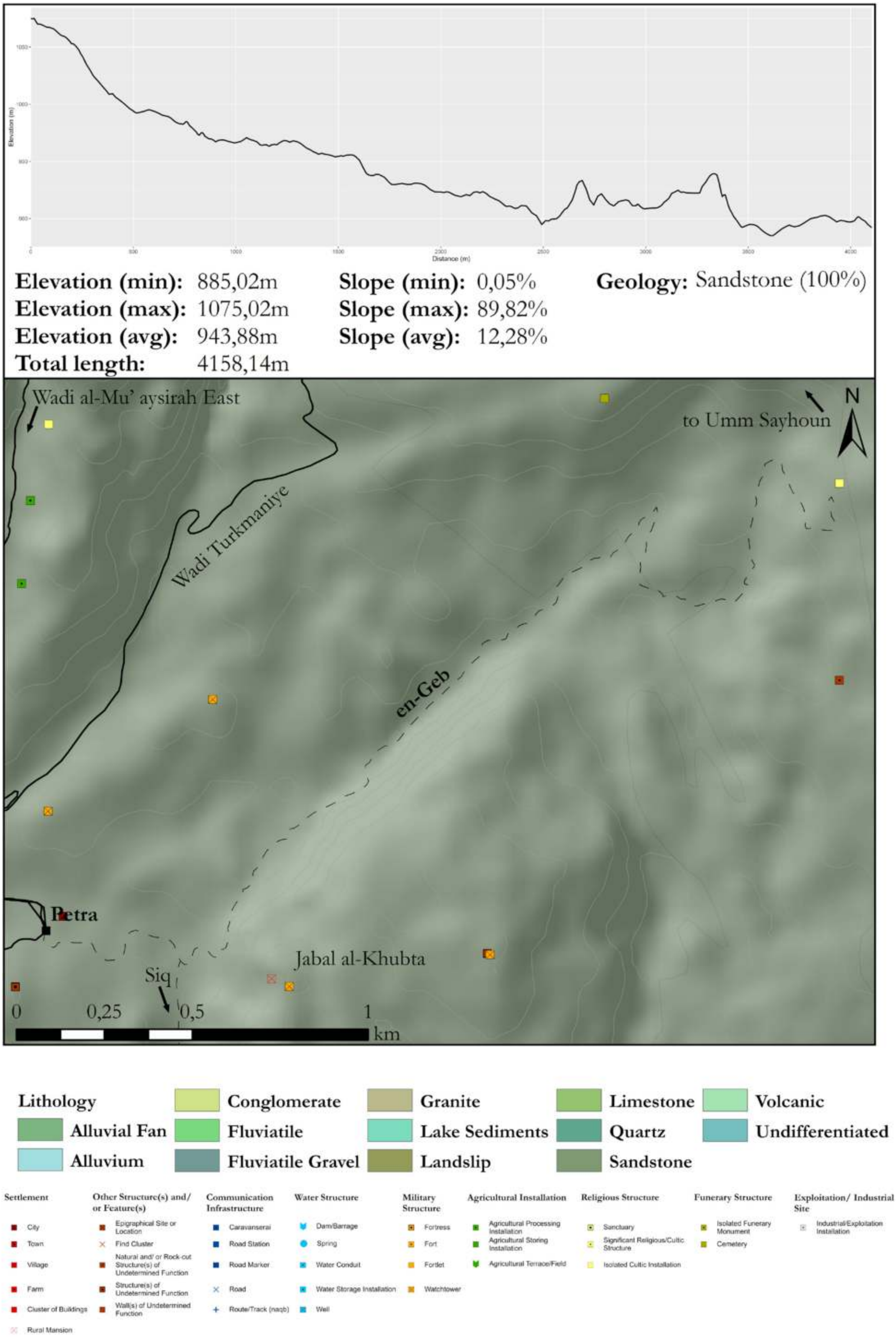


FIG. 254 The course of the en-Geb pass with elevation profile and the covered geological formations (in %).

FIG. 255 Overview of the en-Geb pass. View of Petra towards the south.

tance for the site: Once at as-Sadeh, major camel caravan routes could have continued south to Humeima (ancient Hawara) and eventually to Aqaba (ancient Aila).[1331] Rather than taking the direct route north of Humeima, it was also possible to take the camel routes to Sabra via as-Sadeh, and from there eventually to Petra. Naqb ar-Risha' rish connected Sabra with the major north-south routes in the Wadi Arabah as well. From there it was possible to access the main Petra–Gaza road via Qasr at-Tayyiba, Khirbet as-Faysif and beyond. Acknowledging this high level of infrastructural integration into the supraregional communication network, Sabra was therefore of crucial important.

Accessing Petra from the East

There are only two routes leading into Petra from the east that are currently known. The most southern route is the well-known Siq entrance.

Starting from lower Wadi Musa (ancient Gaia), the Siq reaches the city center after approx. 7,2 km. It has an average slope value of 10,18 % and mostly runs over sandstone (43,69 %) and landslip (39,69 %). The numerous *baetyli* and commemorative inscriptions as well as monumental tombs, particularly the famous al-Khazne monument, suggest that the Siq was used for representative purposes and did not have any infrastructural significance other than offering a comfortable and representative access for visitors.[1332]

The second eastern route leading into Petra begins after following the modern Wadi Musa–Umm Sayhoun road for approx. 1,7 km towards Umm Sayhoun. There, an eroded path was carved into the natural bedrock descending southwestwards to Petra. Following the northern foothills of the Jabal al-Khubtah, this route (referred to as the en-Geb pass), is just over four kilometers long with an average slope value of 12,28 % (FIG. 254). It runs completely over sandstone.

Beginning near a *triclinium* with an associated shaft tomb and cultic niche (WMWS 1996 Site Umm Sayhoun 1)[1333], the en-Geb pass crosses a small room carved high into the natural bedrock cliff, which was

1331 Lindner 2003a, 29–54.
1332 The paving of the Siq dates after the annexation in 106 AD. Before, the Siq and (Roman) colonnaded street in downtown Petra was a mere gravel path. See e. g. Fiema 2003, 47–48. The impracticality of the Siq was also observed by T. E. Lawrence when writing to E. T. Leeds in February 1914 and noticing that only one camel at the time could fit through the Siq gorge: "*Petra, O Leeds, is the most wonderful place in the world, not for the sake of its ruins, which are quite a secondary affair, but for the colour of its rocks, all red and black and gray with streaks of green and blue, in little wriggly lines…and for the shape of its cliffs and crags and pinnacles, and for the wonderful gorge it has, always running deep in spring-water, full of oleanders, and ivy and ferns, and only just wide enough for a camel at a time, and a couple of miles long. But I have read hosts of the most beautifully written accounts of it, and they give one no idea of it at all…so you will never know what Petra is like, unless you come out here… Only be assured that till you have seen it you have not had the glimmering of an idea how beautiful a place can be*" (after Wilson 1988).
1333 See 'Amr et al. 1998.

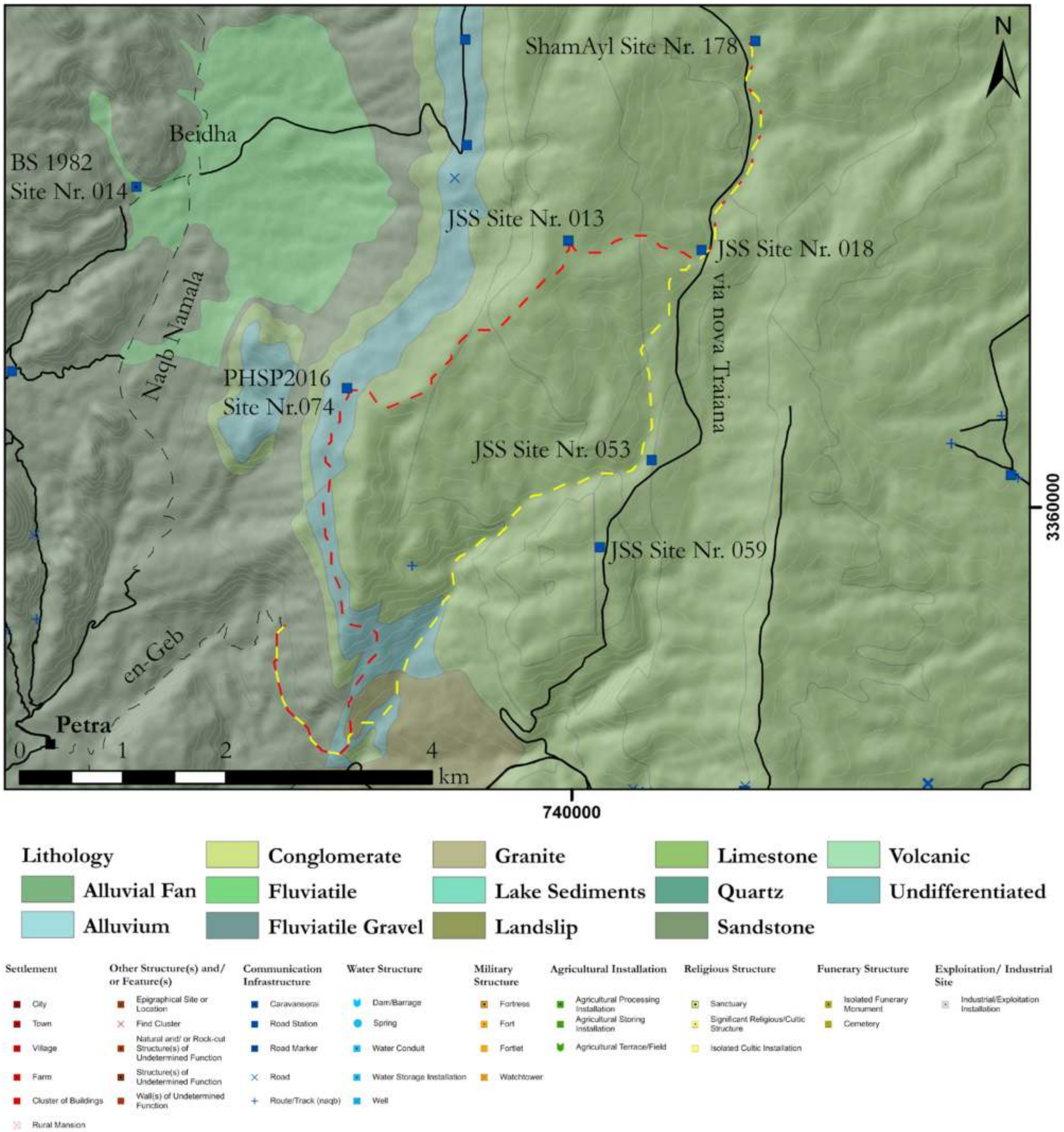


FIG. 256 LCP-routes for a possible connection between the en-Geb pass and the presumed route stations at Hauth al-Heleni 2 (PHSP Site No. 074), JSS Site No. 013 and ShamAyl Site No. 178.

accessible via a rock-cut staircase (FIG. 255). It was most likely of domestic use. The en-Geb route runs close to the still preserved arch of the Ain Musa aqueduct which bridges a steep gorge before continuing along the northern Jabal al-Khubtah face. Finally, just after opening into the Wadi al-Mataha in the Petra valley below, the route gives access to the 'small Siq,' another isolated cultic installation characterized by its numerous *baetyli* and Nabataean commemorative inscriptions.

Although the natural landscape conditions of the en-Geb pass seem to favor larger camel-based travel, the route grows very narrow. While individual camels may have passed along the route, it is not well suited for a larger group of animals. It may therefore be interpreted as an eastern 'back entrance' into Petra, but only for donkeys, mules and/or pedestrians.

However, two route stations can be observed that seem to form a line in southwestern-northeastern direction from the beginning of the en-Geb pass along the modern Wadi Musa–Umm Sayhoun road and ending at ShamAyl Site No. 178. This site is situated along the presumed course of the *via nova Traiana* between

Wadi Musa and 'Ain Nejel.[1334] The western station is referred to as Hauth al-Heleni 2 (PHSP Site No. 074). Surface material tentatively dates the structure between the 1st century BC and the 4th century AD. The eastern station is referred to as JSS Site No. 013 and dates to the 1st century BC and AD.[1335] Although this must be verified in the field, a route may have connected the en-Geb pass with the road stations discussed above and ShamAyl Site No. 178 along the Wadi Musa–'Ain Nejel stretch of the *via nova*. LCP routes were therefore calculated showing a possible course of the presumed route (FIG. 256). When calculating the LCP directly between the en-Geb pass and ShamAyl Site No. 178 (yellow line in FIG. 256), the proposed route follows the direction of the *via nova Traiana*. To verify this route, another LCP (in red) was calculated connecting first the en-Geb pass with PHSP Site No. 074, from there then to JSS Site No. 013 and from there to ShamAyl Site No. 178. This proposal follows the steeper slopes of the Jabal Shara, but its northern part follows the course of the *via nova* as well.

Even if a route did connect these sites, it would cross through difficult terrain and the steep slopes of the Jabal Shara. This route would then be considered as a secondary route, connecting the immediate outskirts of Petra with the eastern high plateau. The environmental constraints would not allow for substantial camel-based travel.

1334 MacDonald et al. 2016, 293 date ShamAyl Site No. 178 between the 1st century BC and the 7th century AD.

1335 Tholbecq 2013a, 2001a and unpublished catalogue of the JSS, kindly provided by L. Tholbecq.

Chapter 7
Military Sites

This chapter deals with archaeological sites with a possible defensive and/or surveillance function. However, the reassessment of the military sites originally identified by the various surveys has exposed a tendency to set any archaeological site positioned at a strategic location and/or sites that are architecturally characterized by solid exterior walls or feature other 'defensive' architectural components too quickly and uncritically in a military context. There is often little, or only inconclusive, archaeological evidence to support the identification of many sites as military structures. These are described by technical terms pertaining to specific military structures such as 'fortresses' and 'forts.' However, it seems that these terms are frequently used arbitrarily and interchangeably, without following any pre-defined criteria. Many reports make no structural or functional distinction between such terms.[1336]

An uncritical adoption of such misleading militaristic approaches would result in the perception that an unrealistically large number of military sites were diffused in the Petraean hinterland. This runs the risk of focusing too strongly on the military function of the discussed structures, without placing them in their wider archaeological and historical context. As S. Fachard points out

> [...] *the civilian, social and economic dimensions of building fortifications have been neglected, and the link between the walls, rural settlement patterns and agricultural resources has not been analyzed enough.*[1337]

Scholars interested in the Roman army in Jordan also state that studies on the military organization of a specific region should be more embedded within the overall, non-military history of the study area.[1338] Future studies should go beyond the traditional militaristic approach and explore the potentially various reasons for selecting a particular location for the construction of specific military structures. While such aspects are generally discussed as part of larger scholarly debates on the function of the (particularly Late) Roman army along the eastern Arabian frontier, this chapter specifically aims to critically re-assess the military structures of the Petraean hinterland. This landscape archaeological approach hopes to provide a detailed archaeological characterization of relevant sites and to consider them in their larger environmental and archaeological context.[1339] Without claiming to be comprehensive, this approach may offer new insights into the function of the discussed military structures and the nature of the military disposition in the Petraean hinterland through time.

Although following strict archaeological definitions (cf. chapter 2), it is particularly difficult to adequately apply predefined archaeological criteria for the discussed military structures without excavation results.[1340] As for other site categories, the dating of the structures is based mostly on surface ceramic material. The dating quality is therefore problematic as well, as it is difficult to securely ascertain the overall duration or possible occupation gaps. However, when discussing potential military structures, surface material presents a particular problem as it does not indicate the *nature* of occupation. Particularly with structures where surface material suggests a long occupation period, it must be acknowledged that while it is likely that certain structures were originally of military character, they may have been subsequently reused by civilians as non-military structures although the archaeological evidence remains inconclusive.

Finally, while this landscape archaeological approach highlights potential functions of the various military structures, one must keep in mind that these functions are always evaluated from a distinctly modern perspective. The applied analytical methods (e.g. the extensive use of GIS-based visibility analyses) automatically stress the importance of certain phenomenological attributes of military structures (such as visibility). While likely, there is no way of knowing for certain that these had significance in antiquity.

1336 This is particularly the case for ShamAyl and ARNAS.
1337 Fachard 2016, 209 who criticizes similar militaristic approaches within the study of Greek rural fortifications.
1338 See e.g. Kennedy 2004, 27 or Findlater 2002, 139.
1339 For a similar landscape approach, see Fachard 2016, 212–230 and, for Jordan, the recent attempt by Castro 2018. However, cf. the critical review of Oleson 2019a.
1340 The only military structures in the study area that were at least partially excavated are the Late Roman fortress of Udruh and the fort at Bir Madkhur.

Particularly in landscape archaeology, there is always the risk of following environmentally deterministic argumentations. One should therefore be aware that the significance of environmental factors may be modern constructs driven by the availability of modern analytical methods.

Fortresses

The only fortress in the Petraean hinterland is the major Diocletianic *castrum* at Udruh which dates to c. 300 AD (FIG. 257).[1341] It is located approximately 20 km east of Petra at a major spring (later incorporated into the northeastern tower of the fortress) and lies at the crossroads of important routes. It forms an important infrastructural focus point that connected the Petraean hinterland with the vast desert area immediately east of Udruh.

Together with the contemporary legionary fortress at Betthorus/um (al-Lejjun), Udruh (c. 4,7 ha) is one of the largest Roman military structures in Jordan. It is built on a slope with a difference in elevation of up to 25 m. This may explain the distorted shape. The exterior wall is 3 m thick and built of limestone ashlars which frame the wall's rubble core. The fortress could be accessed by 3 m wide, single-arched gates placed centrally on all sides of the *castrum*. All gates were flanked by two towers. The fortress has 20 interval towers along the perimeter walls – four on the short sides and six on the long sides. The interval towers are characterized by projecting walls. These are 6–7 m long and are closed by a semi-circle giving a total length of c. 11 m for the towers. The corner towers (c. 22 m in diameter) are constructed by 13–15 m long projecting walls. These are closed by semi-circular walls as well. One of the few excavated structures in the interior may have been the *principia* which Killick thought to have been reused as a Byzantine church.[1342] The Department of Antiquities of Jordan has recently fully excavated a Byzantine church outside the Roman fortress as well.[1343]

Udruh (ancient Adrou) was most likely a Nabataean civilian settlement before the construction of the fortress in the Late Roman period (cf. chapter 5).[1344] Since the first mention of Udruh by Ptolemy in his *Geographia* (2nd century AD), historical sources refer to Udruh exclusively as a civilian settlement.[1345] There is no reference to a military unit stationed at Udruh in the accounts of Eusebius and the site is not listed in the *Notitia Dignitatum*. The only evidence for the presence of a Roman legion is the fortress itself and a building inscription discovered near the western gate.[1346] The monumental inscription lists the tetrachs Diocletian and his co-*Augustus* Maximian (already chiseled off in antiquity), the two *Caesares* Constantius I. and Galerius, the governor and *dux* of the province (*Palestina Salutaris*) as well as the stationed *legion VI Ferrata* and its prefect. The inscription provides a *terminus ante quem* of 305 AD (abdication of Diocletian and Maximian as *Augusti*) for the construction of the fortress at Udruh. The mentioning of the *legio VI Ferrata* not only gives epigraphic evidence for the presence of a Late Roman legion, it also offers insights into the duration of Udruh as a legionary fortress. At the beginning of the Principate, the *VI Ferrata* was originally stationed in Syria (Samosata).[1347] With the annexation of the Nabataean realm it was then briefly moved to the new capital of *Provincia Arabia* at Bostra in 106 AD, but was then deployed to Caparcotna in *Syria Palestina* shortly after 138 AD. A papyrus from Oxyrhynchus dating to 324 AD lists the legion in Egypt.[1348] The Udruh inscription, however, clearly indicates that the legion was at Udruh no later than 305 AD. Kennedy and Falahat propose two explanations: Either the legion was divided, with one part stationed at Udruh and the other in Egypt, or the entire legion was first placed at Udruh and then deployed to Egypt. However, if the dating of the Oxyrhynchus papyrus is correct, the legion's deployment from Udruh to Egypt must have occurred – at the latest – at some point in the 320s AD. Arguably, the *VI Ferrata* was thus stationed at Udruh only for approximately 20 years, which would explain why it is not listed in the *Notitia Dignitatum* (at least for *Palestina*).

Gregory noted that the fortress at Udruh supersedes the fortress at Betthorus/um (al-Lejjun) in size as well as in its constructional details.[1349] It is thus possible that the fortress was constructed as a parallel to, or perhaps even as an imitation of the legionary for-

1341 For a brief, but informative overview on the fortress, see Kennedy – Falahat 2008, 151–157 and Kennedy 2004, 178–180. Wenner 2015, 110–133 also gives a detailed and up-to-date introduction into the research history of Udruh.
1342 Killick 1983a, 237.
1343 Driessen – Abudanh 2013, 52, n. 23; Abudanh – Twaissi 2010, 82.
1344 Consider Killick's discovery of a Nabataean ceramic kiln (Killick 1987, 173) as well as other Nabatean material revealed during previous excavations and surveys of the site.
1345 Ptol. Geog., 5, 16, 4.
1346 Specifically on the inscription, see Kennedy – Falahat 2008.
1347 More on the *legio VI Ferrata* in Kennedy – Falahat 2008, 160 with further references and Kennedy 1980.
1348 POxy, 53, 4359 and IGR I, 1089.
1349 Gregory 1995 followed by Kennedy 2004, 179.

FIG. 257 Aerial view of the present state of the *castrum* of Udruh. Photo: APAAME.

tress at al-Lejjun.[1350] However, in contrast to Udruh, al-Lejjun always remained the legionary fortress of the *legio IV Martia* as noted in the *Notitia Dignitatum* until the mid-6th century AD.[1351] Despite the immense building venture, it is questionable whether Udruh maintained its military significance after the departure of the *VI Ferrata*. Most likely, it quickly regained its civilian status as Byzantine episcopal lists dating from the first quarter of the 5th century AD mentioning the names of bishops from the town of *Augustopolis* (Urdruh) suggest.[1352] Augustopolis is also referred to in the 6th century AD Beersheva Edict and the Petra Papyri as well as by a Byzantine chronicler from 630 AD and Early Islamic sources.[1353] The numerous structures discovered within and without the fortress's walls confirm the continued civilian use of the site.[1354]

The first intensive archaeological investigations at Udruh were initiated by A. Killick in the 1980s.[1355] According to Killick, sites documented outside the fortress include civilian settlements, several 'watchtowers' and other military structures (e.g. Tell Abara or Tell Udruh) as well as a limestone quarry which he claimed to be one of the largest in Jordan.[1356] Killick was also the first to excavate parts of the fortress. Only a few projects continued work within the fortress itself.[1357] Instead, since Abudanh's survey of the Udruh region to further investigate Udruh's role in the larger settlement pattern of the Petraean hinterland, recent research has very much focused on the site's surroundings. For example, Abudanh and Twaissi further investigated the *qanat* systems near Udruh, for which OSL and C^{14}-analyses now suggest an earliest date to the 1st century AD with renovations in the late Roman, Byzantine and Islamic periods (cf. chapter 4).[1358]

Most recently, the aim of the still ongoing *Udruh Archaeological Project* (UAP) is to further research

1350 Kennedy 2004, 179.
1351 Not. Dign. Or, 37, 22, 12. Also cf. Kennedy 2004, 154–159 with further references.
1352 Kennedy – Falahat 2008, 152.
1353 Kennedy – Falahat 2008, 152; Fiema 2002a, 209.
1354 Parker 1986, 95; Glueck 1935, 76–77; Brünnow – von Domaszewski 1904, 59–60.
1355 Killick published several papers on his activities in and around Udruh, none of which more recent than 1987 (Killick 1987; 1986a and b; 1983a and b; 1982). The final report remains unpublished.
1356 Killick 1983b, 127; Killick 1982, 415.
1357 Abudanh et al. 2010; Kennedy – Falahat 2008.
1358 Driessen – Abudanh 2018, 141–148 and 2015, 303; Abudanh – Twaissi 2010.

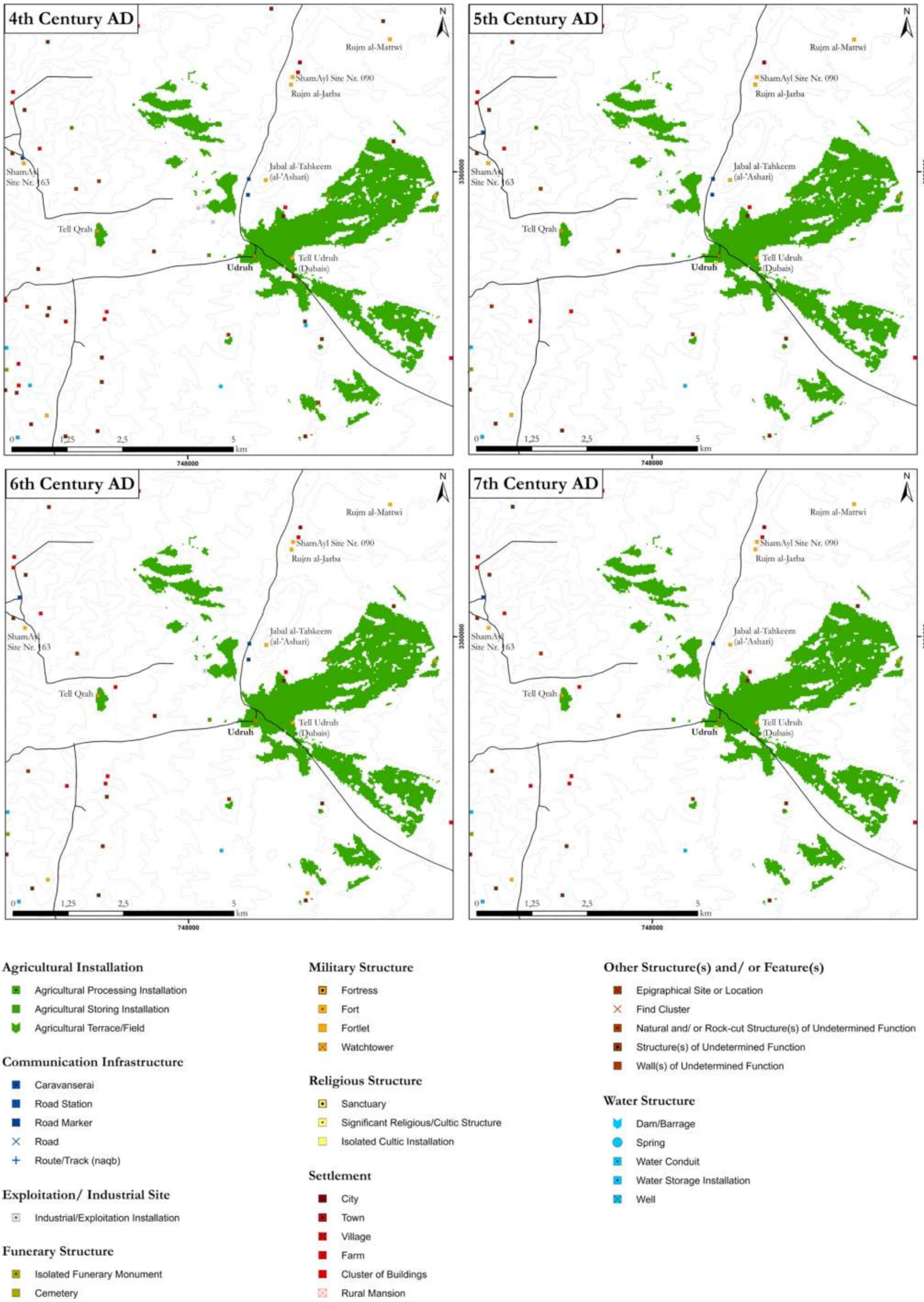


FIG. 258 GIS-based visibility analyses (maximum radius of 4400m) from Udruh with evidenced archaeological sites dating to the 4th – 7th century AD.

"[…] *agro-hydrological innovations, trade logistics, security and settlement systems* […]" in the region around Udruh.[1359] The UAP surveyed an area of up to 2,5 km around Udruh and recorded numerous agricultural fields and terraces, several limestone quarries and a civilian settlement west of Udruh.[1360] The UAP also surveyed several hilltop structures in the vicinity of Udruh that are considered to have served surveillance functions and were part of a signaling system between Udruh and the immediate Petra area.[1361] These are Jabal al-Tahkeem (al-'Ashari) (cf. FIG. 63), Tell Udruh, the so called 'Relais Tower' (Tell Qrah?) between Udruh and Petra, Tell Jraideh (Jurayda), Abu el-Raa (Abu ar-Ru'ah), Tell al-Safia (Tall as-Saffiyah), Tell Qusaib (Qasib), Tell Abara, Abudanh's Du'Aij Tower and Rujm al-Munbajis. Surface pottery dates these hilltop structures primarily to the Nabatean-Roman, but also to the Roman-Byzantine periods. Although their exact function is debatable, it is likely that they served, at least in part, surveillance purposes. However, at least some of the discussed structures are arguably too far away from Udruh to have had good visual contact with the fortress.[1362] Visibility analyses (within a maximum radius of 4400 m only)[1363] show that only Tell Qrah, Tell Udruh and possibly Tell Jraideh are visible from Udruh (FIG. 258). Areas west of Udruh are not under visual control from the fortress.[1364] Although this study cannot confirm such a comprehensive *inter*visual network between Udruh and its surroundings as proposed by the UAP, the site definitely commanded good visual control particularly of the areas to the east which were undoubtedly also well visible from Jabl al-Tahkeem (al-'Ashari), Tell Udruh and Tell Jraideh. This highlights the strategic location of Udruh at the crossroads of important trade routes. Importantly, this was also the case in the Nabataean period, therefore well before the construction of the fortress. In the pre-Roman periods, the assumed civilian settlement of Udruh was already a key site well integrated into the regional trade network of the Petraean hinterland.[1365] The presence of the natural spring, the well-irrigated agricultural lands and the strategic importance probably impacted the decision to construct the legionary fortress at Udruh.

Forts

There are eleven structures in the study area that are interpreted as forts (FIG. 259 and TABLE 30). The basis for this is site size, location and the archaeological characteristics of the structures as documented by the original surveys. None of these sites have been excavated and, with few exceptions, most of the information derives from superficial surface observations.[1366] Except for the forts at Tell Abara and Bir Madkhur, there were also no plans available that would allow for a better structural comparison of the sites. This presented a challenge in assessing their function.[1367] The author therefore created a preliminary comparative overview of plans of the evidenced forts grouped by size (FIG. 260). The forts were classified into large forts (greater than 0,4 ha), medium-sized forts (between 0,4 and 0,2 ha) and small forts (between 0,2 and 0,1 ha). As these plans are based only on site descriptions and, when available, aerial images, they can only be considered as scaled sketches and must be treated with caution. They nevertheless present the most comprehensive overview of forts in the Petra area and serve as a good basis for further insights into the nature of the structures. The following gives an overview of the presumed forts in chronological order.

Apart from Khirbet Ayl and Khirbet Dubayl, all Iron Age forts (cf. chapter 3) are reoccupied by the 1st century BC. Surface material indicates that additional forts were built at that time at Mulgan (ShamAyl Site No. 162), ShamAyl Site No. 236 (name unknown), ShamAyl No. 251, Khirbet al-Teen (ShamAyl Site No. 255), ShamAyl

1359 Cf. Driessen – Abudanh 2019; 2018; 2015 and 2013 as well as Wenner 2015, 33–36.

1360 As the UAP is still an on-going project, no spatial information is yet available for the recorded archaeological sites. However, many of the structures discussed by the UAP were already part of previous surveys.

1361 This was suggested by a GIS-based line-of-sight analysis and Higuchi viewshed analyses conducted by the UAP (Driessen – Abudanh 2019, 456–464; Driessen – Abudanh 2015, 299; Driessen – Abudanh 2013, 46–49, fig. 4). According to the UAP, this presumed visual network is particularly evident when considering the intervisibility between the hilltop structures and the southwestern corner tower of the fortress. Only a few structures were visible from other parts of the fortress.

1362 For example, this applies to Tell al-Safia located 5.6 km or Tell Qusaib situated 7,3 km south of Udruh. Cf. Driessen – Abudanh 2019, 462–463 and 2013, 47–48.

1363 For a general methodological overview on the GIS-based visibility analyses calculated here, see this chapter's section on the presumed watchtowers as well as chapter 2.

1364 With the exception of the so called 'Relais Tower' and Abudanh's Du'Aij Tower (Driessen – Abudanh 2019, 463). Different areas of Udruh's surroundings may have been visible from different standpoints within the fortress as conducted by the UAP. This study calculated visibility fields only from one central position within the fortress.

1365 Cf. also Driessen – Abudanh 2015, 297 and Driessen – Abudanh 2013, 49.

1366 Except for Bir Madkhur which has been partly excavated by the *Bir Madkhur Project*.

1367 Cf. also Findlater 2002, 141–142.

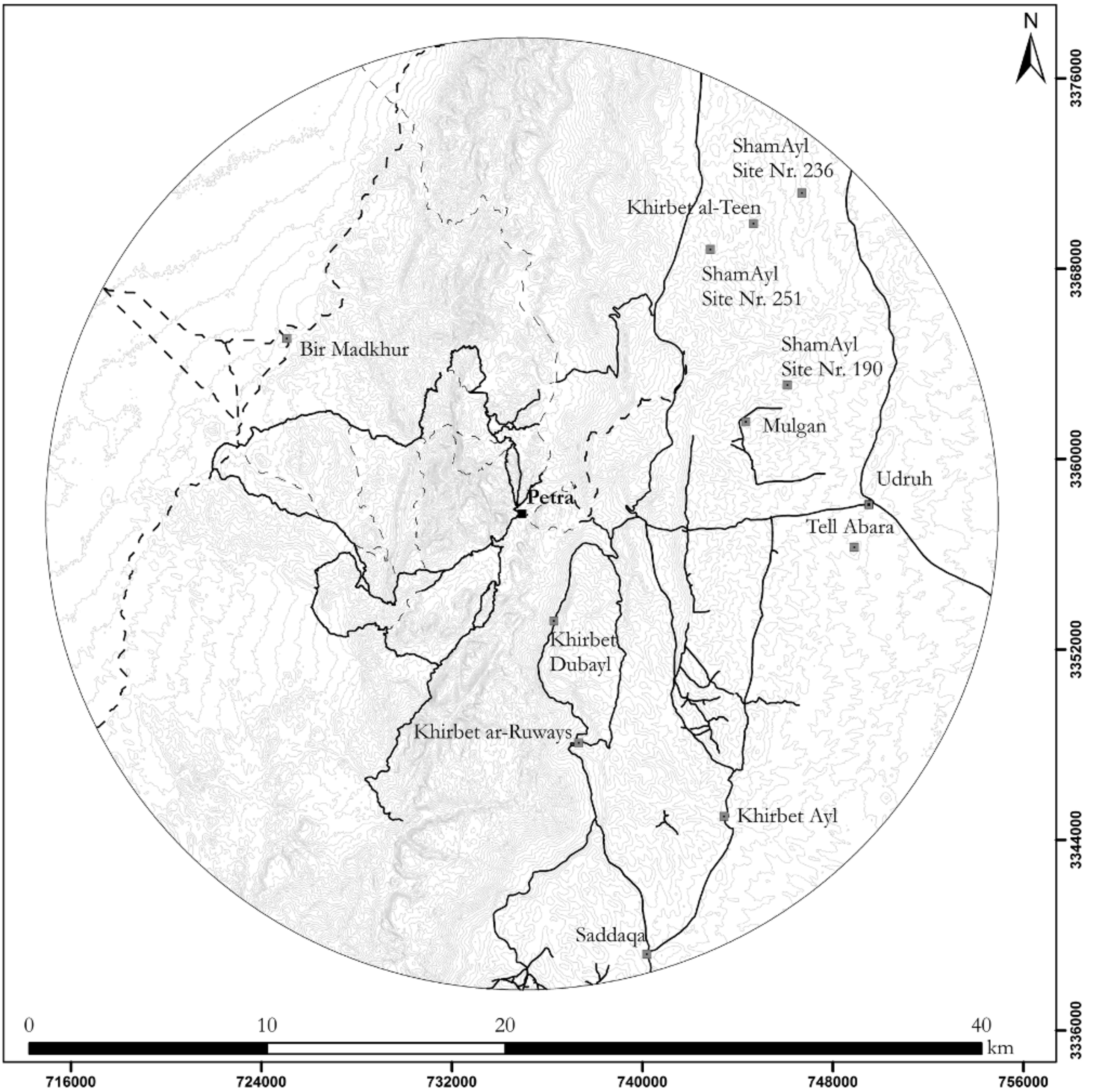


FIG. 259 Distribution map of all forts in the Petra area with the 4th century AD fortress at Udruh.

Site No. 190 and possibly also at Tell Abara (Abudanh Survey Site No. 055). Thus, nearly all forts (8 out of 11) were constructed by the 1st century BC.

Measuring c. 1,8 ha, the hilltop structure of Tell Abara (FIG. 261) is by far the largest known fort in the study area (cf. FIG. 260).[1368] The site was first reported by Killick as a large rectangular structure built of low, poor-quality walls. Kennedy mentions a curved bank extension, a possible *clavicula*, protecting the presumed eastern gateway into the fort.[1369] Tell Abara is widely known as a temporary Roman military camp. If this assumption is confirmed, the site would be one of few temporary Roman military camps in the entire Near East.[1370] The dating of Tell Abara was mainly

1368 Abudanh 2006, 428; Kennedy 2004, 180; Kennedy – Riley 1990, 107–108; Killick 1987, 28–29 and Killick 1986a, 436–438.

1369 Comparable to the *titulum* of the Trajanic fort at Humeima as recently pointed put by Oleson 2019b, 403–404.

1370 See Kennedy 2004, 57–58; 124–125, 174 for comparisons to other presumed Roman temporary military camps in Jordan (all comparable to those known from Masada and Machaerus) at Azraq (c. 1,25 ha), Azaima (c. 0,83 ha) and Khirbet Abu Safat (c. 2,6 ha). Driessen – Abudanh 2019, 460–461 reject the identification of Tell Abara as a temporary Roman fort as it lies on too steep slopes.

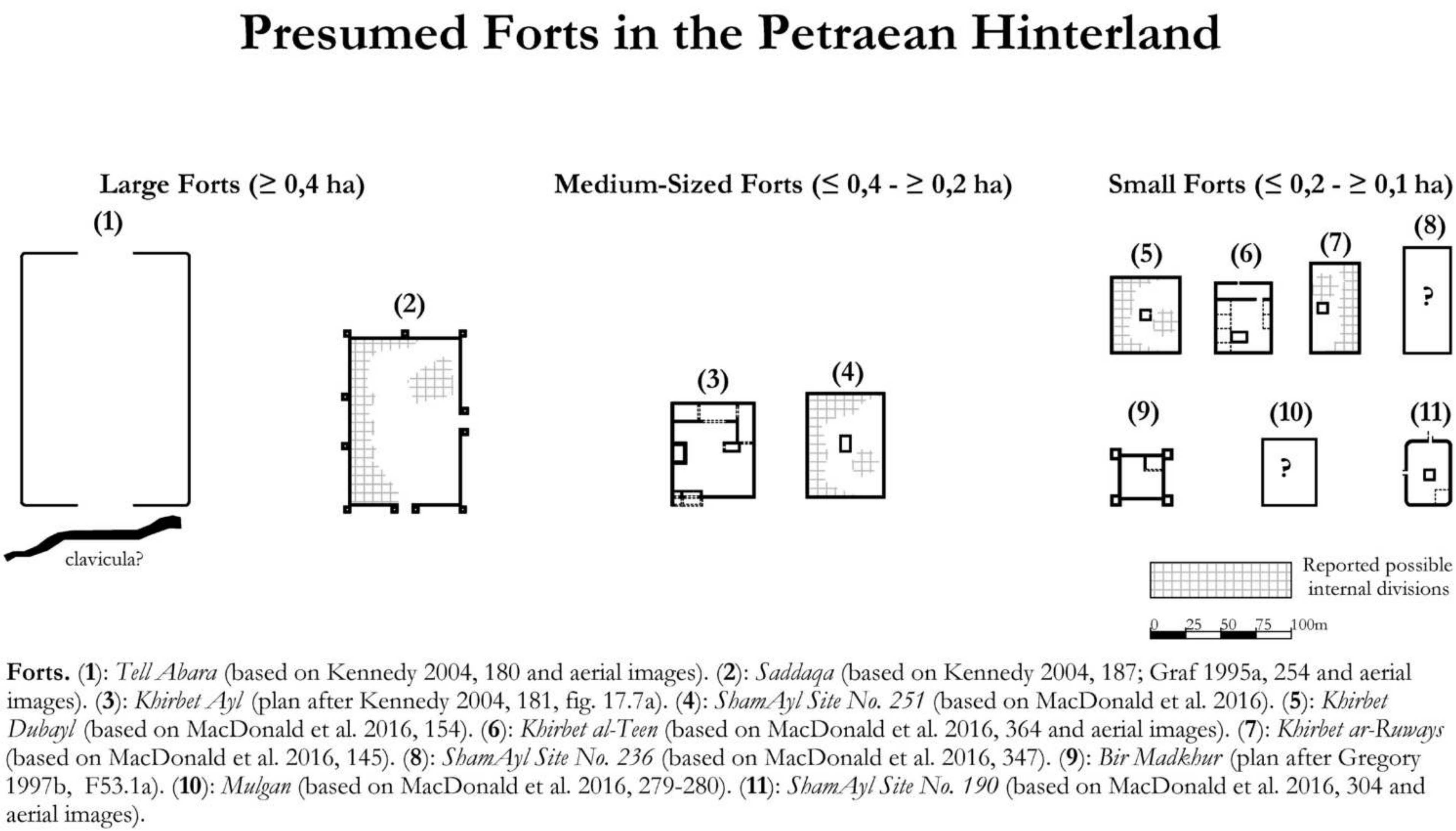


FIG. 260 Scaled sketch plans of forts in the Petraean hinterland.

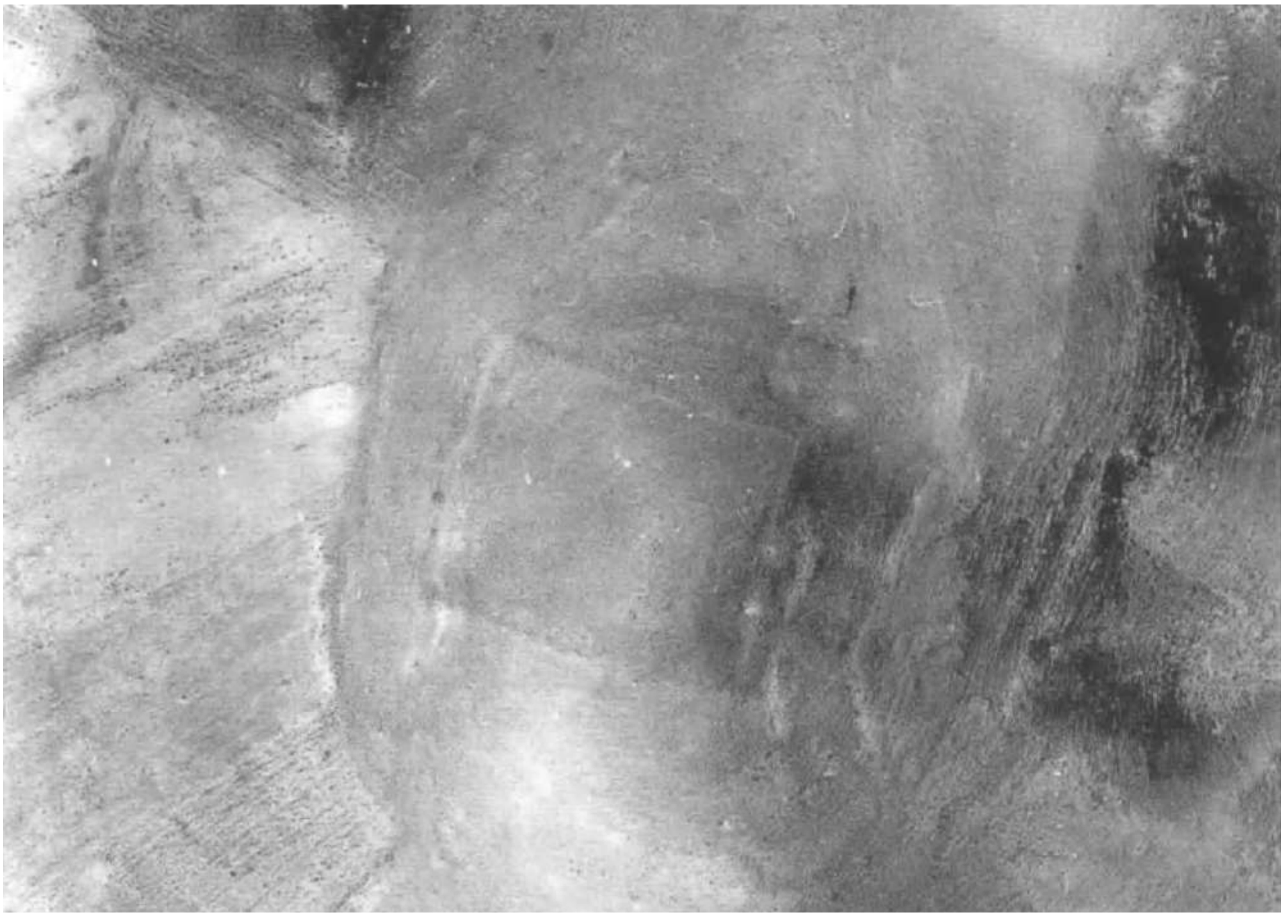


FIG. 261 Aerial view of Tell Abara after Kennedy 2004, 181, fig. 17.6.

based on comparisons to these other Near Eastern examples. To date, Abudanh is the only surveyor to have collected surface pottery material from the site, which he dates to the 'Nabataean/Early Roman' periods without any further clarification.[1371] If Abudanh collected 'Nabataean' pottery, there is a high probability that the fort may date between the 1st centuries BC and AD.[1372] Conversely, if Abudanh's 'Early Roman' reading is correct, there is a high probability that Tell Abara dates to some point of the 2nd century AD. As the fort clearly stands out from other, particularly earlier, forts evidenced in the Petra area in terms of size and overall layout, this study follows the traditional identification of the site as a *Roman* temporary military camp.[1373] Although there is no further description of the pottery material recorded by Abudanh, it can only be assumed that the 'Nabataean' material corresponds to the general Nabataean pottery *style* that continued well into the 4th century AD. Following Abudanh's 'Early Roman' date (2nd century AD), it is possible that the site can be associated with the Roman annexation of the Nabataean realm in 106 AD. If this assumption is correct, Tell Abara would be a unique monument attesting to a formative historical period in the study area, which remains difficult to grasp archaeologically.

Compared to Tell Abara, the dating of the fort at Mulgan (ShamAyl Site No. 162) is less problematic.[1374] Based on surface pottery, the 0,19 ha large rectangular structure was built in the 1st century BC. It is situated along Abudanh's 'Malghan road' on a slope overlooking the contemporary village of Mulgan (ShamAyl Site No. 161) as well as the settlement's spring, Ain Mulgan. The survey reports do not mention any internal divisions.

Presumably built in the 1st century BC as well, ShamAyl Site No. 236 (name unknown) is located in the far northeastern corner of the study area between the northern stretch of the *via nova Traiana* (between

1371 Abudanh 2006, 428.
1372 Cf. the discussion on the chronological uncertainties in chapter 2.
1373 Confirmed when comparing the fort with the few other examples of Roman temporary military camps known in the Near East. It is furthermore likely that Tell Abara was constructed according to the Roman *pes monetalis* (Oleson 2017, 265).
1374 MacDonald et al. 2016, 279–280.

Wadi Musa and ʼAin Nejel) and the Udruh-Shawbak road.[1375] The fort measures c. 0,26 ha and is situated on a hilltop with good visibility of the surrounding landscape. It is characterized by a c. 1 m thick perimeter wall and is supplied with water by a nearby cistern. No internal divisions were reported.

Belonging to the largest, presumably pre-Roman, fort (next to Khirbet Ayl), the 1st century BC structure of ShamAyl Site No. 251 is situated immediately to the southwest of ShamAyl Site No. 236. This c. 0,42 ha large rectangular structure is positioned on a hilltop and it encloses a presumed tower at its center high point, offering a clear view of the site's surroundings. A cistern supplied the fort with water. The original surveyors noticed further internal divisions as well.

With Khirbet al-Teen (ShamAyl Site No. 255) in the center, ShamAyl Site No. 236 and ShamAyl Site No. 251 form a conspicuous northeast-southwest running line. To date, these are the only forts that are not located along important routes. It may then be hypothesized that these three forts were built along a yet unknown route connecting the Udruh-Shawbak road and the *via nova Traiana*. However, this hypothesis should be considered with caution, as it would indicate a yet unknown heavily fortified secondary route which seems unlikely when considering the otherwise so dispersed forts in the Petra area.[1376]

Khirbet al-Teen (ShamAyl Site No. 255) is a rectangular structure measuring c. 0,21 ha. It is built of c. 1 m thick perimeter walls. Water was available from a presumed cistern.[1377] Although the original surveyors did not explicitly mention internal divisions, aerial images of Khirbet al-Teen (FIG. 262) clearly show that the site can be divided into a forecourt area and a larger internal zone with room units along the external walls. The images also suggest a more substantial rectangular structure in the internal area of the fort. This may have been an internal tower or an older structure that was enlarged at a later period.

Dating from the 1stcentury BC onwards, the original surveyors describe ShamAyl Site No. 190 only as "[…] *a large stone pile with clearly defined retaining walls around it*"[1378] with a good view over the surrounding landscape in all directions. While these observations offer little clarity, aerial images suggest a possible military function (FIGS. 263 and 264). Situated within a cultivated area, the c. 0,16 ha large, rectangular structure is characterized by thick perimeter walls with curved corners. Two possible gates can be identified along the structure's lateral sides. A smaller square or rectangular structure appears to have been built at the site's center. This may be the remains of a central tower. If this is correct, ShamAyl Site No. 190 would resemble other contemporary forts in the study area with internal towers such as ShamAyl Site No. 251, Khirbet al-Teen or Khirbet ar-Ruways.

All forts constructed in the 1st century BC were in continuous use during the 1st century AD.[1379] Surface pottery suggests that Khirbet Ayl was also re-occupied at that time (cf. chapter 3 and FIGS. 260 and 265). There is no evidence that new forts were constructed in the 2nd and 3rd centuries AD, although the extant remains of Tell Abara suggest that the structure is dated to the 2nd century AD (even if there may have been an older structure at the site). In the Late Roman period, new forts were built at Bir Madkhur in the Wadi Arabah and at Saddaqa on the eastern high plateau.

Dating to the late 3rd/early 4th century AD, the *quadriburgium* at Bir Madkhur is well-known (FIGS. 266).[1380] The fort lies at the crossroads of Naqb Namala and the main north-south routes in the Wadi Arabah (cf. chapter 6). Measuring c. 0,11 ha the site is relatively small (cf. FIG. 260). It is characterized by thick (c. 1,8 m wide) perimeter walls and four corner towers (c. 8 × 7 m each). Internal rooms were most likely arranged around a central courtyard and the gate probably opened to the east. Water was available from an associated well. Another large rectangular structure is situated immediately southeast of the fort. It measures c. 30 × 25 m and has been identified as a caravanserai/bath complex. It is most likely contemporary with the fort. Several additional structures were observed west and southwest of the fort. Some of these were excavated by Smith who confirmed the original interpretation that they served domestic purposes. These structures probably belonged to the civilian *vicus* of the fort.[1381] An important contribution to the better understanding of the fort and its surroundings

1375 MacDonald et al. 2016, 347.

1376 This clearly demonstrates the need for a critical evaluation of the presumed forts recorded by ShamAyl, i. e. in particular ShamAyl Site No. 236, ShamAyl Site No. 251 and Khirbet al-Teen. Due to site size, archaeological characteristics and site location, these sites are nevertheless listed as possible forts.

1377 MacDonald et al. 2016, 364.

1378 MacDonald et al. 2016, 304.

1379 Apart from Khirbet ar-Ruways and Tell Abara, all forts seem to have remained in use until the 7th century AD.

1380 Smith 2018, 210–212; Smith – Kay 2018, 133–134; Smith 2010, 39–42 and Smith 2005; Perry 2007; Kennedy 2004, 213 with further references. Previous scholars have debated the ancient identity of Bir Madkhur suggesting that it may represent *Moa* as depicted on the Madaba map or *Calamona,* the base of the *cohors prima equitata* listed in the *Notitia Dignitatum* (Smith 2010, 42 with further references). However, according to Smith, these identifications remain problematic and uncertain.

1381 Consider the extensive cemetery that was documented and partly excavated at Bir Madkhur as well (cf. chapter 8).

FIG. 262 Aerial view of the presumed fort at Khirbet al-Teen. Photo: APAAME.

FIG. 263 Aerial view of the presumed fort of ShamAyl Site No. 190. Photo: APAAME.

FIG. 264 Aerial view of the surroundings of the presumed fort of ShamAyl Site No. 190. Photo: APAAME.

FIG. 265 View of Khirbet Ayl.

FIG. 266 Aerial view of the Late Roman fort of Bir Madkhur with bath house, fort, *vicus,* cemetery and modern settlement. Photo: APAAME.

was made by Smith's recording of "[…] *hundreds of sites near Bir Madkhur and in Wadi Musa to the south* […]" that are related to intensive agricultural activity in the area.[1382] Based on material discovered during the excavation of a nearby farmhouse, these agricultural activities most likely date to the Late Roman and Early Byzantine periods.

The dating of the fort itself is based on earlier surface finds and the still on-going excavation results at Bir Madkhur.[1383] Early explorers collected several Nabataean and (Late) Roman coins, including one from Constantine (306–337 AD) and Constantius II (337–361 AD).[1384] Surface pottery ranges from the Nabataean to the Byzantine periods and recent excavations revealed Nabataean coins and pottery dating as early as the 1st century BC.[1385] This has led to the assumption that a Nabataean structure at Bir Madkhur was reused by the Late Roman army. Kennedy presumes that the Nabataean structure was of military nature as well. While no conclusive archaeological evidence exists to support this claim, it is nevertheless likely.[1386]

In addition to Bir Madkhur, another Late Roman fort was constructed on the eastern high plateau at Saddaqa (Zodocatha/Zadagatta) (cf. FIG. 196).[1387] The *Notitia Dignitatum* lists the Late Roman cavalry unit *equites promoti indigneae, Zodocathae*. This highlights the military importance of the site in the Late Roman period. Moreover, two presumably Late Roman Greek graffiti in the Wadi Haggag in Sinai mention troops at the κάστρον at Saddaqa.[1388] The mentioning of the military officer (*prior*) Flavius Barakhos in the Petra Papyri confirms that a regular military unit was still stationed at Saddaqa in the late 6th century AD, but it is unclear whether it was the same cavalry unit

1382 Smith 2018, 215; Smith 2010, 42.
1383 The on-going *Bir Madkhur Project* will undoubtedly reveal more valuable information on the site. See e.g. the project's website at: https://sites.google.com/site/petra-hinterland/home (last accessed: 16.04.2020).
1384 Smith 2010, 39; Kennedy 2004, 213.
1385 Smith 2018, 212.
1386 No architectural evidence was revealed during excavations that could indicate the nature of the site during the Nabataean period. However, Smith suspects Nabataean structures north of the fort and east of the well (Smith 2018, 212).
1387 Generally on Saddaqa, Kennedy 2004, 187; Fiema 2007 and 2002, 211–212; Graf 1995a, 254.
1388 Kennedy 2004, 187. According to Fiema, the term κάστρον designated a smaller fortified settlement by the 6th century AD and the term *polis* and *κάστρον* were used synonymously (Fiema 2007, 316 and 2002a, 211). It is assumed that in the later periods the military *castrum* and the civilian settlement grew together forming a larger civilian town.

listed in the *Notitia Dignitatum*.[1389] These units most likely resembled the *limitanei*-type and consisted of local recruits similar to the situation at Nessana where soldiers served their home town and owned property.[1390] Structurally, Saddaqa is well known for its extensive (civilian) ruins (c. 3,75 ha) around a c. 0,96 ha large fort with thick external walls with interval and corner towers.[1391] Internal divisions are also reported and clearly visible on aerial images.[1392] Test-trenches revealed only Byzantine and Early Islamic pottery. Kennedy analyzed the aerial images of the fort in more detail suggesting that the structure had gates at the center of the south and west walls.[1393] Next to Tell Abara, Saddaqa is by far the largest fort in the study area.

What first comes to mind when comparing the forts structurally, is the difference in size (cf. FIG. 260).[1394] Large forts include Tell Abara and Saddaqa, medium-sized forts are Khirbet Ayl and ShamAyl Site No. 251 and smaller forts are Khirbet Dubayl, Khirbet al-Teen, Khirbet ar-Ruways, ShamAyl Site No. 236, ShamAyl Site No. 190, Bir Madkhur and the fort of Mulgan.[1395]

The difference in size does not reflect a general chronological development. For example, the Late Roman fort at Saddaqa is grouped together with the Early Roman temporary camp at Tell Abara. Also, the small Late Roman fort at Bir Madkhur is of similar size as the presumed Nabataean forts of Khirbet ar-Ruways, ShamAyl Site No. 236 or Mulgan. Instead, size differences arguably mirror the different functional purposes of the forts.[1396]

In addition to size differences, the structural comparison suggests that most of the pre-Roman forts share common structural features. Most can be characterized as rectangular structures with internal divisions and, more conspicuously, with a single tower enclosed by the perimeter walls. Khirbet Ayl, ShamAyl Site No. 251, Khirbet Dubayl, Khirbet al-Teen, Khirbet ar-Ruways and ShamAyl Site No. 190 show this particularly well. Apart from Khirbet al-Teen and ShamAyl Site No. 190, these date to the Iron Age periods and are reoccupied by the 1st century BC. It is tempting to consider such structures with central towers as possible examples of a local, pre-Roman type of military architecture. However, it is more likely that the presumed towers were later additions and have nothing to do with the original layout of the forts as is the case with other presumed Nabataean forts in the Hisma desert. For example, while similar in size (0,16 and 0,12 ha respectively), the Nabataean forts at Khirbet Khalde and Qasr al-Kithara are distinctly different in terms of layout (FIG. 267). Khirbet Khalde is characterized as a rectangular structure with corner towers. Internal rooms along the external walls form a large interior courtyard. In contrast, Qasr al-Kithara is diamond-shaped. The fort has external towers and internal rooms around a central courtyard as well. The corner towers at Khirbet Khalde and Qasr al-Kithara may be later Roman additions to the Nabataean structures, possibly similar to the originally Nabataean (although essentially Roman) fort at Quweira where *tabula ansata* were discovered on the lintels above the corner towers.[1397] Although now destroyed, earlier explorers observed a smaller rectangular structure in the southern part of the courtyard at Qasr al-Kithara which is identified as a watchtower.[1398] While this might be a possible parallel to the discussed forts in the Petra area, Khirbet al-Khalde and Qasr al-Kithara were continuously used well into the Late Roman period and underwent structural changes.[1399] The central tower at Qasr al-Kithara may have been a Roman addition and does not necessarily have to correspond to the original Nabataean plan at all. More importantly, the different layouts of Khirbet al-Khalde and Qasr al-Kithara attest to the diverse architectural design of regional military structures that seemingly react to the different landscape settings of their environment. It is

1389 Fiema 2007, 317.

1390 Fiema 2007, 317.

1391 It is probably safe to assume that at a certain point of time the civilian population moved into the fort – similar to the situation at Udruh.

1392 Fiema 2007, 316 and 2002, 211 states that "[…] *a necropolis, remains of a temple (?), a water reservoir, and a watchtower*" are associated with the fort as well.

1393 On the reported test-trenches, see Fiema 2002a, 211 and Graf 1995a, 254. Kennedy's analysis of the aerial images is the first to mention more exact measurements of the fort.

1394 While realizing that emphasizing too strongly on size differences is one-sided, the only constant information that is provided by the survey reports concerns site size.

1395 Particularly in comparison to other forts, Bir Madkhur (0,11 ha) and Mulgan (0,19 ha) (C5 and C6 in FIG. 260) are indeed quite small and could therefore also be considered as fortlets. However, consistently following this study's definition of forts having a minimum size of 0,1 ha (cf. chapter 2), the two structures are discussed as forts.

1396 It is nevertheless interesting to note that pre-Roman forts are generally much smaller than the Roman structures (apart from Bir Madkhur, which belongs to the 'small forts'). While most pre-Roman forts do not exceed 0,2 ha, the largest is ShamAyl Site No. 251 measuring only 0,42 ha.

1397 Kennedy 2004, 198–199.

1398 Kennedy 2004, 203.

1399 Neither Khirbet al-Khalde nor Qasr al-Kithara were excavated.

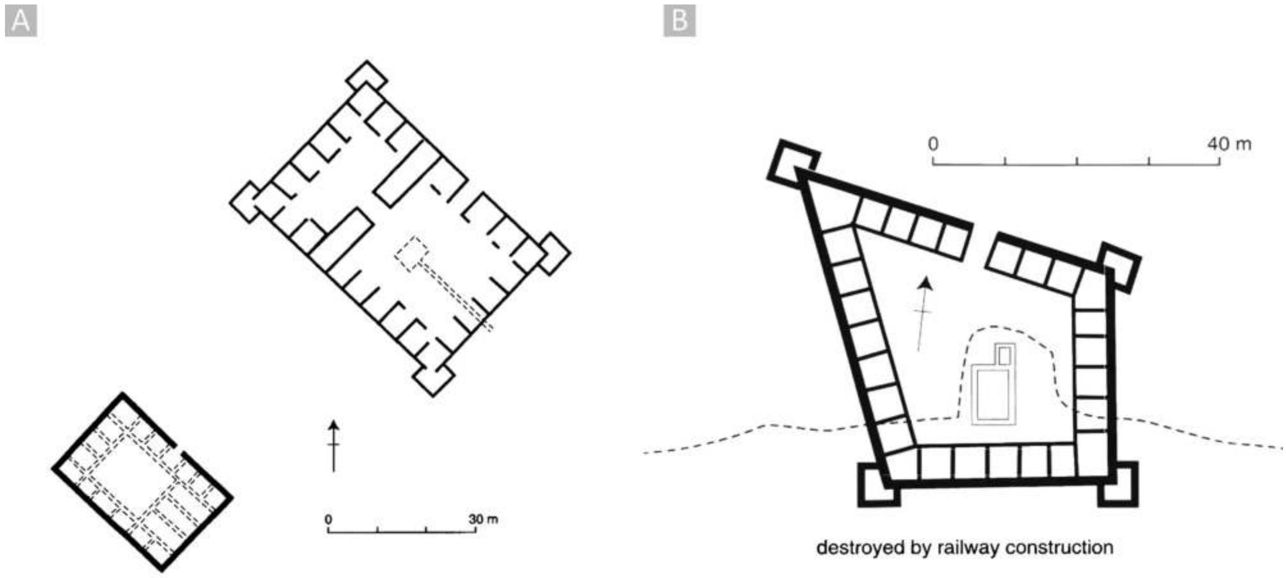


FIG. 267 Plan of the originally Nabataean forts at A: Khirbet al-Khalde and B: Qasr al-Kithara. After Kennedy 2004, 200 and 203, figs. 19.10. and 19.13.

then difficult to define any typical pre-Roman military architecture. While the central towers documented for some of the forts in the Petra area are noticeable, they cannot be considered a typical architectural feature without archaeological excavation.

Another important observation is that, to date, no evidence suggests that pre-Roman forts were abandoned after the Roman annexation (early 2nd century AD). They were mostly continuously used until the Late Byzantine period. This continuation has been observed elsewhere in Nabataea.[1400] The forts probably served for commanding visual control and vigilance of their surrounding landscape. Not only is this structurally corroborated by the internal towers (if they belonged to the original phase of the structures), but more importantly by the fact that most forts are located at prominent landscape positions such as hilltops and slopes along routes. The conspicuously small size of the forts furthermore suggests that they did not accommodate the required number of troops capable of defending any large-scale attacks. Instead, these were arguably smaller units that policed and observed movement in the surrounding landscape.

The forts are not in spatial relation to each other, but are dispersed widely across the Petraean hinterland (particularly on the eastern high plateau) (cf. FIG. 259). GIS-based visibility analyses calculated for all evidenced forts clearly suggests that the structures are not in visual contact with each other (FIG. 268).[1401] For example, the visual range from Mulgan and Khirbet Ayl is surprisingly small.[1402] In addition to accommodating a moderately sized military unit, the purpose of the forts was not to communicate with each other but rather to command visual control over their immediate landscape – most importantly the nearby routes as clearly shown by the visibility analyses. Additionally, when plotting all other archaeological sites over the fort's visibility fields in chronological order (cf. FIGS. 56–57 and FIGS. 269–272), it becomes clear that the forts predominantly controlled natural springs and civilian settlements.[1403] This intervisibility between forts, springs and settlements seems to be an overall stable pattern through time. This strong relation between forts and natural springs is confirmed by the Pearson correlation test as well (TABLE 31). Taking the 2nd century AD as an exemplary period as most of the evidenced forts date to this time, the correlation test particularly highlights the strong spatial correlation between forts and springs. This may be a specific trait of the evidenced forts as there is only a weak correlation between springs and other military structures. The correlation test also suggests only a weak correlation between forts and smaller military structures. This is also confirmed by the visibility analyses.

1400 Cf. al-Khouri 2003, 68–92; Hackl et al. 2003, 69; Parker 1986, 115; MacDonald 1984.

1401 At first glance it seems that ShamAyl Site No. 251, Khirbet al-Teen and ShamAyl Site No. 236 are in visual contact. However, a closer look shows that they are just outside the range of their respective visibility fields.

1402 Particularly compared to the more far-reaching view of Tell Abara.

1403 No visibility analyses were calculated between the 5th and 2nd centuries BC as there are no forts evidenced for this time span. The original surveyors observed visual relations between the forts of Khirbet Ayl, Mulgan and Khirbet ar-Ruways and nearby springs as well.

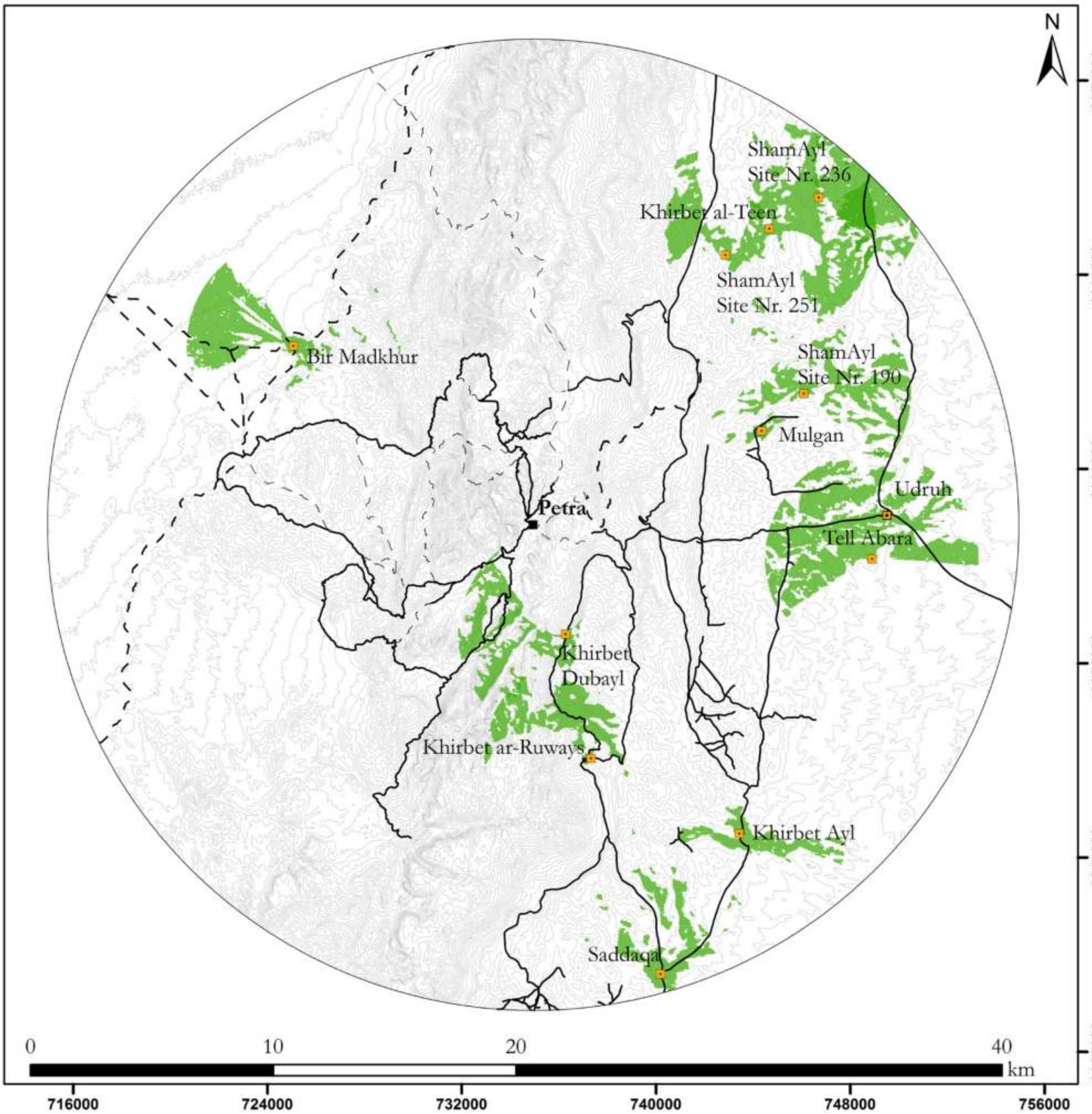


FIG. 268 GIS-based viewshed analyses calculated for all forts in the Petra area with the evidenced road network. Visibility radius of 4400 m.

A close examination of the archaeological sites within the visual range of the forts shows that only a very limited number of other military structures (possible fortlets and watchtowers) are visible. The intervisibility between Tell Abara and the structure of Tell Udruh/Dubais (Abudanh Survey Site No. 047) or the contemporary structure at Jabal Musa al-Ash 'ari is only one example for the 2nd century AD. This pattern is also observed for later periods, as exemplified by the intervisibility between the 4th century AD fort at Saddaqa and the contemporary watchtower of ARNAS Site No. 018.

The landscape archaeological analyses have therefore shown that it is difficult to assume a planned military organization or system in the Petraean hinterland. This implies an interrelation and interdependency between the discussed military structures which both the Pearson correlation tests and the visibility analyses contradict. Instead, forts were associated with civilian settlements, water sources (springs), as well as the local road network. They stationed local garrisons, but arguably addressed only local security concerns, and did not form a central part of any military system. This is confirmed by the small number of fortlets and watchtowers visible from the larger forts. While the forts could have communicated potential threats, the available evidence does not suggest that they formed a larger, independent network.

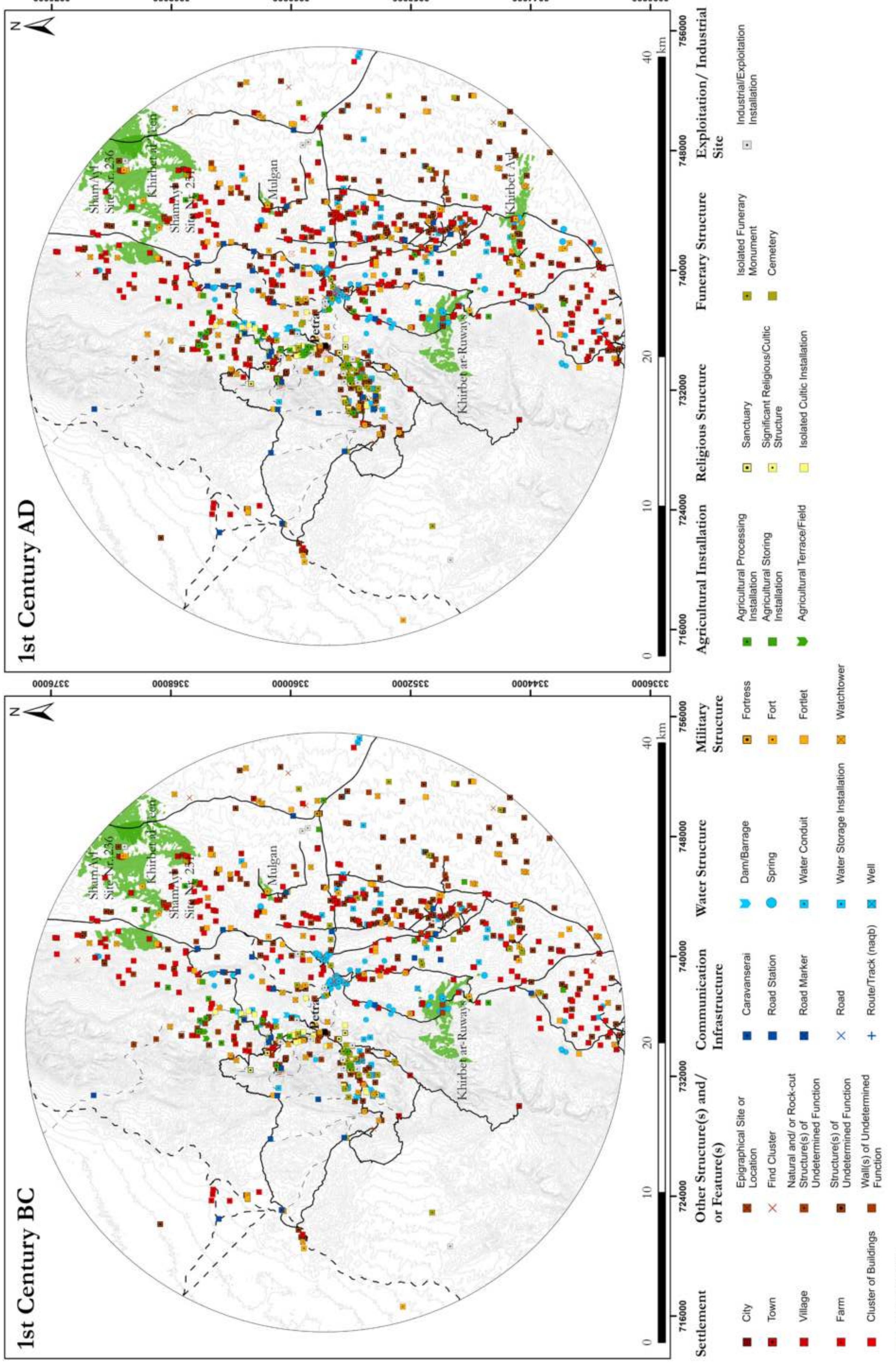


FIG. 269 GIS-based viewshed analyses calculated for 1st century BC and 1st century AD forts in the Petra area with the evidenced road network. Visibility radius of 4400 m.

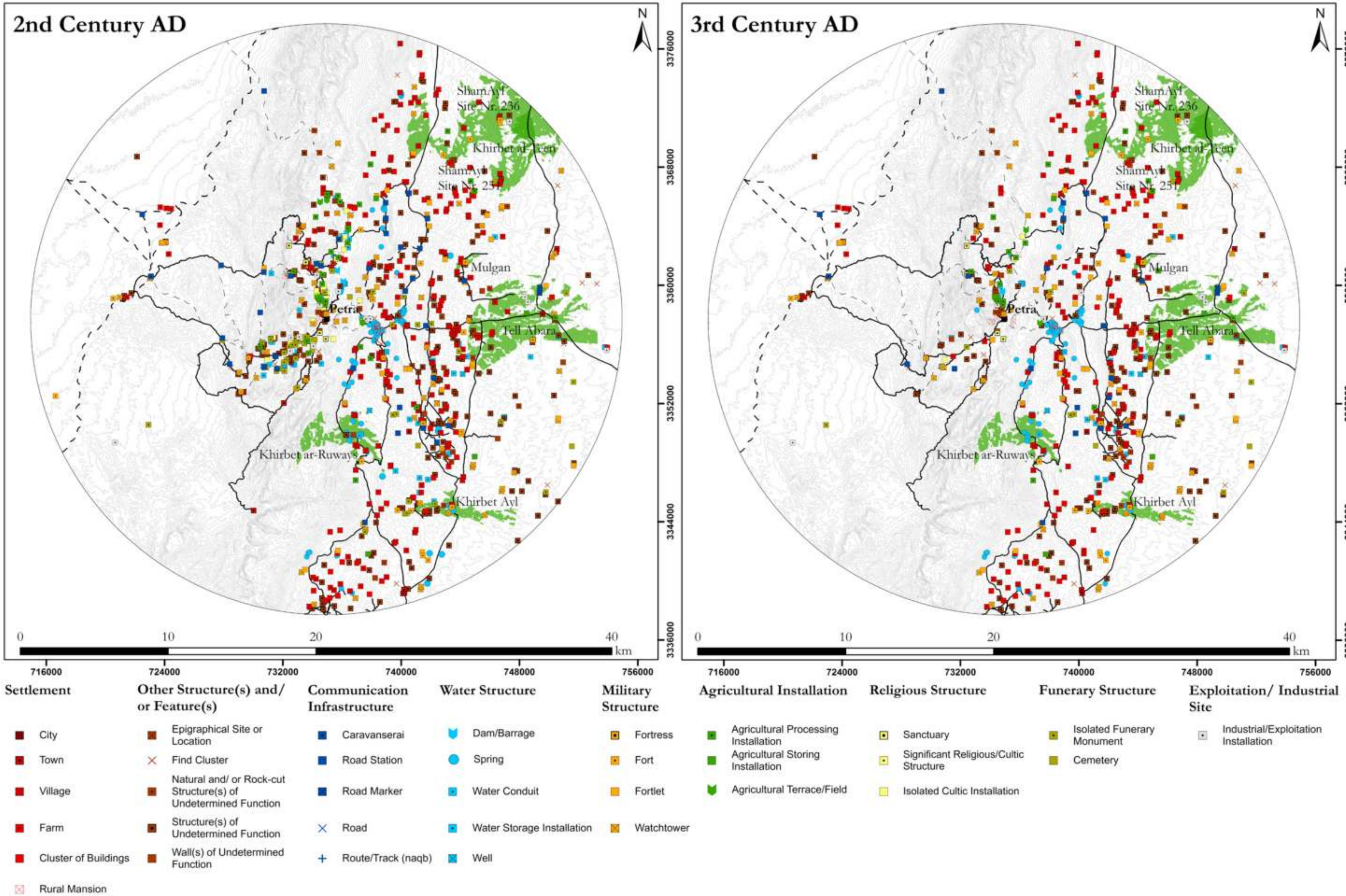


FIG. 270 GIS-based viewshed analyses calculated for 2nd and 3rd century AD forts in the Petra area with the evidenced road network. Visibility radius of 4400 m.

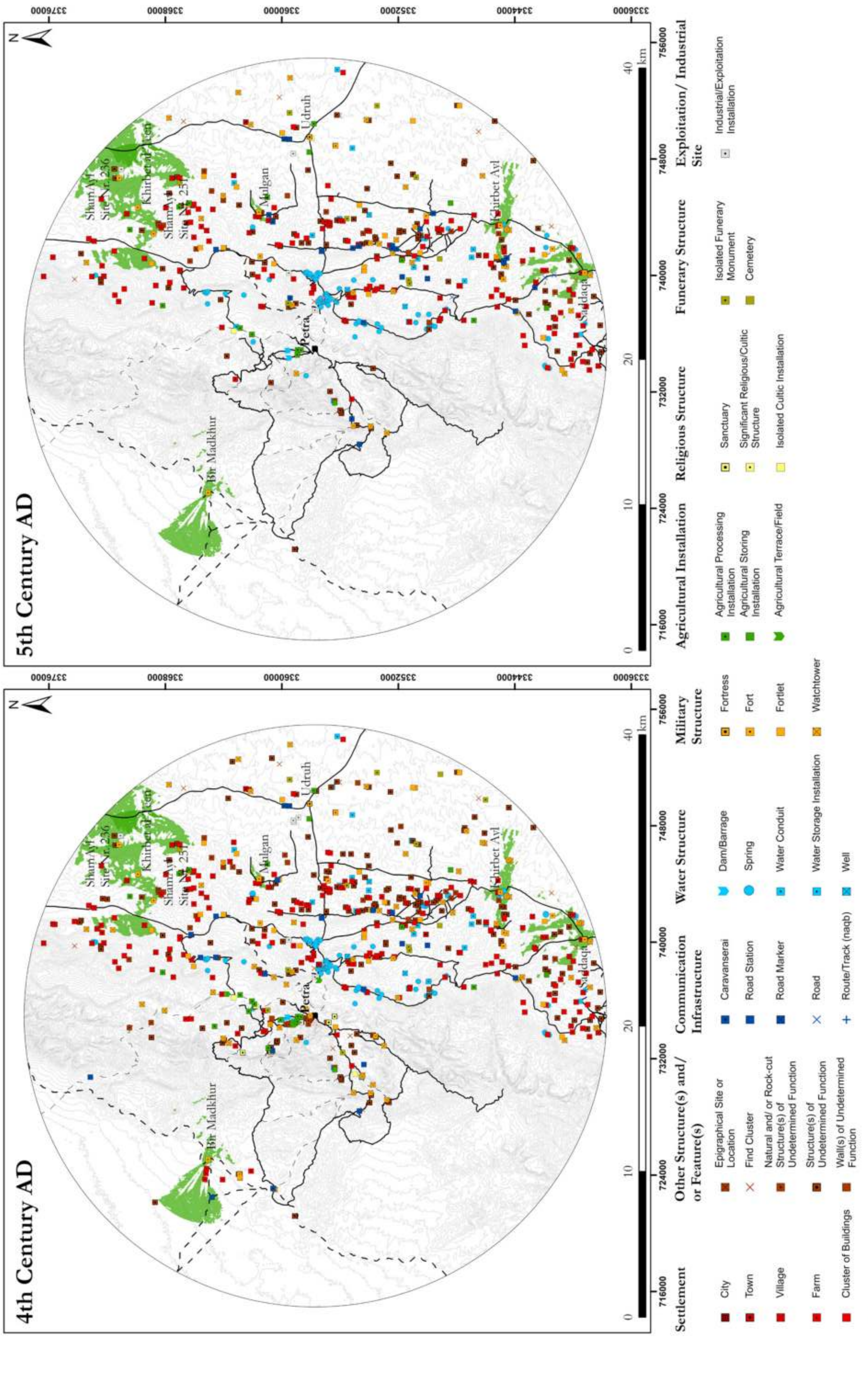


FIG. 271 GIS-based viewshed analyses calculated for 4th and 5th century AD forts in the Petra area with the evidenced road network. Visibility radius of 4400 m.

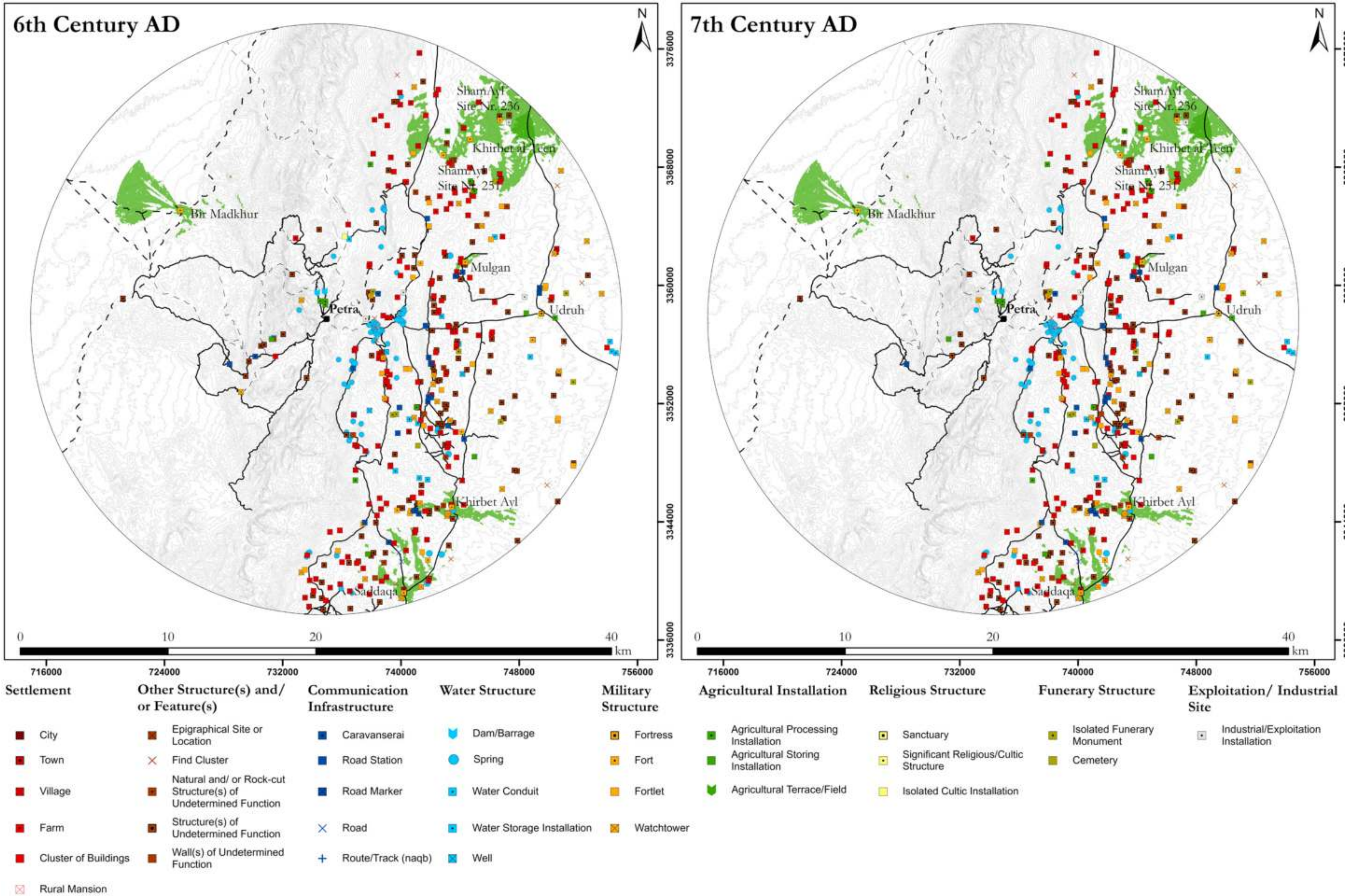


FIG. 272 GIS-based viewshed analyses calculated for 6th and 7th century AD forts in the Petra area with the evidenced road network. Visibility radius of 4400 m.

Fortlets, Watchtowers and Other Structures of Possible Military Function

Fortlets/Road Stations

While a possible military function can be associated with specific structures larger than 0,1 ha ('forts'), there are other fortified structures in the study area that are smaller than 0,1 ha.[1404] In addition to the limited archaeological information provided by the original survey reports, with decreasing site size it becomes even more difficult to clearly identify the function of these smaller sites.[1405] However, the original surveys classified many uncritically as 'military.' Particularly for smaller structures, there is a tendency to quickly assign any rectangular structure with substantial perimeter walls and situated in a prominent landscape setting a purely defensive role.

This study thus exercises particular caution when assigning military functions to fortified structures smaller than 0,1 ha. With few exceptions, no plans are available to allow a more precise structural comparison of these structures, as was the case for the discussed forts. This presents an even greater challenge in assessing them functionally. Based on site descriptions and, when available, aerial images, a preliminary comparative overview of plans is nevertheless presented (FIG. 273).[1406] On the basis of site size, location, the archaeological context and available structural information (cf. TABLE 32), 15 structures smaller than 0,1 ha (but larger than 100 m²) were identified, which may have had a possible military function (FIG. 274).

However, as many are situated along ancient roads and routes, it seems more accurate to refer to these structures as possible 'fortlets/road stations.' These structures include at-Tiyir, ShamAyl Site No. 114, Seil Abu Mrerah, Abu Danna, Qasr at-Tayyiba, ShamAyl Site No. 131, Khirbet ar-Rakham, ARNAS Site No. 042, ShamAyl Site No. 177, Sabra, Rujm Batahe, Qasr Umm Rattam, Umm Hilal, Khirbet al-Hasaieh, and Khirbet al-Unaiq.

Surface material suggests that the majority of these sites date to the 1st century BC. Only at-Tiyir and ShamAyl Site No. 114 are presumably of Iron Age origins (cf. chapter 3). Umm Hilal, Khirbet al-Hasaieh and Khirbet al-Unaiq date from the 1st century AD onwards. Just over half of the structures seem to have been in continuous use until the 7th century AD.[1407] Umm Hilal was presumably occupied until the 3rd century AD and Qasr Umm Rattam until the 4th century AD. The remaining structures (Seil Abu Mrerah and Qasr at-Tayyiba) were abandoned by the 2nd century AD. The following presents a critical overview of the presumed fortlets/road stations in this chronological order.

The site of at-Tiyir measures only 0,07 ha and is one of the earliest possible fortlets in the Petraean hinterland (cf. FIG. 273, No. 1 and TABLE 32).[1408] It is situated between Saddaqa and Ayl along Abudanh's 'Fardakh Road.' Surface pottery dates between the 12th century BC and 7th century AD with an apparent lack of material for the 5th century AD. This extremely broad dating is problematic and raises questions about the original nature of the structure. The original surveyors describe the site as a possible 'fort' as it is located on a prominent slope overlooking the settlement of Fardakh.[1409] It is built of large, irregularly formed stone blocks and the external walls are 2 m thick. The site features internal divisions as well. Aerial images possibly show a centrally placed gate that opens into a small courtyard area. This gives access to at least two side rooms and possibly two further rooms in line with the presumed entrance (FIG. 275). Based on the thickness of the walls and the site's location along the Fardakh road, it may be assumed that at-Tiyir had a military function. It may have accommodated a small unit for controlling movement along the Fardakh road and monitoring activities at ancient Fardakh.

ShamAyl Site No. 114 can be described as a possible fortlet as well (cf. FIG. 273, No. 2 and TABLE 32).[1410] Surface pottery suggests a dating range between the 10th and 6th century BC as well as between the 1st century BC and 7th century AD. The site is situated some kilometers south of Udruh (cf. FIG. 274). Due to its position on a prominent hilltop the site commands an excellent view over the surrounding landscape. ShamAyl Site No. 114 is described only as a rectangular structure with possible internal divisions and was built of thick walls. The original surveyors interpret the site as "[…] *an observation point for hunters and as a watchtower and/or fort.*"

Khirbet al-Haisaieh is located on the eastern border of the study area on a plain near a local spring southeast

1404 A 'fortified structure' consists of a substantial perimeter wall that suggests a defensive character.

1405 Mattingly faced the same problem when identifying possible outposts smaller than 0,1 ha in *Tripolitania* (Mattingly 1995, 164–165).

1406 The presented plans can only be considered as scaled sketches and should be treated with caution.

1407 Khirbet al-Haisaieh, Khirbet ar-Rakham, ShamAyl Site Nos. 131 and 177, Abu Danna, ARNAS Site No. 042.

1408 At-Tiyir belongs to the few sites in the study area where surface material suggests a Hellenistic date (4th to 2nd century BC) as well.

1409 MacDonald et al. 2012, 192.

1410 MacDonald et al. 2016, 230.

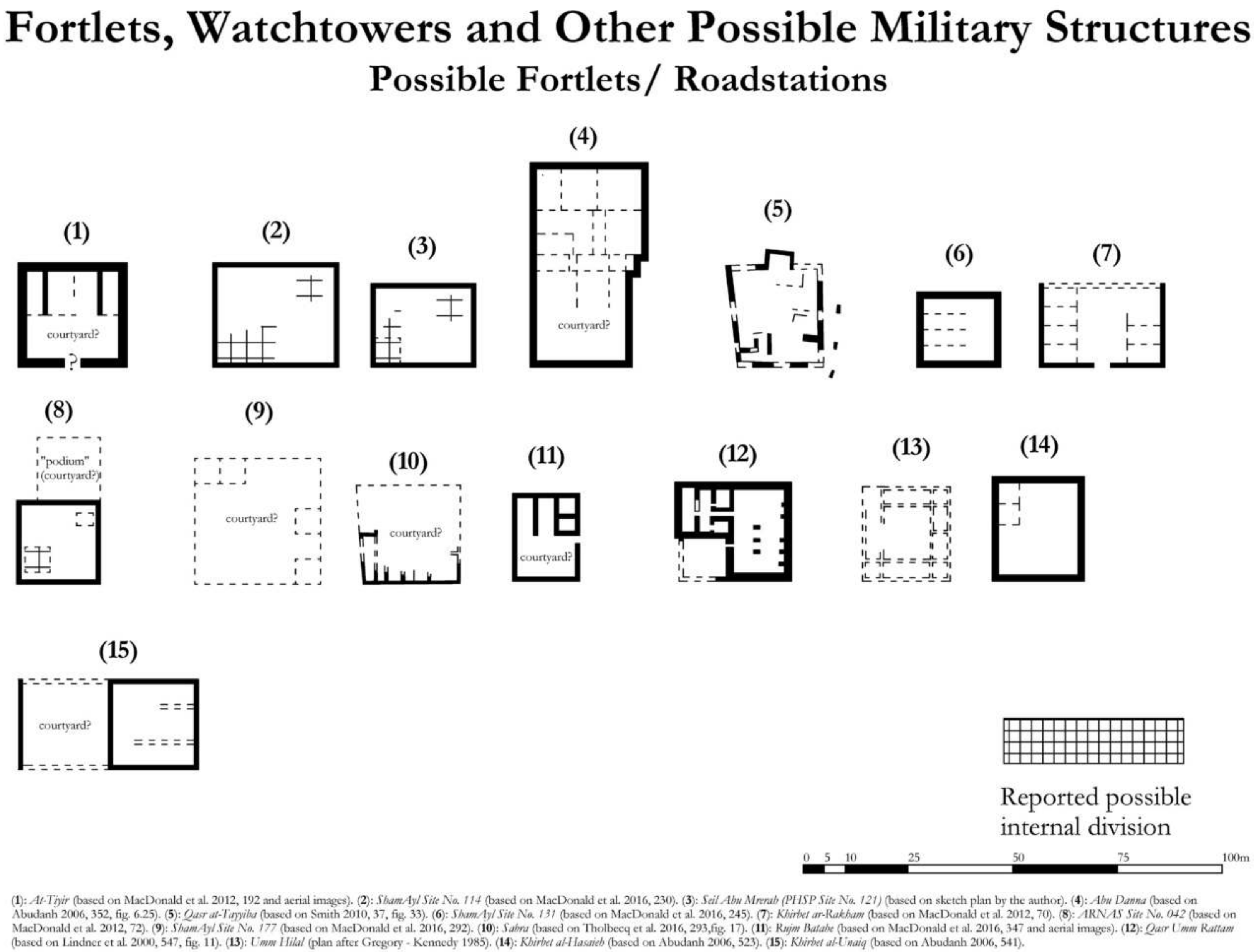


FIG. 273 Scaled sketch plans of the possible fortlets/road stations in the Petraean hinterland.

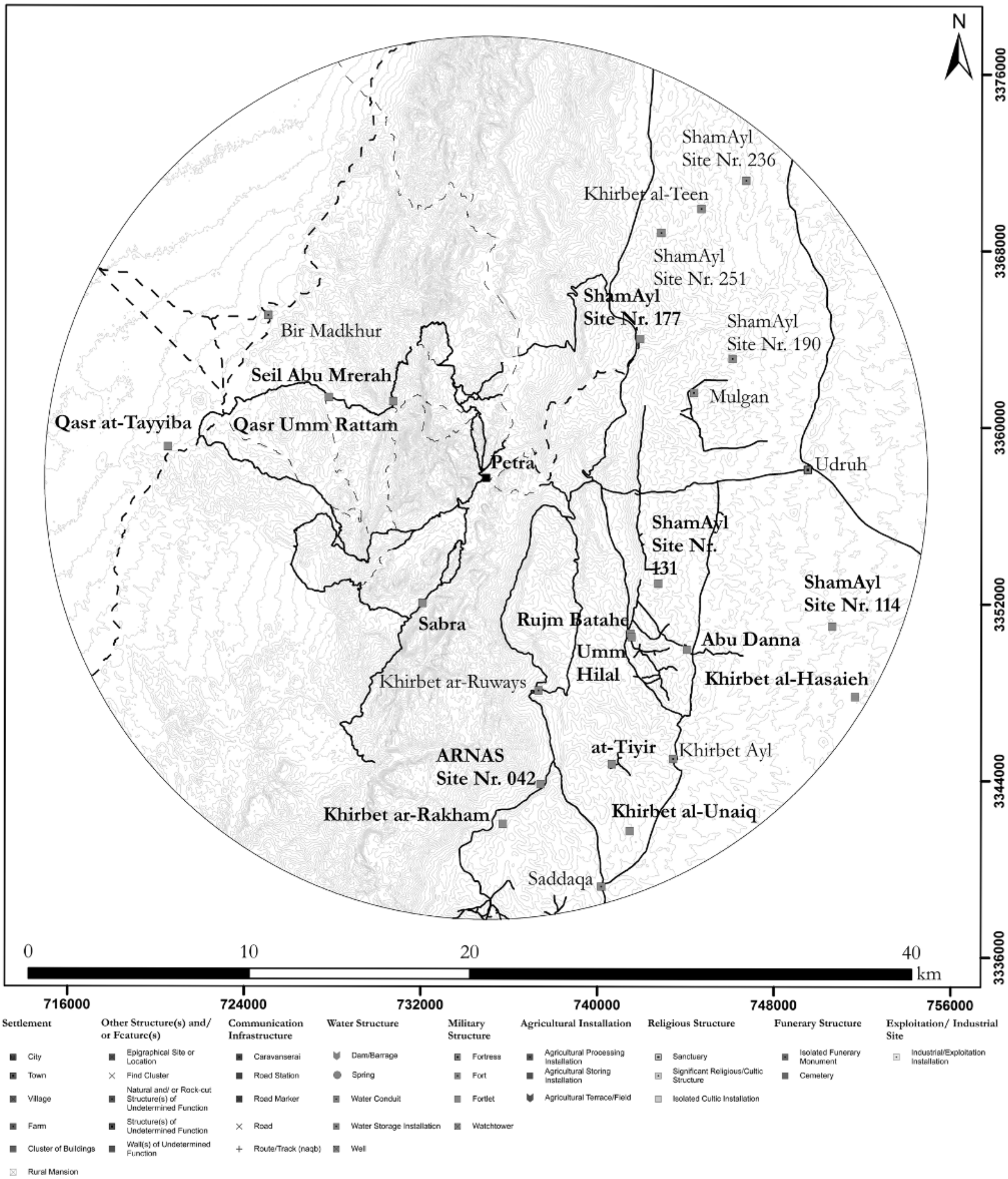


FIG. 274 Distribution map of all possible fortlets and/or road stations together with the recorded forts in the study area.

of ShamAyl Site No. 114 (cf. FIG. 273, No. 14 and TABLE 32). The rectangular structure measures c. 0,06 ha and has thick perimeter walls. It features possible internal divisions as well.[1411] Based on the available information it is difficult to assign a specific function for the site, but it seems to have been used for monitoring activities around the mentioned spring.

Khirbet ar-Rakham is situated on a hilltop along the southern stretches of the Darb ar-Rasif (cf. FIG. 273, No. 7 and TABLE 32).[1412] The rectangular structure is built of thick outer walls with possible internal divisions. An ancient pathway seems to run towards it. Aerial images show that the path leads directly into a presumed internal courtyard area that divides the

1411 Abudanh 2006, 523.

1412 MacDonald et al. 2012, 70.

FIG. 275 Aerial view of the fortlet at at-Tiyir and its surroundings. Photo: APAAME.

FIG. 276 Aerial view of the possible fortlet/road station of Khirbet ar-Rakham. Photo: APAAME.

structure into two halves with rooms on each side (FIG. 276). The site measures c. 0,06 ha. While it cannot be concluded whether Khirbet ar-Rakham had a military or administrative/communication function, the site was most likely associated with observing activities along the Darb ar-Rasif.

ShamAyl Site No. 131 is a rectangular structure built of conspicuously thick walls with possible internal divisions (cf. FIG. 273, No. 7 and TABLE 32).[1413] The site is located on a plain and commands a good view over the surrounding landscape. Its presumed military character is based only on the site's structural characteristics and the good visual control of its environment.

ShamAyl Site No. 177 is even more difficult to clarify functionally (cf. FIG. 273, No. 9 and TABLE 32). This site is located along the northern stretch of the *via nova Traiana* between Wadi Musa and Nejel. It consists of several rectangular structures arranged around a possible courtyard.[1414] The original surveyors postulate that the site may have had a "defensive purpose," without giving any specific argument for it. The site is most likely related to the management of the local road network.

The well-known site of Abu Danna is located on a hilltop along the Udruh-Basta Road, overlooking the settlement of Abu Danna and its reported well (cf. FIG. 273, No. 4 and TABLE 32). Until Abudanh resurveyed the site, the c. 0,05 ha large, rectangular structure had only been described as "constructed from well-drafted ashlars." No accurate plan or dating material was available.[1415] Abudanh sketched the structural remains, showing a large core area with many internal divisions and a possible courtyard area immediately in front of the presumed rooms. While Killick claims a Roman date for the structure, Abudanh collected Nabataean surface pottery material.[1416] Abudanh postulates that Abu Danna served military purposes for controlling activities at the settlement or, alternatively, as a possible "tax collecting point," due to the site's vicinity to the Udruh-Basta road.[1417] While the latter remains speculative, it seems likely that the site served a controlling and road-related administrative function.

ARNAS Site No. 042 is situated north of Khirbet ar-Rakham along the southern stretch of the Darb ar-Rasif (cf. FIG. 273, No. 8 and TABLE 32). The c. 0,04 ha square structure had solid external walls and possible internal divisions. The original surveyors interpret it as a possible "small fort."[1418] They also mention a "large podium" on the northwestern side of the structure. Although it is difficult to interpret the exact meaning, it can be speculated that the 'podium' is in fact a possible forecourt. Although the surveyors suggest a military function of the site, its immediate vicinity to the Darb ar-Rasif indicates that the structure was associated with the administration and control of road-related activities.

Qasr Umm Rattam is located c. 7,5 km northwest of Petra along the Wadi Musa (cf. chapter 6) (cf. FIG. 273, No. 12 and TABLE 32). Under the direction of M. Lindner and U. Hübner, the *Naturhistorische Gesellschaft Nürnberg* (NHG) conducted an intensive survey of the site.[1419] It presumably dates from the Nabataean to the Early Byzantine period. The site consists of a smaller watchtower on the opposite wadi bed that oversees the main complex and its associated agricultural terraces. Lindner et al. interpret the main *qasr* as a Roman or Early Byzantine administrative building. A large reservoir supplied the *qasr* with water by a Nabataean or Roman aqueduct coming from the eastern end of the Wadi Musa (FIGS. 277 and FIG. 189).[1420] The undisputed relation between the complex of Qasr Umm Rattam and the route of Wadi Musa justifies to refer to the site as a road station. However, the fact that an aqueduct supplied the site with water, the overall substantial architecture of the *qasr* and the presumed watchtower to observe activities around the site, highlights the strategic importance of Qasr Umm Rattam. It also implies that a larger group of people was stationed there permanently. It may therefore be speculated that civilian administrators or military personnel were stationed at the site to control and manage traffic along the Wadi Musa. Possibly, Qasr Umm Rattam had a mainly administrative function, while playing a defensive role when necessary.

Continuing the Wadi Musa eastwards from Qasr Umm Rattam and then north at Dawrum Day along the route of Naqb Abu Mrerah (cf. chapter 6), the PHSP discovered a rectangular structure of c. 1,2 m thick walls with possible internal divisions (cf. FIG. 273, No. 3 and TABLE 32). While it is likely that this structure, referred to here as Seil Abu Mrerah (cf. FIG. 235), is a simple road station for managing activities along Naqb Abu Mrerah, the considerable

1413 MacDonald et al. 2016, 245.
1414 MacDonald et al. 2016, 292.
1415 Cf. Kennedy 2004, 180 with further references. Graf 1997, 279 refers to the site as a *castellum*.
1416 Abudanh 2006, 515. Without more information on the pottery material, Killick's 'Roman' and Abudanh's 'Nabataean' date do not necessarily have to contradict each other. Stylistically 'Nabataean' pottery is known to run well into the 4th century AD.
1417 Abudanh 2006, 515.
1418 MacDonald et al. 2012, 72.
1419 Lindner et al. 2000, 535–567.
1420 Lindner et al. 2007, 247; Lindner et al. 2000, 535.

FIG. 277 Aerial view of the possible fortlet/road station of Qasr Umm Rattam. Photo: APAAME.

size of the ashlars used for the site's external walls also suggest a defensive character.

Qasr at-Tayyiba is situated southwest of Qasr Umm Rattam along the important north-south route in the Wadi Arabah (cf. FIG. 273, No. 5 and TABLE 32). The square structure measures c. 0,06 ha and is characterized by c. 1,15 m thick external walls. [1421] Possible interior rooms are aligned around a central courtyard. A possible gate or tower is built centrally into the structure's western wall. While only little surface material was recorded at the *qasr* itself, Smith surveyed other smaller structures in its immediate vicinity. These date mostly to the Nabataean and Early Roman periods.[1422] Copper slags were discovered near Qasr at-Tayyiba as well, suggesting that the site was associated with the processing of copper ores. If these slags were processed locally, Qasr at-Tayyiba may have served for protecting and/or depositing the copper products. The structural remains of the site may indicate a defensive purpose. However, due to its location along the major north-south axis of the Wadi Arabah, the site can be better associated with the management and control of traffic in the Arabah.

At Sabra, the *Mission Archéologique Française* has recently identified a c. 23 × 12 m isolated structure along the lower bed of Wadi Sabra (cf. FIG. 273, No. 10, TABLE 32 and FIG. 278).[1423] The structure is characterized by a long, ca. 1 m thick perimeter wall with several perpendicular walls in its interior. It is unclear if these walls form open rooms or closed compartments, but they suggest a clear internal division. There are so far no available dating information.[1424] Should future investigations confirm an internal courtyard, the surveyors interpret the structure as a possible caravanserai or 'fort.' The vicinity to the important caravan route of Wadi Sabra would associate the structure with the management and control of activities along the wadi. While a possible military function of the structure remains speculative, it is postulated that a Late Roman military post was stationed

1421 Smith 2010, 36–37.
1422 Smith 2010, 37.
1423 Tholbecq et al. 2016, 289–292 and Tholbecq 2015, 93–94.
1424 For now, the broad dating of the entire site of Sabra has to be considered. This ranges from the 1st century BC to the Late Roman period (cf. Tholbecq et al. 2016, 292 and Tholbecq 2015, 94).
1425 Kennedy 2004, 183 with further references. On Sabra during the Late Roman period cf. Tholbecq et al. 2016, 292 and Tholbecq 2015, 94.

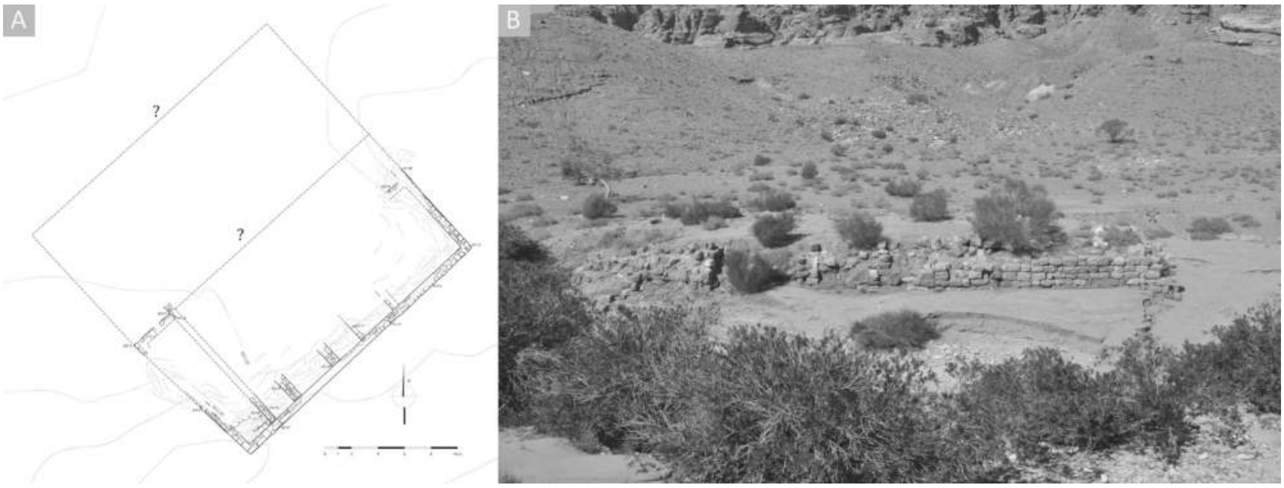


FIG. 278 The presumed fort or caravanserai at Sabra. A: Preliminary plan after Tholbecq et al. 2016, 293, fig. 17. B: Overview of structural remains after Tholbecq et al. 2016, 294, fig. 18.

at Sabra.[1425] The *Notitia Dignatatum* lists the *equites primi felices* [sagittarii indigenae] *Palestini, Sabure sive Veterocariae* – a mounted archers unit of *primi felices Palestini*, at Sabura or Veterocaria.[1426] Not only does the toponym *Sabura* resemble the modern name Sabra, Eusebius may have also meant *Veterocaria* when stating that a garrison was stationed at *Carcaria*, which was only one day's journey from Petra. This fits the distance between Sabra and Petra well. [1427] Previous scholars therefore assumed that the *equites primes felices* were stationed at Sabra. Eusebius explicitly states the presence of a φρούριον at Carcaria. When equating Carcaria with Sabra, however, locating the mentioned φρούριον is difficult. There is no structure known at Sabra that fits the description of Eusebius, except the one described above. However, even when accepting a military function of this structure, it is too small to have accommodated a full-sized cavalry unit as listed in the *Notitia Dignitatum*. While a small infantry or archers' unit may have been stationed at Sabra, the listed *equites primes felices* would have necessitated a larger structure, possibly like the fort at Saddaqa where the Late Roman *equites promoti indigneae* were stationed according to the *Notitia Dignitatum*. It therefore seems unlikely that Carcaria can be located at Sabra. An alternative proposition was already made by Alt who places the site – and therefore the *equites primes felices* and Eusebius' φρούριον – in Petra's "östliches Gebirge" near Ma'an, which is only a day's journey from Petra as well.[1428] Following Alt, it seems more likely to associate the much larger (c. 0,3 ha) structures with interior compartments and central courtyards (e. g. al-Mutrab) in the vicinity of al-Hamman near modern Ma'an, with the *equites primes felices* (FIG. 279).[1429] Although these sites resemble caravanserais or early Islamic residences and the majority of the reported surface pottery was indeed Islamic, Roman period material was collected at the sites as well. As Kennedy states, it "[…] *seems likely* [that] *the area does include one or more genuine Roman military structure even if those identified as such are in fact Islamic*."[1430] Except for al-Hamman, which is identified as ancient Ammatha in the Beer Sheva Edict, one of these structures may be better equated with Carcaria and the *equites primes felices*. While this remains speculative, Sabra cannot be convincingly associated with the *equites primes felices* either.

Rujm Batahe dates as early as the 1st century BC and was in continuous use until the 7th century AD (cf. FIG. 273, No. 11 and TABLE 32).[1431] The site is located north of at-Tiyir and west of Abu Dana on a slope along Abudanh's 'Zharah road.' The 0,03 ha large site is described as a substantially built rectangular structure with possible internal divisions. Aerial images of the site clearly show a possible entrance and an open courtyard area (FIG. 280). At least three equally sized rooms make up one half of the structure. One of the lateral rooms seems to be further divided. The site's structural characteristics and location along the Zharah road suggests a military and/or administrative function.

Umm Hilal was first described by Stein and, based in his report, Gregory and Kennedy could sketch a preliminary plan of the site (cf. FIG. 273, No. 13, TABLE 32).

1426 Not. Dign. Or. 34, 28. Also cf. e. g. Kennedy 2004, 183.
1427 Eus. On. 116, 17–19: "*Καρκᾶ (Judges 8, 10). ἔντα »Ζεβεέ καί Σαλμανᾶ « , οὓς ἀνεῖλε Γεδών. Καί ἔστι νύν Καρκαρία φρούριον ἀπέχον Πέτρας πόλεως μόνην <ἡμέραν>.*"
1428 Alt 1935, 42–43 and 25, Abb.1.
1429 Kennedy 2004, 184–186.
1430 Kennedy 2004, 186.
1431 MacDonald et al. 2016, 436.

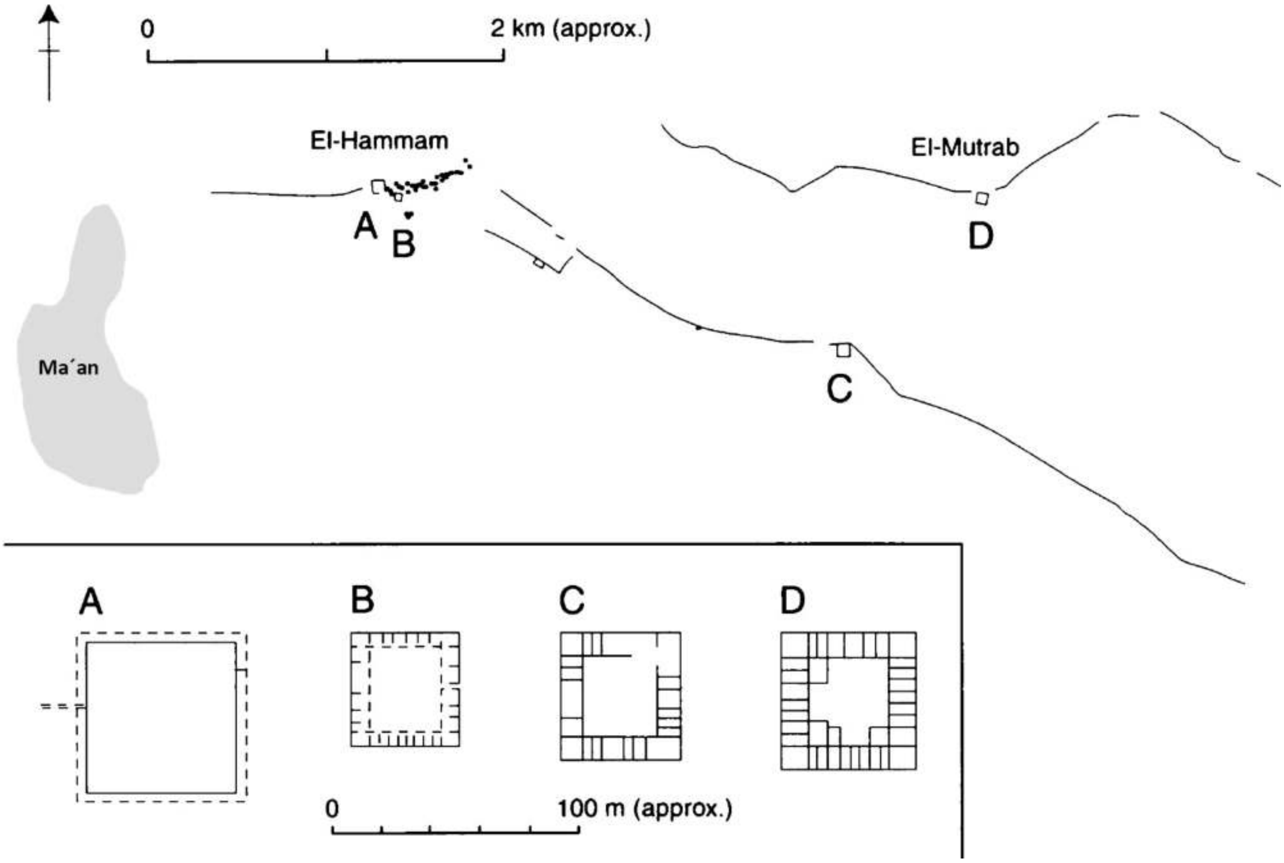


FIG. 279 Possible structures around al-Hamman near modern Ma'an which could have accommodated the *equites primes felices.* Plans after Kennedy 2004, 186, fig. 18.3.

The c. 0,05 ha large, rectangular structure is located on a hilltop just east of Abudanh's Zharah road with a good view of its surrounding area. It features possible interior rooms or compartments placed around a central courtyard. Abudanh later revisited Umm Hilal for his survey and interpreted it as a defensive structure due to its strategic location on a hilltop and its vicinity to the Zharah road.[1432] It is possible that the site had a defensive role, but the vicinity to the road also suggests that it monitored activities along the road.

Khirbet al-Unaiq is located on a hilltop southwest of Fardakh and the natural spring of Ain al-Unaiq (cf. FIG. 273, No. 15 and TABLE 32). Surface material suggests that the site was occupied from the 1st century AD onwards. The square structure measures c. 0,05 ha. It is characterized by a c. 1 m thick perimeter wall with possible internal divisions.[1433] Outside the main structure, Abudanh observed a wall running parallel to the structure's southern wall. The area between these two walls is reportedly paved. This may suggest an open courtyard area. Abudanh claims that Khirbet al-Unaiq is the 'small fort' observed by Graf.[1434] The site's location on a hilltop overlooking the spring of al-Unaiq and the surroundings of Fardakh as well as its structural characteristics suggest that Khirbet al-Unaiq served some military purpose.

The visual control of roads and routes is a common feature of all fortlets and/or road stations. All structures are located along, or in close vicinity to, roads and routes. Their function therefore must be associated with the management and control of activities along these roads/routes. Determining a purely military function of the presented fortlets and/or road stations is difficult. The described visibility to nearby roads and routes is also confirmed by cumulative GIS-based viewshed analyses. They clearly show that many of the fortlets/road stations command visual control over vast stretches of the road/route network (FIG. 281). This is particularly the case for the southeastern quarter of the study area where the Darb ar-Rasif, Graf's 'central road,' Abudanh's 'Zharah road' as well as parts of the Saddaqa-Udruh connection are under good visual control. The cumulative viewshed analyses demonstrate that only four structures (Rujm

1432 Abudanh 2006, 541.
1433 Abudanh 2006, 541–542.
1434 Abudanh 2006, 542.

FIG. 280 A: Aerial view of the fortlet at Rujm Batahe and its surroundings. B: Detailed view. Photos: APAAME.

Batahe, Umm Hilal, Abu Dana and ShamAyl Site No. 131) have overlapping visibility fields. Intervisibility can only be assumed between Rujm Batahe, Umm Hilal and Abu Danna. The structures mainly command visual control of their immediate surroundings observing mostly civilian settlements in addition to the road network (FIGS. 282–285). As argued for the evidenced forts, this implies that fortlets/road stations were not part of a large, interrelated military system. They probably served as local control points instead.

This phenomenon remains the same from the 1^{st} century BC through to the 7^{th} century AD. Independent of the time period, the control of road activities was therefore the most important function of fortlets and/or road stations. The only intervisibility between a fort and a presumed fortlet is between Saddaqa and Khirbet al-Unaiq from the 4^{th} century AD onwards (cf. FIG. 284). The available evidence thus does not suggest a visual network between forts and fortlets/road stations. Moreover, while the combined viewsheds for the forts and the fortlets/road stations (FIG. 286) show that the Petraean hinterland is generally under good visual control, the most significant areas are not. These include the central stretch of the Darb ar-Rasif, Graf's central road, the western stretch of the Petra-Udruh road, a vast area north of Petra and most of the western naqb. Importantly, the Petra valley and the city itself are not visually controlled by forts or fortlets/road stations.

Possible Watchtowers

In describing the events of 311 BC, when Antigonos Monophtalmos and his son Demetrios Poliorketes attempted to conquer Nabataean territories in and around Petra, Diodorus Siculus mentions the persisting Nabataean concern about potential hostile activities by the Antigonids.[1435] In response to this Antogonid threat, the Nabataeans placed watchmen – σκοποί – on hilltops who observed the surrounding landscape and communication routes:

> […] *ἀλλὰ τὰς ἐλπίδας ἔχοντες ἀμφιδοξουμένας σκοποὺς μὲν κατέστησαν ἐπὶ τῶν λόφων, ἀφ᾽ ὧν ἦν ῥᾴδιον συνορᾶν πόρρωθεν τὰς εἰς τὴν Ἀραβίαν ἐμβολάς* […]
>
> […] *but regarding their prospects as uncertain, they placed watchmen upon the hills from which it was easy to see from a distance the passes into Arabia* […][1436]

1435 Hackl et al. 2003, 439; 446.

1436 Diod. Sic. 19, 96, 3. Loeb Classical Library edition, 1954. Translation by Russel M. Geer.

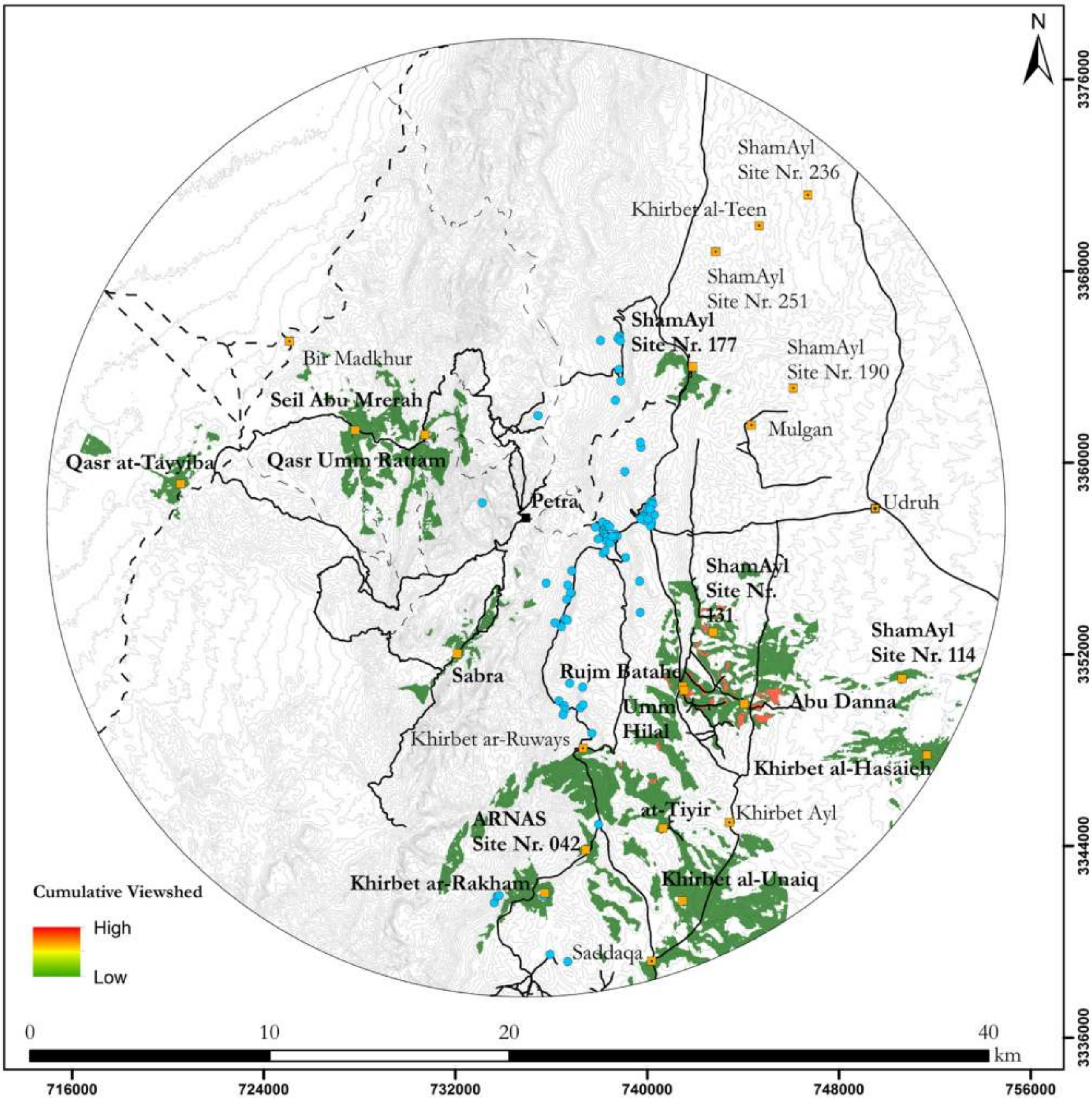


FIG. 281 Cumulative viewsheds calculated for all discussed possible fortlets and/or road stations in the Petra hinterland with springs (blue). Maximum overlap of visibility fields from 4 structures only (marked in orange). Visibility radius of 4400 m.

In another passage, Diodorus describes how Demetrios Poliorketes circumvented the main passages into Nabataean territory to launch a sneak attack. However, he was spotted by the Nabataean watchmen who alarmed each other by means of fire signals:[1437]

> *Οὗτος* [Demetrios] *μὲν οὖν ἐφ᾽ ἡμέρας τρεῖς ἀνοδίᾳ πορευόμενος ἔσπευδε λαθεῖν τοὺς βαρβάρους, οἱ δὲ σκοποὶ κατανοήσαντες πολεμίαν δύναμιν εἰσβεβληκυῖαν ἐσήμηναν τοῖς Ναβαταίοις διὰ τῶν συγκειμένων πυρσῶν* […]

> *Demetrios, therefore, advanced for three days through regions with no roads, striving not to be observed by the barbarians; but the lookouts, having seen that a hostile force had entered, informed the Nabataeans by means of prearranged fire signals* […][1438]

These two passages are important references to a presumed early Nabataean communication network of σκοποί that were placed on strategic hilltops to monitor the surrounding landscape and to communicate potential threats by visual means. It is tempting

1437 Hackl et al. 2003, 446.

1438 Diod. Sic. 19, 97, 1. Loeb Classical Library edition, 1954. Translation by Russel M. Geer.

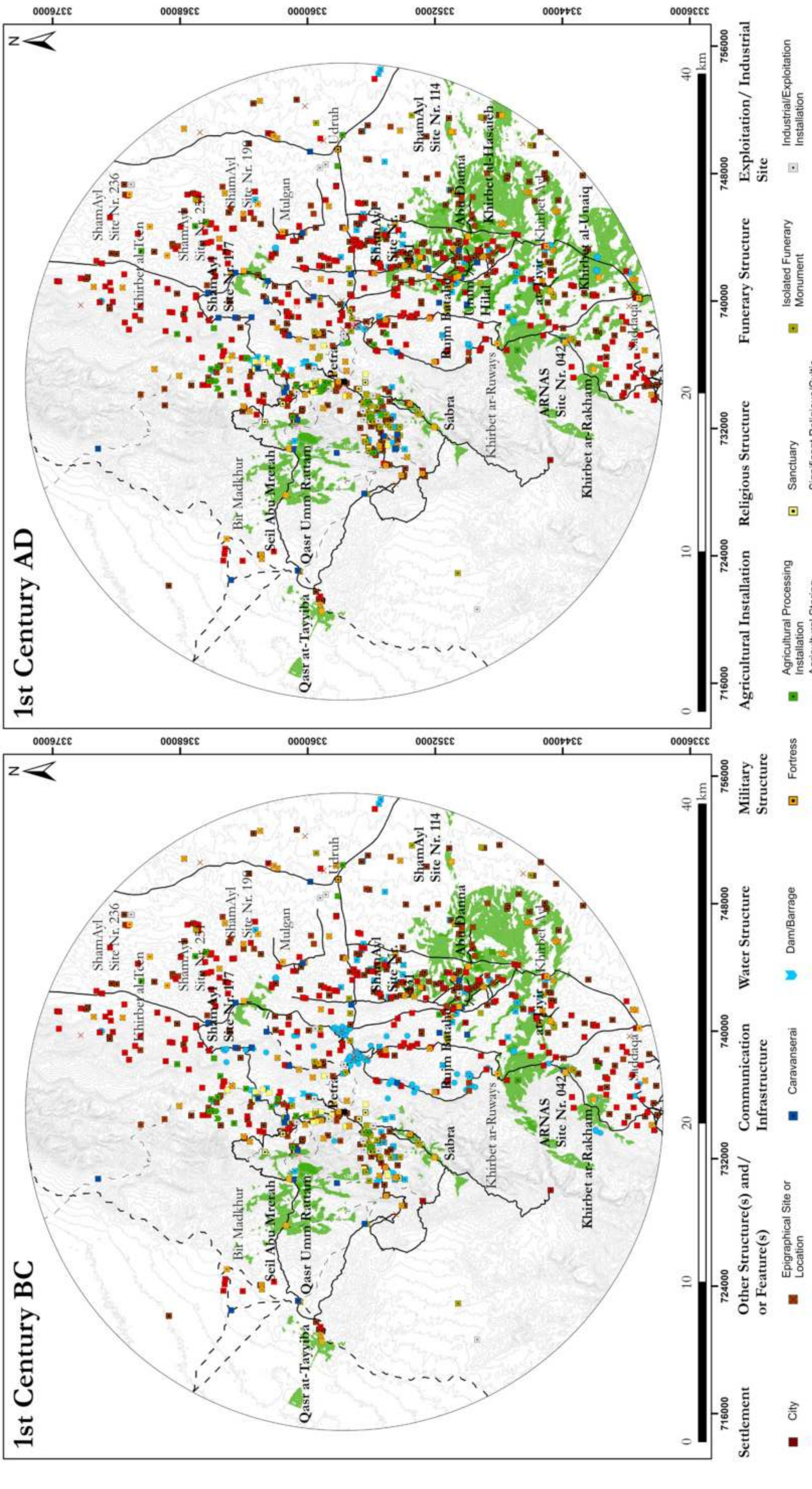


FIG. 282 GIS-based viewshed analyses calculated for 1st century BC and 1st century AD fortlets/road stations in the Petra area with the evidenced road network. Visibility radius of 4400 m.

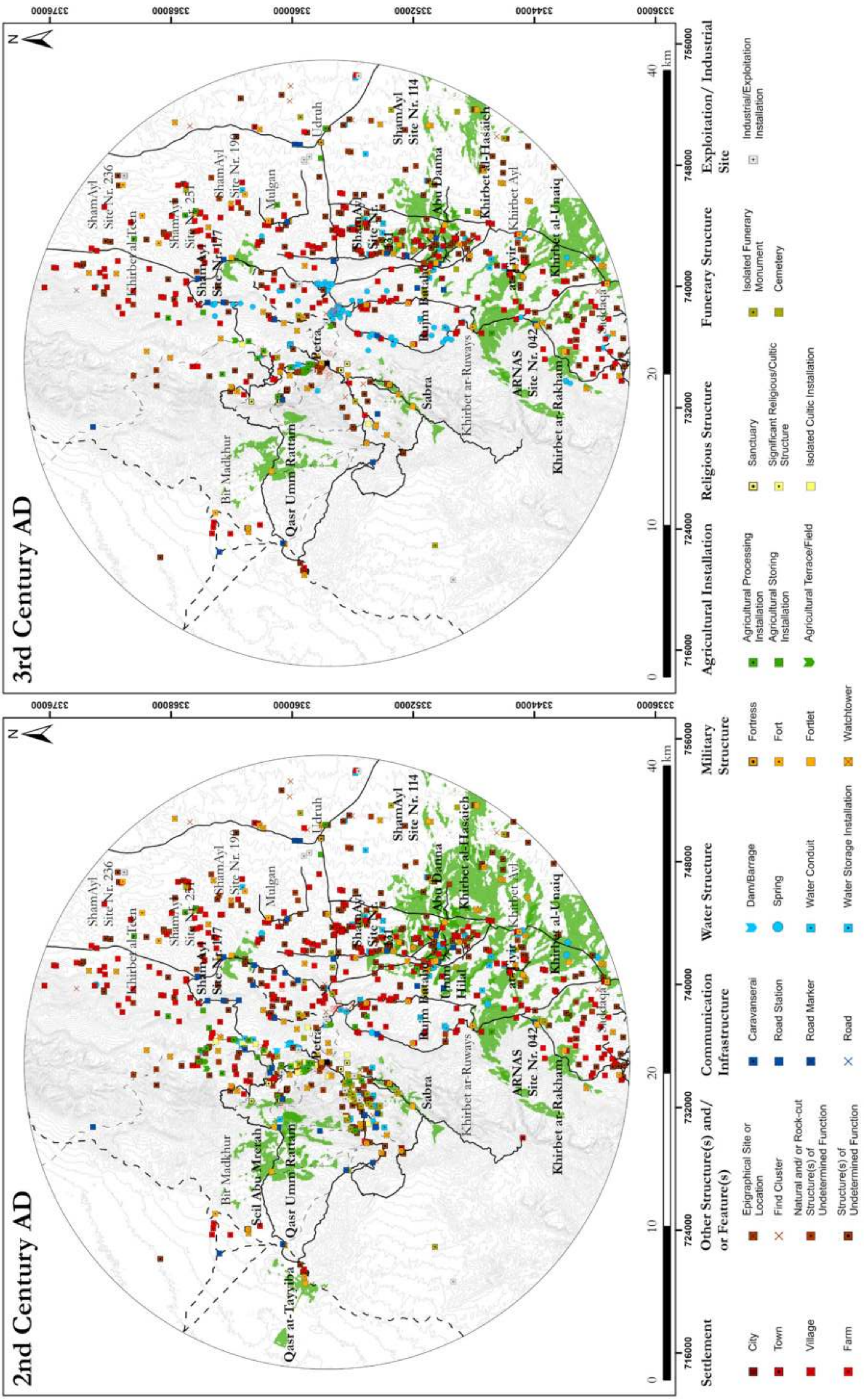


FIG. 283 GIS-based viewshed analyses calculated for 2nd and 3rd century AD fortlets/road stations in the Petra area with the evidenced road network. Visibility radius of 4400 m.

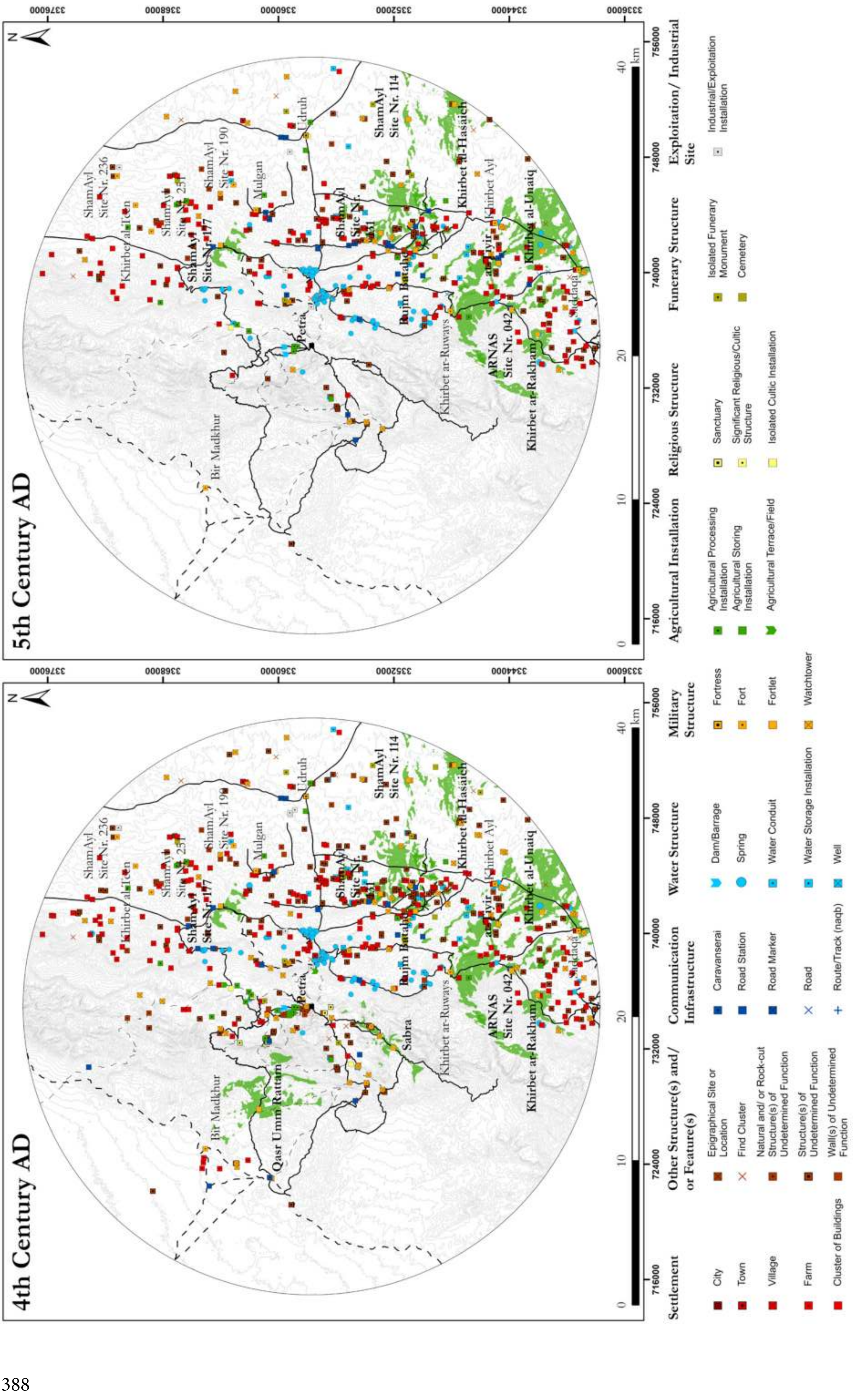


FIG. 284 GIS-based viewshed analyses calculated for 4th and 5th century AD fortlets/road stations in the Petra area with the evidenced road network. Visibility radius of 4400 m.

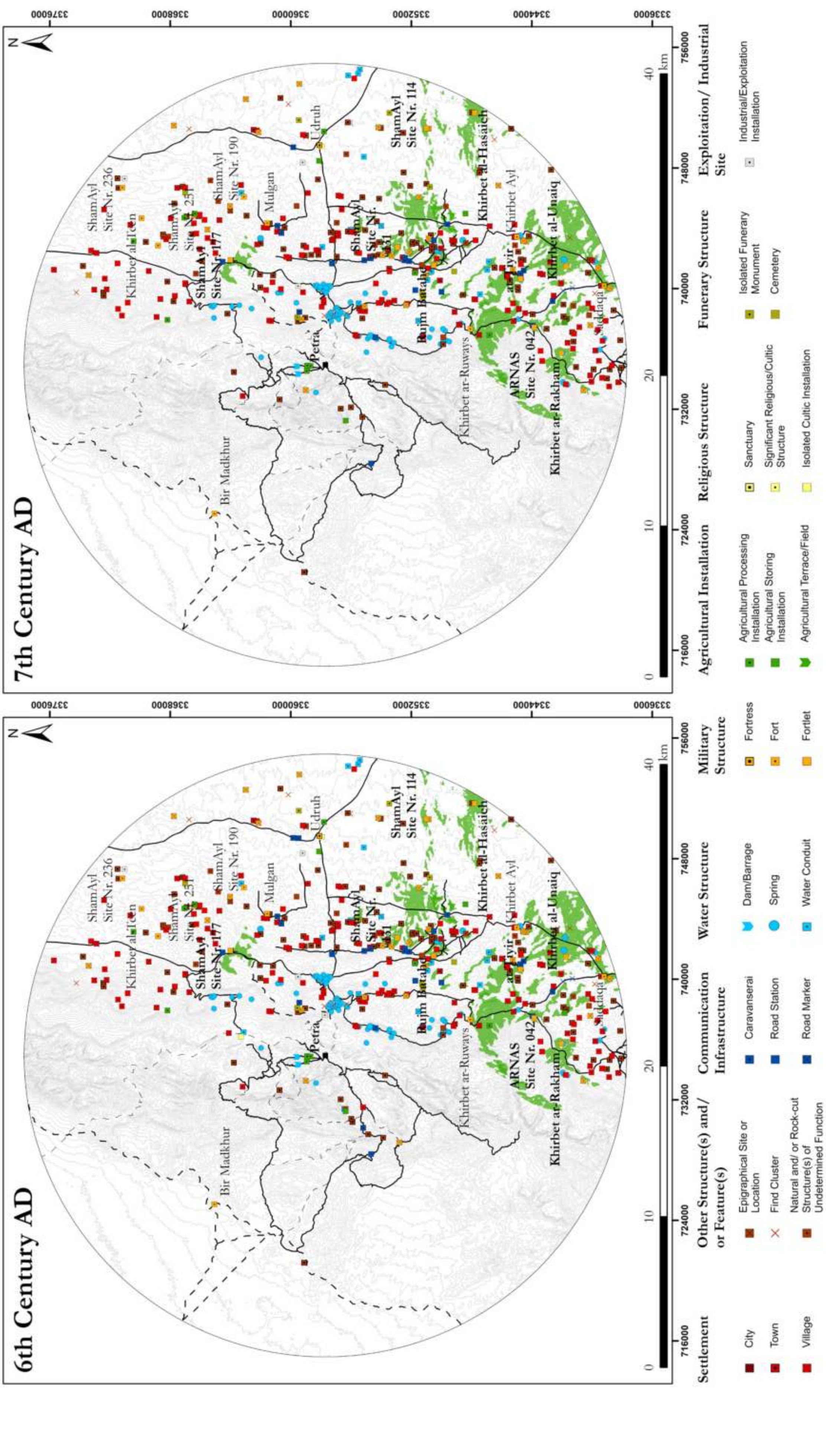


FIG. 285 GIS-based viewshed analyses calculated for 6th and 7th century AD fortlets/road stations in the Petra area with the evidenced road network. Visibility radius of 4400 m.

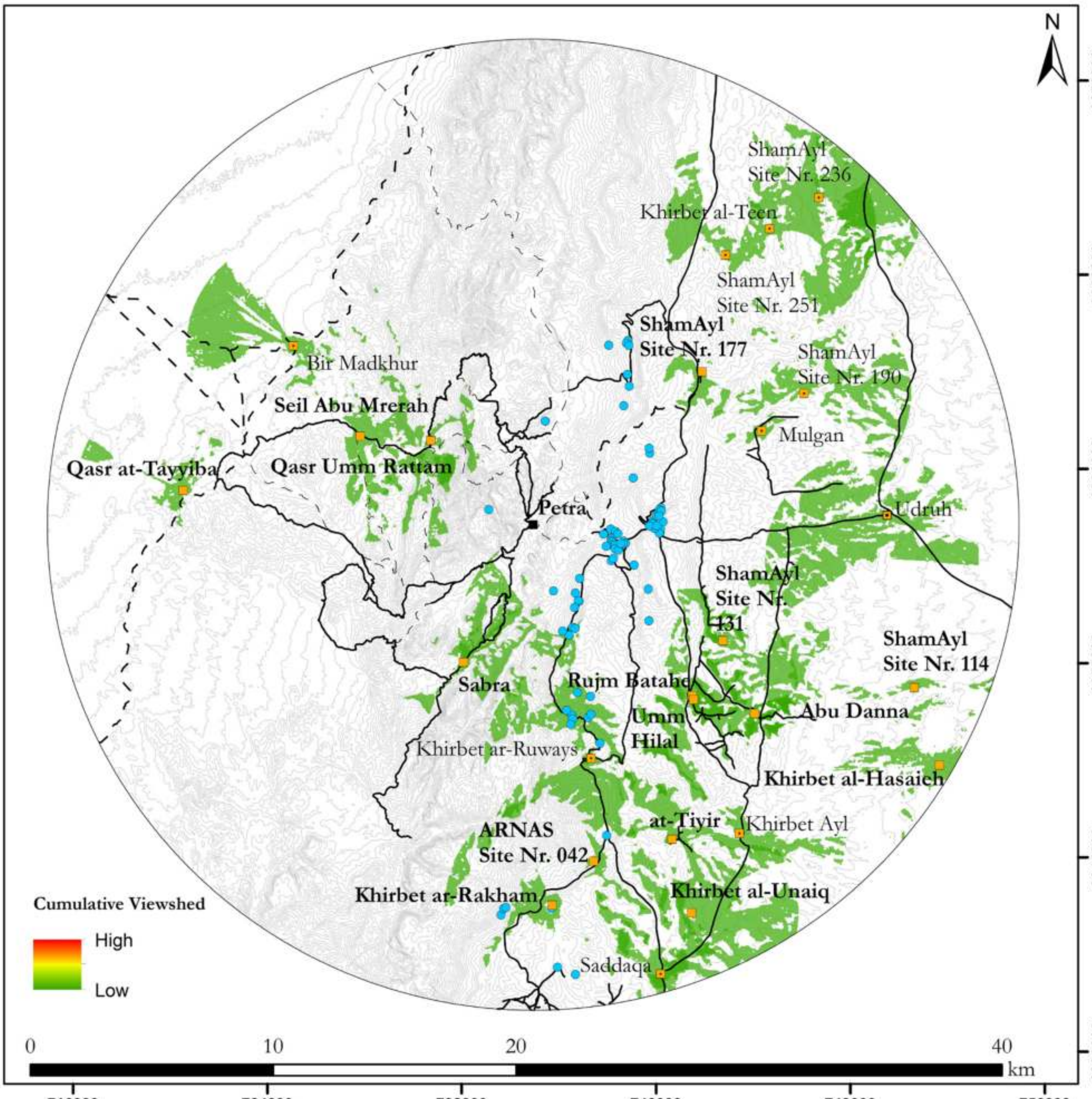


FIG. 286 Combined GIS-based viewshed analyses calculated for all evidenced forts and fortlets/road stations in the Petra area with the evidenced road network and springs (blue). Visibility radius of 4400 m.

to associate the numerous Nabataean watchtowers identified by regional surveys in the Petra region with the communication network described by Diodorus.[1439] As a result of an earlier study on this presumed network, the author already proposed optimal visual parameters that arguably enabled the described Nabataean communication network of watchtowers (cf. chapter 2).[1440] Assuming a maximum observer height of 4 m, structures of similar height were best visible within a maximum radius of 4400 m from the observer's standpoint. While this earlier study considered only few selected sites, the various surveys documented an overwhelming number of small, rectangular or square structures commanding good visual control over their surrounding landscapes. In total, the original surveys identified 97 structures in the Petraean hinterland as potential watchtowers or observation posts. However, there is a tendency of identifying every small tower-like structure with good visibility over its surroundings as a military watch-

1439 See for example the numerous towers identified by the *Wadi el Hasa Archaeological Survey* (MacDonald 1984) or the *Limes Arabicus Project* (Parker 2009b and 1986). Also note M. Gichon's attempts to classify presumed military watchtowers along the *limes palestinae* (Gichon 1974).

1440 Kennedy 2016b and 2013b.

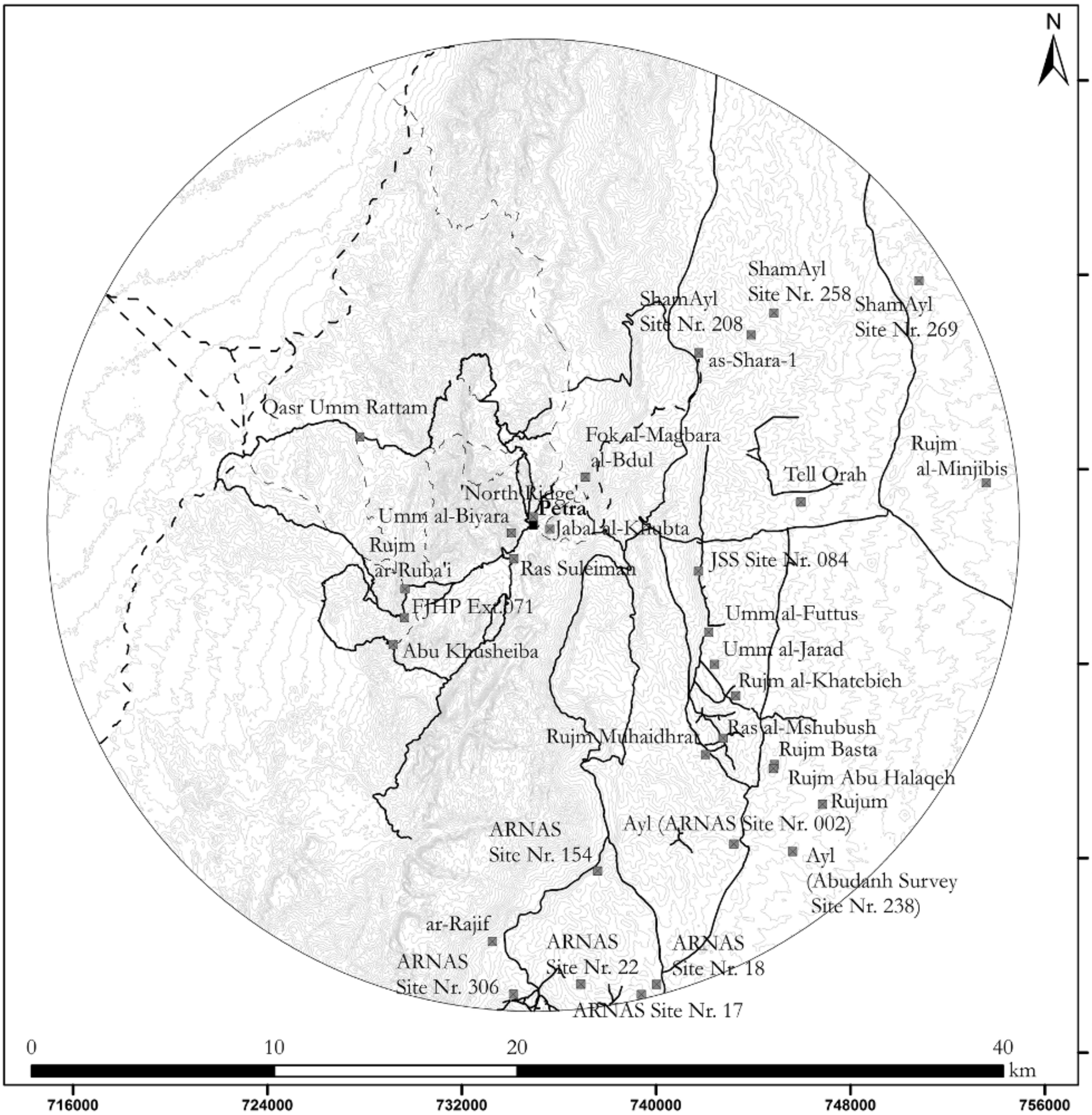


FIG. 287 Distribution map of all watchtowers in the Petraean hinterland.

tower. M. Lindner criticized this over 25 years ago stating that "[...] *far too many buildings of the* [Petra] *region are uncritically described as watchtowers.*"[1441] In recognition of Lindner's criticism and on the basis of site size, structural characteristics, site location and archaeological context, this study only accepts 32 of the originally identified 97 structures as watchtowers (FIG. 287). While it is possible that some of the *rejected* 65 'towers' served surveillance purposes as well, they are either structurally too ambiguous to be considered as proper watchtowers or are dismissed as such completely.[1442] The undifferentiated inclusion of these 65 structures would lead to a crude statistical distortion of the discussed watchtowers and prompt misleading results. These structures were therefore excluded from the statistical and landscape archaeological analyses.

1441 Lindner 1992a, 264.

1442 Of the 65 rejected towers there are 48 structures for which the possibility cannot be completely discarded that at least some served surveillance purposes as well. These include: Abudanh Survey Nos. 197 (Tell Qusaib), 229; ARNAS Site No. 188; FJHP Site No. Ext. No. 087, Ext. No. 061, S132; JSS Site Nos. 113, 140; PHSP Site Nos. 002-ST005, 005-ST018, 005-ST020, 009, 018-ST027, 027-ST036, 027-ST040, 028-ST044, 038-ST048, 039-ST061, 044-ST073, 045, 050-ST075, 058, 072, 076, 079, 098, 118, 123, 142, 145, 161; PRP Site No. wmw 6; SAAS No. 322; ShamAyl Site Nos. 051, 086, 105, 145, 202, 289, 303, 320, 332, 334, 354, 356; Udruh Survey Sites E and G as well as WMWS 1996 Site No. Ayl 1. While there is no argument directly *against* an

Some structures that the original surveys have identified as watchtowers are particularly problematic.[1443] These are either directly located in, or immediately associated with, cultivated lands. This circumstance brings the important scholarly discussion to mind that was ignited after the publication of E. Banning's seminal paper *Peasants, Pastoralists and Pax Romana: Mutualism in the Southern Highlands of Jordan* in 1986. Studying the relationship between ancient agriculturalist and nomadic groups in the Roman East, Banning re-evaluated survey results from B. MacDonald's *Wadi al-Hasa Survey* and argues for a mutually beneficial and peaceful coexistence of these two groups. This has been criticized by Parker and Mayerson.[1444] The significant issue in this context is that Banning hypothesizes that, particularly during the Roman-Byzantine periods when agricultural activities were supposedly at a peak, presumed watchtowers in the Wadi al-Hasa area did not have any military surveillance function. He argues that they were used as shelters for farmers and herders as well as possible storage facilities for agricultural goods as was the situation in Samaria.[1445] Parker criticized this conclusion arguing that Samaria is the only case for such use of towers and that the region was well within province borders and not on the desert fringes, where interaction between nomadic and sedentary populations was more likely.[1446] Samaria was not part of a provincial military frontier zone as the Wadi al-Hasa region. In addition, Parker refers to the *Notitia Dignitatum* according to which northern and central Palestine was almost completely devoid of garrisons around 400 AD. However, troops were stationed east of the Jordan river, along the *via nova Traiana*, the Wadi Arabah, southern Palestine and the northern Negev.[1447] Parker claims that epigraphic evidence suggests that towers were frequently built along the Late Roman frontier in Arabia by both military personnel and civilians, thus serving civilian and military purposes. Furthermore, Parker states that even when towers were built by civilians, their construction implies the need for security. He thus poses the question: "*If there was not at least the threat of harm to person or property, why bother building such costly structures at all?*"[1448]

Arguably, these "costly structures" are the problem of this argumentation. Parker associates the term tower with the Latin *burgus*.[1449] Although often referred to as watchtowers, a *burgus* is better understood as a diminutive *castellum*, a small military camp, and thus far larger than the structures discussed here as watchtowers.[1450] A good example of a proper *burgus* in the Near East is En Boqeq in modern-day Israel.[1451] While such *burgi* can correctly be referred to as "costly structures" with an undeniable defensive function, they cannot be compared to the structures discussed in this study. It is likely that Banning was not claiming that *burgi* were used as shelters, but rather towers comparable to those presented here.

This debate certainly highlights the difficulty to ascertain concrete functions of the discussed towers and serves as a warning not to assume one single function, but to contextualize the individual structures in their archaeological and environmental setting. It then seems likely that towers associated with agricultural areas served more as shelters for farmers or storage facilities for agricultural goods.[1452] While they may have served as potential observation posts for farmers to guard their lands as well, it is doubtful that they were part of any comprehensive military communication network.

The following presents the available information on the 32 structures that are accepted as possible watchtowers (FIG. 288 and TABLE 33).[1453] Based on the site descriptions provided by the original surveys, general structural characteristics of the presented watchtowers can be defined: All towers are situated on prominent hilltops or slopes. The rectangular or square structures range between 12 and c. 92 m² in size and their exterior walls are c. 0,5 – 0,75 m thick. Singular cases show internal divisions. Some structures are constructed by well-drafted ashlars while others are built of roughly hewn stone blocks or slabs. The construction mate-

interpretation of these structures as potential watchtowers, there is none that can be raised *for* such an interpretation. Cf. chapter 2 for this study's definition of a watchtower.

1443 There are 17 of such problematic structures. These include: Abudanh Survey Nos. 128, 236; ARNAS Site No. 325; BMP/CAS Site No. 20/21; ShamAyl Site Nos. 076, 100, 101, 278, 292; FJHP Site Nos. S112, S118; PHSP Site Nos. 024-ST031, 024-ST032, 028-ST043, 051, 083 and WMWS 1996 Site No. Bayda 10.

1444 Banning 1992, 1987, 1986b; Mayerson 1989; Parker 1987a.

1445 Banning 1986, 35–36 citing Applebaum et al. 1978 for the towers of Samaria.

1446 Parker 1987a, 39.

1447 Parker 1987a, 39.

1448 Parker 1987a, 40.

1449 Parker 1987a, 39.

1450 For example Reddé 2015, 126.

1451 Gichon 1993.

1452 Cf. n. 1443.

1453 These include: as-Sharra-1; Abudanh Survey Site Nos. 020, 038, 108, 132, 134, 159, 177, 222, 238 (1), 260 (= ARNAS Site No. 002); ARNAS Site Nos. 017, 018, 022, 154, 306; FJHP Site Nos. S054, Ext. 071, Ext. 079; JSS Site No. 084; ShamAyl Site No. 006, 116, 208, 258, 269; IUBP-ST10; PHSP Site Nos. 003-ST006, 016-ST026, 037, 077, 080 and the tower at Qasr Umm Rattam. The archaeological details are given in TABLE 33.

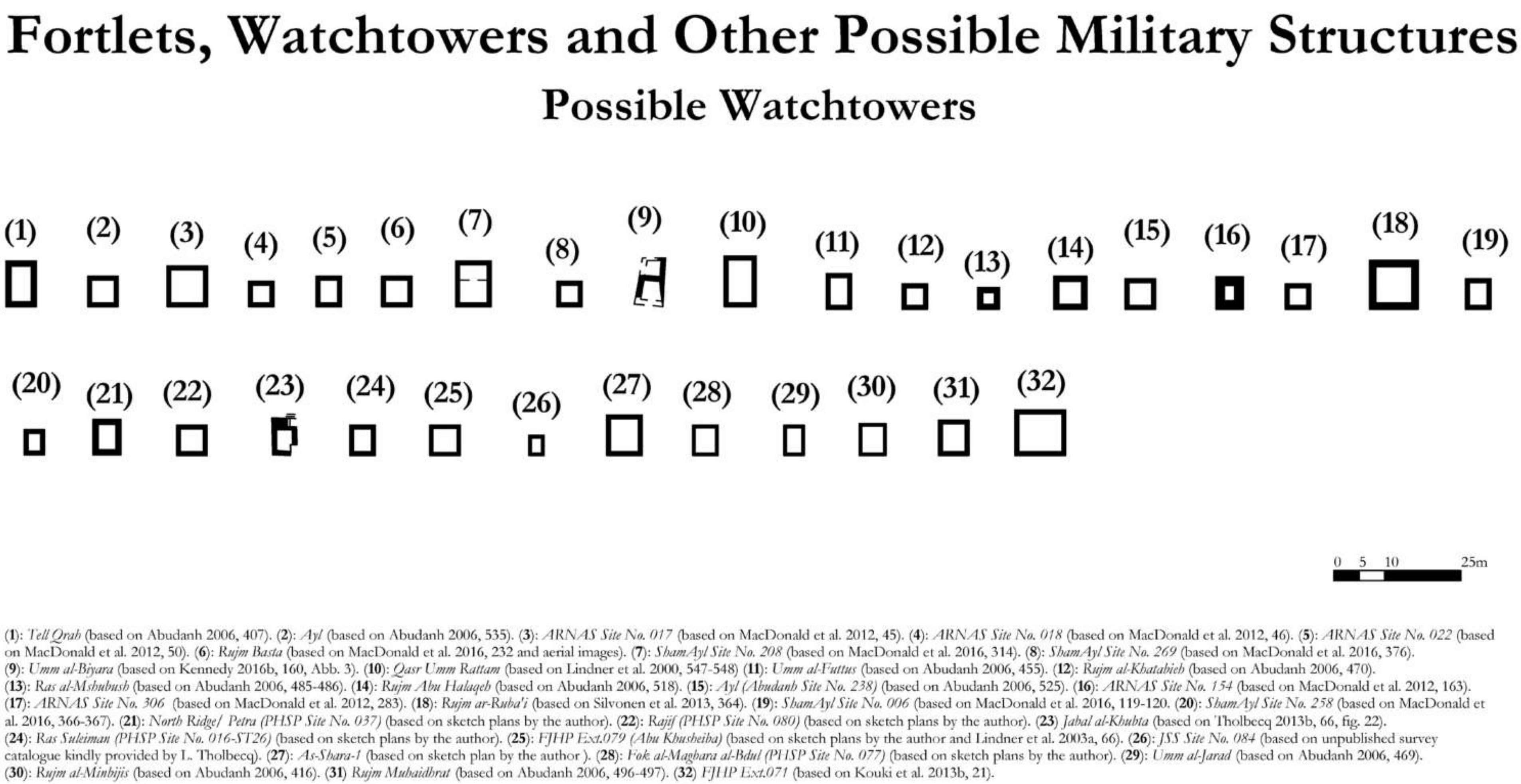


FIG. 288 Scaled sketch plans of possible watchtowers in the Petraean hinterland in chronological order.

rial varies depending on the availability of local stone (mostly lime- and sandstone). These structural characteristics apply to towers of all periods. No architectural development can be observed through time and they cannot be distinguished in terms of size or layout. FIG. 289 shows some exemplary towers which, according to surface finds, were occupied between the 10th century BC and 7th century AD. Size, layout and construction technique is dependent on the towers' environmental context which determined not only the availability of building material, but also the general architectural design. The excavation of the 10 × 7 m large watchtower on top of Umm Biyara has shown that the structure was occupied from the 7th century BC through to the 2nd century AD (FIG. 290).[1454] It is built of flat, irregularly cut sandstone slabs which were carved directly out of the sandstone plateau of Umm al-Biyara. While the luxurious 'palatial' complex of Umm al-Biyara is situated on the eastern edge of the plateau, the tower is located immediately on the western edge and thus stands isolated. This might explain the less monumental appearance of the tower as its main purpose was to guard the access way to the summit and to monitor its surrounding landscape.

The situation on Jabal al-Khubtah is different (FIG. 291). In this case, a presumed watchtower is part of a multi-functional, monumental complex including cultic installations, utilitarian quarters as well as a bathing complex situated on the western edge of the Jabal al-Khubtah.[1455] Measuring 5,5 × 4,75 m, the tower is relatively small, but is characterized by 0,8 m thick walls built of well-cut sandstone ashlars as the rest of the Jabal al-Khubtah complex. It is accessed by a built staircase. A bedrock platform stretches immediately north of the tower. In contrast to the situation on Umm al-Biyara, the Khubtah tower seems to have been incorporated into the overall design of the entire complex. The building material was most likely carved directly from the sandstone summit.

Another example is the c. 6 × 6 m watchtower along Naqb Saqqara that oversees the settlement of Abu Khusheiba (FIG. 292). As Lindner already noted, the structure is conspicuously well-built by sandstone and limestone ashlars and its interior is covered with whitish plaster.[1456] The building technique is identical to that of other structures known from Abu Khusheiba and is thus most likely contemporary (1st century AD onwards). The building material is probably local and the substantial architecture of the tower can be explained by its exposed location along Naqb Saqqara.

The examples from Umm al-Biyara, Jabal al-Khubtah and Abu Khusheiba are only a few that highlight the dependency of layout, size and constructional quality on the environmental and archaeological setting of towers.[1457]

There is also no typo-chronological development of watchtowers in the Petraean hinterland. This stands in contrast to the results of the *Limes Arabicus Project* where a categorization of towers was proposed according to different time periods:[1458] Towers measuring between c. 7 × 7 m and 15 × 15 m (Iron Age/Nabataean and occasionally Late Roman/Early Byzantine periods); towers measuring between c. 3 × 3 m and 15 × 15 m (Nabataean/Early Roman periods) and towers measuring between 8 × 8 m and 11 × 11 m (Late Roman period). The earliest tower group is characterized by dry stone walls built of roughly cut stones and without noticeable entrances. The second

1454 Kennedy 2013b, 277–280.

1455 For a general overview on the Jabal al-Khubtah complex, see e. g. Tholbecq et al. 2014 and Tholbecq 2013b, 43–80 (particularly on the presumed tower, p. 67).

1456 Lindner 2003a, 66–67 and 1992a, 264–265.

1457 The 'Conway Tower' situated at the northern tip of Petra's (probably) 2nd century AD city wall could be added to this list. It is curiously round and measures c. 25 m in diameter. It is built of massive limestone blocks. The unique structure encloses a natural sandstone outcrop and rock-cut 'ramps' can still be observed within the structure's interior. The original excavators initially considered these ramps to be processional ways around a sacred rock and interpreted the structure as a Nabataean (1st century BC) sanctuary (Cleveland 1954; Albright 1935). Parr later claimed that the ramps were the foundation trenches of a massive tower that was part of Petra's city wall (Parr 1990, 11–12 and 1986, 200; Parr 1962). This has found widespread scholarly consensus (e. g. Graf 1994b; McKenzie 1990, 109). However, Parr's arguments for a *military* structure may be contested. First, the argument that the ramps served as foundation trenches for superstructures may be doubted as the natural bedrock already forms a sufficient foundation on its own. Second, the excavators have revealed a pedestal that stands c. 1 m away from the limestone ring wall, which is constructed of a completely different building technique (Cleveland 1954, 61–62). Although it is said to have had a different function at a later phase (Parr 1962, 72), this suggests potentially various functions of the 'tower' at different times. It also remains unclear how the city wall relates to the tower chronologically. The city wall has a completely different construction technique (double-faced sandstone wall as most recently studied by Parker 2016). Dating material suggests a date to the 1st century BC for the tower, but the city wall was not constructed until the late 1st/early 2nd century AD (Parker 2016). Parr's structural comparisons to other round, presumably military towers are expressly short and thus regrettably superficial. They range from free-standing round towers from Hellenistic Palestine and other sites of the wider Hellenistic World to round corner towers of Late Roman fortresses such as al-Lejjun and Udruh in Jordan (Parr 1962, 78–79). This certainly calls for a more detailed discussion on the 'Conway Tower.'

1458 Clark et al. 2006, 31–32 as well as Clark – Parker 1987.

FIG. 289 Presumed watchtowers in the Petra area. A: Rujm Basta (10th – 6th century BC and 1st century BC – 4th century AD) Photos: APAAME. B: Rujum (1st century BC and 7th century AD). Photo: APAAME. C: Petra, North Ridge (1st and 2nd century AD). D: Ras Suleiman (1st – 4th century AD). E: ar-Rajif (1st and 7th century AD).

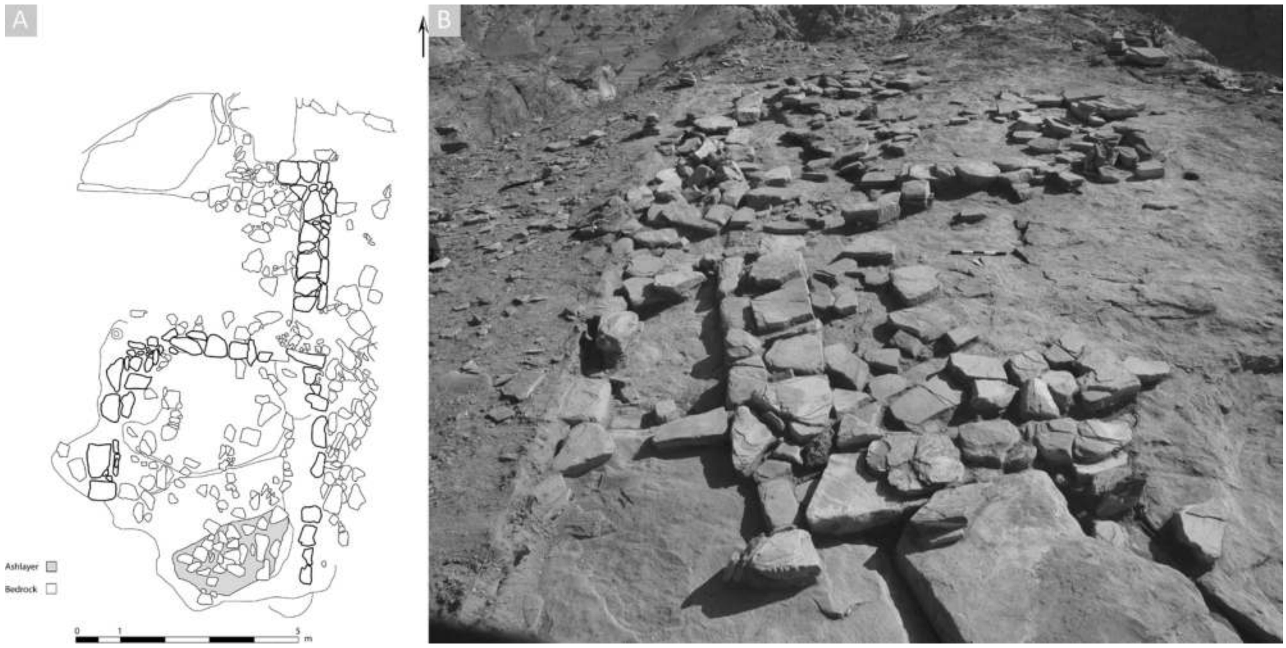


FIG. 290 The excavated watchtower on top of Umm al-Biyara. A: Excavation plan. B: Overview of structural remains.

group is built of larger ashlars and shows internal divisions, but without noticeable entrances. The Late Roman examples are built of well-drafted ashlars with the use of mortar and have a ground-floor entrance. This implies a linear structural development of watchtowers through time. However, this categorization is based on architectural observations alone and makes little notice of the environmental and archaeological context of the structures. It was nevertheless accepted by other projects researching aspects of the ancient military organization in Jordan.[1459]

The FJHP also follows the *Limes Arabicus Project*'s categorization of towers when discussing the well-known watchtower of Rujm ar-Ruba'i (FIG. 293). This tower is situated along the important route of Naqb ar-Ruba'i leading from the al-Farasha plain at the foothills of Jabal Harun to the Wadi Arabah (cf. chapter 6).[1460] Located on a gentle hilltop, the c. 7 × 7 m large structure is characterized by 1,25 m thick walls built of roughly cut sandstone ashlars. It commands an excellent view over the surrounding landscape as well as Naqb ar-Ruba'i. As most of the surface pottery dates to the 4th century AD, the FJHP draws parallels to the *Limes Arabicus Project*'s first category of towers.[1461] However, the FJHP also states that the surface pottery suggests two phases: An earlier phase dating to the Nabataean-Roman and a later phase dating to the Late Roman-Byzantine periods.[1462] The tower could therefore be easily grouped into the *Limes Arabicus Project*'s second category as well. This highlights the inherent problems of this categorization. The implied linear development becomes even more problematic when realizing that it is based entirely on surface observations and is not corroborated by excavation results. Structural variances of towers are therefore better explained by their locational and archaeological context and are independent of temporal developments.

The landscape archaeological analysis of the accepted watchtowers shows that there is only little spatial correlation between the towers and other contemporary structures (cf. the Pearson correlation coefficients presented in TABLE 31). The towers are built in isolated positions on hilltops or slopes and cannot be associated with other structures functionally. It is thus assumed that their main purpose was the surveillance of their immediate landscape and the monitoring of activities at the sites and features within their visual range.

While the construction of the tower on Umm al-Biyara during the 7th century BC marked the begin-

1459 See e.g. Castro 2018, 43.
1460 Kouki et al. 2013a, 233–234; Silvonen et al. 2013, 364 with further references.
1461 Kouki et al. 2013a, 233 also state that the tower's measurements correspond to ca. 24 × 24 Roman feet. It can only be assumed that the authors suggest that the structure was constructed by workers who followed Roman architectural standards and that this may be an additional dating element. Even if this is the case, this alone would not necessarily have chronological implications as Nabataean architecture in Petra adapts Graeco-Roman architectural norms well before the Roman annexation.
1462 Kouki et al. 2013a, 234.

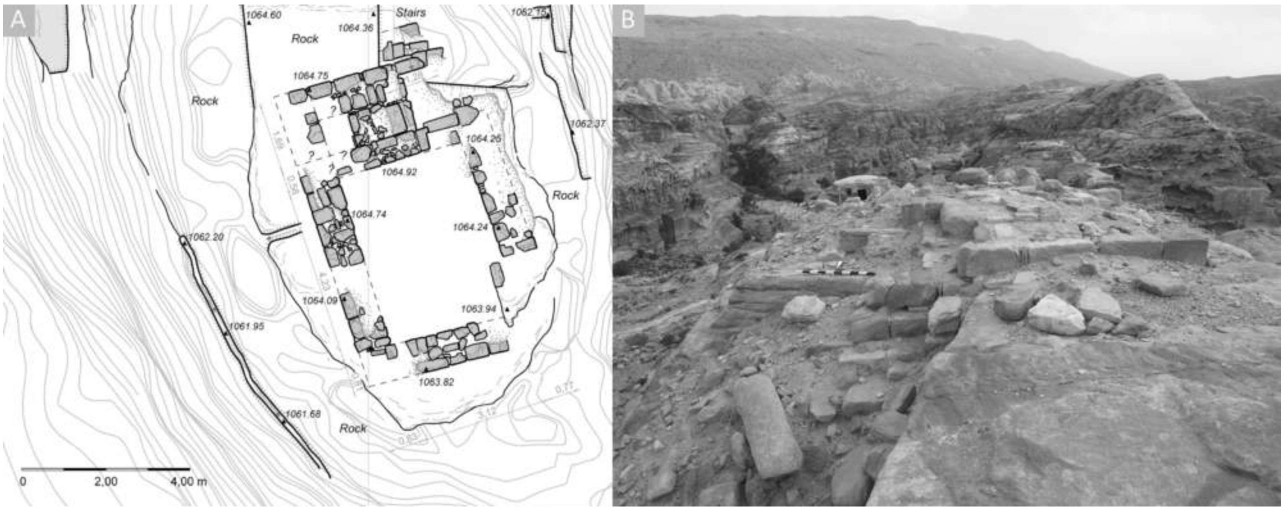


FIG. 291 View of the presumed watchtower on Jabal al-Khubtah. A: Plan of the tower after Tholbecq 2013b, 66, fig. 22. B: View of the tower with remains of a staircase.

ning of a westward shift of the distribution of towers (cf. chapter 3), this continued dramatically in the 1st century BC. As the GIS-based cumulative viewshed analyses for all watchtowers dating to the 1st century BC suggest, the Petra valley and the routes leading westwards from Petra are under good visual control (FIGS. 294–297, particularly FIG. 294). Nearly the entire eastern limits of the study area (including mostly civilian settlements and water structures) along the Sadd-aqa-Udruh road are monitored by the towers as well. The most visible area (a maximum of eight towers) is the area around Ayl and Basta. These were important nodes along the roads of the eastern high plateau. This trend culminates in the 1st century AD when nearly all watchtowers were occupied (the most visible area being controlled by a maximum of eight towers).

By the 1st century AD, a vast area of the Petraean hinterland is under visual control. This includes the entire Petra valley and its immediate surroundings to the north and southwest, important stretches of the routes leading westward to the Wadi Arabah as well as almost the entire road network along the eastern high plateau. The areas around Ayl and Basta are more extensively monitored than during the previous century.[1463]

During the 2nd century AD, the Petra valley and its immediate surroundings are still under very good visual control, but the region around Ayl is less monitored. This development corresponds to a general decrease of towers and a shift of settlements out of the immediate Petra area (particularly the al-Begh'ah plain and the areas north of Beidha) up to the eastern high plateau. This development begins during the 3rd century AD.

At this time, the Petra valley is only poorly monitored while the areas around Ayl and Basta as well as the settlements along the eastern high plateau continue to be under good control. This remains unchanged during the 4th century AD, but by the 5th century AD almost all towers are abandoned and only limited areas along on the eastern high plateau and in the Wadi Arabah are under surveillance. The Petra valley is no longer controlled. Together with the continuing shift of settlements eastward, the number of towers decreases further in the 6th and 7th centuries AD and, particularly in comparison to the situation between the 1st century BC and 2nd century AD, only limited areas along the eastern high plateau are visually controlled.

It is now interesting to relate these results with Diodorus' reference to a presumed visual communication network of Nabataean σκοποί. This mainly concerns the question of *inter*visibility.

While no intervisibility could be observed for watchtowers in previous periods, a first network of intervisible towers developed during the 1st century BC around the settlements of Ayl and Basta. The Petra valley is only controlled by singular towers that are not intervisible. This changes dramatically by the 1st century AD when the cumulative viewsheds suggest a dense network of intervisible watchtowers immediately in and around Petra. This network of intervisible towers remained intact during the 2nd century AD, but was largely abandoned by the 3rd century AD when

1463 Cf. similar observations made by the UAP for the Udruh area (Driessen – Abudanh 2019, 464–467).

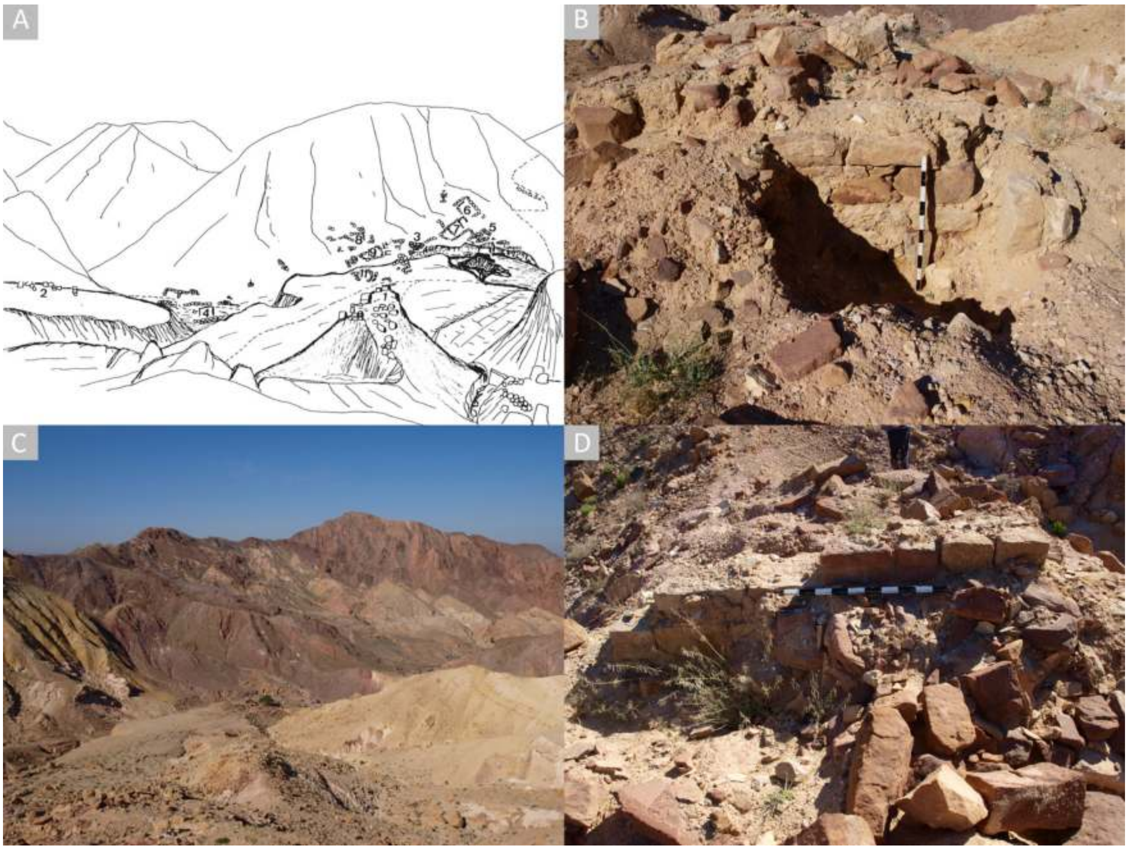


FIG. 292 A: Watchtower (No. 1) on sketch plan after Lindner 2003a, 67, Abb. 5. B: Structural remains of the Abu Khusheiba tower. C: View over Abu Khusheiba with the presumed watchtower in the foreground. D: Structural remains of the Abu Khusheiba tower.

FIG. 293 View of Rujm ar-Ruba'i along Naqb ar-Ruba'i with the Wadi Arabah in the background.

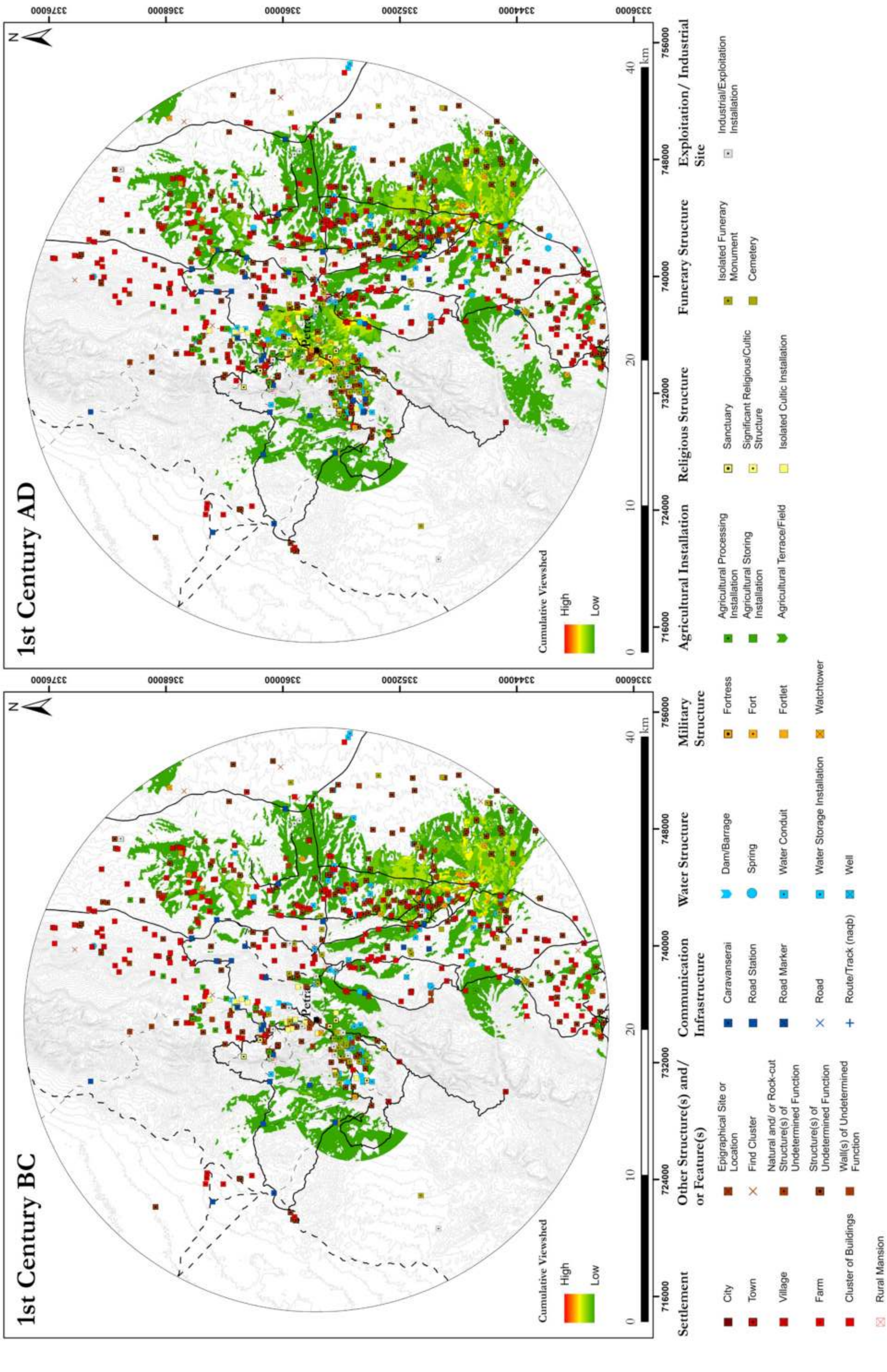


FIG. 294 Cumulative viewsheds of all presumed watchtowers in the Petraean hinterland dating to the 1st century BC and AD. Maximum cumulative visibility from 7 towers. Visibility radius of 4400m.

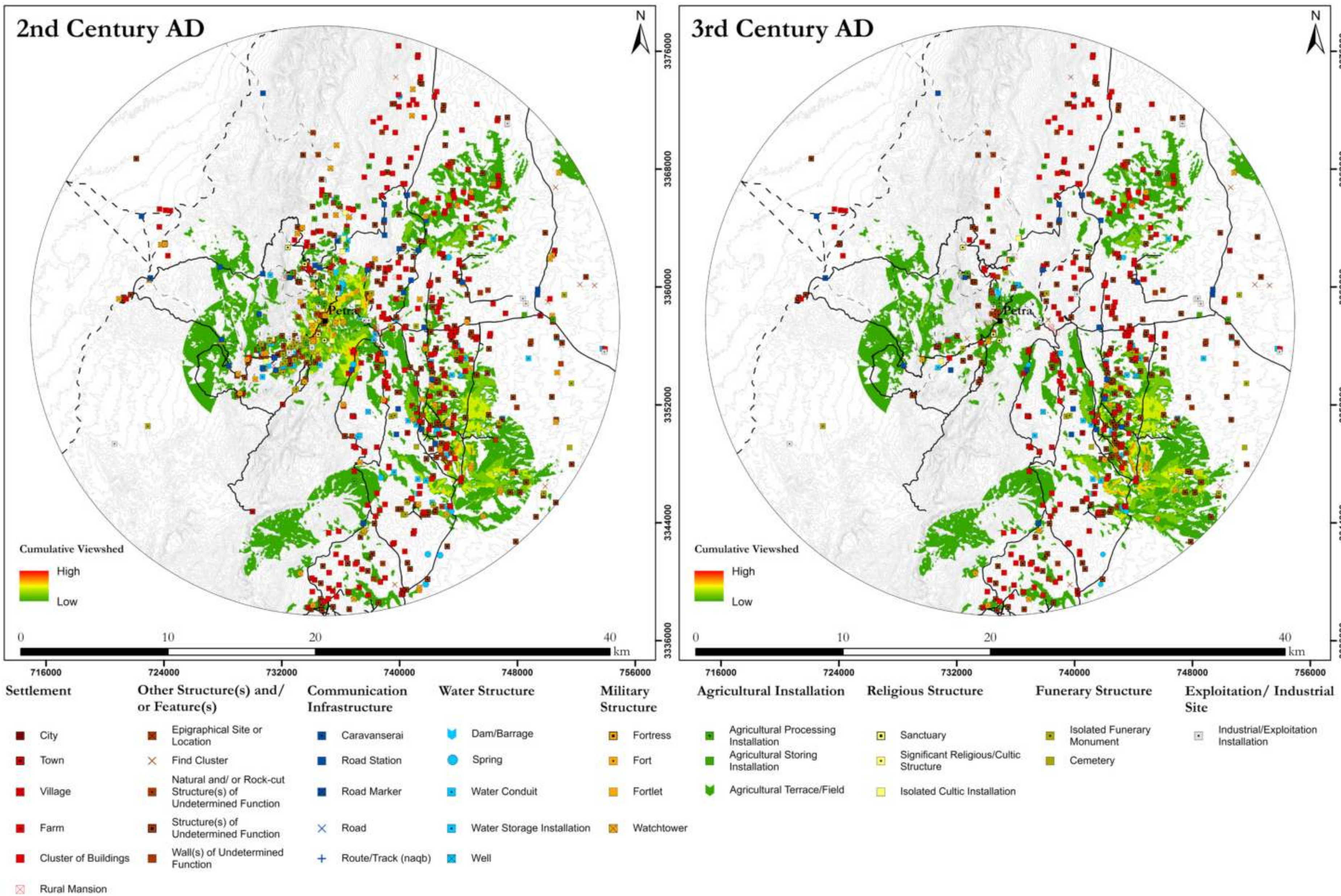


FIG. 295 Cumulative viewsheds of all presumed watchtowers in the Petraean hinterland dating to the 2nd and 3rd century AD. Maximum cumulative visibility from 6 towers. Visibility radius of 4400m.

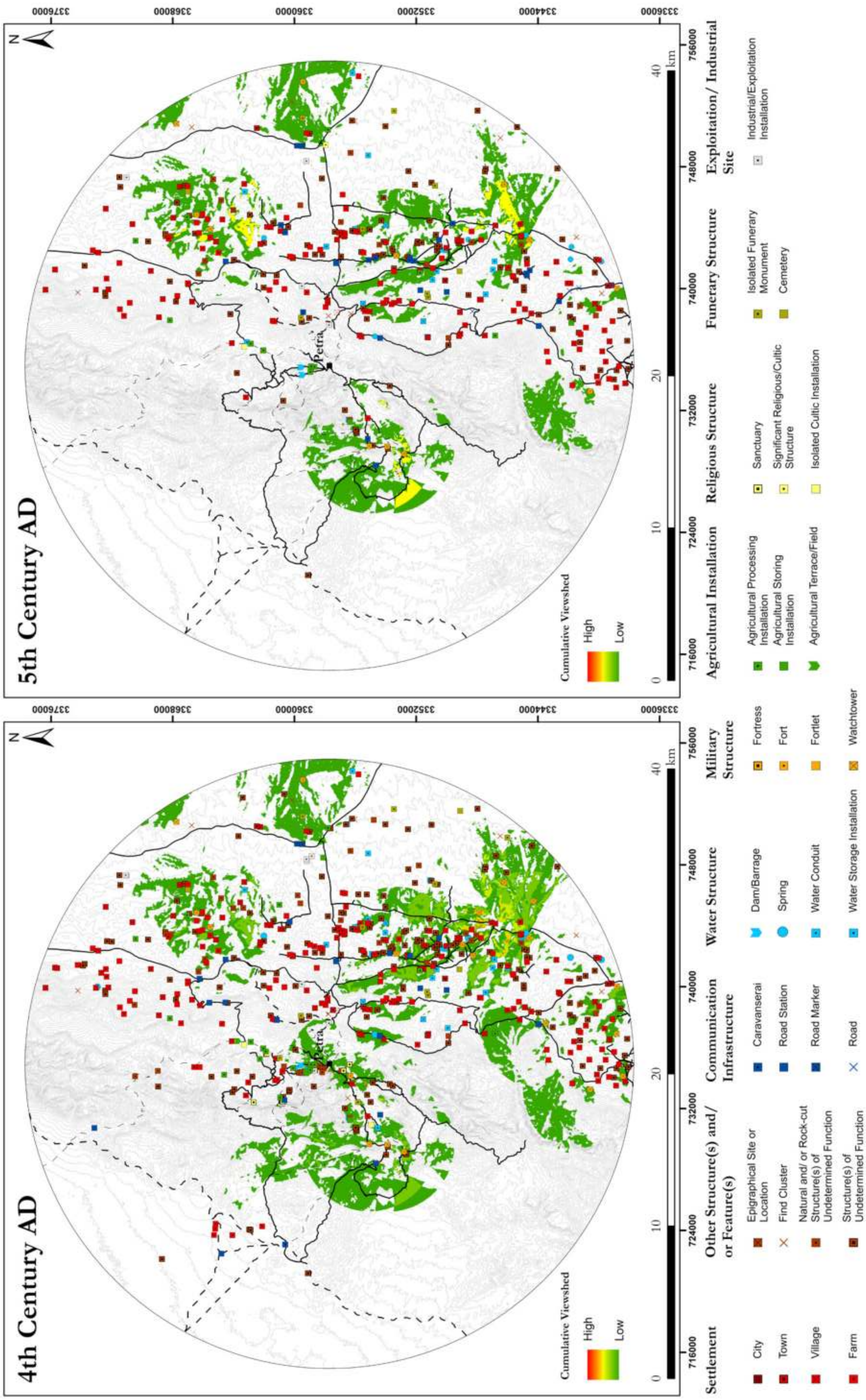


FIG. 296 Cumulative viewsheds of all presumed watchtowers in the Petraean hinterland dating to the 4th and 5th century AD. Maximum cumulative visibility from 6 towers. Visibility radius of 4400m.

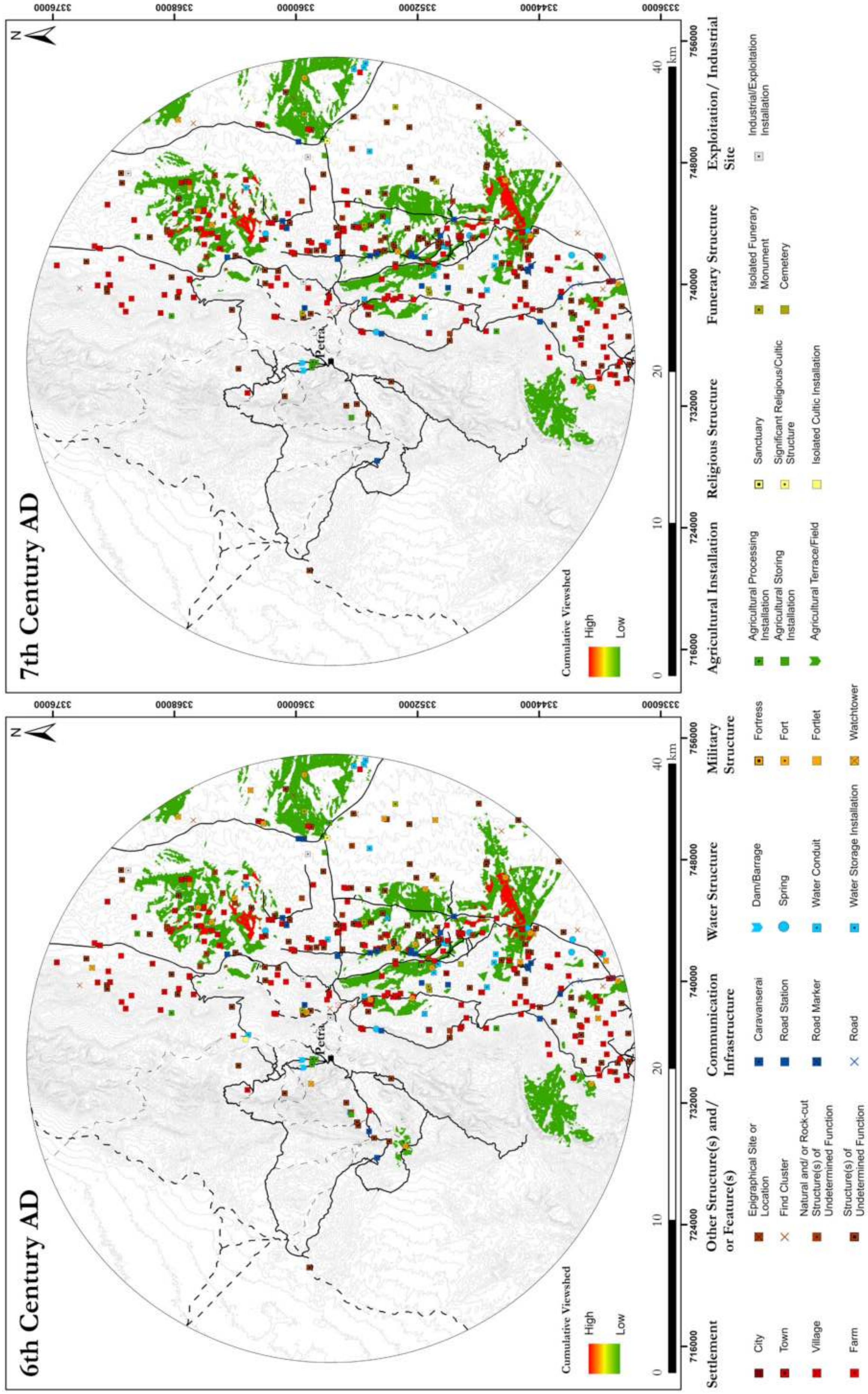


FIG. 297 Cumulative viewsheds of all presumed watchtowers in the Petraean hinterland dating to the 6th and 7th century AD. Maximum cumulative visibility from 2 towers. Visibility radius of 4400m.

intervisble towers are only evidenced for the areas around Ayl and Basta. Beginning with the 5th century AD, the few towers continue to monitor large areas of the study area, but they are no longer intervisible. Although watchtowers command the best visual control over the study area of all discussed military structures, a comprehensive intervisible communication network as described by Diodorus can therefore only be attested for the 1st and 2nd centuries AD.

Furthermore, the great structural variance of the discussed towers prompts the important question of what to expect archaeologically when attempting to corroborate Diodorus' accounts of a Nabataean visual communication network. A closer examination of the text passages seems warranted: In both the above-mentioned accounts, Diodorus only makes use of the (conjugated) masculine term σκοπος which loosely translates as "one that watches."[1464] This is not to be confused with the feminine term σκοπή which can be translated as the actual "look-out *place*" or watchtower.[1465] This is an important distinction as Diodorus does not mention any structural accommodation of the Nabataean σκοποί. It is tempting to associate these watchmen with physical structures, ideally towers from which the surrounding landscape was monitored, but there is no literary confirmation of this practice. Instead, Diodorus explicitly states that the σκοποί were stationed directly on hilltops (λόφων). It therefore seems more likely that Diodorus is not referring to a communication network of watch*towers*, but simply of watch*men* – σκοποί – stationed on prominent *natural* hilltop positions without built structures. Although important, this aspect has not yet been recognized. At least in part, this is most likely because such presumed 'natural' observation posts are very difficult, if not impossible, to identify archaeologically. However, two sites discovered by the PHSP may serve as examples of temporary installations positioned strategically in the natural landscape (cf. FIG. 112).[1466] One example is situated along the northern part of the route of Wadi al-Mu'aysirah West on an elevated, flat bedrock surface (cf. chapter 6). Measuring an area of c. 2 × 3 m, the site features six irregularly shaped holes carved in the natural bedrock forming a quasi-rectangular pattern. These were most likely post-holes for a temporary, tent-like installation. If correct, the site may have been used for monitoring traffic along Wadi al-Mu'aysirah West.[1467]

Further along Wadi al-Mu'aysirah West, on the summit of Jabal Umm Zaythuna and directly facing Petra's city center, a similar find was made (cf. chapter 4). Measuring an area of c. 3 × 3,65 m, this site features five presumed post-holes that were arranged in a trapezoidal pattern. This site was most likely a tent-like installation as well. Its strategic position on the summit of Jabal Umm Zaythuna overlooking the city center of Petra and its surroundings leaves no doubt that the site served some form of observation purpose. Although the dating of the structure is problematic, surface pottery dating to the 1st century AD was recorded at a wall-like feature immediately behind the post-holes. This may offer a very rough dating indication. Several other post-holes, possibly used for tent-like installations, were observed elsewhere in the study area as well. These were often observed on hilltops or other places with good visibility of the surrounding landscape.[1468] Although remaining inherently problematic, such finds suggest a potentially widespread use of the otherwise untouched, natural landscape for various purposes – particularly when considering the semi-nomadic, mobile background of the Nabataeans (cf. chapter 4).[1469] Temporary installations and/or the

1464 Diod. Sic. 19, 96, 3 "[…] *σκοποὺς μὲν κατέστησαν ἐπὶ τῶν λόφων* […]" *and 19, 97, 1:* "[…] *οἱ δὲ σκοποὶ κατανοήσαντες πολεμίαν δύναμιν εἰσβεβληκυῖαν ἐσήμηναν τοῖς Ναβαταίοις διὰ τῶν συγκειμένων πυρσῶν* […]." Generally on the term, see LSJ s. v., 1614. The only other accounts where Diodorus uses the derivative form of σκοπος are Diod., 19, 93, 2: "*τούτου δ᾽ ὄντος κατὰ πορείαν Δημήτριος διὰ τῶν σκοπῶν ἀκούσας τὸν Κίλλην στρατοπεδεύειν καταπεφρονηκότως περὶ Μυοῦντα, τὴν μὲν ἀποσκευὴν ἀπέλιπε, τοὺς δὲ στρατιώτας εὐζώνους παραλαβὼν νυκτὸς πορείαν σύντομον ἐποιήσατο* […]" – "*While Cilles was on the way, Demetrius, hearing from spies that he was carelessly encamped at Myus, left his baggage behind and with his soldiers in light equipment made a forced march* […]." (translation: Loeb Classical Library edition, Vol. X, 1954).

1465 LSJ s. v., 1614.

1466 Cf. Kennedy 2016a, 147–149.

1467 No dating evidence was observed at the site.

1468 Cf. particularly similar post-holes discovered at the *stibadium* complex on Jabal al-Khubtah and the Bab as-Siq in Petra (Tholbecq 2018, 9–14, 26.;Darchambeau et al. 2016, 63–65, 75).

1469 Compare also the account of the al-Bdul Bedouin reporting that until the early 20th century, local Bedouin would light a large fire on top of a prominent hilltop behind at-Tayyiba in times of unrest and communicate with friendly tribes in the region (cf. chapter 4). The modern accounts of the al-Bdul and Diodorus' description of a Nabatean communication network by means of fire signals very tentatively suggest a habitual tradition of appropriating the dominant natural landscape of the Petra area for communication purposes. This seems corroborated by the excavation results of the presumed Nabataean watchtower on Umm al-Biyara that revealed a distinct ash layer immediately above the tower's bedrock foundation (Kennedy 2013b, 277–280). This could have been used to convey signals. The same possibility was also discussed for a thick ashy soil discovered underneath the 'Western Building' of Jabal Harun (Lahelma et al. 2016, 36–37).

natural landscape may have also been used for strategic purposes. This is supported by the fact that Diodorus' description of a visual communication network of Nabataean σκοποί is placed in a context when Nabataean territory was under direct threat of the Antigonids. It therefore cannot be assumed that a permanently functioning communication 'system' was in place. It seems more likely that the described σκοποί became active only in times of an immediate military threat. In times of peace, there would have been no need for the σκοποί to be permanently stationed. Only a limited number of permanently manned structures – such as the towers discussed above – would have sufficed to monitor activities at civilian settlements and along important trade routes. Imminent threats could have been communicated swiftly. This model seems mostly appropriate for the 1st century BC onwards, when there is secure archaeological evidence for increasing and permanent building activity at Petra and when there is evidence for built watchtowers in the city's hinterland. However, it is likely that Nabataean σκοποί made more use of the undeveloped, natural landscape. This raises questions concerning the necessity of *built* watchtowers in general.[1470]

Other Structures of Possible Military/ Communication Function

The original surveys have identified other structures in the Petraean hinterland that may have had a military and/or communication function. However, these cannot be convincingly attributed to this study's pre-defined categories of military sites (FIGS. 298, 299 and TABLE 34). Although the structural nature of these sites is either too inconclusive or the available archaeological information insufficient, the various surveys nevertheless refer to them as simple 'watchtowers.' In many cases, this is a functional oversimplification of more complex structures. These are referred to here as possible 'hilltop refuges' (cf. similar structures already discussed for the Iron Age periods in chapter 3).[1471]

The first structure is Rujm al-Mattwi (cf. FIG. 298, No. 9). This c. 225 m² large, square structure is located on a hilltop with a wide view over its surrounding landscape. Abudanh identifies the site as a watchtower, but in comparison to the size of the accepted watchtowers described above, it is too large.[1472] The site possibly served additional functions than just surveillance and is thus better described as a refuge. It tentatively dates to the 1st centuries BC and AD and from the 4th century AD onwards.

The rectangular structure of Rujm al-Khatabiyya (ShamAyl Site No. 126) dates to the same periods and is of similar size (cf. FIG. 298, No. 13). The original surveyors mention that the site offers a good view to (modern) Rashid, Rujm Basta and Ain Tallat Ali and thus interpret it as a watchtower.[1473] While this is likely, it seems too large to be a simple watchtower. It may have served additional functions beyond surveillance and could therefore be better referred to as a small refuge. However, as no internal divisions are reported, this remains speculative.

A similar interpretation can be proposed for Rujm al-Bitar (cf. FIG. 298, No. 14). This site is only slightly larger and is situated on a hilltop along the Udruh-Basta road immediately north of modern Rashid (al-Qa'). It offers an excellent view over its surrounding landscape, including agricultural areas. It is particularly impressive as a large mound of debris still stands c. 2,5 m high. This suggests a substantial structure of significant height (FIG. 300). Abudanh interprets Rujm al-Bitar as a watchtower.[1474] However, the many large and well-dressed ashlars as well as the structure's comparatively large size does not permit to consider the site as a simple watchtower. As Rujm al-Bitar most likely served defensive purposes, it may be referred to as a possible hilltop refuge. Surface material suggests that the site dates between the 1st century BC and the 2nd century AD.

JSS Site No. 070 presumably dates between the 1st century BC and 2nd century AD (cf. FIG. 198, No. 22). It is described as a rectangular structure on a hilltop with thick walls and possible internal divisions with a probable cistern in its interior.[1475] The structure could be interpreted as a possible watchtower, but it is quite large compared to the accepted watchtowers. Whether the site can also be considered as a possible hilltop refuge remains speculative.

FJHP Ext. 101 measures c. 100 m² (cf. FIG. 298, No. 25). It is a rectangular structure built of well-dressed

1470 Cf. S. Fachard's critical take on ancient fortifications as part of a visual network: *"For surveillance, it would have been more efficient and cheaper to rely on mobile troops, guards, scouts and mounted guards with deep knowledge of the local terrain to convey oral messages with precise information* [...] *it is not necessary to build an expensive network of towers and forts to emit signals, when scouts positioned on mountain tops and ridges could take care of it more efficiently and at minor cost"* (Fachard 2016, 230).

1471 Cf. chapter 3 for a more elaborate definition of this term.

1472 Abudanh 2006, 414.

1473 MacDonald et al. 2016, 241–242.

1474 Abudanh 2006, 451.

1475 Unpublished catalog of the JSS kindly provided by L. Tholbecq.

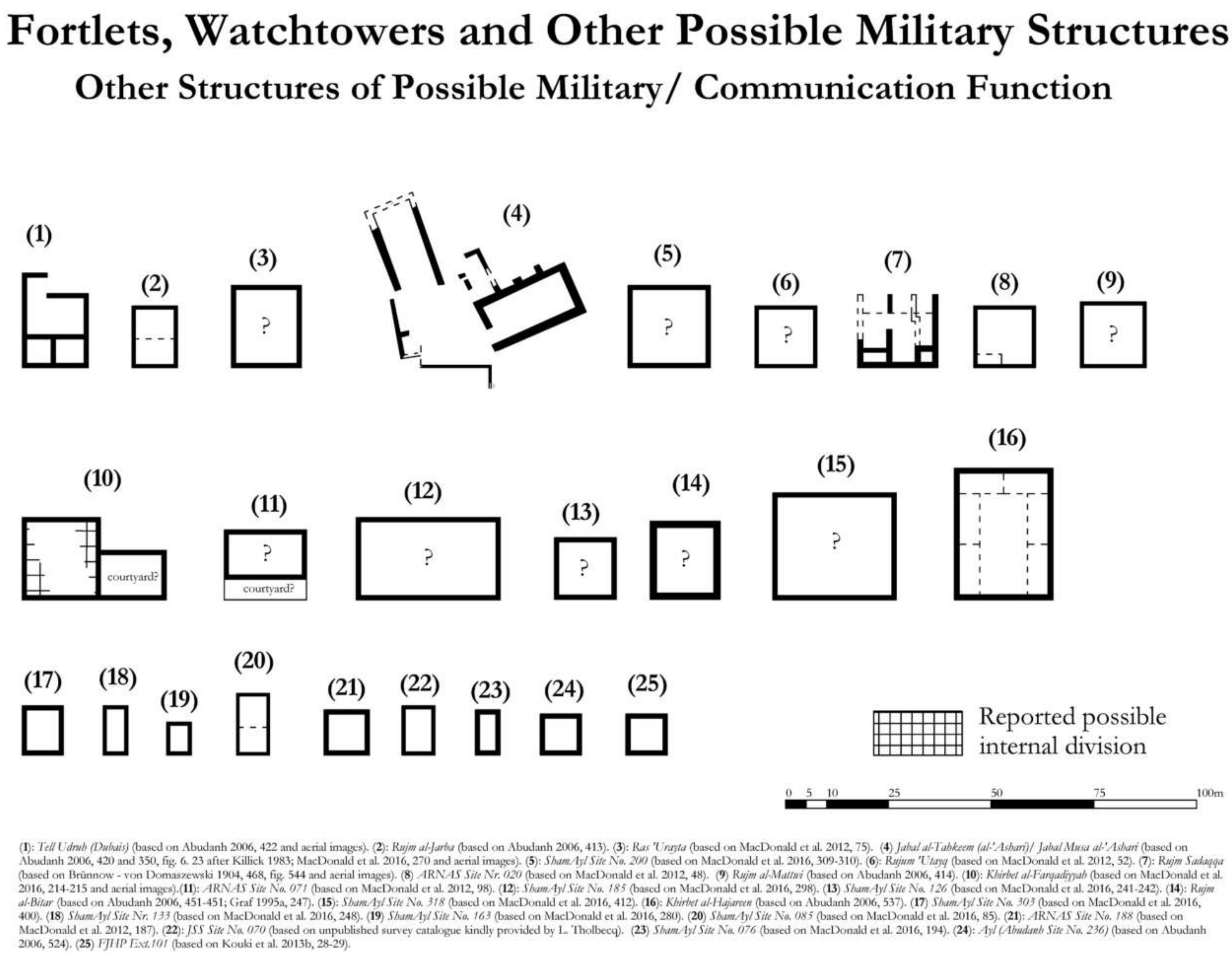


FIG. 298 Scaled sketch plans of 'other structures of possible military and/or communication function' recorded in the Petra area.

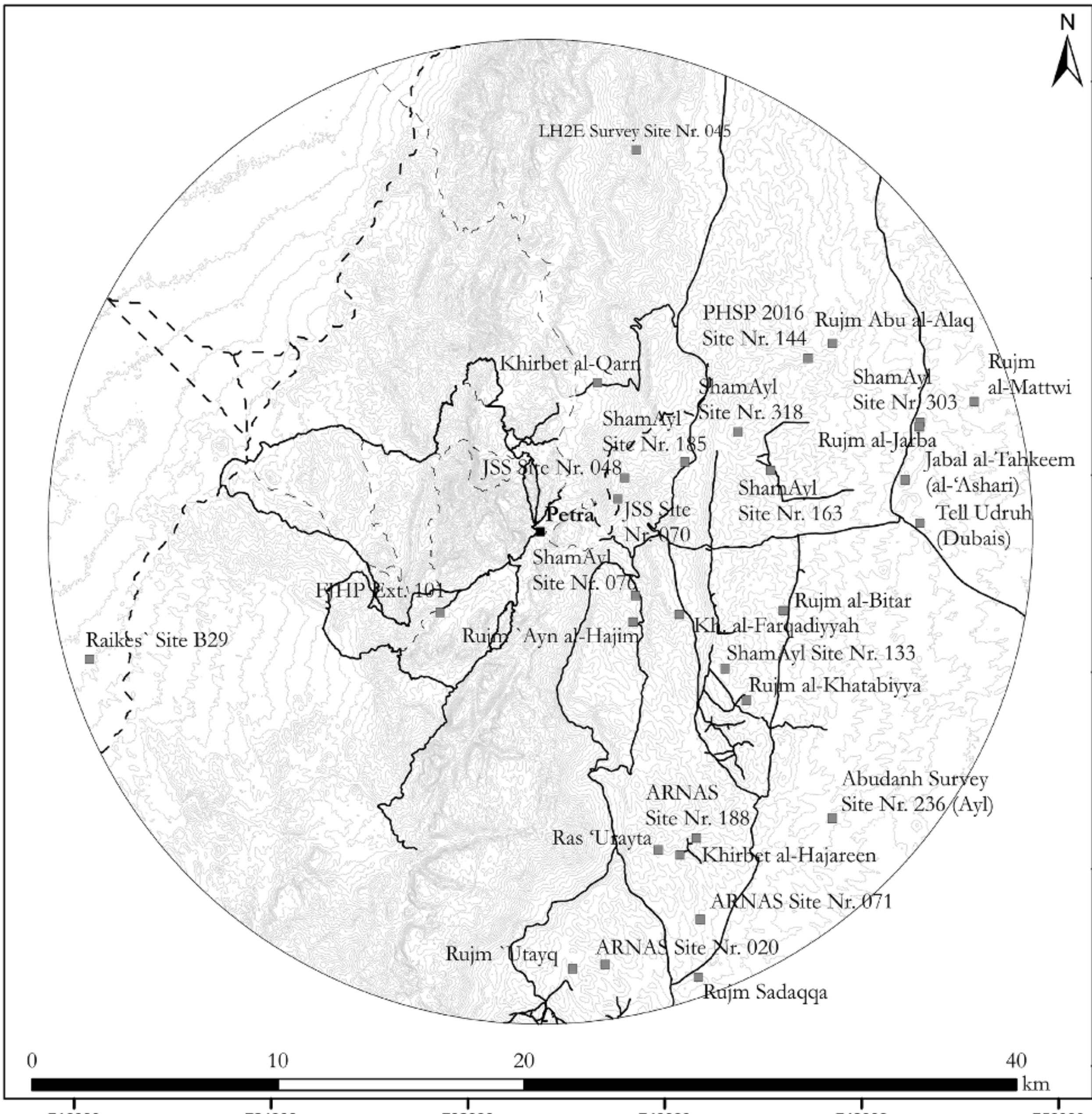


FIG. 299 Distribution map of all discussed structures of possible military and/or communication function.

ashlars, located on a hilltop south of Wadi 'Iyal 'Id in the al-Farasha plain at the foothills of Jabal Harun. The original surveyors interpret the site as a possible watchtower.[1476] While this is likely, it seems quite large compared to the accepted watchtowers. The site may have had functions additional to surveillance.

Similar to the possible 'hilltop refuges' identified for the Iron Age periods, these structures are larger, more complex and better built than simple watchtowers. They are situated on hilltops along important roads and routes and command good visibility over their surroundings. This suggests that they had additional functions than only surveillance. While identifying them as 'hilltop refuges' remains speculative, they most likely served more than one purpose and cannot be considered as simple watchtowers.

In addition to these presumed 'hilltop refuges,' the original surveys have identified yet other structures that may have had a possible military and/or communication function.[1477] However, the archaeological evidence is inconclusive as discussed in the following.

Khirbet al-Farqadiyyah (cf. FIG. 298, No. 10) dates from the 1st century BC onward. It measures c. 0,06 ha and is located on a small hilltop with good visibility to a nearby spring. It shows an internal division and a possible forecourt area (FIG. 301). While the original

1476 Kouki et al. 2013a, 28–29.

1477 Cf. also chapter 3.

FIG. 300 A: View from Rujm al-Bitar. B: The structural remains of Rujm al-Bitar.

surveyors postulate that the site served a defensive purpose in relation to the spring, it could equally be interpreted as a domestic structure, possibly a farm.[1478] A defensive interpretation of Khirbet al-Farqadiyyah is thus doubtful.

ARNAS Site No. 071 dates to the same period (cf. FIG. 298, No. 11). The site measures c. 0,03 ha and is a rectangular structure with a possible small forecourt. It is situated on a hilltop commanding a good view over its surroundings, including stretches of the Udruh-Basta road, Ain'Uneiq, Fardakh, modern Ayl and other sites in the area. The original surveyors consider the site as a "small fort."[1479] However, the site is too small to meet this study's requirements of a 'fort' and the little structural information does not allow for such a classification. The site may be considered as a road station and/or fortlet instead.

ShamAyl Site No. 185 is contemporary with ARNAS Site No. 071 (cf. FIG. 298, No. 12). It is a relatively large, rectangular structure and located along the *via nova Traiana* a few kilometers north of Wadi Musa. The original surveyors relate it to the management and monitoring of activities along the road. [1480] Whether this necessarily means that the site had a defensive function is doubtful.

ShamAyl Site No. 318 dates from the 1st century BC to the 4th century AD (cf. FIG. 298, No. 15). It is a c. 0,08 ha large, rectangular structure and commands a good view over its surrounding landscape and a nearby spring.[1481] Due to the site's vicinity to the spring, the original surveyors suggest that it is either a farm or an "observation point" for the protection of the spring. As no further structural information is available, the first proposal is favored.

Measuring c. 0,1 ha, Khirbet al-Hajareen is one the largest structures discussed in this section (cf. FIG. 298, No. 16). The site is located on a slope immediately south of Khirbet al-Unaiq along the road leading from Saddaqa to Basta and Udruh. It is characterized by c. 1,2 m external walls and features six interior rooms around a central courtyard.[1482] According to MacDonald et al. the site does not resemble any of the other sites surveyed by ARNAS. They postulate that it may have been related to ARNAS Site No. 071 (see above) and interpret it as a possible military barrack.[1483] While this remains speculative, Abudanh's interpretation as a possible "security or military structure" or a "caravanserai" is more likely.[1484]

PHSP Site No. 144 (Wadi al-Arrja) is a large, rectangular structure with impressively thick (c. 1,5 m) perimeter walls situated along the modern road leading from al-Jarba to Wadi Musa. Significant debris suggests that the structure was once of substantial height.[1485] The conspicuously thick walls may indicate a defensive function. Few Roman period pottery fragments were observed at the site.

In his unpublished survey report from 1976, T. Raikes describes a "Nabataean fort or guard post" (Raikes'

1478 MacDonald et al. 2016, 214–215.
1479 MacDonald et al. 2012, 98.
1480 MacDonald et al. 2016, 298: They also refer to D. Kennedy who supposedly identifies the site as a "tower," however ShamAyl does not give any bibliographical reference.
1481 MacDonald et al. 2016, 412.
1482 MacDonald et al. 2012, 99; Abudanh 2006, 537.
1483 MacDonald et al. 2012, 99.
1484 Abudanh 2006, 537.
1485 Due to pressing time issues, exact measurements could not be recorded. Any propositions on PHSP Site No. 144 are therefore tentative.

FIG. 301 Aerial view of Khirbet al-Farqadiyyah. Photo: APAAME.

Site B29) in the Wadi Arabah.[1486] Smith was unable to relocate the site, but gives coordinate information for its approximate location.[1487] According to Smith, Raikes observed few pieces of copper ore as well as lithics at the site. Smith was able to analyze this material as well and claims that the (few) pottery finds discovered at Raikes' Site B29 indicate a Nabataean/Early Roman date (1st century BC to 2nd century AD).[1488] No further information is available and the site's identification as a possible military structure remains doubtful.

ʾAmr et al. resurveyed a "Nabataean/Roman fortress" (WMWS 1996 Site No. Bayda 28/Khirbet al-Qarn) on a hilltop near the modern village of Beidha.[1489] The site was originally recorded by G. Palumbo in 1994 as part of the unpublished *Report on the Cultural Resources Impact Assessment for the UNESCO Petra National Park Management Plan*.[1490] No further information is available for the presumed 'fortress' of Khirbet al-Qarn. ʾAmr et al. only mention additional smaller structures on the hill's slopes. This limited information does not suffice to list the site as a military structure.

JSS Site No. 048 is a "mid-sized" structure situated along a north-south running route west of the presumed course of the *via nova Traiana* (cf. FIG. 299).[1491] The route crosses agricultural lands. It is thus assumed that the structure served a defensive function in relation to the route. While possible, without further information, this remains speculative. Surface material suggests that the structure was occupied during the 2nd and 3rd centuries AD.

While the possibility that these sites served military and/or communication purposes cannot be dismissed entirely, the inconclusive evidence raises serious doubts whether they can be positively referred to as military sites.

1486 The information provided here is based on A. Smith's work (Smith 2010) who assessed T. Raikes' unpublished report, *Ancient Sites in the Wadi Arabah and Nearby*, from 1976.
1487 Smith 2010, 74.
1488 Smith 2010, 90, n. 25.
1489 ʾAmr et al. 1998, 515.
1490 As listed in the bibliography of ʾAmr et al. 1998.
1491 Unpublished survey report of the JSS kindly provided by L. Tholbecq.

Chapter 8
Funerary and Religious Sites

This chapter deals with the funerary and religious landscape of the Petraean hinterland. The first section presents all funerary structures in the study area. This is followed by a presentation of the different religious structures. Before presenting the relevant evidence, however, a brief introduction into the socio-cultural significance of Nabataean funerary architecture and a general overview of Nabataean religion is offered. This shall serve as a basis for further discussions on rural Petra's funerary and religious structures (chapter 9). The definitions of the individual subcategories of all funerary and religious sites are given in chapter 2.

Funerary Structures

Urban Petra is most famous for its over 600 monumental rock-cut tomb façades in both Graeco-Roman and Near Eastern decorative styles. This has attracted much scholarly attention in the past. In addition to typo-chronological studies on the façades, recent research has focused strongly on their stylistic and architectural forms.[1492] The relationship between the Petraean tomb façades and their parallels from Medain Salih (ancient Hegra) in Saudia Arabia were comprehensively worked out.[1493] Not only are the Hegraean tombs typologically similar to the tomb façades in Petra, many are accompanied by funerary inscriptions that mention the exact regnal year of the Nabataean king in power at the time of the completion of the tomb.[1494] By typological comparison with the dated monuments from Hegra, the Petraean tomb façades were fixed into a better chronological frame. On this basis, McKenzie defined the Petraean tomb façades chronologically that are not known in Hegra as well. Her typo-chronological classification system was subsequently modified and extended by Wadeson.[1495] In Petra, only 14 façades are securely dated on the basis of archaeological excavation results or epigraphical evidences.[1496] The earliest Nabataean tomb façades date to the second half of the 1st century BC.[1497] The latest datable tomb façade in Petra is that of Sextius Florentinus, governor of the Roman *Provincia Arabia* in 127 AD and who died shortly thereafter.[1498]

The first systematic excavation of a Nabataean tomb and its associated structures was that of the 'Roman Soldier Tomb Complex' (FIG. 302).[1499] Among other research objectives, the project followed up on an early hypothesis that the Nabataean tombs structurally mirror Graeco-Roman luxury architecture.[1500] Although individually distinguishable, Nabataean façade tombs in Petra share the same basic structural composition. The tombs are centered around an open courtyard and are not only equipped with the monumental tomb façade, but also a large cistern and banqueting installations (*triclinia*, *biclinia* or *stibadia*).[1501] These funerary structures are thus defined as Nabataean tomb *complexes*.[1502] Most were enclosed by walls and therefore not accessible to the public.

Dating to the mid-1st century AD, the Roman Soldier Tomb is the best example of a Nabataean funerary complex featuring a monumental classical

1492 For example, cf. Schmid 2009 or Wadeson 2010 with further references.
1493 In addition to Healey's seminal epigraphical work on the funerary inscriptions from Hegra (Healey 1993), see L. Nehmé's more recent contribution in Nehmé 2015a.
1494 The inscribed tombs at Hegra can be dated between 1 and 76 AD (Healey 1993, 6).
1495 Wadeson 2010. This system is followed here. For McKenzie's typological and architectural analysis on the tomb façades, see McKenzie 1990, 33–59.
1496 Cf. e.g. Wadeson 2010, 54.
1497 Based on limited excavated grave goods. However, excavated material of the Petraean 'Block Tombs' date these funerary monuments between the 2nd and 1st centuries BC (cf. e.g. Mouton – Renel 2013, 157–159).
1498 Wadeson 2013, 171, 175–176 and 2010, 54. Sextius Florentinus was most likely buried in an earlier Nabataean tomb that must have been abandoned by the first quarter of the 2nd century AD (cf. chapter 9).
1499 Schmid 2012a and b as well as 2009.
1500 Cf. Bachmann et al. 1921, 89–94. This was confirmed by Schmid's comparative analysis of other Nabataean tomb façades in Petra and their associated structures: Schmid 2012a and b; 2009; 2007b.
1501 On Nabataean *stibadia* in Petra, cf. recently Tholbecq 2018. On Nabataean *tricilinia*, cf. recently Durand 2017 and Charloux et al. 2016.
1502 Schmid 2009. Conceptual parallels to contemporary Mediterranean and oriental funerary cultures are additionally discussed in Petrovszky 2013a and b as well as in Gorgerat – Wenning 2013. In addition to Schmid's listing of Nabataean tomb complexes, also see the so called 'Aslah-Triclinium Complex' dating to the early or mid-1st century BC as presented in Gorgerat – Wenning

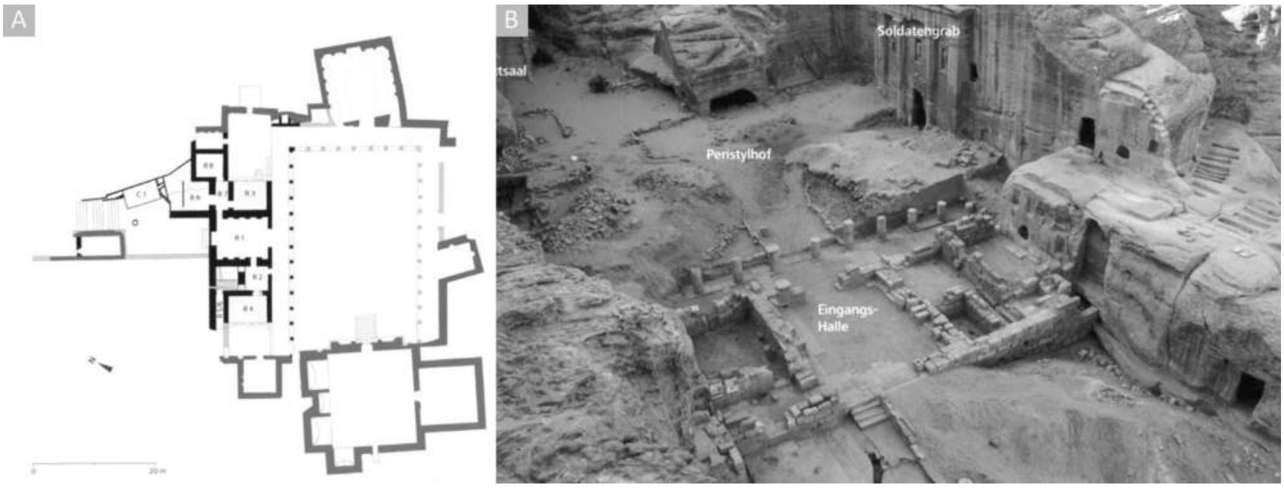


FIG. 302 The Roman Soldier Tomb Complex in the Wadi Farasa. A: Plan after Schmid 2012b, 184, Abb. 2. B: View of the Soldier Tomb Complex from the north after Schmid 2012b, 184, Abb. 3.

tomb façade, two *triclinia* and a *stibadium*, a large cistern, service rooms, as well as a central courtyard framed by a two-storied *porticus*.[1503] Based on the many luxurious architectural features, the complex was most likely used frequently.[1504] The large quantities of water stored in the cisterns of the complexes specifically point to frequented visitations, perhaps for particular funerary rites or for the preparation of food and drink consumed in the various banqueting installations.

Over 100 *triclinia*, *biclinia* and/or *stibadia* are documented in Petra.[1505] Approximately one quarter of these can be associated with funerary complexes. The others can probably be related to Nabataean *marzeah*, the cultic associations of different social groups collectively commemorating a common deity during which ritual banquets were held.[1506] Collective *convivia* and social *symposia* were central.[1507] The tomb complexes thus mirror the distinct social status of both the deceased and the bereaved. The conceptual citations of Graeco-Roman luxury architecture as well as the certainly exuberant costs of constructing such tomb complexes suggests that the tomb owners belonged to the social elite and it is generally assumed that they were based on family, clan or tribal associations.[1508] Nabataean tomb complexes in Petra highlight the social unit of kinship. Within the multifunctional tomb complexes, there was no differentiation between the living and the dead. The collective identification of kinship was important.[1509] In Petra, Nabataean tomb complexes were thus clearly reserved for, and visited by, a very specific and selective group of the Nabataean elite.

Introduced by Michel Foucault in the 1960s for describing primarily architecturally defined spaces that could only be accessed and used by a select group of people, S. Cormack adopted Foucault's term *heterotopiai* for her study on ancient funerary structures in

2013 (specifically concerning the dating, pages 223–224). The fact that the mentioned features were an integral part of Nabataean funerary complexes is confirmed by the inscription of the 'Turkmaniye Tomb' just north of Petra's city center. The inscription mentions that the Turkmaniye complex consisted of "[…] *an external peribolos with columns, domestic quarters, gardens as well as banqueting and water installations*." (Petrovszky 2013b, 459; Schmid 2009, 144; Brünnow – von Domaszewski 1904, 362–366 No. 633; Hackl et al. 2003, 259–263; Healey 2001, 51–52; McKenzie 1990, 167–168; Wenning 1987, 269–270). The discovery of a heart-shaped column-drum found *in situ* during excavations of the precincts of the Turkmaniye Tomb as well as similar finds revealed at the Roman Soldier Tomb confirms that Nabtaaean tomb complexes were enclosed by a *peribolos*. Cf. Schmid 2009, 145 and 160.

1503 Schmid 2009, 144–148. The dating of the complex is based on pottery evidence discovered beneath the original pavement of the courtyard (Schmid 2009, 148).

1504 Schmid 2009, 162; Kühn 2005, 35–77; Healey 2001, 50–52; 169–175. This assumption is also followed by Petrovszky (2013b, 461) for other tomb complexes in Petra.

1505 Tholbecq 2018 lists 17 *stibadia* in Petra and its immediate environment.

1506 Healey 2001, 51.

1507 Without direct epigraphical evidence, however, it remains unresolved whether *marzeah* also came together for conducting funerary rites in Petra. See Sachet 2010a for a discussion on 'funerary *marzeah*.'

1508 Although it is also speculated that tomb complexes mirror a far more diverse social structure, as argued e.g. by Kühn 2005, 41–43.

1509 As Kühn plausibly summarized, Nabataean tomb complexes stabilized "[…] *the connection to the deceased* […] *the collective community and therefore decisively supporting the tribal system and thus, eventually, Nabataean culture. In that sense* […] *the Nabataean tombs and funerary complexes are an expression of a collective, Nabataean self-conception*" (Kühn 2005, 77).

Asia Minor.[1510] Schmid recently argued to consider Nabataean tomb complexes as *heterotopiai* as well, as they can be defined as "[…] *closed spaces, where only restricted and well-defined people or groups of people are granted access*."[1511] Taking the Roman Solider Tomb as an example, he specifically refers to the banqueting installations and the central courtyard of the complex. As the tomb's precinct was closed off by the courtyard and its *porticus*, this suggests that access to the complex was restricted to a specific social group.[1512] Moreover, the monumental rock-cut *triclinium* of the Roman Soldier Tomb is situated exactly opposite the tomb façade. This indicates that the central burial within the tomb itself and the *triclinium* were of equal importance and were conceptually as well as spatially set in relation to each other.[1513] It may then be assumed that regular funerary assemblies held within Nabataean tomb complexes in Petra were a central aspect of elite funerary culture as early as the 1st century BC.[1514] At least for Petra, these funerary *heterotopiai* were important forms of spatial organization of the Nabataean elite.[1515] The Foucauldian *heterotopia* may be understood as a generic term for describing structures that reflect the distinctive family-, clan- or tribal social structures of Nabataean Petra.

Scholars postulate that following the Roman annexation in 106 AD, specific Nabataean *heterotopiai* in Petra and elsewhere in Nabataea were either abandoned or significantly altered.[1516] Specifically concerning the tomb complexes, the Roman Soldier Tomb is one example of a distinctly altered Nabataean *heterotopia* shortly after the annexation as excavations have shown that by the early 2nd century AD the tomb complex went through significant structural changes. As rooms 2, 4 and 5/6 (cf. plan in FIG. 302) were modified, this affected the water management of the entire complex so badly that seasonal flash floods became increasingly problematic.[1517] Also, the three original entrances into the monumental *triclinium* were blocked by walls. Access was only possible through the main central entrance, which was now closed by double-doors.[1518] The upper *stibadium* of the complex was cut by several shaft tombs by the late 1st century AD as well. These continued to be used in the early 2nd century AD although adequate space remained in the original tomb. This has led to the hypothesis that members of the social group associated with the tomb complex were denied the right to bury their dead within the tomb complex, necessitating alternative solutions.

Such alterations of heterotopical banqueting installations within the Roman Solider Tomb Complex around the Roman annexation are suspicious. While this alone cannot offer satisfying evidence for any substantial change in Petraean funerary customs, the fact that the latest Nabataean tomb complex in Petra was appropriated by a Roman official and does not date later than the first quarter of the 2nd century AD (i.e. the early years of *Provincia Arabia*), may further indicate changes in funerary customs around the time of the annexation. The proposition that the end of heterotopical structures in Petra by, or shortly after, the Roman annexation is explained by the general suspicion of Roman authorities towards any sort of *social* gatherings. Arguably, heterotopical Nabataean funerary complexes in Petra would not have been excluded. While such conclusions remain preliminary,[1519] characterizing Nabataean funerary complexes in Petra as socially distinct *heterotopiai* of the elite upper class, and reflective of the core tribal structure of Nabataean society in Petra seems warranted.

Nabataean funerary culture is not limited to elite monumental tomb complexes. In urban Petra and its environs, communal *shaft tombs* can be observed in large numbers. They provide the majority of burial types in Petra and other parts of the Nabataean realm.[1520] Shaft

1510 Cormack 2004, 46–47, 106–107, 122. For a more detailed theoretical discussion of Foucault's *heterotopia*, see Schäfer-Biermann et al. 2016, 49–87. Cf. also e.g. Smith 2013, 15–38 for a recent archaeological study dealing with heterotopical spaces in a much more comprehensive and differentiated manner.

1511 Schmid 2013a, 252–254.

1512 While this indicates a clear heterotopical character of the tomb, its location across the processional way to the major Nabataean 'High Place' on the Jabal al-Madhbah emphasizes its characterization as a *heterotopia*. Access had to be granted by the tomb owners to a larger public in order to pass the tomb's precincts for ritual processions to the Jabal al-Madhbah (cf. Wenning 2012, 481 and Schmid 2009, 144–152).

1513 In many Petraean tombs the central burial is often larger and architecturally emphasized. This most likely marked the burial of the tomb founder and thus central figure for the social group convening within the tomb complex (cf. Schmid 2013a, 252; Wadeson 2012b, 204–205 and 2012b, 107). Schmid also draws parallels between the "central placing" of the burial niche of the Roman Soldier Tomb and the spatially central setting of the large *triclinium*.

1514 As evidenced by the Aslah-Triclnium Complex.

1515 Similar claims can also be made for private residences, specific sanctuaries and other installations for tribal gatherings (more below) (cf. Schmid 2013a, 258).

1516 E.g. Durand 2017, 95–98; Renel – Monchot 2017, 70; Charloux et al. 2016; Tholbecq 2016, 1066–1067; Schmid 2013a, 258–259;

1517 Cf. also Schmid 2007b and 2008b.

1518 Whether this corresponds to the increasingly deteriorating water management system of the complex or reflects a more restricted access policy cannot be determined.

1519 Cf. Rohmer 2016, 400.

1520 Perry 2002, 270.

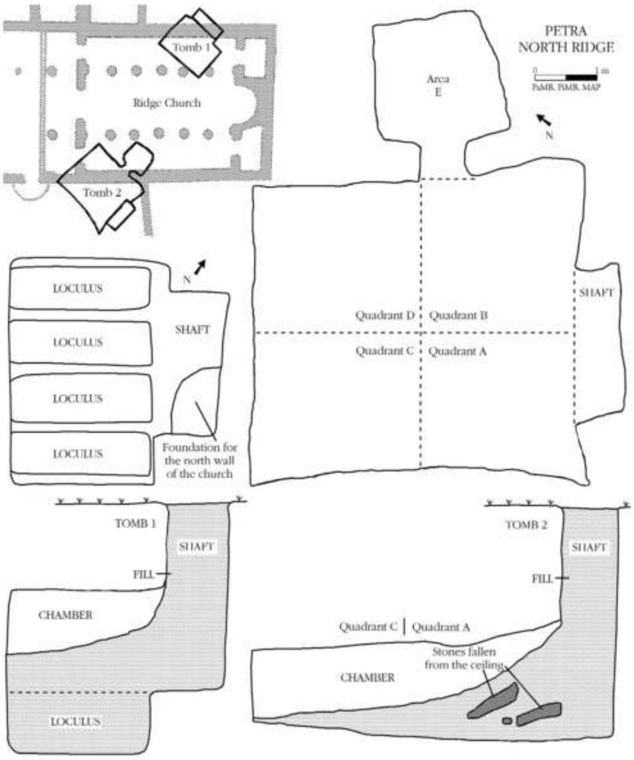


FIG. 303 Exemplary plan of a Nabataean shaft tomb in Petra: Tombs 1 and 2 of the North Ridge after Perry 2002, 266.

tombs can be characterized as underground communal burial chambers which were accessed by a shaft cut into the chamber's ceiling (FIG. 303).[1521] They can have several burial chambers in which the burial shafts (*loculi*) were cut holding one or numerous individuals. Excavated shaft tombs in Petra date as early as the 2nd and 1st centuries BC, although the majority were from the 1st and 2nd centuries AD.[1522] The excavations revealed a rich variety of 1st century AD Nabataean fine ware suggesting that shaft tombs were not limited to the lower social classes.[1523] While the effort and cost of constructing a shaft tomb cannot be compared to that of commissioning a Nabataean tomb complex, it is reasonable to assume that shaft tombs were issued and used by the Petraean 'middle class.'

Simpler burial forms are known from Petra as well. These are rock-cut pit graves for one or more individuals. They are characterized by a single rectangular grave shaft that varies in size and depth. In contrast to a shaft tomb, these do not give access to a larger burial chamber. Depending on their depth, they only allow for single or multiple burials that succeeded on top of one another, separated by stone slabs.[1524] Typologically, there is no difference between rock-cut pit graves and the *loculi* carved within the Petraean façade or shaft tombs.[1525] While isolated rock-cut pit graves in Petra exist, the majority appear in clusters. Good examples are the more than 50 pit graves cut into the bedrock surfaces in front of the Aslah Triclinium Complex.[1526] Likely due to the prevailing sandstone of urban Petra, no earthen pit graves are known within the city.

There are no *hypogea* or burial cairns known within the urban limits of Petra. These burial types seem unique to the Petraean hinterland.

After this brief introduction into Nabtaean funerary culture in Petra, the following presents the documented funerary structures in the city's surroundings (FIGS. 304–307). These are distinguished between 'isolated funerary monuments' and 'cemeteries' (cf. chapter 2).

Isolated Funerary Monuments

Isolated funerary monuments are the most documented type of funerary structure in the Petraean hinterland (FIG. 308). They date as early as the 1st century BC.[1527]

Façade Tombs

Based on typological comparisons and surface pottery, there are no Nabataean façade tombs in the Petraean hinterland that date before the 1st century AD. Generally, the number of façade tombs decreases with greater distance from Petra. To date, the FJHP documented the southwestern-most façade tomb in the

1521 Kouki – Silvonen 2013b, 301–302; Perry 2002; Bikai – Perry 2001, 59–62.

1522 Kouki – Silvonen 2013b, 315, n. 8; Wadeson 2012a, 113–114 (with further references); Perry 2002; Sachet 2009. Particularly note the excavations of shaft tombs conducted by I. Sachet (Sachet 2009, 100), which revealed pottery material dating between the 2nd century BC and 2nd century AD with some sherds dating as late as the 4th century AD as well. However, these burials are associated with a Petraean 'Block Tomb' and cannot necessarily be considered as an isolated shaft tomb (cf. also Mouton – Renel 2013). For excavated shaft tombs at the Roman Soldier Tomb, see Schmid et al. 2008, 141–144. See Wadeson 2012a, 113 on the idea that shaft tombs may have pre-dated the Nabataean tomb façades, as some shaft tombs were seemingly converted into façade tombs at a later point.

1523 Kouki – Silvonen 2013b, 315, n. 8; Wadeson 2012a, 101–103; Perry 2002, 267–268.

1524 Wadeson 2012a, 101.

1525 Cf. e.g. the excavated *loculi* of the Aslah Triclinium Complex (Gorgerat – Wenning 2013, 229–230) and the 'Renaissance Tomb' in the Wadi Farasa (Schmid et al. 2008).

1526 Gorgerat – Wenning 2013, 224, fig. 1 and 2.

1527 It should be noted that the original surveys identified several problematic structures as possible funerary monuments. However, the nature and dating of these sites is highly elusive and therefore difficult to categorize convincingly. These include ShamAyl Site No. 001, 095, 155.

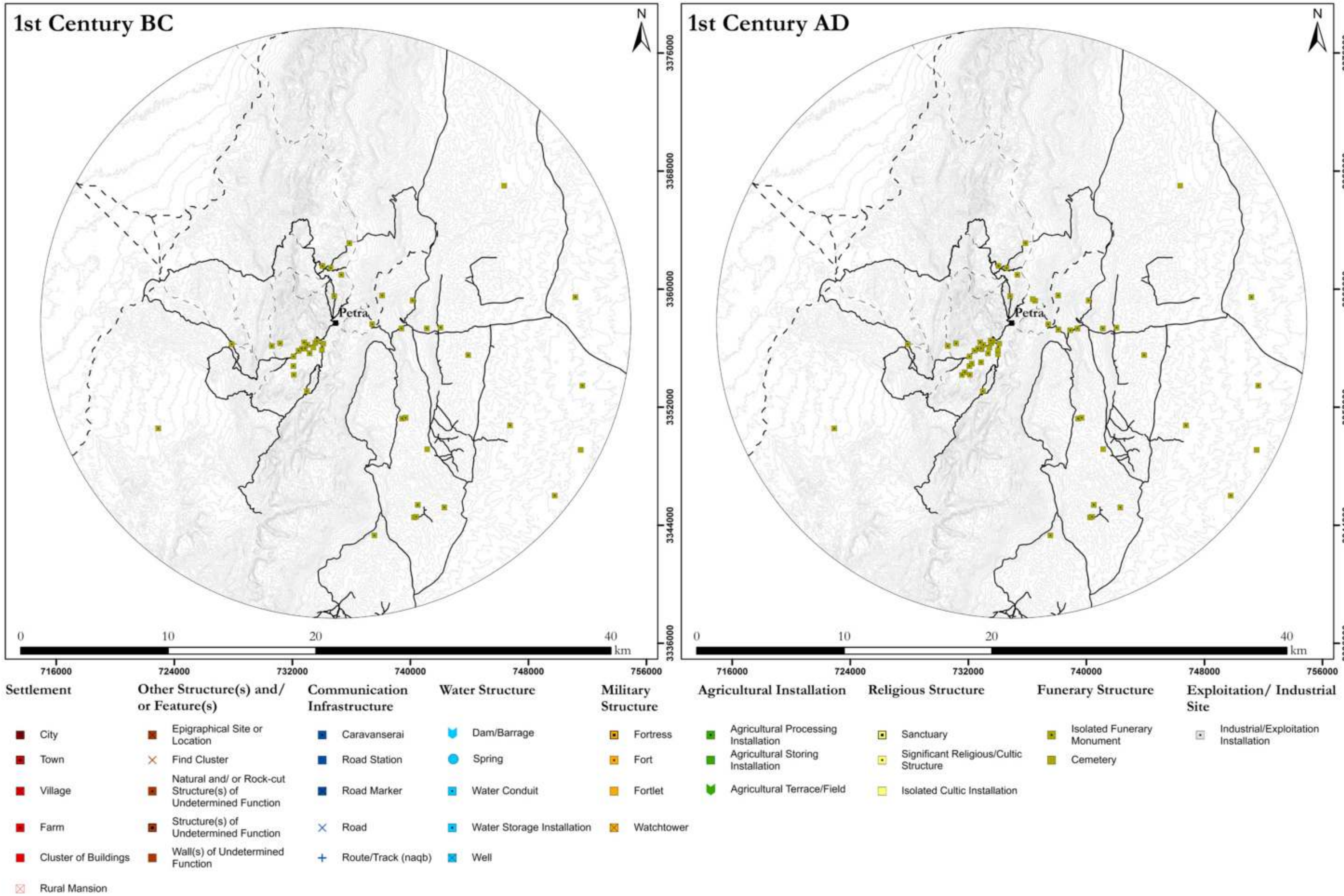


FIG. 304 Distribution map of 1st century BC and 1st century AD funerary structures in the Petraean hinterland.

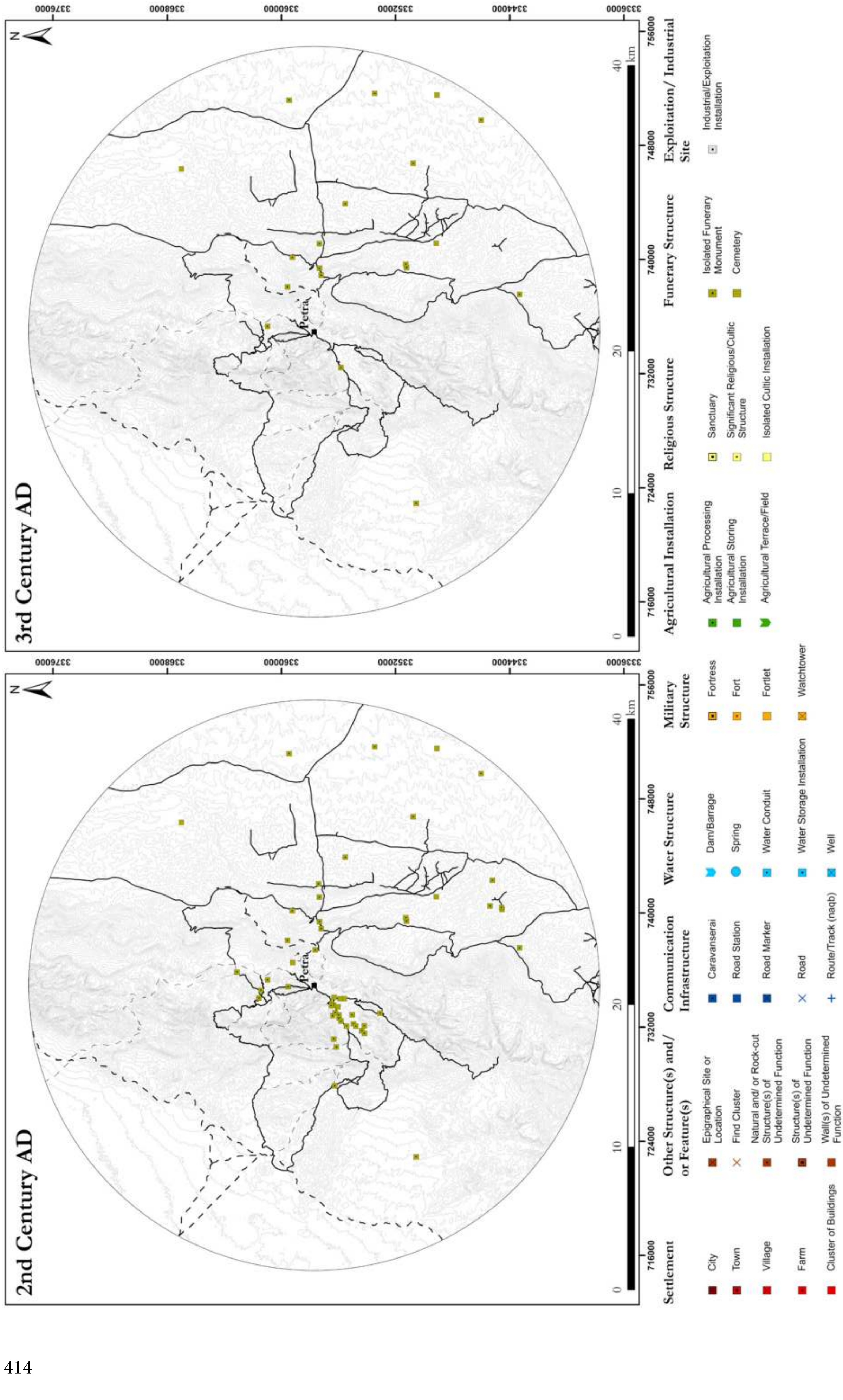


FIG. 305 Distribution map of 2nd and 3rd century AD funerary structures in the Petraean hinterland.

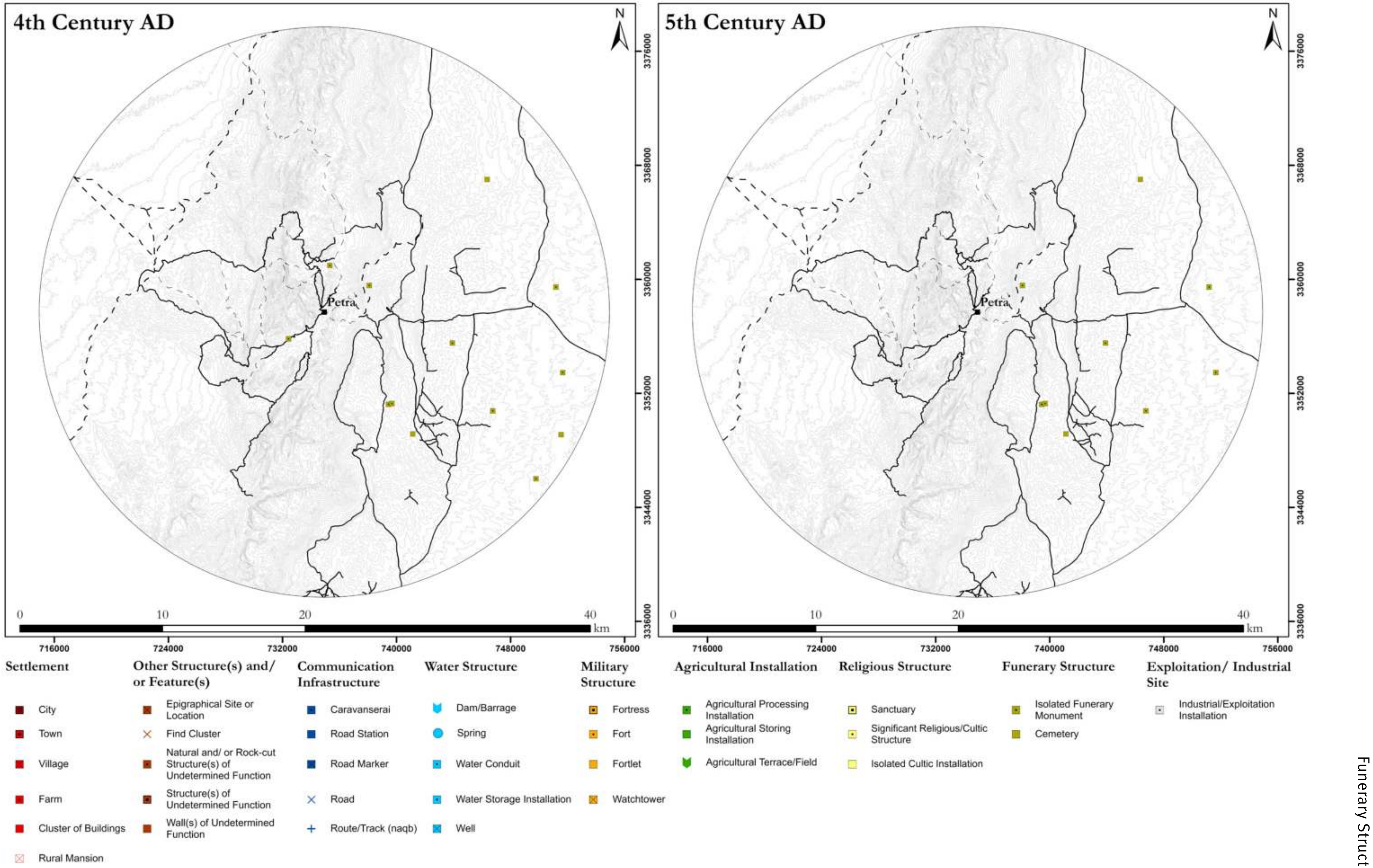


FIG. 306 Distribution map of 4th and 5th century AD funerary structures in the Petraean hinterland.

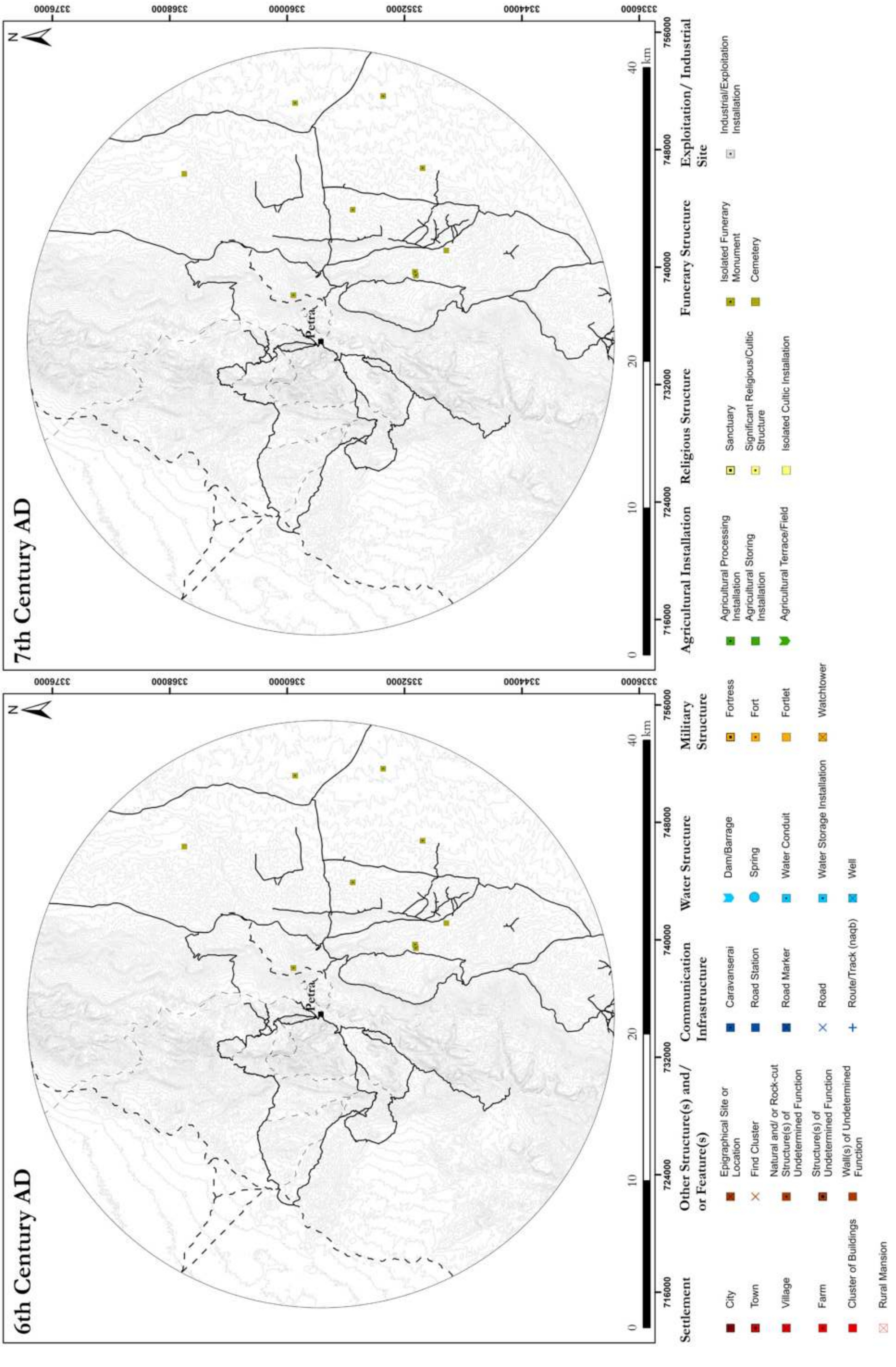


FIG. 307 Distribution map of 6th and 7th century AD funerary structures in the Petraean hinterland.

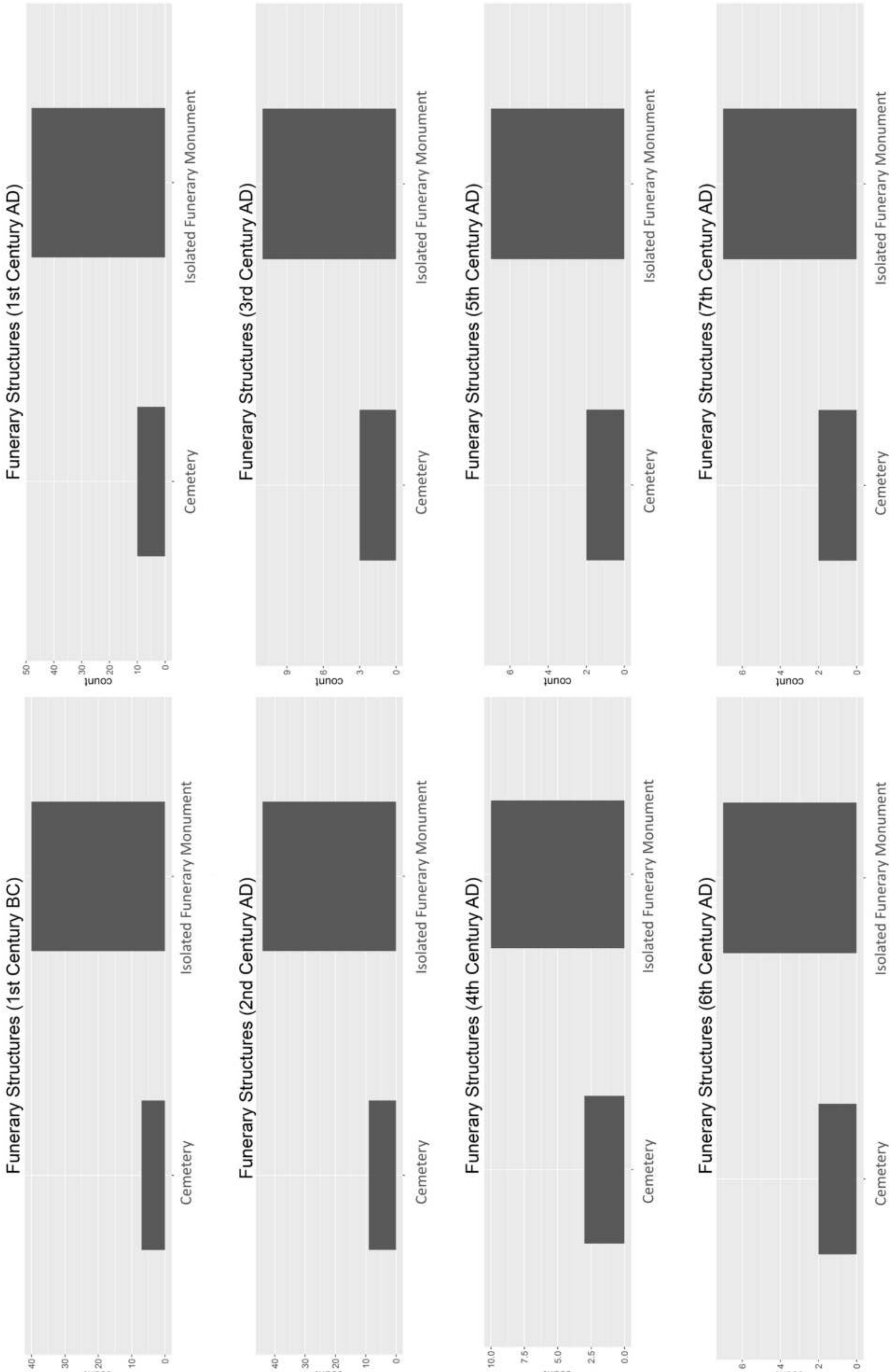


FIG. 308 Number of funerary structures from the 1st century BC to 7th century AD.

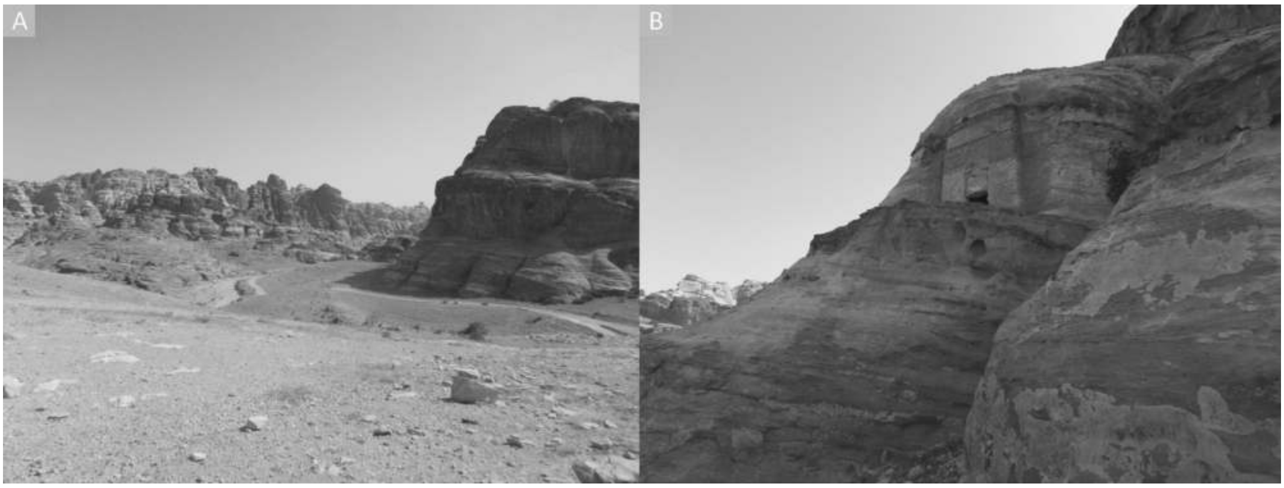


FIG. 309 Nabataean façade tomb along the Darb al-Lethie (PHSP Site No. 127). A: Darb al-Lethie. B: Pylon tomb.

study area.[1528] FJHP Site No. Ext155 is a double pylon tomb carved at the foot of Umm Barra. FJHP Site No. Ext078 is an unfinished façade tomb situated in the Wadi al-Waqit along the northern as-Sto'e route, not far from the Isis sanctuary in the Wadi Abu Olleqah.

Apart from the façade tombs of Beidha, the northern-most façade tomb in the study area is PHSP Site No. 127. This single pylon tomb is carved high in the face of a larger outcrop along the Darb al-Lethie leading from the western al-Begh'ah area northwards to Beidha (FIG. 309).

The PRP recorded an isolated step tomb along the route of Wadi al-Mu'aysirah East (PRP Site No. wme013).[1529] According to the surveyors, the tomb is clearly visible for travelers coming from Shammasa and the al-Begh'ah plain. Apart from a few documented shaft tombs, this façade tomb is the only monumental tomb recorded in the northern section of both Wadi al-Mu'aysirah West and East. The fact that the tomb was surrounded by agricultural fields and other agricultural installations has led the surveyors to suggest that it may have been associated with an individual or family responsible for the management of the local agricultural system.[1530] The façade tomb along the Darb al-Lethie may have also been associated with the agricultural installations in the al-Begh'ah area. However, this remains speculative.

The stretches of Wadi al-Mu'aysirah West closer to Petra show more rock-cut façade tombs, some of which seem to be later alterations of older shaft tombs. These include BD 540, 542 and 543, which are situated on a smaller outcrop with several additional shaft tombs.[1531] At BD 540 a double pylon façade was added to the original shaft tomb. A façade of the proto-hegr type was added at BD 542 and a single pylon façade at BD 543. Based on other examples of shaft tombs converted into façade tombs in Petra, Wadeson concludes that mainly small and simple façades were added.[1532] It is presumed that the original tomb owners could not afford a proper façade tomb and therefore resorted to the communal shaft tomb. Such observations highlight interesting aspects of Petra's extra-urban funerary landscape and potentially mirror the social changes of singular Nabataean families or clans.[1533]

ShamAyl Site No. 001 describes an inscription on a stone which supposedly was part of a wall of a presumed tomb or grave (MacDonald et al. 2016, 116). Surface pottery suggests a date between the 1st century BC and the 4th century AD. As no further information is given, the exact nature of this presumed funerary monument remains unknown. ShamAyl Site No. 095 describes two presumed burial cairns that are tentatively dated between the 4th century BC and 7th century AD (MacDonald et al. 2016, 272). However, located in a still cultivated area, the surveyors admit that the cairns could also be simple field clearances. ShamAyl Site No. 155 is only a sherd scatter with material dating between the 10th century BC and 7th century AD, but the surveyors mention that the scatter may be related to a tomb east of the site (MacDonald et al. 2016, 272). No further information is given. If the early dating and the identification of the mentioned tomb is confirmed, the site would be one of the oldest isolated funerary monuments in the study area. In addition to the Bronze Age – and possibly earlier – burial sites known in the wider Petra area (Hertell 2013, 324–325 with further references). Finally, Lindner mentions two isolated tombs on the way from Ras Suleiman to Sabra, one being rock-cut and the other freely built (Lindner 2003a, 92). No further information is available.

1528 Kouki – Silvonen 2013b, 301.

1529 Berenfeld et al. 2016, 94.

1530 Berenfeld et al. 2016, 94.

1531 Wadeson 2012a, 114–117 mentioning other converted shaft tombs. 'BD' refers to Brünnow and von Domaszewski's original numbering of the Petraean tombs.

1532 Wadeson 2012a, 116–117. In Petra, these simple façades date around the second half of the 1st century AD.

1533 Without further archaeological investigations and supporting textual evidence, this remains suggestive. Note

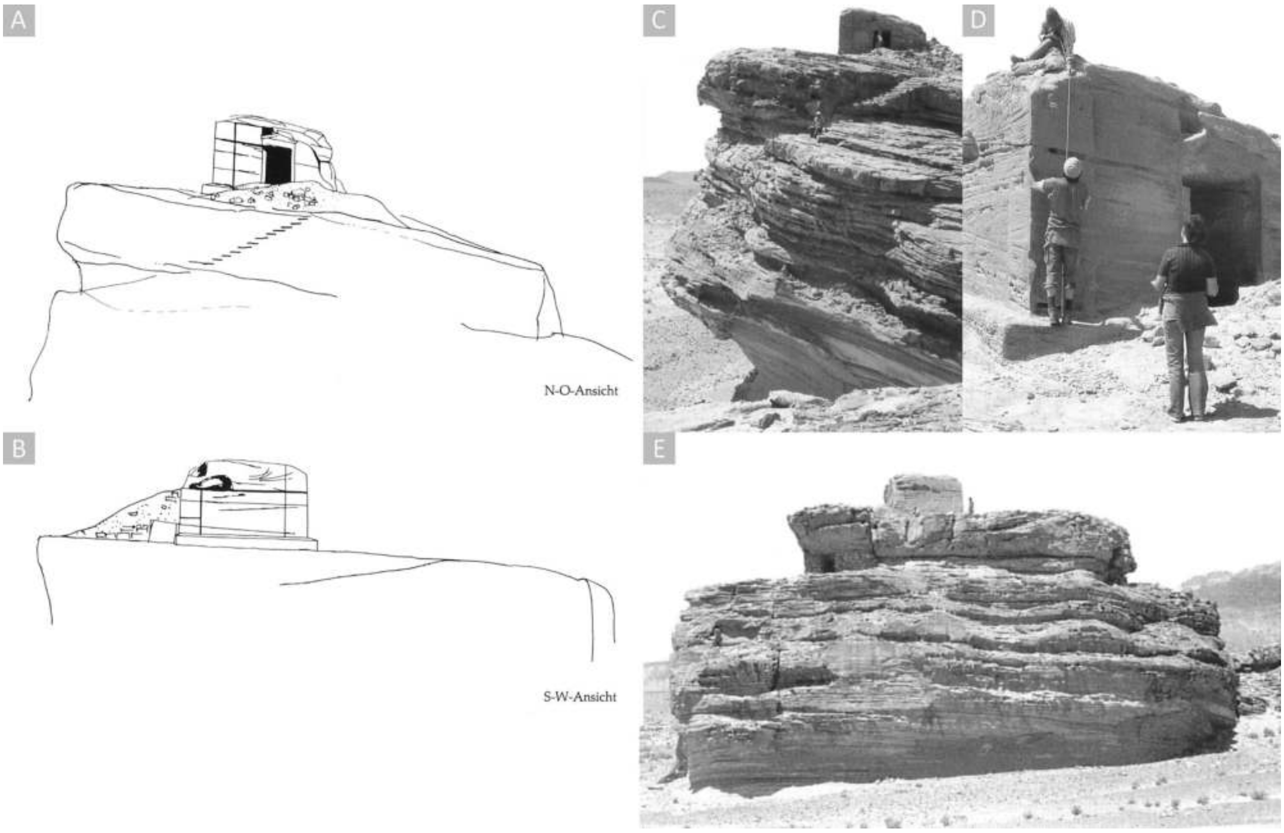


FIG. 310 The monumental rock-cut tomb of Mukheifer in the Wadi Arabah. A and B: Scaled sketch plan of Mukheifer (c. 1:200) by E. Gunsam in Lindner 1986a, 182, Abb. 17. C–E: Photographs taken by Lindner and his team (Lindner 2003a, 96–98, Abb. 14–16).

Although not a typical Nabataean *façade* tomb, the monumental rock-cut tomb at Mukheifer in the Wadi Arabah is a unique funerary monument in Petra's western hinterland. Despite the fact that the tomb was already well known by early travelers to the Petra region (FIG. 310), the site is still relatively unexplored.[1534] Continuing westwards along Wadi Sabra, the tomb is situated on a large sandstone outcrop and is well visible from afar.[1535] It encompasses two terraces. The lower terrace has a rock-cut room and is accessed by a path leading up the outcrop. The monumental cuboid-shaped tomb itself crowns the summit. It is framed by rock-cut corner-pilasters and the entrance seems to have been architecturally adorned as well.[1536] Both Kind and Lindner mention the ruins of a presumed village with additional smaller tombs in the immediate vicinity of Mukheifer. "Nabataean to Late Roman" pottery sherds were observed and Kind apparently collected 40 pre-annexation Nabataean coins near the site.[1537] The tomb may have been associated with the industrial activities at the nearby copper mines of Umm al-'Amad (cf. chapter 4).[1538]

Shaft Tombs

The FJHP documented two isolated shaft tombs that, based on surface pottery material, date as early as the 1st century BC (FIG. 311).[1539] With the exception of FJHP Site No. Ext034, these early shaft tombs were in continuous use throughout the 1st century AD when six

that the various surveys emphasize only the façade as the 'monumentalizing' element of rural funerary structures. The possibility that these tomb façades could have been part of an elite Nabataean funerary *complex* has not yet been entertained.

1534 Lindner 2003a, 96–98; 1986a, 175–183 and Kind 1965, 64. Consider David Roberts' famous lithograph (1842–1849) depicting the site. Lindner 2003a, 98, n. 2 states that David Roberts documented built superstructures which have already collapsed by the time Lindner visited the site. Lindner and his team were able to take some measurements of the tomb (Lindner 2003a, 98, Abb. 16 and Lindner 1986a, 175–183). Due to time reasons, however, the team was not able to document the site sufficiently (Lindner 2003a, 96).

1535 Cf. Lindner 2003a, 96.

1536 Based on Lindner's published photographs (Lindner 2003a, 97–98, Abb. 14–16).

1537 Lindner 2003a, 96–98; Kind 1965, 64 and 63, Abb. 3.

1538 Cf. Lindner – Zeitler 1997, 542 although this was previously rejected by Lindner 1986a, 188.

1539 These are FJHP Site Nos. Ext067and Ext168. On the evidenced shaft tombs recorded by the FJHP, see Kouki – Silvonen 2013b, 301–308.

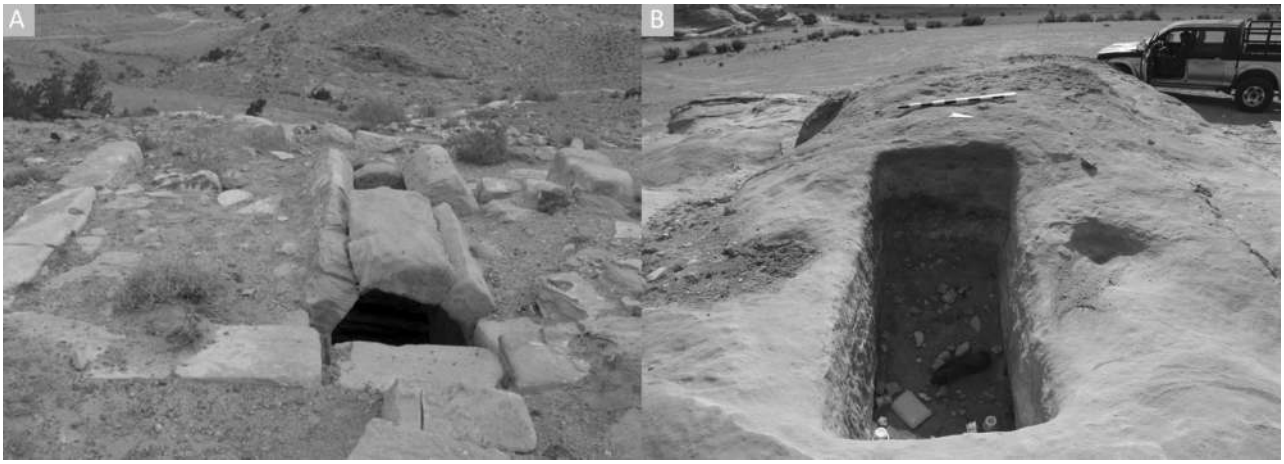


FIG. 311 Two examples of shaft tombs in the Petraean hinterland. A: FJHP Site No. Ext120. Photo: Kouki – Silvonen 2013b, 307, fig. 16. B: PHSP Site No. 005-ST013 in the Beidha area.

further shaft tombs were constructed in the al-Farasha and as-Sto'e plains.[1540] All shaft tombs documented by the FJHP were still in use in the 2nd century AD.

The PHSP recorded a possible shaft tomb at Ras Amm Ay'ed along the northern as-Sto'e route.[1541] The PRP noted some shaft tombs along the Wadi al-Mu'aysirah East and a shaft tomb was recorded by the WMWS in the Wadi Musa area as well (WMWS 1996 Site No. Wadi Musa 3).[1542]

Particularly interesting is FJHP Site No. Ext120 located just below Tulul Mutheilya opposite the Wadi al-Baqiya on a low hilltop (cf. FIG. 311). The surveyors emphasize its isolated position to other funerary structures.[1543] Constructed above the shaft is a vault framed by a c. 3,70 × 3,70 m well-built walled area. In addition to ashlars observed around the site, the FJHP also documented "[…] *two architectural blocks with carved half capitals, showing the distinctive Nabataean diagonal dressing.*"[1544] If the finds can be associated with the tomb, the half-capitals probably decorated the burial's entrance that gave the tomb a more monumental character. The tomb's shaft gives access to an underground, rectangular chamber which is partially filled by sand. No *loculi* were mentioned, but human skeletal remains were recorded. This suggests that at least one burial was located at the site. Surface pottery dates the structure between the mid-1st and early 2nd century AD. The FJHP is certainly correct in drawing parallels to the monumental Nabataean tomb discovered at Khirbet Suboor near at-Tayyiba.[1545] The tomb of Khirbet Suboor is situated along an ancient road and, similar to FJHP Site No. Ext120, is framed by a large, rectangular enclosure demarcating the tomb's precinct.[1546] The tomb itself consists of only one subterranean vaulted *loculus* and its good construction quality is particularly striking.[1547] The individual buried at Khirbet Suboor must have been of greater importance.[1548] Therefore, if there is only one burial at FJHP Site No. Ext120, the site may be considered as the burial place of a locally important individual as well.

Simple Pit Graves

Pit graves are one of the most common burial types in Petra's immediate environs. The FJHP recorded eight rock-cut pit graves dispersed throughout the al-Farasha and as-Sto'e plains.[1549] With the exception of FJHP Site No. Ext034, these pit graves were in continuous use throughout the 1st century BC. Two further pit graves were constructed in the FJHP's study area in the 1st century AD.[1550] Based on surface pottery material, all pit graves documented by the FJHP were in continuous use in the 2nd century AD as well. At al-Ghurm al-Ahmar near Beidha, the PHSP documented a possible rock-cut pit grave.[1551] Based on the well-documented parallels in and around Petra, it is possible

1540 These are FJHP Site No. Ext033, Ext078, Ext120, Ext133, Ext138 and Ext155.
1541 PHSP Site No. 022. Although no surface material was observed at the site, it most likely dates to the Nabataean period.
1542 Berenfeld et al. 2016, 94.
1543 Kouki – Silvonen 2013b, 301, 306–307.
1544 Kouki – Silvonen 2013b, 301, 307. Presumably, the FJHP discovered two engaged half-capitals.
1545 Kouki – Silvonen 2013b, 301, 307.
1546 Abudanh et al. 2011. It is possible that the precinct may have been used for ritual purposes.
1547 Abudanh et al. 2011, 77–79.
1548 Cf. also Wadeson – Abudanh 2016, 92.
1549 These include FJHP Site Nos. Ext008, Ext025, Ext034, Ext107, Ext108, Ext128, Ext129, Ext163, as well as FJHP Site No. S183. Generally on the pit graves recorded by the FJHP, see Kouki – Silvonen 2013b, 301–308.
1550 These are FJHP Site No. Ext128 and Ext133.
1551 PHSP Site No. 005-ST013.

FIG. 312 Selective overview of burial cairns in the study area. A: Two views of an-Jur (PHSP Site No. 131). B: Wadi Sabra (PHSP Site No. 038-ST047). C: Naqb Saqqara (PHSP Site No. 087). D: Naqb Mistalgile (PHSP Site No. 117) with burial pit (right).

that the site dates to the Nabataean period. The PRP documented both isolated as well as clustered rock-cut pit graves along Wadi al-Mu'aysirah West.[1552]

Burial Cairns

The burial cairns in the Petraean hinterland strongly resemble Nabataean, Roman and Byzantine parallels known throughout Jordan, e.g. at 'Ayn Abu 'Uwayna near Wadi Ramm, along the Kerak Plateau, in the southern Ghor and the Wadi Arabah, at Wadi Musa as well as near Tafileh and Busayra.[1553]

Dating as early as the 1st century BC, possible burial cairns are ShamAyl Site Nos. 049 and 096 (FIG. 312).[1554] The FJHP identified eight burial cairns as well.[1555] The most prominent examples are FJHP Site No. Ext001

1552 Berenfeld et al. 2016, 94.
1553 Perry 2007, 88 with further references. At average, all cairns measure between 4 and 7 m, fitting well with the dimensions of the burial cairns in the study area.
1554 However, at both sites surface pottery dates as late as the 7th century AD as well.
1555 Hertell 2013.

and 168.[1556] The only dated burial cairns are FJHP Site No. Ext123 and Ext138 dating to the 1st and 2nd century AD.[1557] The remaining six are undated.[1558] All cairns recorded by the FJHP are located either on ridge or hilltops, ledges or on slopes, i. e. at locations with good visibility to and from the sites.[1559] The same observations was made at other burial cairns in the study area: The PHSP recorded five cairns, some of which date as early as the 1st century BC. In addition to an earthen pit grave, PHSP Site No. 164 is a small cairn on a ridge at the junction between Naqb ar-Ruba'i, the Umm Qamar pass and Naqb Mistalgile. The presumed small route station of Seir Umm Qamar is just below the cairn, which suggests that it might be associated with the site. Although only little surface pottery was found, the site may be dated between the 1st century BC and 2nd century AD.

An interesting find was also made by the PHSP at Site No. 131. The possible burial cairn is located on the hilltop of an-Jur along the Wadi Siq al-Ghurab pass, leading from the al-Begh'ah plain to Beidha commanding an excellent view across the surrounding landscape. Although the site was looted and the sandstone blocks were removed, the site was undoubtedly a small cairn. The PHSP documented a large amount of Nabataean pottery dating between the 1st century BC and 2nd century AD.

Another possible cairn (PHSP Site No. 038-ST047) may be located on top of a ridge along the southern banks of the Wadi Sabra shortly before reaching the ancient settlement from the east. It is a large, heavily disturbed cairn measuring c. 5 × 7 m with a preserved height of ca. 1,50 m (FIG. 312). Some Nabataean pottery was observed at the site, dating between the 1st century BC and 2nd century AD. The site is well visible from the wadi below and the entire Wadi Sabra can be overseen from the cairn.[1560]

PHSP Site No. 117 can also be characterized as a burial cairn (FIG. 312). The site is situated along the upper part of Naqb Mistalgile, shortly before reaching the al-Farasha plain below Jabal Harun. It consists of a c. 4 × 6 m large collapsed stone pile of irregularly shaped limestone blocks of yellowish color. The coloring of the stone is particularly interesting as the site is located in a predominantly reddish sandstone area. The site therefore clearly stands out as a landmark along Naqb Mistalgile. The looted cairn reveals a c. 1 m long and 0,5 m wide stone-lined earthen pit grave in the center of the disturbed stone pile. Rock carvings of humanoid and animal figures mark a flat sandstone surface immediately northwest of the site. The little surface pottery material recorded at the cairn tentatively dates the site to the Nabataean period, presumably the 1st century AD.

The PHSP recorded another possible cairn along Naqb Saqqara. Situated immediately south of the northern part of the route, PHSP Site No. 087 is a c. 4 × 4 m large stone pile of irregularly cut limestone blocks (cf. FIG. 312). Three wall courses were observed amidst the collapse, which may mark the original stone-lined pit grave. Together with some blocks showing the typical Nabataean 45° tool marks, surface pottery finds suggest a preliminary dating to the 1st century AD.[1561] While the presence of ashlars with typical Nabataean tool marks as well as the observed wall courses may indicate a larger funerary monument, the stone collapse also resembles that of a burial cairn.[1562] Further archaeological investigations are necessary to clarify the function of this site.

Hypogea

Apart from the façade tombs and the two vaulted burials discovered at FJHP Site No. 120 and Khirbet Suboor, the only monumental funerary structures in the Petraean hinterland are the communal *hypogea* recently investigated by L. Wadeson and F. Abudanh (FIG. 313).[1563]

Previously, the WMWS already recorded two *hypogea* in the Wadi Musa area: WMWS 1998 Site Nos. 25 and 33.[1564] Belonging to the presumed "cemetery" of an-Naqla, the former was described as a subterranean, vaulted "family tomb" with several *loculi*. WMWS 1998 Site No. 33 is also considered as a *hypogeum* of similar type, however it seems to be rock-cut and not built as WMWS 1998 Site No. 25.[1565]

1556 However, the latter most likely dates to the Chalcolithic-Bronze Age (Hertell 2013, 323).

1557 Hertell 2013, 323. Surface pottery material at FJHP Site No. Ext123 however, only dates to the 1st century AD (Kouki et al. 2013b, 35).

1558 These include FJHP Site Nos. Ext121, Ext130, Ext139 and Ext170.

1559 Cf. table 1 in Hertell 2013, 324.

1560 The author first considered the site as a possible watchtower. However, the poor state of PHSP Site No. 038-ST047 does not allow any secure functional interpretation. It seems more likely that site is a burial cairn.

1561 This structure was identified together with C. Ben David to whom the author is most grateful for assisting in the investigation of the site.

1562 Without a definite identification of a burial, the site may also have had a completely different function.

1563 Wadeson – Abudanh 2016.

1564 'Amr – al-Momani 2001, 268; 'Amr et al. 1998, 526. Also see Wadeson – Abudanh 2016, 84–85.

1565 Note that based on the surveyors' description it is unclear whether this tomb is indeed rock-cut. 'Amr – al-Momani 2001, 270 describe a "[…] *Nabataean tomb, of loculi built inside a natural cave, similar to those recorded at an-Naqla*

FIG. 313 Monumental *hypogea* in the Petraean hinterland. A: The *hypogeum* at Saddaqa. B: Views of PHTP Site No. 002 after Wadeson - Abudanh 2016, 87, fig. 4; 88, fig. 6; 91, fig. 10.

These *hypogea* show striking similarities to the monumental, subterranean tomb excavated by the Department of Antiquities of Jordan at Saddaqa. However, this type of *hypogeum* has a central shaft with the *loculi* on the sides. It was also sealed by a flat roof and not vaulted as the examples from Wadi Musa.[1566] The tombs from Wadi Musa and Saddaqa date to the 1st century AD.

As part of the *Petra Hinterland Tombs Project* (PHTP), Wadeson and Abudanh discovered five additional *hypogea* throughout the Jabal Shara range, three of which are in the study area: PHTP Site Nos. 001, 002 and 012.[1567] These are located on the highest points of the Jabal Shara range with an excellent view across the surrounding landscape. Apart from PHTP Site No. 12, all tombs share the same essential characteristics as the parallels from Wadi Musa, "[...] *comprising a subterranean, vaulted chamber with rows of square-shaped loculi in the walls, constructed of irregular ashlar blocks.*"[1568] The chambers measure between c. 2,5 × 1,50 m and 4 × 3,30 m and the number of the visible *loculi* varies between six and 16. Large quantities of pottery were recorded dating between the 1st and 3rd centuries AD.

On the surface, PHTP Site No. 12 measures 6,45 × 6,45 m and is situated on a ledge along an ancient road overlooking the Petra valley and Jabal Harun. While the tomb is heavily filled by debris, built *loculi* are nevertheless visible. The PHTP suggests that it may be arranged like the tomb at Saddaqa with a central shaft instead of a chamber.[1569]

Two types of monumental *hypogea* are thus evidenced along the Jabal Shara range, all of which are positioned on prominent high points and along ancient roads. It is possible that they were communal burials of socially high ranking families, clans or tribes that were able to monumentalize their social standing.[1570] Their possible function as important landmarks is emphasized when considering that, at least the vaulted *hypogea*, most likely had superstructures.[1571]

These tombs are not unique to the Petra area.[1572] Dating to the Nabataean and Roman periods, similar *hypogea* are also known from Humeima, Wadi Ramm, Umm al-Jimal, Khirbet adh-Dharih and Mampsis. The contemporary Palmyrene *hypogea* may be considered as parallels as well.[1573]

In addition to the investigations of the PHTP, more monumental funerary structures were also documented by other surveys in the study area. However, the exact nature of these tombs cannot be clarified. These include ShamAyl Site No. 109 which is characterized as a square structure (c. 4 × 4 m) with well-built interior walls (c. 1 m wide).[1574] The site dates extremely roughly between the 1st century BC and 7th

(Site Wadi Musa 25)." It is unclear whether the surveyors meant that the *loculi* were built *into* the natural cave – thus rock-cut – or whether they were *built* in the cave. As the latter seems unlikely, it can only be assumed that the *loculi* were rock-cut.

1566 Wadeson – Abudanh 2016, 85–86 in reference to Kurdi 1972.

1567 Wadeson – Abudanh 2016, 86–93. The PHTP also recorded other funerary structures that are not *hypogea*, but no further information is so far provided.

1568 Wadeson – Abudanh 2016, 87.

1569 Wadeson – Abudanh 2016, 91.

1570 Cf. Wadeson – Abudanh 2016, 92, 97.

1571 Wadeson – Abudanh 2016, 90.

1572 Wadeson – Abudanh 2016, 93–97 with further references.

1573 Although much more comprehensive work is necessary for assessing such potential parallels.

1574 MacDonald et al. 2016, 227. The surveyors also emphasize the good visibility from the presumed tomb to the watchtower of Khirbet al-ʿAbd East dating between the 4th and 7th century AD. Arguably, it could be suggested that ShamAyl Site No. 109 may be a watchtower, but, century AD. Also, ShamAyl Site No. 135 is a possible tomb with good visibility to the possible fortlet at Rujm al-Bitar.[1575] Surface pottery finds suggest a very coarse dating between the 1st century BC and the 7th century AD. Surface pottery from ShamAyl Site No. 148, however, indicates a slightly more precise dating from the 1st century AD onwards.[1576] This well-built structure measures c. 3 × 3 m with c. 0,5 m wide walls. The surveyors describe the structure to have been c. 1 m deep, which may suggest that the site is indeed a more monumental, underground tomb. Although hypothetical, these structures may be further *hypogea* as they seem to share similar features with the tombs documented by the PHTP. If this should be verified, it would underline the PHTP's observation that the evidenced *hypogea* are restricted to the Jabal Shara region.[1577]

At Umm Hilal, Abudanh Site No. 173 may be a different type of isolated funerary monument along the eastern high plateau.[1578] The site consists of two low, circular walls with a diameter of c. 1,5 m located c. 30 m apart from each other. Although both burials are looted, the long limestone slabs that once covered the apparent burials are still visible. No dateable surface material was recorded at the site. The site may represent yet another type of a more monumental underground tomb, presumably only for one individual as suggested by the narrow width of the circular chamber.

Cemeteries

The earliest recorded cemeteries in the Petraean hinterland can be dated to the 1st century BC (FIG. 314).[1579] The majority of these early cemeteries were discovered in the extended area of the FJHP where sandstone prevails. This explains the relatively high density of rock-cut pit graves and shaft tombs documented in the area.[1580] For example, a dense cluster of such funerary structures was recorded as FJHP Site No. Ext060 on a ridge at the foothills of Umm Barra immediately east-southeast of the 'Snake Monument.'[1581] Continuing along the ridge in east-western direction, another group of funerary structures was documented as FJHP Site No. Ext050. It consists of a small Nabataean façade tomb (?), a presumed shaft tomb as well as two pit graves which seem to be associated with a rock-cut *nephesh*. At the southeastern foothills of Umm Barra, c. 20 burials (earthen and rock-cut pit graves) were documented as FJHP Site No. Ext169. Another larger cemetery (FJHP Site No. Ext043A) was observed immediately south of the Snake Monument consisting mostly of earthen pit graves. Based on surface pottery, these burials date between the late 1st and early 2nd century AD. Consisting of a cluster of rock-cut and earthen pit graves, FJHP Site No. Ext043B was recorded in an area between the Snake Monument and FJHP Site No. Ext043A.

ShamAyl recorded three cemeteries in the Jabal Shara region: ShamAyl Site Nos. 15, 103 and 245. The surface material of these sites only offers an extremely rough dating between the 1st century BC and the 7th century AD.[1582] ShamAyl Site No. 15 is described only as "a series of graves." Situated north of Basta, ShamAyl Site No. 103 however, consists of several cairns with indications of internal graves.[1583] At al-Quleeb al-Garby (West), ShamAyl Site No. 245 is described as a possible cemetery as well. Only a series of wall lines and stones tentatively indicate the location of possible pit graves.

Two cemeteries were identified in Umm Sayhoun: WMWS 1998 Site No. Umm Sayhoun 5 and 6. The former consists of eight earthen pit graves where pottery dating to the 1st and 2nd centuries AD was revealed. WMWS Site No. Umm Sayhoun 6 is described as six earthen pit graves dating to the 1st century AD.[1584]

The recent explorations at Bir Madkhur have reexamined and excavated some burials of the cemeteries at the site. At the 'South Graves' area, the excavation results revealed a minimum of nine simple burials marked by ovoid stone rings or cairns. This area also included a larger burial cairn. The 'North Grave' area includes 60–75 burials marked by ovoid stone rings as well.[1585] Although the dating of the cemeteries remains

without giving any argument, the surveyors state that "[t]*he structure appears to have been a tomb rather than a watchtower*" (MacDonald et al. 2016, 227).

1575 MacDonald et al. 2016, 249. Surface pottery material at Rujm al-Bitar (ShamAyl Site No. 059) very roughly dates the site to the Iron Age, Nabataean and Byzantine periods.

1576 MacDonald et al. 2016, 261.

1577 Wadeson – Abudanh 2016, 97.

1578 Abudanh 2006, 494.

1579 There are seven of such early cemeteries in the study area.

1580 Kouki – Silvonen 2013b, 304–307. Presumably dating to the Nabataean period, cemeteries of simple pit graves are also known from Medain Salih (Sachet 2005, 27).

1581 Dalman already describes many funerary structures in this area (Dalman 1908, 215–217 referred to by Kouki – Silvonen 2013b, 305). Also note I. Sachet's excavations at the Snake monument: Sachet 2009.

1582 MacDonald et al. 2016, 140, 222, 354. Surface material at ShamAyl Site No. 15 dates no later than the 5th century AD.

1583 A small cemetery of presumably Nabataean cairns is also known at Jabal al-Khreimat west of Medain Salih (Sachet 2005, 27–28).

1584 ʾAmr – al-Momani 2001, 259.

1585 Perry 2007, 83.

FIG. 314 Possible burial cairns in the cemetery (?) of Khirbet as-Faysif.

problematic, the evidence suggests that the cemetery was used from the Bronze Age to the Byzantine periods.[1586] The 'North Grave' area contains later burials (3rd to 5th century AD and one possible Islamic burial), while the 'South Grave' area seems to correspond to the 'Classical period,' presumably meaning the Nabataean-Roman periods.[1587]

A small cemetery of several burial cairns was also documented immediately west of the route station of Khirbet as-Faysif in the Wadi Arabah.[1588]

At Sabra, Lindner identified a small cemetery of ten simple pit graves carved into smaller sandstone outcrops along the northeastern part of Jabal Mutheilya.[1589] The pottery dates exclusively to the Nabataean-Roman periods. Additionally, following the Wadi Sabra in northwestern direction, Lindner observed a conspicuous amount of Nabataean-Roman pottery in a sanded area in close vicinity to a modern Bedouin cemetery. This has led him to postulate that this area also marks the location of an ancient cemetery.[1590]

Abudanh Site No. 035 describes a cemetery of several multi-period earthen pit graves and small cairns at Wadi al-Jerba on the eastern high plateau.[1591]

Religious Structures

Nabataean religion was not structured by a pantheon of deities as the Graeco-Roman world. There is only a limited number of supreme deities, most notably Dushara, who, as "the one from the Shara mountains," is closely associated with the Jabal Shara and the immediate Petra region. The veneration of Dushara found widespread popularity and he was commemorated in major Nabataean religious structures and smaller cultic installations throughout the entire Nabataean realm.[1592] In addition

1586 Perry 2007, 88–89.
1587 Perry 2007, 86–87.
1588 Smith 2010, 37; Perry 2007, 81.
1589 Lindner – Zeitler 1997, 558–559; Lindner 1992b, 196.
1590 Lindner – Zeitler 1997, 558.
1591 Abudanh 2006, 415.
1592 For a brief, but recent insight into the religious life of the Nabataeans, see Tholbecq et al. 2019; 2017b; 2017c and 2016 as well as Wenning 2019; 2017 and 2016, 511–512 which further discuss the presented issues. For a more general overview of Nabataean religion, see Alpass 2013 and the seminal work of Healey 2001.

to Dushara, there is a small number of local supreme Nabataean deities, of which little is known.[1593] The veneration of local deities is dependent on the sanctity of a specific place, and emphasizes the locally variable and individual characteristics of Nabataean gods and goddesses.[1594] This is shown by the titles of Nabataean deities with clear associations to particular places: Al-Allat of Amnad, al-Uzza of Bostra, or al-Khubtah of Gaia.[1595] This reflects a pluralistic society characterized by tribal associations or local social groups following a variety of traditions and religious influences, which were nevertheless an integral part of the Nabataean realm. Particularly in Petra, it was possible to worship multiple supreme deities in order to accommodate the different creeds of the various groups of worshippers.[1596] Many sacral places are not necessarily associated with 'official' supreme Nabataean deities exclusively, but may reflect local, specific family or tribal beliefs and traditions.[1597] This pluralistic religious belief system was maintained throughout the Nabataean realm. The only attempt of any 'state'-driven unification of the diverse deities and beliefs in form of the veneration of the then dynastic god Dushara, can be observed by the alleged religious *renovatio* under the last Nabataean king Rabbel II shortly before the Roman annexation in 106 AD.[1598] It has been argued that, anticipating the inevitable incorporation into the Roman Empire, by introducing Dushara as *the* dynastic supreme deity of Nabataea and a general return to more traditional religious practices, Rabbel II attempted to overcome tribal particularisms and to unify the various tribes within the Nabataean realm by the common veneration of a god that was directly associated with the Nabataean royal dynasty in Petra. Whether or not one accepts this hypothesis, it is clear that Dushara developed into the dynastic deity of the Nabataean kings and was frequently referred to as "Dushara, god of our lord (the king)" or "God of Rabbel" and so forth.[1599] This raises the issue regarding Dushara's political significance. The close association between Dushara and the Nabataean kings has led Dijkstra to argue that the veneration of the deity, particularly in remote places within the Nabataean realm, may be considered a declaration of loyalty towards the Petraean kings.[1600] While this may or may not have been the case, the cult of Dushara was extremely popular in its own right, simply because Dushara appears to have been the common cultural-religious identifier of the various social groups within Nabataea.[1601] There are, however, no indications of a Nabataean religious 'policy' to achieve any form of imposed religious amalgamation.

As there are no historical sources on Nabataean cult practices, further information on the subject is derived by the analysis of the material remains of Nabataean religious structures.[1602] At Petra, the high mountainous outcrops of the city were often the setting of the typical 'high place' sanctuary for the worship of various deities (most notably Dushara).[1603] These structures not only demonstrate the religious significance of Petra itself, but also that the veneration of gods was particularly placed in an open-air 'natural setting.'[1604] Common features of these high places include an altar (*motab*), a water system for ritual practices as well as banqueting installations for the gathering of worshippers in form of rock-cut or built benches (*tri-* and/or *biclinia* or *stibadia*).[1605] Such banqueting installations for ritual *symposia* are important for understanding Nabataean *social* structures as well.

In addition to the ritual banqueting installations associated with Nabataean high places, there are numerous other *triclinia* and *stibadia* at Petra.[1606] The large number of banqueting installations in Petra alone attest to the popularity of such installations within the Nabataean architectural repertoire.[1607] Such installations can be found in domestic, religious or funerary contexts and must first be considered as

1593 The exceptional appearance of paired deities is "al-Uzza and the Lord of the Temple."
1594 Wenning 2016, 511 therefore refers to Nabataean religion as 'henotheism' or 'henolatrism.' Also see Alpass 2013, 7 and Wenning 2011, 280.
1595 Also see Wenning 2011, 293, 298.
1596 In addition to Petra, e.g. Bostra, Dhat Ras, Tell ash-Shuqafiyeh and Qasr Gheit (Wenning 2011, 280). Deities were not joined in form of a *synnaoi theoi* (at least before the Roman annexation of the Nabataean realm in 106 AD).
1597 Cf. e.g. Wenning 2019, 555–557.
1598 See e.g. Wenning 2017, 121 and 2011, 289–291 with further references; Hackl et al. 2003, 78–79, 105, 105. For more on Rabbel II's presumed religious and cultural *renovatio*, see also Schmid 2001, 400–402 with further references.
1599 Alpass 2015, 373–375 and 2013, 236; Healey 2001, 92–93.
1600 Dijkstra 1995, 34–80. Cf. also Alpass 2013, 236.
1601 Alpass 2013, 236–237: The aspect is seemingly confirmed by the sole invocation of Dushara by Nabataeans abroad as evidenced by the small Nabataean shrine in Pozzuoli as well as further dedications known from Miletus and Delos (cf. e.g. Alpass 2013, 236–237).
1602 Wenning 2019, 554 and 2011, 281.
1603 Alpass 2013, 68–73. Prominent examples of high place sanctuaries in Petra are e.g. the structures on the Jabal al-Khubtah or *the* 'High Place' on the Jabal al-Madhbah. However, cf. chapter 2 on the general difficulty in defining Nabataean sanctuaries.
1604 Tholbecq 2011a, 315 in reference to Starcky 1966, col. 1006; Schmid 2001, 377.
1605 Wenning 2007 and Wenning 1987; Schmid 2001, 377; Nehmé 1997a, 1035–1036.
1606 Nehmé 2013 and Nehmé 1997b.
1607 Tholbecq 2018 ; Durand 2017; Charloux et al. 2016, 13; Nehmé 2013 and Nehmé 1997b; Tarrier 1995; Brockes 1994.

gathering points for social groups that convened either for cultic purposes or with more secular intensions.[1608] The aspect of coming together for *convivium* purposes reflects a strong sense of community.[1609] Strabo emphasizes this as well when offering more detailed accounts on how Nabataean *symposia* proceeded:

> *They* [the Nabataeans] *eat their meals in companies consisting of thirteen persons. Each party is attended by two musicians. But the king gives many entertainments in great buildings. No one drinks more than eleven [appointed] cupfuls, from separate cups, each of gold.*[1610]

Before, Strabo mentions that the Nabataeans (including the king) possessed only few slaves and served each other. He describes the Nabataean king as a sort of *primus inter pares* who did not rule in an absolute monarchic fashion, but regularly had to account for his actions publicly.[1611] This passage then deals more with the community-based, socio-political organization of (elite) Nabataean society and nicely underlines the significance of communal feasts.[1612]

Moreover, numerous inscriptions in Petra attest to the distinct gatherings of the *marzeah*, a ritual or fraternal community or *thiasos* that met in honor of one or several deities and held communal *symposia* and ritual meals.[1613] These *marzeah* were not necessarily organized by families or tribes, but rather by social standing and professional associations. For example, Nabataean *marzeah* communities of freedmen, clerks, artisans and members of the military were identified in the 'district' of al-Madras in Petra.[1614] While only approx. one quarter of the over 100 banqueting installations in Petra can be set in a sepulchral context, the rest may possibly be associated with *marzeah*.[1615]

Furthermore, L. Nehmé has established that most of the nearly 1000 documented inscriptions are associated with *triclinia* or rock-cut chambers.[1616] Comprehensively evaluating personal names mentioned in these inscriptions, Nehmé demonstrated that the inscription groups reflected "[…] *a socially based organization of the space*."[1617] The majority of the inscriptions repeatedly mentions the same names, often followed by the same patronym.[1618] Most importantly, the names were inscribed in clusters within certain areas of the city. This suggests that

> […] *the persons who belong to social groups attached to either a sanctuary, a funerary assembly or a fraternal society never leave their signature in more than one specific area of Petra. When they do sign their name more than once, it is always in the same area.*[1619]

It was therefore possible to determine socially distinct 'districts' in Petra that correspond to the location of religious and/or funerary structures with banqueting installations (cf. FIG. 364).[1620] The apparent exclusive use of such distinct 'social spaces' by a designated group of people in Petra may be described by the Foucauldian term *heterotopiai* as well (cf. above). The term is not restricted to Nabataean funerary complexes alone, but applies to Nabataean *marzeah* and ritual banqueting installations as well.[1621] Ritual banqueting does not only reflect upon Nabataean religious or funerary practices, but is highly significant for understanding the *social* structure of Nabataean culture that is deeply rooted in family, clan or tribal traditions.

However, Nehmé's research on the inscriptions of the Petraean districts has shown few family-based relations and only uncertain professional associations among the *marzeah* groups. There are only few affiliations to funerary assemblies as well. The majority of the attested social groups can be linked by the common veneration of a specific deity.[1622] This has led to

1608 On a private domestic context, see Charloux et al. 2016, 13–14 referring to the unpublished doctoral thesis *Les triclinia nabatéens dans la perspective des installations de banquets du Proche-Orient* of D. Tarrier from 1988. For a critical appraisal, see Brockes 1994, 108–115. On a funerary context, see Wadeson 2011, 9–11 as well as Sachet 2010a and Sachet 2010b; Schmid 2009 and Brockes 1994, 43–75. On a cultic context, see Wenning 2007, 251 and 263 as well as Brockes 1994, 76–94. For general references, see Alpass 2013, 77–79, 232–233; Nehmé 2013 and Nehmé 1997a, 1032–1034; Dentzer 2010, 198–202 and Healey 2001, 165–168

1609 Dentzer 2010, 200.

1610 Str. 16, 4, 26. Translation after ed. H. C. Hamilton, W. Falconer 1903.

1611 Str. 16, 4, 26.

1612 Cf. also Dentzer 2010, 201 : *"Il déduit de ce geste le caractère démocratique de l'autorité royale chez les Nabatéens alors qu'il correspond à un rituel d'hospitalité de base qui s'impose au chef de famille ou de tribu arabe."* Cf. also Teixidor 1995, 114.

1613 Charloux et al. 2016, 14; Alpass 2013, 51, 65–66; Kropp 2013a, 304–306; Nehmé 2013; Wenning 2007, 257; Kühn 2005, 75; Healey 2001, 51, 166–167.

1614 Kühn 2005, 75; Healey 2001, 166; Nehmé 1997a, 1047.

1615 Healey 2001, 51.

1616 Nehmé 2013, 115–116, table 1. Further concentrations of inscriptions were also documented at sanctuaries and *nephesh*. Cf. also Tholbecq et al. 2019, 22 and 2016, 1061–1062.

1617 Nehmé 2013, 118.

1618 Nehmé 2013, 118–121. Particularly tables 2 and 3.

1619 Nehmé 2013, 122–123.

1620 Nehmé 2013, 117 lists nine presumed districts at "[…] *al-Madras, al-Hraymiyyah, the Theatre mount, an-Nmayr, Wādī aṣ-Ṣiyyagh, Wādī ad-Dayr, Dayr Plateau, M'ayṣrah West and Wādī al-Amṭī in the Bayḍā area.*"

1621 Cf. e.g. also Charloux et al. 2016, 29 who adopts the term.

1622 Nehmé 2013, 123–124.

the conclusion that the commemoration of particular deities was superimposed on family, clan or tribal affiliations; an argument that may find confirmation by the various sanctuaries in Petra visited by different social groups.[1623] Also, Wenning claims that the different groupings of *baetyli* within the numerous cultic niches of Petra does not represent any kind of formalized pantheon of Nabataean deities, but rather specific cultic particularities of the various Nabataean tribes.[1624] It thus seems that different Nabataean social groups regularly gathered to collectively worship a particular deity in Petra. At least in Petra, specific Nabataean religious structures may also be considered as *social* focus points with local and regional importance, possibly even serving as tribal pilgrimage destinations.[1625]

Concluding this brief overview of Nabataean religion, the following presents the different religious structures recorded in the Petraean hinterland.

Sanctuaries

The earliest sanctuary in Petra's immediate surroundings is the 'Obodas Chapel' dating as early as the late 2nd century BC.[1626]

By the 1st century BC nine further sanctuaries were added to the religious landscape of the Petraean hinterland including (arguably) Ras Hamra, Jabal Numayr, the Isis sanctuary in the Wadi Abu Olleqah on the way to Jabal Harun and the Isis sanctuary in the Wadi as-Siyyagh, the large hilltop sanctuary on Jabal Harun, FJHP Site No. Ext103, ad-Dahhune Slaysil (Ras Slaysil), en-Nu'eira as well as Jabal Qarun (FIG. 315). These structures were all in use throughout the 1st century AD. The sanctuary of Khirbet Braq presumably dates to the 1st/early 2nd century AD.

As evidenced by the Isis sanctuary in the Abu Olleqah and most importantly by the Obodas Chapel, most of the sanctuaries are abandoned by the early to mid-2nd century AD. Only little surface pottery of later periods (not later than the 3rd century AD) was documented at the sanctuaries of ad-Dahhune Slaysil, Jabal Qarun, and Ras Hamra. This suggests that they were only sporadically used and their religious functions may be questioned for later phases.[1627]

The formal spatial analysis of sanctuaries demonstrates that they cluster around Petra.[1628] The kernel density estimation shows high-density clusters south-southwest and north of Petra (FIG. 316).[1629] All sanctuaries lie along routes and concentrate mainly on elevated hilltops in and around the Petra valley at elevation values between 950 and 1050 m a. s. l. (FIG. 317, TABLE 36). There are no sanctuaries farther east than the Jabal Shara range and none westwards towards the Wadi Arabah. The Pearson correlation test shows only weak or very weak spatial correlations to most of the other archaeological categories (TABLE 37).[1630]

The Obodas Chapel

The Obodas Chapel is one of the most extensively explored rural sanctuaries in the Petraean hinterland.[1631] Since 2002, the French Archaeological Mission in Petra has intensively researched and excavated the sanctuary. It is situated only a few kilometers southeast of Petra in a mountainous massif and is accessible from the as-Sto'e plain southwards through the Wadi Numayr and then via a north-south running, rock-cut passageway. Alternatively, a c. one kilometer long path leads directly from the Jabal al-Madhbah in Petra's city center to the sanctuary.[1632] The name of the sanctuary is based on the dedicatory inscription (CIS II 354) of a statue of the deified Nabataean king Obodas dating to 20 AD in a partly rock-cut, partly

1623 Nehmé 2013, 124: *"Dūšarā the god of Madrasā (along with Obodas) in al-Madras, the god Obodas in an-Nmayr, the god of Boṣra in Qaṭṭār ad-Dayr, Zeus Hagios on Umm al-Biyārah, al-Kutbā in the Wādī aṣ-Ṣiyyagh, Isis in the Wādī Waqīt."* Also cf. Wenning 2007, 250: *"Neben den wenigen, uns geläufigen Namen von Gottheiten ist wahrscheinlich mit einer großen Zahl von Familien- und Schutzgottheiten der tribal strukturierten nabatäischen Gesellschaft zu rechnen."* Although the veneration of a common deity was a central factor in the composition of social groups, in some cases, religious structures are also directly linked to one particular family or tribe (e. g. the 'Obodas Chapel').

1624 Wenning 2007, 253.

1625 Dentzer 2010, 196: *"On peut imaginer, dans un pèlerinage de caractère officiel, le déplacement de représentations divines d'un groupe plus large, d'un clan ou d'une tribu ou encore ceux d'une ville ou d'un sanctuaire important."* See also Wenning 2007, 263.

1626 Tholbecq – Durand 2013, 212–220.

1627 The surface pottery from these sites was observed by the PHSP. Cf. also the presence of Late Roman pottery discovered at the Obodas Chapel, which the excavators associate with an insignificant use of the site as well.

1628 The analyses were conducted for the 1st century AD only, when all sanctuaries were in use.

1629 The standard distance of not even 3 km between sanctuaries is relatively low (see TABLE 35), thus the high degree of clustering. The low GIV is due to the generally low number of sanctuaries.

1630 However, there are also moderate correlations, e. g. between sanctuaries and funerary structures. There is also a strong spatial correlation to industrial/exploitation installations (cf. chapter 9).

1631 Cf. most recently: Tholbecq et al. 2019, 22–23 and 2016, 1062–1067.

1632 Tholbecq – Durand 2013, 205; Tholbecq 2011b, 31, 42–43; Tholbecq et al. 2008, 235; Tholbecq – Durand 2005, 299.

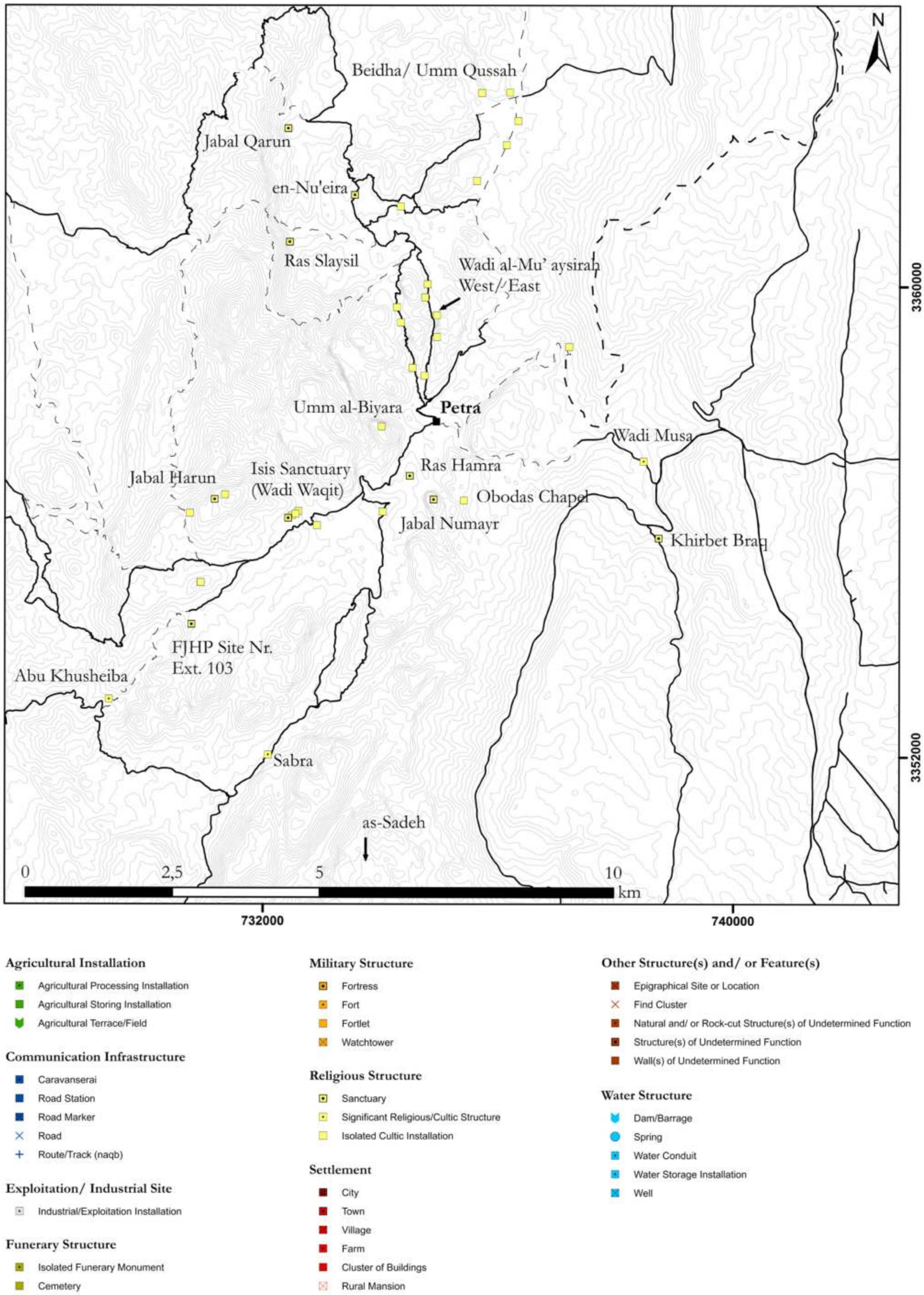


FIG. 315 Overview map of all religious structures in the Petraean hinterland.

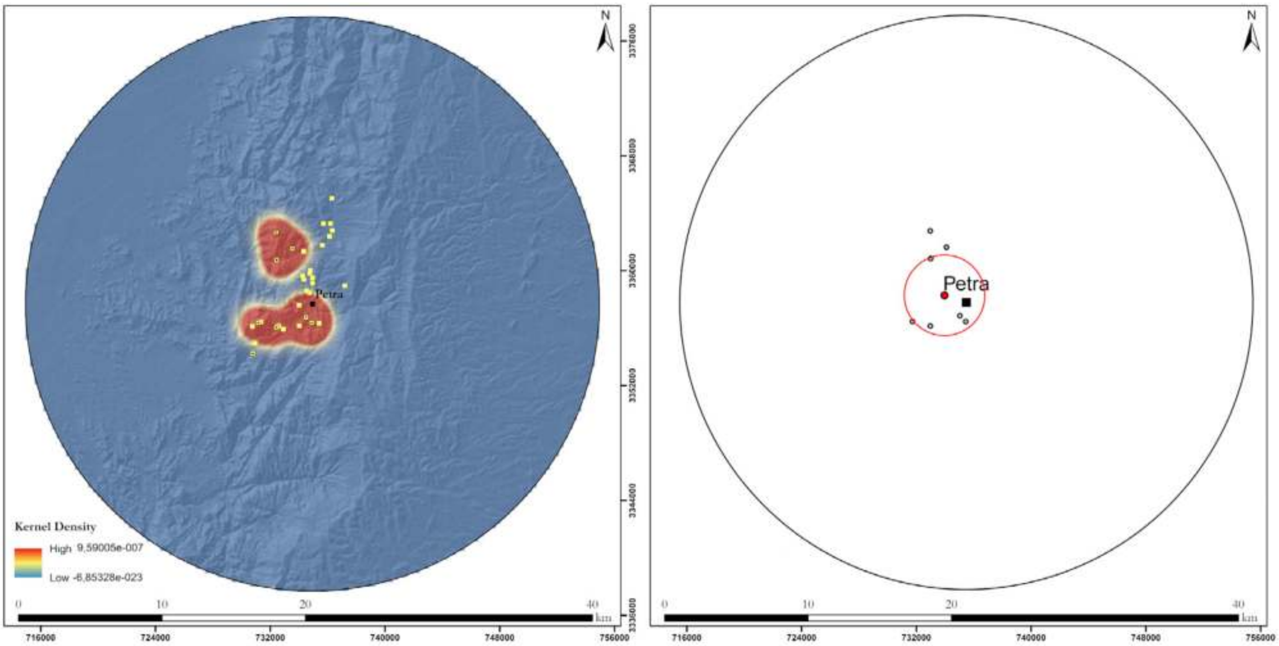


FIG. 316 Left: Kernel density map of 1st century AD sanctuaries in the Petraean hinterland. Right: Sanctuaries dating to the 1st century AD. The red point marks the mean center of the point pattern encircled by the standard distance between all sanctuaries.

built *triclinium*.[1633] The dating and identification of the statue as 'Obodas Theos' has been widely discussed.[1634] It was most likely displayed in a central niche cut in the rock-cut *triclicinium*.[1635] The inscription mentions the veneration of the god 'Dutara' and gives evidence that cultic activities were held at the sanctuary by two generations of one Nabataean family or tribe.[1636] It is postulated that, first, a certain Petamun was worshipped as the alleged great-grandfather of the last worshippers at the sanctuary. The cult of Dutara was then introduced by the grandfather of the sanctuary's last worshippers, Hutaysu, who may have been responsible for the construction of the open-air *triclinium*. The veneration of 'Obodas Theos' was presumably initiated by the last generation of worshippers.[1637] The sanctuary can therefore be securely interpreted as a Nabataean family or tribal religious structure.[1638]

It consists of several rock-cut and built installations used for cultic practices; most notably the large rock-cut *triclinium*. Another, large open-air *triclinium* was freely built (FIG. 318).[1639] The excavators distinguish three phases:[1640] The first phase could be documented under the open-air *triclinium* and was most likely a successive waste deposit of a small rock-cut room overlooking the central terrace of the sanctuary.[1641] Belonging to this first phase was probably either a (cultic) bench or a wide platform, which was subsequently overbuilt by the open-air *triclinium*.[1642] The excavators hypothesize that these earliest structures may represent a freestanding *motab* as known, for example, from the Nabataean temple at Khirbet edh-Dharih.[1643] Stratified ceramic evidence clearly indicates that the first phase of the Obodas Chapel can be dated as early as the late 2nd century BC.[1644] The second phase, dated towards the mid-1st century BC

1633 Tholbecq – Durand 2013, 205; Tholbecq 2011b, 31; Tholbecq – Durand 2005, 299–300. The statue was discovered by L. Nehmé during excavations in 2001, who published the findings as well as the inscription in Nehmé 2002. For more on the statue itself, see also Wenning 2015, 44–46.
1634 Most recently Roche 2014 and Nehmé 2012b, 184–190. For more on 'Obodas Theos,' cf. Wenning 2015 and Kropp 2013a, 307–309.
1635 Wenning 2015, 44; Tholbecq 2011b, 42; Nehmé 2002.
1636 Tholbecq – Durand 2013, 220; Tholbecq 2011b, 31. On Dutara, see Tholbecq 2011a, 316 with further references.
1637 Tholbecq 2011b, 43.
1638 Note that a fragmentary inscription was found during the 2002–2004 excavations of the Obodas Chapel supposedly mentioning a cultic *marzeah* of a female goddess (Nehmé 2012b, 203; Tholbecq – Durand 2005, 303). Cf. also Kropp 2013a, 306.
1639 Specifically on the *triclinia*, see recently Durand 2017, 86–90.
1640 Tholbecq – Durand 2013, 205; Tholbecq 2011b, 37.
1641 Tholbecq et al. 2008, 239.
1642 Tholbecq 2011b, 37.
1643 Tholbecq – Durand 2013, 206.
1644 Tholbecq – Durand 2013, 212–220: The ceramic dates are also corroborated by C^{14} dates. See also, Tholbecq et al. 2008, 235, 238.

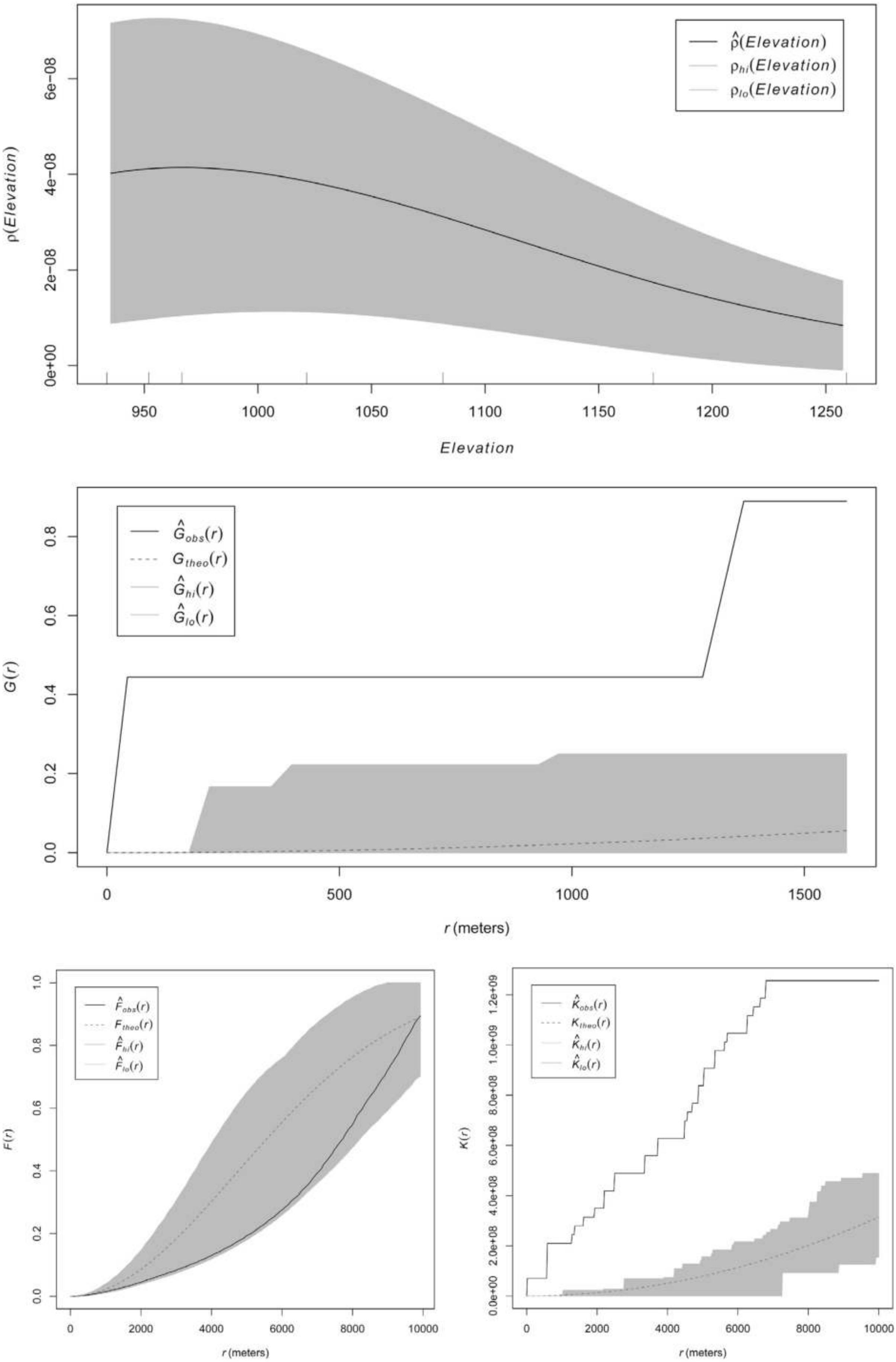


FIG. 317 Above: Intensity function of terrain elevation for 1st AD sanctuaries. Center: G-function of 1st century AD sanctuaries. Below: F- and K-function of 1st century AD sanctuaries.

FIG. 318 Plan of the 'Obodas Chapel' after Tholbecq – Durand 2013, 207, fig. 2.

based on stratified ceramic finds, marks the construction of the monumental open-air *triclinium* which is one of the largest freestanding examples known in a Nabataean context.[1645]

In the third and main phase of the sanctuary, the actual 'Chapel' was constructed during the first quarter of the 1st century AD, and with it a monumental forecourt giving access to the new *triclinium* of the deified Obodas.[1646] This forecourt marked the limits of the sanctuary as ten cultic niches were carved into the natural rock immediately north of the court's entrance.[1647] Three smaller rock-cut rooms may also belong to this phase. They were most likely used for cooking and preparing food and drink, as particularly the large quantity of coarse ware in 'room 4' suggests.[1648] At some point towards the end of the 1st century AD, the open-air *triclinium* fell out of use and was filled in. Possibly, the smaller rock-cut *triclinium* no. 9 was then carved to the east of the open-air structure (cf. FIG. 318).[1649]

The entire sanctuary was deliberately destroyed at some point around the mid-2nd century AD. From then on the complex was only in very sporadic use as indicated by few Late Roman as well as Ayyubid-Mamluk period ceramic finds.[1650]

With its dedicatory inscription, the over 130 Nabataean graffiti, the various banqueting installations, as well as the large quantity of stratified pottery evidence, the sanctuary serves as one of the best examples for a continuously used social and religious *heterotopia* for one to two generations of a Nabataean family or tribe from the Petra area.[1651]

Ras Hamra

Leaving the urban limits of Petra and heading south-southwest along the northern as-Sto'e route, a presumed sanctuary is situated along the southern skirts of Umm al-Biyara on the hilltop of Ras Hamra, south of the terraces of the 'South Ridge' (cf. FIG. 315).[1652] The flat hilltop is approx. 170 m long, with a maximal width of 75 m. The PHSP documented structural remains at its northern tip.[1653] Brünnow and von Domaszewski only mention the hilltop superficially and Dalman did not make out any building remains.[1654] Without publishing his observations, Lindner visited the site prior to the first scientific publication of the site authored by Hübner in 2002.[1655] In a recent contribution, Parcak and Tuttle further investigated Ras Hamra with the help of remote sensing technologies.[1656]

Set within a large rectangular-shaped and flattened platform measuring c. 56 × 49 m and enclosed by massive walls (almost 1 m in width) is a smaller structure measuring approx. 8,5 × 8,5 m (FIG. 319).[1657] Columns were once placed on these walls, thus framing the entire complex.[1658] Within the larger platform, a smaller platform (c. 46 × 44,5 m) or a presumed stylobate was constructed around the smaller structure and paved with flagstones. Parcak and Tuttle assume that the smaller platform may have been fronted by a row of columns that framed a monumental staircase facing the east.[1659] To the south, another flight of steps gave access to the smaller platform as well.[1660] Hübner mentions another smaller entrance to the north. He also claims to have observed

1645 Tholbecq – Durand 2013, 206–207; Tholbecq 2011b, 38, 40–41; Tholbecq et al. 2008, 238. Cf. also Charloux et al. 2016.
1646 Tholbecq – Durand 2013, 208; Tholbecq et al. 2008, 235; Tholbecq – Durand 2005, 301–303.
1647 Tholbecq 2011b, 33; Tholbecq et al. 2008, 235. Further structures presumably belonging to the third phase of the sanctuary, include a cultic *bothros* (or a possible *stibadium* (cf. Tholbecq 2018, 32), but convincingly identified otherwise in Tholbecq 2011b, 33–36). Also note the rock-cut *biclinium* of the complex (Tholbecq et al. 2008, 240; Tholbecq – Durand 2005, 303 and Nehmé 2002, 250–251). Tholbecq 2011b, 43 emphasizes the closed and private appearance of the sanctuary once the forecourt was built.
1648 Tholbecq – Durand 2013, 208; Tholbecq 2011b, 42. The ceramic dating indicates that this room was in continuous use during the entire 1st century AD until the mid-2nd century AD. Also see Tholbecq – Durand 2005, 301.
1649 Tholbecq – Durand 2013, 208; Tholbecq et al. 2008, 239.
1650 Tholbecq – Durand 2013, 211; Tholbecq 2011b, 43; Tholbecq et al. 2008, 235, 240, 241.
1651 Tholbecq 2011b, 31, 43–44; Tholbecq et al. 2008, 247.
1652 Parcak – Tuttle 2016, 39; Hübner 2002, 169. For a more detailed topographical map of the environs of Ras Hamra, see Hübner 2002, 170, Abb. 1.
1653 Hübner 2002, 169. PHSP Site No. 001-ST003 describes a single-rowed wall standing one course high, built of irregularly cut limestone slabs of various forms and sizes in a stretcher-header configuration. A small heap of stone tumble was also noticed immediately west of the wall. While no clear function can be determined, the site commands an excellent view over Petra.
1654 Dalman 1908, 226; Brünnow – von Domaszewski 1904, 135, 174, 285, 527, figs. 108, Taf. IX. Cf. also Hübner 2002, 169–171.
1655 Hübner 2002, 171.
1656 Parcak – Tuttle 2016.
1657 Hübner 2002, 171 also mentions the massive stone ashlars used for the construction of the walls, which measure up to 1,60 m in height. He also describes a cistern along the western slopes of the hill.
1658 Hübner 2002, 171 mentions re-used column drums with a diameter of 0,42–0,47 m along the northern side of the complex. These were also observed by the author in 2016. Hübner 2002, 173 argues that the column drums are too large to have adorned the outer platform walls or the smaller structure.
1659 Parcak – Tuttle 2016, 42.
1660 Parcak – Tuttle 2016, 42. Hübner hypothesizes that this once formed the main entrance.

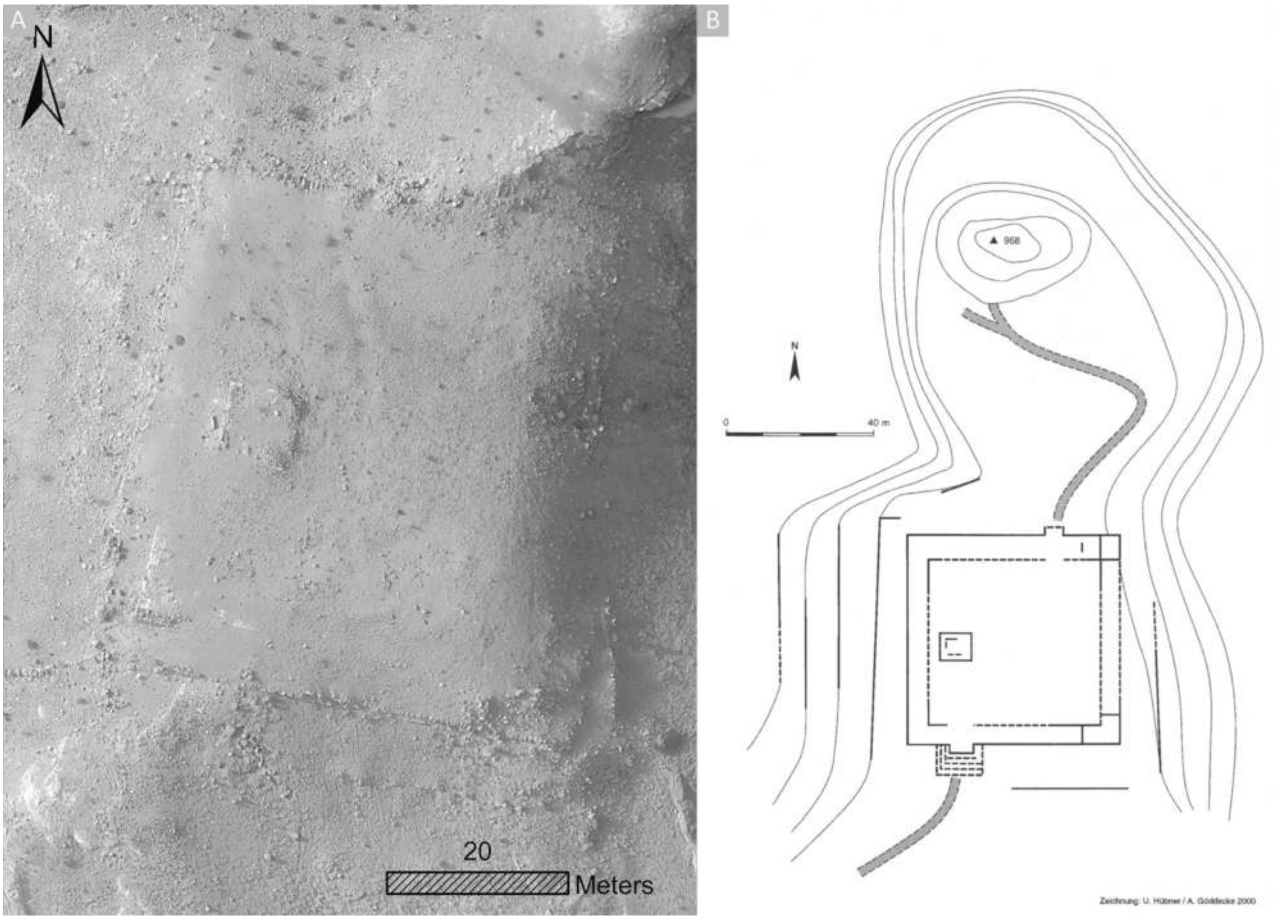


FIG. 319 A: Aerial View of the presumed sanctuary of Ras Hamra after Parcak – Tuttle 2016, 44, fig. 8. B: Schematic plan of the complex after Hübner 2002, 172, Abb. 2.

potential rooms in the northern and southern corners of the complex.[1661]

The smaller structure is built of max. 0,30 m wide single-course walls, suggesting that it was not of considerable height (FIG. 320).[1662] The entrance is still well-preserved and opens to the east.[1663] It may have been adorned by fronting columns of a smaller order than those of the presumed monumental stairway. Other building remains found at the site indicate a lavishly decorated structure.[1664]

Surface material tentatively dates the structure as early as the 2nd century BC and as late as the 6th century AD, although the majority of the surface pottery and the documented architectural features indicate that it may have been constructed during the 1st century AD.[1665] The re-used column drums incorporated into the northern outer wall of the complex suggest a later renovation or re-use of the complex.[1666] Although an exact date cannot be given, Hübner considers an alternative use of the structure in Roman times.[1667]

While the eastward orientation of the presumed monumental stairway does not face the city, the good visual relations between the structure of Ras Hamra with the sanctuary on Jabal Numayr, Umm al-Biyara,

1661 Hübner 2002, 171.
1662 Parcak – Tuttle 2016, 42; Hübner 2002, 171.
1663 Hübner 2002, 171.
1664 Parcak – Tuttle 2016, 42. If the proposition that the structure could have been adorned by columns is based on the re-used column drums discovered along the northern side of the complex, this may be questionable as argued by Hübner 2002, 173, who correctly states that no larger architectural features such as pediments or friezes were documented. Merely the presumed wall decoration of dolomite-breccia plates found in the vicinity of the smaller structure indicates a more representative decoration of the structure.
1665 Parcak – Tuttle 2016, 42. Surface pottery material includes Schmid's Dekorphasen 1–4 (see Schmid 2000), common wares as well as "[…] *black glazed, stamped wares, Terra Sigilatta, and Eastern Sigilatta* […]" (Parcak – Tuttle 2016, 42). Also, *tesserae* were found at the site, which are apparently only known in Petra from the Late Roman/Byzantine periods, thus giving the late date of the complex. However, Hübner 2002, 173 argues that the limited amount of such later finds does not necessarily indicate an intensive use of the complex in later periods.
1666 Hübner 2002, 171–173.
1667 Hübner 2002, 173.

FIG. 320 Smaller, interior structure of Ras Hamra. View to the southwest.

as well as Umm Barra, Ras Suleiman, the luxurious mansion of ez-Zantur IV, the al-Habis, as well the sanctuary on Jabal al-Madhbah (the 'High Place') in Petra were rightly pointed out.[1668] In combination with the overall architectural design, this led Parcak and Tuttle to the assumption that the structure at Ras Hamra may have served cultic purposes.[1669] Hypothesizing that excavations may reveal a further internal division with a potential 'Breitraumcella,' Hübner states that the smaller structure within the complex resembles a 'Langraumtempel,' thus interpreting the site as a religious structure as well.[1670] Wenning also tentatively lists Ras Hamra as a Nabataean sanctuary.[1671]

While only excavations can bring a more detailed understanding of the complex, the site's monumental structural remains suggest that an important Nabataean sanctuary lies still unearthed. This may be confirmed by the good visual relation between the site and other major religious structures in and around Petra. The prominent location on the hilltop of Ras Hamra clearly suggests that the site functioned as a central focus point in the landscape. This is further highlighted by its close vicinity to the northern as-Sto'e route, the only southern access route to Petra after Ras Suleiman. Any traveler accessing Petra from the south would have passed Ras Hamra. This would emphasize the site's strategic importance and perhaps explain the observed re-use of the complex in a later phase. The northern as-Sto'e route also corresponds to what is known as the *Darb an-Nabi Harun*, the presumed pilgrim route to Jabal Harun that passes the small Isis sanctuary in the Wadi Abu Olleqah. Ras Hamra's location along such a 'sacred' route may then further indicate that it was a Nabataean sanctuary. Based on its vicinity to a major access route to Petra and its overall monumentality, it may have had a more regional importance, similar to the sanctuary on Jabal Harun.

1668 Parcak – Tuttle 2016, 42; Hübner 2002, 169.
1669 Parcak – Tuttle 2016, 45–48.
1670 Hübner 2002, 171–173 bases the argument for a possible 'Breitraumcella' on architectural comparisons between contemporary temples in the Near East.
1671 Wenning 2007, 260.

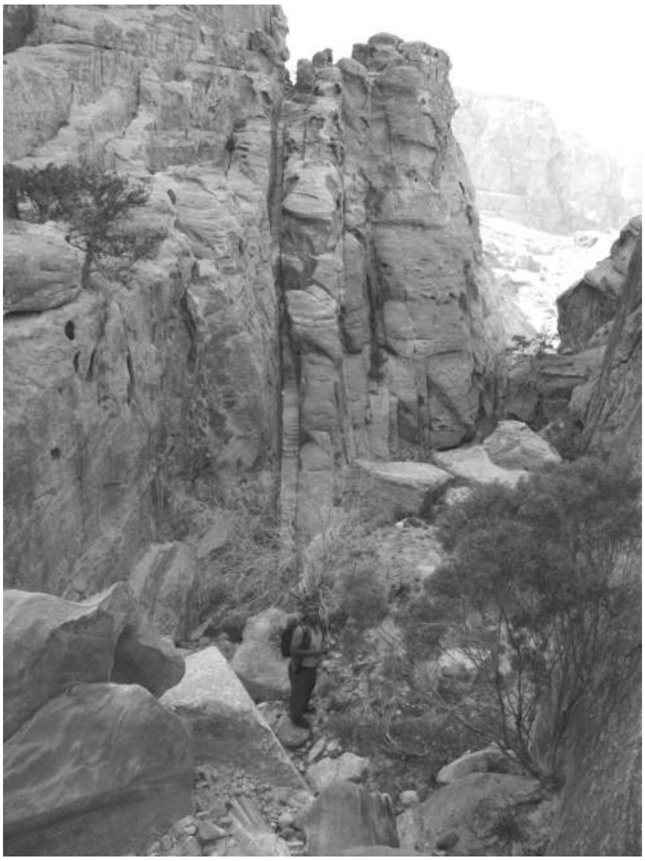


FIG. 321 Rock-cut access way to Jabal Numayr. View to the north.

Jabal Numayr

The 1117 m high mountain of Jabal Numayr dominates the southern outskirts of Petra and oversees the wide as-Sto'e and al-Farasha plains as well as the southern access routes to Petra. From its northern summit, other topographical markers such as Umm al-Biyara, Umm Barra, Ras Hamra and Jabal al-Madhbah, are clearly visible.[1672] Located on the mountain's peak, the sanctuary is approximately one kilometer away from the Obodas Chapel (in a geodesic line), northwest along the Wadi Numayr.

With the exception of the French Archaeological Mission in Petra, surprisingly little archaeological work has been carried out at this important site since its first scientific exploration by Dalman. Originally, Dalman identified two sanctuaries on the Numayr summit: The first at the southern end, characterized by a small rock-cut complex with a presumed *motab* and large cuboid rock, carved from the natural bedrock. The second sanctuary is on the northern edge of the plateau and consists of a monumental structure, identified as a possible temple.[1673] Recent studies on Nabataean religious structures accept Dalman's identification of the site as a Nabataean high place.[1674] To date, the most recent and detailed archaeological evaluation of Jabal Numayr was published by L. Tholbecq in 2011.[1675]

After entering Wadi Numayr, the summit can be accessed by a rock-cut staircase carved into the eastern flank of the mountain. This access way is accompanied by many rock-cut (cultic) niches, as well as other rock-cut installations.[1676] Before ascending the staircase, the first feature of Jabal Numayr is a conspicuously large architecturally framed rock-cut niche at the beginning of Wadi Numayr.[1677] This niche might have marked the sacred entrance of the wadi.[1678] Passing the niche, the actual ascent to the summit begins. It is characterized by a narrow (0,80–1 m wide) stairwell cut into a natural break of the bedrock (FIG. 321). As the stairwell winds up the mountain, one encounters two small cultic niches followed by a small natural terrace holding four additional niches. Proceeding along this terrace in a southern direction, the rock-cut stairwell continues reaching a larger terrace that stretches along the eastern side of the Jabal.[1679] Along this terrace, Tholbecq tentatively identified a rock-cut bench for banqueting and associated cultic niches.[1680] From there, the ascent continues in south-southeastern direction, passing yet another *baetylus* niche and reaching a figural relief carved into the vertical face of the bedrock, shortly before climbing the last flight of rock-cut stairs leading to Dalman's presumed first sanctuary. Although the relief is heavily eroded, the figure is clearly dressed in a short, pleated tunic (FIG. 322). Since the torso (as the legs) shows heavy signs of erosion, the sex of the figure cannot be determined for certain. A cuirass can nevertheless be made out under an additional cloak. The right arm is stretched above the head holding a wreath. The left arm rests on the figure's hips. Behind the waving cloak, there appears to be a long pole behind the left side of the figure. Dalman interprets this as a spear or a flagpole, thus associating the figure with the military.[1681] It was first assumed that the figure

1672 Tholbecq 2011b, 31; Tholbecq 2011a, 301.
1673 Wenning 1987, 253; Dalman 1908, 207–211.
1674 Cf. e.g. Tholbecq et al. 2019, 23–24 and Alpass 2013, 72. Also consider Ma'oz 2008 for a (somewhat problematic) discussion of the site.
1675 Tholbecq 2011a. However, cf. recently also Tholbecq et al. 2019, 23–24.
1676 These were partly described by Dalman and L. Nehmé. See Tholbecq 2011a for Nehmé's survey results.
1677 Tholbecq 2011a, 303–305.
1678 Tholbecq 2011a, 305.
1679 For a more detailed description of these niches, see Tholbecq 2011a, 305.
1680 Tholbecq 2011a, 305 suggesting that a rectangular cavity under one of these niches could have carried a *tabula,* which may have mentioned the venerated deity and/or the names of the worshippers. Tholbecq 2011a, 308 draws comparisons to niche D 607 in Petra (cf. Dalman 1908, 311, fig. 16.264).
1681 Dalman 1908, 208.

FIG. 322 A: Figural relief on the way to the summit of Jabal Numayr. B: Sketch by Dalman 1908, 208, Abb. 131. C: Figure of the façade of the Roman Soldier Tomb in the Wadi Farasa. Photo: A. Weiße.

resembles depictions on Nabataean coins holding a scepter topped with a trophy, similar to representations of Tyche.[1682] Tholbecq rejects this and instead draws convincing parallels to the 'soldier' depicted in the central niche of the façade of the Roman Solider Tomb in the Wadi Farasa, dating to the first century AD.[1683] Following Schmid's assertion that this figure may be interpreted as a possible iconography of the Nabataean kings (particularly Aretas IV as demonstrated by iconographic comparisons with coins), a similar assumption may also be claimed for the figure of Jabal Numayr.[1684]

Continuing further up the stairwell, one reaches a small natural terrace of c. 10 × 12 m. This is Dalman's first sanctuary of Jabal Numayr (FIG. 323).[1685] It consists of a rock-cut room, an elongated rock-cut 'bench-like' feature or niche for inserting mobile objects (most likely *baetyli*) as well as a slightly eroded square platform that can be identified as a *motab*.[1686] This small complex marks the beginning of the final flight of rock-cut stairs that lead to the southern part of Jabal Numayr's summit.

The summit can be structured into three parts:[1687] a rock-cut cuboid[1688] (still belonging to Dalman's first sanctuary) is situated in the south after reaching the top of the stairwell (FIG. 324). One then continues to the central plateau and the monumental structure at the northern tip of the summit.

To date, the central plateau shows no signs of structural development, but a high concentration of surface pottery was noticed to the north and east of the massif that dates between the late 1st century BC and 1st century AD.[1689] No post-1st century AD surface finds were documented. A series of rock-cut channels leads from the massif to a large cistern, which was originally covered.[1690]

The original access to the northern plateau of Jabal Numayr and Dalman's second sanctuary was most likely from the southeast as suggested by a rock-cut pathway running along the western edge of the moun-

1682 Tholbecq 2011a, 309–310 with further references.
1683 Tholbecq 2011a, 309.
1684 Schmid 2013b, 766.
1685 Tholbecq 2011a, 310; Dalman 1908, 208.
1686 A close look at FIG. 323 may lead to the assumption that a (highly eroded) two-lined inscription is written along the vertical surface above the bench-like niche. Tholbecq 2011a, 311 does not mention rock carvings or inscriptions on the niche, claiming that such observations are an *"illusion entretenue par la photographie"* and *"un négatif d'érosion."* Dalman does not mention any inscription either. However, L. Nehmé has confirmed the probable existence of an inscription (personal communication 18.07.2020). This is much appreciated. In order to read it however, a reexamination in the field is necessary.
1687 Tholbecq 2011a, 311.
1688 Such rock-cut cuboids are also known from urban Petra (e.g. in the Wadi Farasa and the Jabal al-Madhbah). It has been previously suggested that these rocks had some symbolic meaning. However, the possibility that such cuboids have no intentional meaning at all and may perhaps only be the result of quarrying activities is only rarely realized. This is convincingly argued for the cuboid on Jabal Numayr (Tholbecq 2011a, 311 in reference to Bessac 2007, 79–81).
1689 Tholbecq et al. 2019, 23 and 2011a, 314. This could also be confirmed by the PHSP.
1690 Tholbecq 2011a, 312.

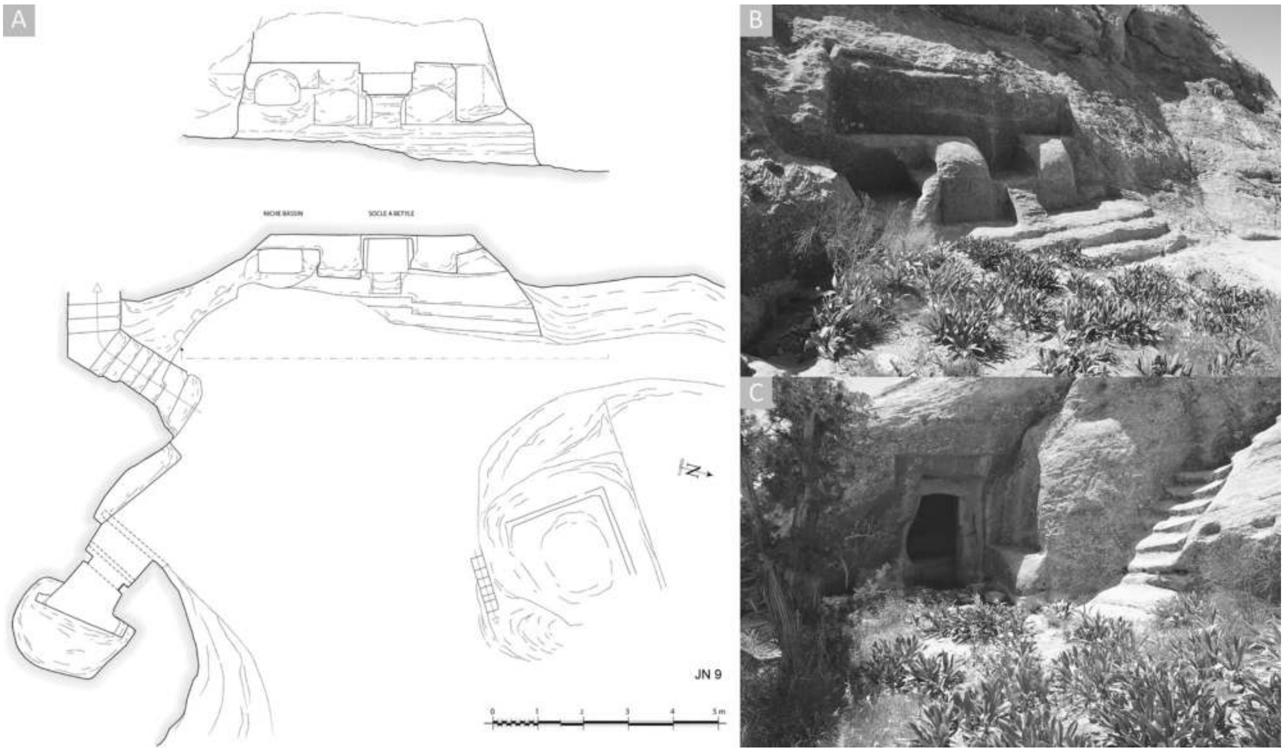


FIG. 323 Dalman's first sanctuary on the way to the summit of Jabal Numayr. A: Plan of the sanctuary with the presumed motab in the northeast of the complex after Tholbecq 2011a, 310, fig. 17. B: 'Bench-like' installation most likely for inserting mobile *baetyli*. C: Rock-cut room with benches.

tain. The presumed sanctuary consists of four substantial double-faced walls that form an almost square structure (11,20 × 12,80 m) (FIG. 325). It is placed centrally in a rock-cut courtyard (23 × 26 m) that was framed by walls built immediately along the Jabal's cliff.[1691] Despite recent looting activities, the thickness of the walls (0,70 m) as well as the considerable amount of substantial building material suggest that a monumental building once stood on Jabal Numayr.[1692] The southern and eastern side of the northern plateau may have served utilitarian purposes and rock-cut stairs lead to additional rooms along the northwestern flank of the mountain.[1693] Although only the rock-cut negatives of these presumed rooms are preserved, they may have been used for ritual banquets.[1694]

Based on the parallels to Nabataean high places in Petra, the structures of the northern plateau of Jabal Numayr can be identified as a Nabataean hilltop sanctuary.[1695] Typologically, Tholbecq draws comparisons with the pre-Roman structures of Khirbet et-Tannur, thus considering the main building of Jabal Numayr as a monumental *motab* or hybrid "*môtab*-chapelle"-like structure.[1696]

The discovery of two fragmentary floor slabs with carved representations of feet has led to discussions about the venerated deity (FIG. 326). Similar feet were carved into the bedrock near a rock-cut tomb south of Oboda (Avdat), accompanied by a short inscription stating "Live Obodas," as well as further depictions of feet carved into a rock-cut *motab* at Beidha that are also associated with the signature "Obodas." The finding of the engraved feet on Jabal Numayr has led Tholbecq to tentatively associate the sanctuary with the deified Nabataean king Obodas.[1697] However, he also refers to the common practice of depicting feet on votive tablets in Graeco-Roman temples in Egypt, which cannot be associated with the cult of a deified Nabataean king.[1698] Furthermore, Nehmé explicitly

1691 Tholbecq 2011a, 313; Dalman 1908, 210–211.
1692 Tholbecq 2011a, 313 mentions a small rock-cut stairwell leading from the courtyard into the structure from its northeastern corner. The main entrance may have been situated in the southwestern part of the southern wall. This would fit nicely with the accessing pathway.
1693 Tholbecq 2011a, 313–314.
1694 Tholbecq et al. 2019, 23 and 2011a, 314. In the case that these structures cannot be identified as possible banqueting installations, Tholbecq does not rule out the possibility that ritual meals could have been held anywhere within the courtyard or even on the central plateau of Jabal Numayr (Tholbecq 2011a, 317). The large quantity of pottery may be an indicator for this proposition.
1695 Cf. Tholbecq 2011a, 314–316.
1696 Tholbecq 2011a, 317.
1697 Tholbecq 2011a, 318. More on the feet discovered at Oboda, see Nehmé 2012b, 192–193. On the parallels from Beidha: Nehmé 1995, 431.
1698 Tholbecq 2011a, 318, n. 49.

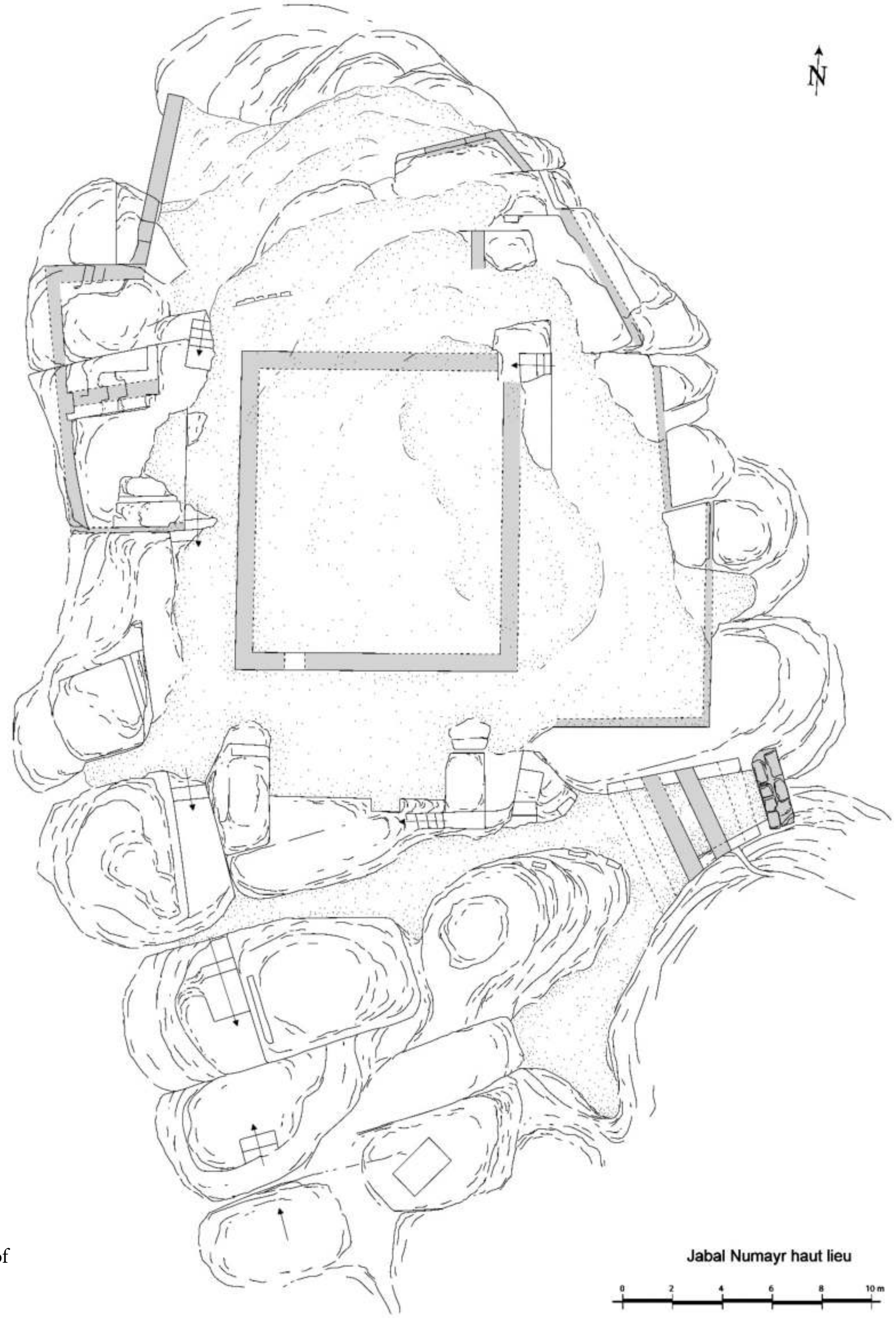


FIG. 324 Plan of the summit of Jabal Numayr after Tholbecq 2011a, 313, fig. 25.

mentions the frequent use of "Obodas" as personal names. The association with the name and the engraved feet at Oboda and Beidha may thus very well be coincidental.[1699] In his contribution to the study of 'Obodas Theos,' Wenning does not mention any association between the king and the depiction of feet.[1700] They are a common feature along processional pathways, in the immediate vicinity of religious structures as well as on high mountaintops in and around Petra. While they are associated with pilgrimages or processions, the epigraphical evidence cannot pinpoint them to a certain deity.[1701] Depictions of feet

1699 Nehmé 2012b, 197–198; Tholbecq 2011a, 318.
1700 Wenning 2015.
1701 Cf. e.g. Fiema 2016, 542; Kouki – Silvonen 2013b, 310–311, Eklund 2013, 284–285, 292; Miettunen 2008, 39 as well as Lindner 2003a, 147, 157, 184–186 and Lindner 1997b, 305.

FIG. 325 View of the main structure of the sanctuary on Jabal Numayr with Petra below in the background.

are common and not restricted to the veneration of the deified Obodas. Such is the case on Jabal Numayr as well. In addition to the engraved feet on the pavement slabs, there are further depictions of feet on the far northeastern edge of the mountain (FIG. 326). The presence of such representations of feet may perhaps be explained with a higher religious significance of the site, thus emphasizing the importance of Jabal Numayr as a more 'public' religious structure.[1702]

While the proximity between Jabal Numayr and the Obodas Chapel may point to a connection between the two sanctuaries, there is no evidence for this.[1703] In contrast, as the Obodas Chapel is a 'private,' family-based sanctuary and the high place on Jabal Numayr a more 'public' place of worship, Tholbecq hesitates to draw such a connection.[1704] It is possible that both sanctuaries were run by the same social group, but while the Obodas Chapel was an exclusive sanctuary, Jabal Numayr would have been a gathering place of a larger cultic community.[1705] Additionally, the obvious spatial distinction between two cultic structures on Jabal Numayr (Dalman's first and second sanctuary) may reflect restrictive access rights to the sanctuary as is known, for example, at Khirbet edh-Dharih and Khirbet et-Tannur.[1706] Arguably, only prominent groups of worshippers were allowed access

1702 Acknowledging that distinguishing between 'public' and 'private' religious structures is too simplistic, this study follows Tholbecq 2016, 1061, n. 18 who states that a 'public cult' *"is subordinate to an official religious branch of an entire community, which recognizes the ruling political authority."* A 'private cult' is not an *"individual, subjective, or singular"* cult. Instead, the term refers to a framework that *"regulates community or associative cults,"* but is not dependent on an official political entity with governing authority (e.g. a state, city etc.).

1703 Tholbecq et al. 2019, 24; 2016, 1068.

1704 For a distinction between 'public' and 'private,' see above.

1705 Tholbecq 2011a, 319.

1706 Tholbecq et al. 2019, 23. Cf. also Schmid 2013a, 254 for the comparison with Khirbet et-Tannur where a substantial wall offered only limited access to the temple. Cf. Kropp 2013a, 340–341 and Tholbecq 2011a, 319 on Khirbet edh-Dharih where multiple courtyards were destined for different groups of worshippers. Specifically on the late 2nd/early 3rd century AD *triclinia* at Khirbet et-Tannur and Dharih, see Durand 2017, 93–95.

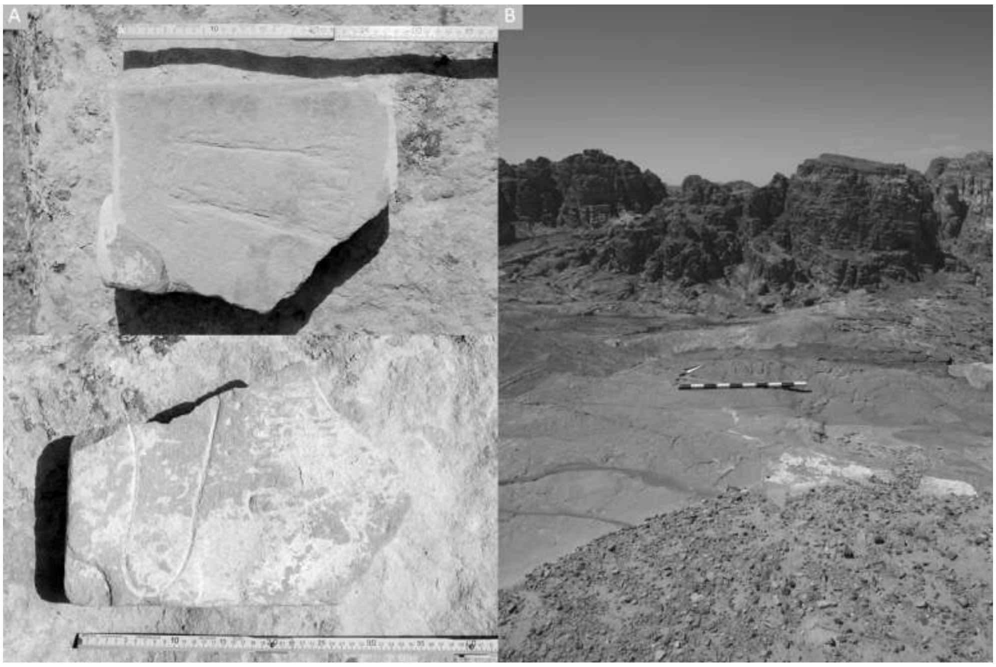


FIG. 326 A: Fragmentery pavement slabs with engraved feet found on Jabal Numayr. B: Feet carved into the northeastern edge of Jabal Numar with view to Umm al-Biyara.

to the main cultic structure on the summit of Jabal Numayr. Other groups, without such full-access rights, were not allowed to reach the summit and therefore full exposure to the venerated deity. Instead, they were perhaps confined to Dalman's first sanctuary below.[1707]

Although the archaeological evidence remains elusive, surface observations suggest that ritual banqueting installations were an integral part of the Jabal Numayr sanctuary. This highlights the site's social significance in addition to its religious importance. In combination with the proposed restricted access rights, this emphasizes the heterotopical nature of the sanctuary. Although the site was certainly not reserved for family or tribe members only (as the Obodas Chapel), cultic activities on Jabal Numayr, particularly on the summit, may have been restricted to a very specific social group.

The Isis Sanctuaries in the Wadi Abu Olleqah and Wadi as-Siyyagh

There are two small Isis sanctuaries in the immediate Petra area. One in the Wadi Abu Olleqah along the *Darb an-Nabi Harun* to Jabal Harun and the other in the Wadi as-Siyyagh.[1708]

The sanctuary in the Wadi Abu Olleqah is mostly known for its rock-carved relief of a seated female figure dressed in a draped cloak with an 'Isis-knot,' several cultic niches and over 200 Nabataean graffiti carved into the natural bedrock of both sides of the wadi bank (FIG. 327).[1709] Together with two Nabataean inscriptions specifically mentioning the veneration of Isis and referring to a *marzeah* in honor of her cult as well as the relief itself, the identification as an Isis sanctuary is clear.[1710] This cult was practiced on the southern side of the Wadi Abu Olleqah and faced a larger terrace once framed by a wall and columns. There is also a small, seasonal waterfall, ending in an elongated bedrock-basin at the Isis relief and one of the numerous inscriptions of this sanctuary mentions a physician, potentially indicating a ritual healing function of the basin.[1711]

Further east from this central part, there are more Nabataean graffiti and rock-carved footprints. These may be associated with ritual pilgrimages to the sanctuary. A small *biclinium* was also documented.[1712] According to Roche, surface pottery finds as well as the paleography of the inscriptions date the sanctuary between the late 1st century BC and the late 1st or early 2nd century AD. No later material was documented at

1707 If Tholbecq's identification of a rock-cut feature on the lower terraces of the mountain as a banqueting installation is correct, this would further indicate a structured hierarchy of cultic activities on Jabal Numayr.
1708 Fiema 2016, 542; Vaelske 2013; Roche 2012b, 55–57.
1709 The head, breast and hands were deliberately smashed; possibly in the context of the Christianization of the Petra area (Fiema 2016, 543). For a more stylistic discussion of the Isis figure, see Vaelske 2013, 355.
1710 Fiema 2016, 543; Roche 2013, 546–548 and 2012b, 57, 59–62 for a discussion on the inscriptions referring to Isis.
1711 Fiema 2016, 543; Roche 2013, 548–549 and 2012b, 64–65.
1712 Roche 2013, 549–552 and 2012b, 58, 65.

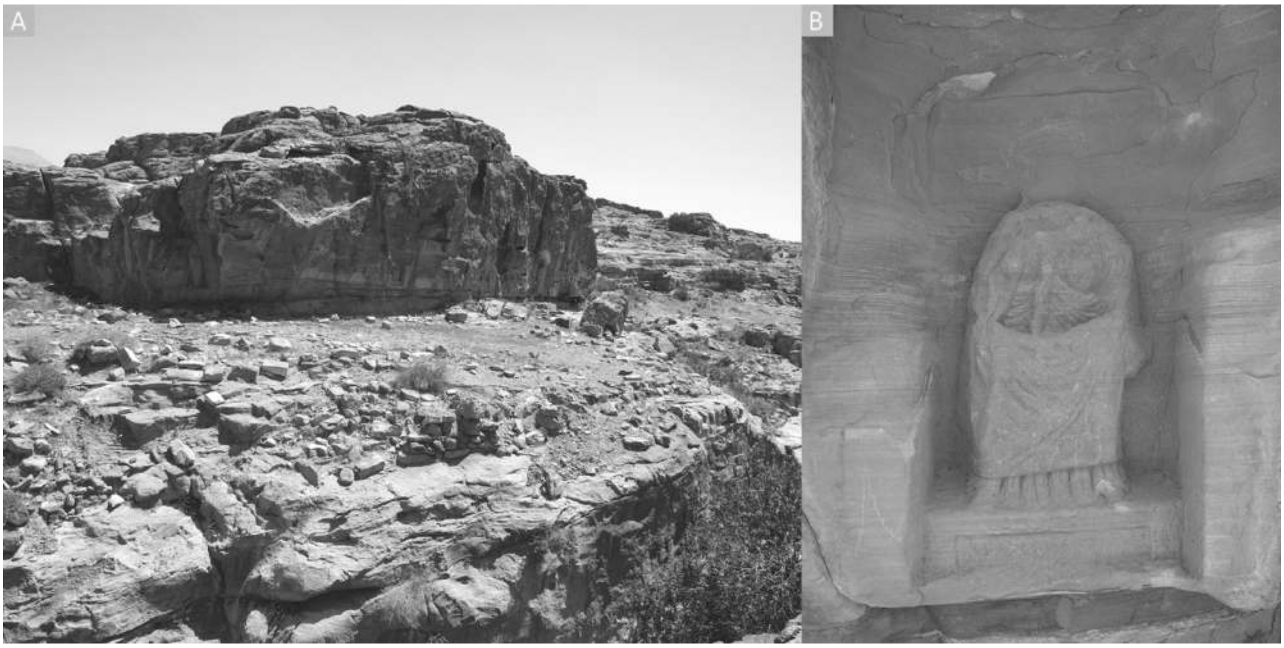


FIG. 327 A: View of the Isis sanctuary in the Wadi Abu Olleqah. View to the south. B: Detail of the Isis relief.

the site. It is therefore assumed that the sanctuary was abandoned by the early 2nd century AD.[1713]

In addition to the Isis sanctuary in the Wadi Abu Olleqah, Wenning and Merklein intensively re-surveyed another sanctuary dedicated to the goddess in Sadd al-Murayriyya, a small gorge immediately east of Wadi as-Siyyagh (FIG. 328).[1714] The now inaccessible sanctuary could only be reached with difficulty and involved some climbing due to the partly eroded rock-cut staircases giving access to the sanctuary.[1715] The site stretched over three rocky terraces or ledges cut into the natural bedrock of the Sadd al-Murayriyya gorge with some considerable height above the wadi ground. Passing along the first ledge, one passed several rock-cut rooms as well as Dalman's "First Sanctuary of Es-sījar" with several cultic niches and a "pillar-shaped idol."[1716] Continuing further up the ledge, an intermediary terrace was reached with rock-cut rooms, which Merklein and Wenning set into a domestic context. From there a larger plateau below the Isis sanctuary could be accessed by a flight of rock-cut stairways.[1717] On this plateau, along with a cultic niche with a *baetylus*, a single shaft tomb and an unfinished façade tomb was cut into the bedrock.[1718] The plateau was covered with Nabataean surface pottery (fine and coarse ware) dating from the mid-1st century BC to the end of the 1st century AD. There is no material evidence that would suggest a use of the sanctuary after the beginning of the 2nd century AD.[1719] The high amount of pottery indicates frequent cultic activities

1713 Roche 2012b, 58, 67–68. Roche hypothesizes that the observed vandalism of the Isis relief is a result of the alleged rivalry between Aretas IV and the minister Syllaios for the Nabataean crown. She claims that "[t]*he queen Huldu (Aretas' spouse) was probably of royal descent, according to her prominent place during the reign of Aretas, and she probably played a decisive role during the contest between Aretas and Syllaeus. She had close ties with the Isiac cult, which took on an official status at the time of Aretas, and this could explain the revenge of the supporters of Syllaios uopon the image and the name of the goddess*"(Roche 2012b, 68). Without any further archaeological or historical evidence, however, this seems historically circumstantial. Additional Nabataean graffiti mention Dushara as well and attest to his veneration in the Wadi Abu Olleqah. Paleographically, the Dushara graffiti supposedly also date between the 1st century BC and 2nd century AD (Roche 2012b, 68).

1714 Merklein – Wenning 2001, 421; Merklein – Wenning 1998; Donner 1995, 12–13. This Isis sanctuary is considered to be one of the earliest archaeological evidence for the introduction of the Isis cult in the Petra area (Vaelske 2013, 352).

1715 Merklein – Wenning 2001, 421–425; Merklein – Wenning 1998, 162–164. There are no coordinate information available for the site.

1716 Dalman 1908, 240–241, No. 389–391.

1717 Merklein – Wenning 2001, 423: *"The plateau is 7.5 m above the upper terrace, 15.40 m above the floor of Sadd al-Murayriyya and 28.5 m above the floor of Wadi as-Siyyagh."*

1718 Merklein – Wenning 1998, 163–164. On the significance of the tomb, see Merklein – Wenning 2001, 423: *"To find a tomb so close to the veneration place of Isis – and it seems that this closeness was intended – is not surprising, since Isis was a mighty deity connected with the netherworld and was already shown as a tutelary goddess in this context at the most famous tomb of Petra, Khaznat Fir ʾawn."*

1719 Merklein – Wenning 2001, 424 and Y. Gerber in Merklein – Wenning 2001, 427.

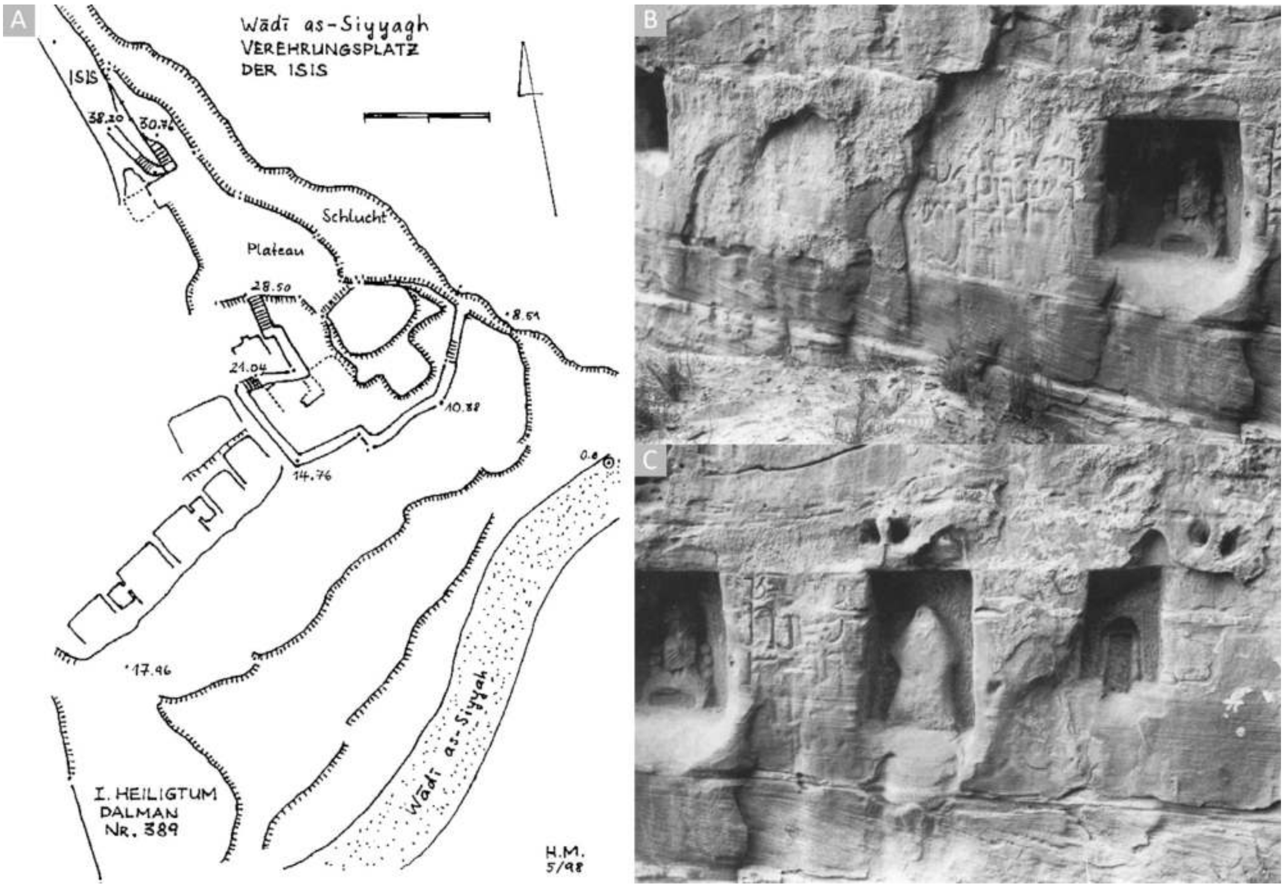


FIG. 328 A: Schematic plan of the Isis sanctuary in the Wadi as-Siyyagh after Merklein – Wenning 2001, 422, fig.1. A and B: Photographs of the sanctuary after Merklein – Wenning 1998, Tafel 7A and B.

associated with the Isis sanctuary above (and not with the tomb), most likely in form of a cultic *marzeah*. As there are no banqueting installations at the sanctuary itself, ritual activities may have took place on the plateau instead (possibly with simple mats).[1720] A last flight of rock-cut stairs led to the Isis relief and the Nabataean dedicatory inscription mentioning the goddess. It can be dated to 26/25 BC.[1721]

The Isis sanctuary is characterized by four niches. While the first niche is empty, the second shows the relief of the goddess in grieving pose. The third contains a highly eroded figure or idol.[1722] The fourth "[…] *combines a rectangular betyl in a negative image set into an arched niche in the greater rectangular niche.*"[1723] The inscription is carved on both sides of the niche with the draped Isis figure, which has no traits that are typical for Isis.[1724] The identification of the goddess is only based on the inscription, which also states that the sanctuary was built by three sons of an unknown individual.[1725] The inscription refers to an entire Nabataean family as the benefactor.[1726]

The sanctuary in the Wadi as-Siyyagh features a water basin as well. This further points to the mystery cult of Isis.[1727] Only a few meters north of the water basin, there is a group of Nabataean graffiti and stone mason marks carved into the bedrock. As these are typical at quarrying sites, Merklein and Wenning associate them with stone masons who thanked the goddess for being allowed to cut the sacred rock.[1728]

Despite the absence of banqueting installations, the Isis sanctuary in the Wadi as-Siyyagh is a perfect parallel to the Obodas Chapel as a private family,

1720 Cf. Hackl et al. 2003, 257; Merklein – Wenning 2001, 424; Merklein – Wenning 1998, 164. No sherds were documented at the Isis relief itself.
1721 Merklein – Wenning 2001, 425. The dating is based on the listing of the king Obodas. Cf. also Hackl et al. 2003, 256–257 and Merklein – Wenning 1998, 166–169.
1722 Merklein – Wenning 1998, 173–175.
1723 Merklein – Wenning 2001, 425. See also Hackl et al. 2003, 256.
1724 Hackl et al. 2003, 256; Merklein – Wenning 2001, 425; Merklein – Wenning 1998, 166.
1725 Merklein – Wenning 2001, 426; Merklein – Wenning 1998, 169–173.
1726 The inscription of the Isis sanctuary in the Wadi Abu Olleqah only mentions one individual (Roche 2012b, 63).
1727 Hackl et al. 2003, 257; Merklein – Wenning 2001, 426; Merklein – Wenning 1998, 174–175.
1728 Merklein – Wenning 2001, 426; Merklein – Wenning 1998, 175–176.

clan or tribal sanctuary. The difficult access of the sanctuary highlights the social seclusion of the site. While the Isis sanctuary in the Wadi Abu Olleqah is more easily accessible along the route to Jabal Harun, the reference to a *marzeah* as well as the banqueting installations does not suggest a public nature of the sanctuary. This rather points to a more restricted use of the site by a specific social group most likely affiliated with the entourage of the inscribed Nabataean benefactor of the sanctuary. Both sites may therefore be considered as Nabataean *heterotopiai*.

Jabal Harun

Together with the Obodas Chapel, Jabal Harun is the most extensively researched religious structure outside Petra. From 1997 to 2013, the FJHP excavated the Byzantine monastery of the Prophet Aaron on the plateau of the highest mountaintop in the Petra area. The project also conducted an intensive survey of the immediate surroundings.[1729] Although the religious significance of Jabal Harun is mostly associated with the Christian monastery and the Islamic *weli* (14th century AD) commemorating Aaron (Harun), the mountain was originally occupied by a major Nabataean sanctuary dating to the 1st centuries BC and AD (FIG. 329).[1730]

The 'Western Building' is considered to be part of a Nabataean sacral complex. Its precise nature cannot be determined for certain as the Byzantine occupation of the site overbuilt or demolished previous structures.[1731] However, the undoubted religious significance of Jabal Harun in the Byzantine and Islamic periods suggests that previous structures were of cultic nature as well.[1732] The Western Building has a completely different orientation than the later Byzantine monastery and was built in front of a large natural cavity that probably served as a cistern (FIG. 330).[1733] The dating of the Nabataean structures is based on the overall architecture and construction technique as well as 1st and 2nd century AD pottery finds.[1734] Rooms 25 and 26 of the Western Building (FIG. 331) may have been a Nabataean shrine and architectural fragments as well as other decorative elements suggest that the structure was of monumental design in Graeco-Roman style, thus

> […] *a conscious and intentional hybrid, which presumably would generate more legitimacy and find more acceptance in the Hellenistic-Roman world than the customary Nabataean mountaintop sanctuary.*[1735]

In a later (still Nabataean) phase, room 27 was added to the Western Building. It was spanned by arches and equipped with three benches, suggesting a *triclinium*.[1736] The large arched hall of room 28 was constructed simultaneously with room 27 and could have served for ritual practices as well.[1737] A series of additional rooms were built in the southern part of the building. Their function is difficult to determine. The archaeological record does not permit a clear reconstruction of the Nabataean phase.[1738] All Nabataean structures were en-

1729 See the publication series of the project: Fiema et al. 2016; Kouki – Lavento 2013 and Fiema – Frösén 2008. Also acknowledge M. Lindner's contributions in Lindner 2003a, 177–204.

1730 Fiema 2012b, 27. In fact, it has been proposed that the mountain was the main rural sanctuary of Petra in Nabataean times (Fiema 2016, 540 and 2012b, 28–30 in reference to Robinson 1908 and Crawford 1930, 296). Other high places were oriented towards the mountain (Fiema 2016, 540 and n. 15 in reference to Ma'oz 2008).

1731 For a more detailed archaeological discussion of the Western Building, see Lahelma et al. 2016. Also cf. Fiema 2016, 540: "[…] *facing the lack of definitive proof, such as inscriptions, a variety of possible functions for the pre-Byzantine site at Jabal Hārūn had to be considered. Initially, a military outpost would make sense in this place as the visibility factor is excellent, allowing for covering the approach to Petra from the Wadi ʾAraba. Another possibility is a suburban villa, perhaps the seat of an agricultural estate, judging from the presence of runoff cultivation farming installations all around the mountain. Neither of these possibilities, however, appear plausible. The massiveness of the Western Building is unparalleled and incompatible with a domestic function. On the other hand, the evidence of clear architectural decoration and further embellishment (architectural blocks, stucco) do not rest well with an assumed military function and would instead apply to a structure of outstanding importance and appearance, such as a sacral building in cultic use.*" See also Schmid 2016, 67 and Fiema 2012b, 30.

1732 Fiema 2016, 540.

1733 Fiema 2016, 541; Schmid 2016, 67 and Fiema 2012b, 30.

1734 Fiema 2016, 540; Schmid 2016, 67 and Fiema 2012b, 30.

1735 Fiema 2016, 541–542 and 2012b, 30. A possible Nabataean shrine may have been located on the mountain's summit, thus being a typical Nabataean 'high place.' However, this cannot be verified as it would lie underneath the Islamic *weli* (cf. Fiema 2016, 540–541). It is plausible that the presumed shrine and the structures of the Western Building were contemporary.

1736 Fiema 2016, 541 and Fiema 2012b, 30.

1737 Fiema 2016, 541: The fact that room 28 is larger than room 27 may lead to the suggestion that it once served for hosting larger gatherings and thus reacting to a potential increase in pilgrim traffic.

1738 Fiema 2016, 541 nevertheless hypothesizes: *"Possibly a combined structure, i. e., Rooms 25 and 26 being during the Nabataean phases an one, undivided space, may have been an elevated, open-air sanctuary, accessible by staircase and with a Semitic motab, i. e., a platform- or podium-like installation on top of which were located betyls or other cultic items or installations. The motab itself could have been free-standing in the southeastern corner of the combined space. Alternatively, if it abutted Walls 2K and 2J, the entire space of later Room 26 might have been a motab."* For a more extensive discussion of the Western Building on Jabal Harun from the perspective of Nabataean sacral architecture, see Schmid 2016.

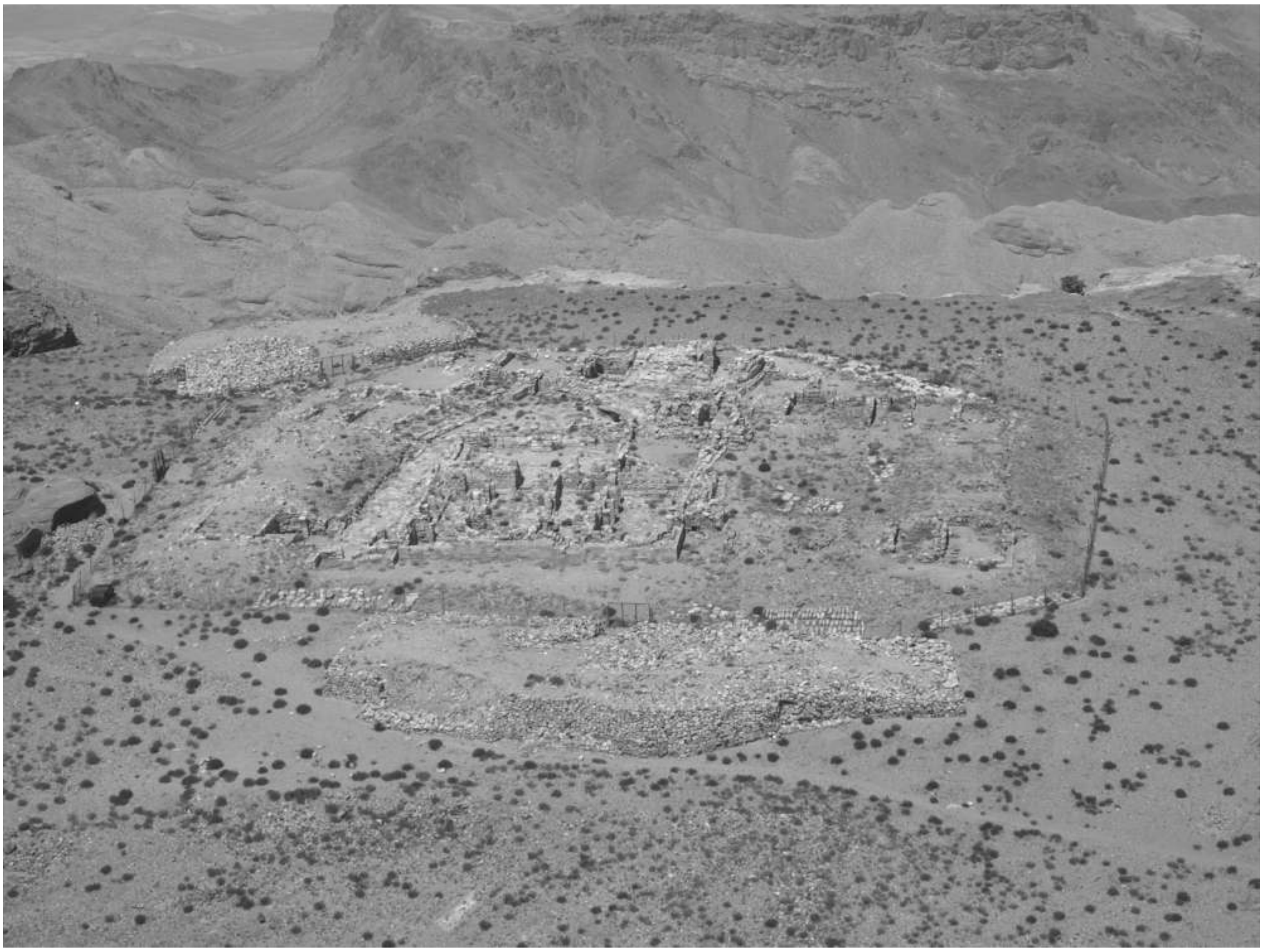


FIG. 329 View of the Byzantine monastery on Jabal Harun.

closed by a square *temenos* with the above-mentioned natural cavity in its center. It may have been adorned with columns.[1739] In a final, pre-Byzantine phase (early 2nd century AD until the earthquake in 363 AD) rooms 30 and 33/34 were constructed. Room 33/34 could have hosted further gatherings or, alternatively, served for storing agricultural products since the room was previously used for producing flour.[1740] Additional traces of Nabataean activities on Jabal Harun can be found along the entire plateau.[1741]

Although there are no positive indications on the deity that was venerated on Jabal Harun in Nabataean times, the excavators assume that it was a female deity linked with fertility and agriculture, possibly Isis. [1742] The natural cavity or fissure in the bedrock, situated centrally within the Western Building, seems to have been of major ritual importance, particularly when considering it as a sacred spring for potential ritual healing.[1743] The significance of water at the Isis sanctuaries in the Wadi Abu Olleqah and Wadi as-Siyyagh may serve as a further argument for considering Isis as the main goddess venerated on Jabal Harun.[1744] The modern ritual procession of *Amm al-gheth* in prayer to the Prophet Harun for more rain, indicating an

1739 Fiema 2016, 541. This would explain the (partially re-used) Nabataean capitals documented by the FJHP. See also Fiema 2012b, 31. However, cf. Schmid 2016, 68 for another proposition of placing the columns.

1740 Fiema 2016, 541, 543.

1741 For example, at the foot of the mountain's summit there is a huge cistern, most likely of Nabataean origin. A cultic *baetylus* niche is directly associated with the cistern as well as a semi-circular enclosure. For more Nabatean structures on Jabal Harun, see Fiema 2016, 539–540 and 2012b, 31.

1742 Fiema 2016, 542 and 2012b, 31, n. 8. See Wenning 2016, 519–524 for a more detailed discussion on the extensive popularity of Isis in Petra both as a private as well as an official (perhaps even royal) cult. Cf. also Schwentzel 2014. Assuming that Isis was truly worshipped at the sanctuary (or at least a female deity), Schmid 2016, 69 notes that Jabal Harun could have mirrored the Jabal Shara range – the seat of Dushara, who overlooked the northern and eastern stretches of Petra and its hinterland, while Isis potentially reigned over the south(west).

1743 Fiema 2016, 542.

1744 Fiema 2016, 543; Roche 2012b, 64–65. For further examples from the Near East and Egypt of sacral complexes with 'holy lakes' and basins, see Schmid 2016, 67 in reference to Lembke 2004 and Wild 1981.

FIG. 330 View of parts of the 'Western Building' of Jabal Harun with the natural cavity in the bedrock.

agricultural association with the prophet, may even be regarded as a cultic continuity of the veneration of Isis in the form of the Prophet Harun.[1745] However, Tholbecq warns that the association of Isis with the Nabataean sanctuary on Jabal Harun is based on inconclusive argumentative grounds and that it should not be taken for granted.[1746]

Furthermore, the excavators claim that the Nabataean sanctuary was in continuous use until the earthquake in 363 AD and that there is evidence of small-scale occupation after the quake.[1747] While there are no detailed accounts on the cultic continuity from the Nabataean sanctuary to the Christian veneration of Aaron, the excavators nevertheless postulate that previous Nabataean religious traditions were maintained to a certain extent until Late Antiquity.[1748] This assumed continuity of the Nabataean sanctuary throughout the Roman periods was critically reviewed by Tholbecq who notes that the dating of the Nabataean phases is based exclusively on a statistical assessment of the datable ceramic material found in secondary contexts and that stratified (later) 2nd and 3rd century AD material was absent from the archaeological record. The little Late Roman (4th century AD) material consisted mainly of a few glass fragments and derived from later contexts.[1749]

These are two significantly different interpretations which have an important impact on the as-

1745 Fiema 2016, 542. For more ritual processions to Jabal Harun, see Miettunen 2008, 42–43.

1746 Tholbecq et al. 2019, 24 and 2016, 1069. Most importantly, however, cf. his review of the second Jabal Harun volume: Tholbecq 2017c, 693–694.

1747 Although remaining mainly unused until the construction of the Byzantine monastery in the late 5th century AD (Fiema 2012b, 31).

1748 Cf. Fiema 2016, 545–565 and 2012b, 31–34.

1749 Tholbecq 2017c, 694 states: While the majority (63 %) of the fine ware finds of the main phase of the Nabataean sanctuary (phase II) belonged to Schmid's 3b phase (70–100 AD), the latest ceramic finds of this phase date only to the first quarter of the 2nd century AD (Lahelma et al. 2016, 30–31); in addition to a "[…] *mammalian bone radiocarbon-dated to 1865 ± 35 BP, Hela-1061, A.D. 150 ± 70 cal, collected from the foundations (E.26c) of the Phase VI church*" (Lahelma et al. 2016, 34). Only one Roman Imperial coin dating to 274/75 AD was discovered in a layer of late debris (latest phase of occupation). None of the latter two finds were in their original context.

1750 Fiema 2016, 540.

FIG. 331 Plan of Phase III of the monastic complex on Jabal Harun showing the original Nabataean sanctuary after Fiema et al. 2016, 591.

FIG. 332 A: View of the small sanctuary of FJHP Site No. Ext103. B: Detail of the group of three *baetyli* on the right-hand side of the small alcove. After Kouki et al. 2013b, 29–30, figs. 86 and 87.

sessment of the religious landscape of the Petra area in the Roman period (cf. chapter 9). If one accepts the excavator's claim for continuity, this stands in stark contrast to other religious structures in the Petraean hinterland, seemingly abandoned by the early to mid-2nd century AD. If so, this could only be explained by the regional importance of Jabal Harun in Nabataean times, which seems further supported by the fact that the FJHP documented an extensive system of agricultural terraces, barrages/dams as well as other agricultural installations in the immediate surroundings of Jabal Harun.[1750] The FJHP postulates that this runoff cultivation system was centrally managed and administered by one single estate – possibly the religious authorities on Jabal Harun.[1751] Jabal Harun's regional importance as a possible pilgrim center furthermore suggests a strong public nature of the sanctuary, similar to Ras Hamra (cf. above). Both sanctuaries are more monumental than most of the other sanctuaries in Petra's hinterland, both are situated along important access routes to Petra and both appear to be associated with a larger system of agricultural installations.

However, if one accepts Tholbecq's doubts that Isis was venerated at Jabal Harun and the assertion that the sanctuary was most likely abandoned by the 2nd century AD, this falls in line with observations made at other rural sanctuaries and cultic installations that were seemingly abandoned by the early to mid-2nd century AD as well.

FJHP Site No. Ext103

Not far from Jabal Harun, another small sanctuary may be located along a ridge between Jabal al-Farasha and Tulul Mutheilya towards the western end of Wadi 'Iyal 'Id, immediately before the western descent towards the Wadi Arabah (cf. FIG. 315).[1752] The site is characterized by three small sandstone outcrops (FIG. 332). A small doorway-like alcove was cut in the central outcrop. Both sides of this alcove show a small group of three rock-cut *baetyli*. Below the right-hand group there also seems to be a small *motab* carved into the bedrock. Opposite of this alcove, the FJHP noticed a tumble of building blocks suggesting that a built structure was originally part of this small complex. While it is difficult to determine the function of this structure, 1st century BC surface pottery and typical Nabataean diagonal chisel marks observed on the ashlars may indicate that FJHP Site No. Ext103 was a small, private Nabataean shrine or sanctuary.

The Sanctuary of ad-Dahhune Slaysil (Ras Slaysil)

Being the first to describe the extensive site of Ras Slaysil, Musil claims that its sanctuary served as a "subsidiary shrine" to Jabal Harun due to the good intervisibility of the sites.[1753] Located on the far western cliff of the volcanic al-Somrah and overlooking the larger settlement of Ras Slaysil to the east as well as the steep descent of Naqb Slaysil towards the Wadi

1751 Fiema 2012b, 31. On the agricultural installations in the Jabal Harun area, see Kouki 2013b; Kouki et al. 2013a; Lavento et al. 2013b.

1752 Kouki et al. 2013b, 29–30.

1753 Lindner – Gunsam 1995b, 267; Musil 1907, 333.

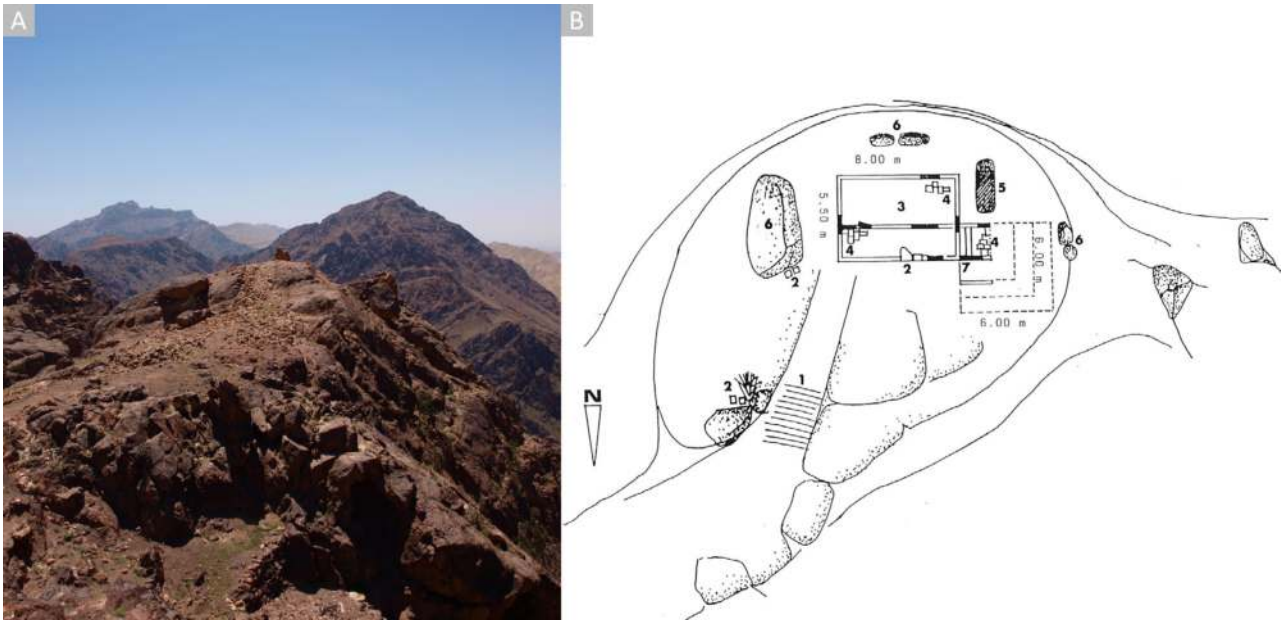


FIG. 333 A: The small sanctuary of ad-Dahhune Slaysil (Ras Slaysil) on the volcanic al-Somra cliff. B: Preliminary plan of the site after Lindner 2003a, 171, Abb. 13.

Arabah, Kirkbride mentions that *ad-Dahhune Slaysil* was paved. She also describes a conspicuous amount of building collapse (FIG. 333).[1754] M. Lindner later re-investigated the site in the late 1980s and documented a 8 × 5,5 m rectangular structure constructed of well-worked ashlars.[1755] It was built on the flattened bedrock surface of the hilltop and was accessible via a well-built flight of stairs (c. 3.5 m wide and 24 m long). These are now heavily disturbed and hardly visible.[1756] To the north, the structure is flanked by a large 2 m-high freestanding quartz stone, which Lindner describes as a "millstone."[1757] He also recorded well-worked architectural elements and marble fragments, thus interpreting the structure as a sanctuary.[1758] Wenning and Nehmé agree with this interpretation.[1759] The more recent *Brown University Petra Archaeological Project* (BUPAP) also considers the site to be a sanctuary and, based on their surface pottery analyses, date the structure as early as the 3rd – 2nd century BC.[1760] Due to the sanctuary's prominent position on the al-Somrah cliff with good visibility to and from its environs as well as its immediate proximity to the settlement of Ras Slaysil and Naqb Slaysil, it may be assumed that the site was not limited to private use. It may have served as a more public religious structure, possibly for the inhabitants of Ras Slaysil and its immediate surroundings. No banqueting installations were documented at the sanctuary. Despite its early date, the PHSP documented Roman period (3rd century AD) sherds as well. This corresponds to pottery finds from Ras Slaysil. It therefore seems possible that the ad-Dahhune sanctuary was also in use at that time.[1761]

The Sanctuary of en-Nu'eira

The sanctuary of en-Nu'eira is situated only a few kilometers northeast of Ras Slaysil along the prolonged route of Naqb al-Farsh coming from Jabal Qarun (FIG. 334). The main structure of the presumed sanctuary is located in the northern part of the site and measures c. 7 × 5 m (FIG. 335). Although the structure is heavily disturbed by modern looting activities, an internal division can be observed. The large sandstone ashlars of the well-preserved walls and the conspicuous building collapse point to a once substantial building. The PHSP documented a large quantity of Nabataean surface pottery dating to the 1st century AD.

1754 Kennedy 2016a, 146; Alcock – Knodell 2012, 12; Lindner 2003a, 168–169; Lindner – Gunsam 1995b, 268–269; Kirkbride 1961.
1755 Lindner 2003a, 168.
1756 Kennedy 2016a, 146, Lindner 2003a, 168; Lindner – Gunsam 1995b, 269.
1757 Being the translation of 'ad-Dahhune' (Lindner – Gunsam 1995b, 269).
1758 Kennedy 2016a, 146, Lindner 2003a, 169; Lindner – Gunsam 1995b, 269–273.
1759 Wenning 2007, 260; Nehmé 1997a, 1034.
1760 Knodell et al. 2017; Kennedy 2016a, 146, Alcock – Knodell 2012, 12–13; Knodell – Alcock 2011, 502–503.
1761 The monumental Nabataean structure commonly referred to as the 'Pond Temple,' located immediately west of ad-Dahhune Slaysil after a 450 m drop down Naqb Slaysil and Naqb Seir al-Begh'er is not considered as a religious struc-

FIG. 334 Panorama overview of the presumed sanctuary at en-Nu'eira. View to the south.

FIG. 335 The presumed main structure of the sanctuary of en-Nu'eira. View to the east.

FIG. 336 Rock-cut *motab* immediately south of the main structure of the sanctuary of en-Nu'eira.

FIG. 337 View of the presumed sanctuary of Jabal Qarun on the volcanic al-Somrah cliff overlooking the steep descent to the Arabah in the west.

FIG. 338 Structural remains of the disturbed sanctuary of Jabal Qarun.

Immediately south of the sanctuary, a 2 m large *motab* is carved into the face of a sandstone outcrop. A depression was carved into the upper part for placing a portable *baetylus* (FIG. 336).[1762] A rock-cut channel runs around the outcrop and into a cistern.[1763] In 1984, Lindner observed a small water basin in front of the cistern with an open-air, c. 25 m^2 large room with three rock-cut benches behind it.[1764] While the room is still well discernible, the limestone *tesserae* of a mosaic floor that Lindner mentions cannot be verified.[1765] While Lindner first considered the room as a potential sanctuary, he reinterpreted the structure as

ture, but as a possible rural mansion (cf. chapter 5). In contrast, see Ben David 2013, 276 and 2012, 21; Alcock – Knodell 2012, 12; Lindner 2003a; Lindner – Gunsam 1995a.

1762 Cf. Lindner 2003a, 148 and Lindner 1986b, 103.

1763 Lindner 2003a, 148 and 1986b, 103 claim that parts of this channel were also built.

1764 Lindner 2003a, 148.

1765 Lindner 2003a, 148 and 1986b, 103.

a wine press and thus claims that the entire site of en-Nu'eira was a Nabataean domestic site with local agricultural terraces, water channels and a small private altar.[1766] However, if the rock-cut features in the room can be identified as benches, the 'room' could also be interpreted as a *triclinium*. While the agricultural context of the site was certainly important, if en-Nu'eira consists of a possible rock-cut *triclinium*, a rock-cut *motab* as well as a large structure with an abundance of Nabataean fine ware and high-quality building material, Lindner's original proposal for identifying the site as a sanctuary is more convincing. Furthermore, following Naqb al-Farsh north-northwestwards from en-Nu'eira, one reaches the presumed sanctuary of Jabal Qarun after a few kilometers. Lindner refers to this part of Naqb al-Farsh as a pilgrim trail and mentions rock-carved depictions of riders, tribal markers (*wusūm*), Safaitic letters as well as carved footprints along the way.[1767] En-Nu'eira's location along this presumed pilgrim trail to Jabal Qarun thus reinforces its interpretation as a sanctuary.

The Presumed Sanctuary on Jabal Qarun

Similar to the sanctuary of ad-Dahhune Slaysil, the presumed sanctuary on Jabal Qarun is situated directly on the al-Somrah edge, only 2 km north of Ras Slaysil as the crow flies (FIG. 337). The rectangular structure measures 8 × 7 m. The state of preservation is generally good, although there are significant signs of looting. The structure is characterized by a large debris of well-cut sandstone ashlars suggesting that it was originally of conspicuous height (FIG. 338). A small 0,80 × 0,50 m basin is inserted into the interior of the western wall.[1768] Lindner still observed a collapsed stairwell leading up to the structure which is now almost completely lost.[1769] Surface pottery dates the structure between the 1st centuries BC and AD.[1770]

Coming from the Wadi Arabah along the route Naqb Abu Mrerah, Jabal Qarun was either reached via Naqb al-Aqab or Naqb al-Asmar Sheiq an-Nisr (cf. chapter 6). Once on the al-Somrah escarpment and at Jabal Qarun, Beidha was easily accessible via Naqb al-Farsh.

The site is difficult to define functionally. However, due to the large amount of Nabataean fineware and the structural and locational parallels to the sanctuary at ad-Dahhune Slaysil (the monumental stairwell documented by Lindner as well as the site's location on the al-Somrah cliff), Lindner's original interpretation of Jabal Qarun as a Nabataean sanctuary is likely.[1771] The fact that Jabal Qarun is situated along important routes, suggests that the site was important for its immediate environment. It may have served as a public religious structure central to the inhabitants of the al-Farsh area. This again draws parallels to the sanctuary at ad-Dahhune Slaysil.

The Sanctuary at Sabra

A c. 35 × 40 m large *temenos* with a major temple is situated on the northern bank of the Wadi Sabra, directly opposite Sabra's rock-cut theater (FIG. 339).[1772] Immediately northwest of the *temenos* is an 'acropolis' as well as a bath complex to the southwest, which presumably was associated with the sacred area.[1773] Although the wadi has washed away a part of the northeastern corner of the *temenos* area, Zeitler was able to observe column drums of a two-storied portico that framed the limits of the *temenos*.[1774] The main structure and presumed Nabataean temple is situated in the center of the sanctuary and measures c. 10 × 8 m (FIG. 340). The first excavations conducted by Zeitler revealed a preserved height of up to 2,80 m.[1775] The façade of the structure was framed by two pilasters on each side and a combination of pilaster-quarter columns in front of the main entrance. This order stood on a pedestal with attic bases. Profiled, shell-limestone ashlars formed the building material of the walls. Based on architectural comparisons with monuments from urban Petra, Zeitler reconstructs a semicircular *tympanon*. The interior of the structure can be divided into two main

1766 Lindner 2003a, 148.
1767 Lindner 2003a, 148–149 and 1986b, 103.
1768 Lindner speculates that the basin collected water from a possible roof (Lindner 2003a, 150 and 1986b, 106). However, there is so far no evidence that would support this.
1769 Lindner 2003a, 150.
1770 Cf. also Lindner 2003a, 150 and 1986b, 106.
1771 Lindner 2003a, 150 and 1986b, 106 notes two modern graves at the foot of the site. For Lindner, this is indicative for a religiously significant site. Nehmé 1997a, 1034 also recognizes Jabal Qarun as a rural sanctuary. Note that the author previously interpreted the site as a Nabataean watchtower (Kennedy 2016a, 147; 2016b, 166 and 2013b, 284–286.) This view is now revised.
1772 The recent investigations of the *Mission Archéologique Française* have tremendously increased our knowledge on Sabra in general and particularly on its sanctuary. See e. g. Tholbecq 2016, 1072–1074; Tholbecq et al. 2016 and the contributions by Tholbecq et al. in Tholbecq 2015, 63–100. For previous studies on the temple at Sabra, see Lindner – Zeitler 1997 and Zeitler 1992.
1773 Tholbecq et al. 2016, 281–283.
1774 Tholbecq et al. 2016, 283; Lindner – Zeitler 1997, 551–558; Zeitler 1992.
1775 Lindner – Zeitler 1997, 553; Zeitler 1992.

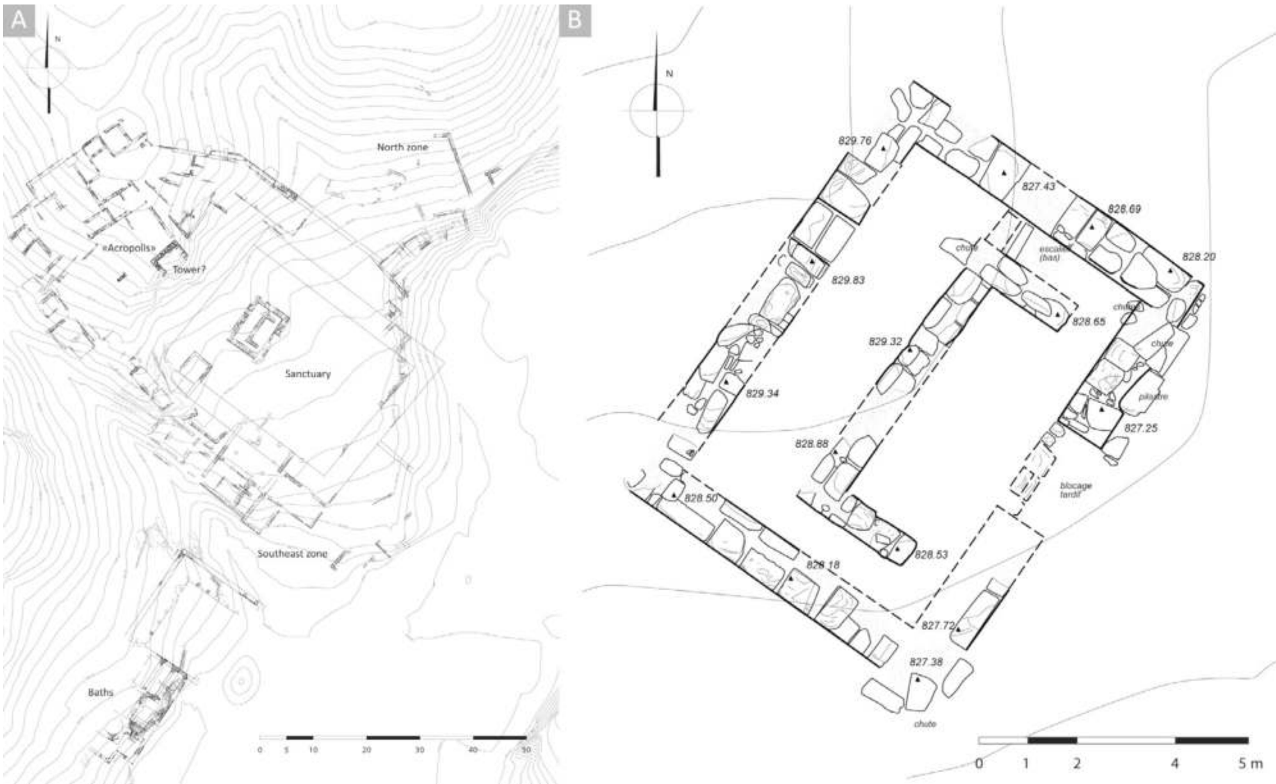


FIG. 339 A: Plan of the remains of the *temenos* area of Sabra after Tholbecq et al. 2016, 282, fig. 5. B: Detailed plan of the Nabataean temple at Sabra after Tholbecq et al. 2016, 283, fig. 6.

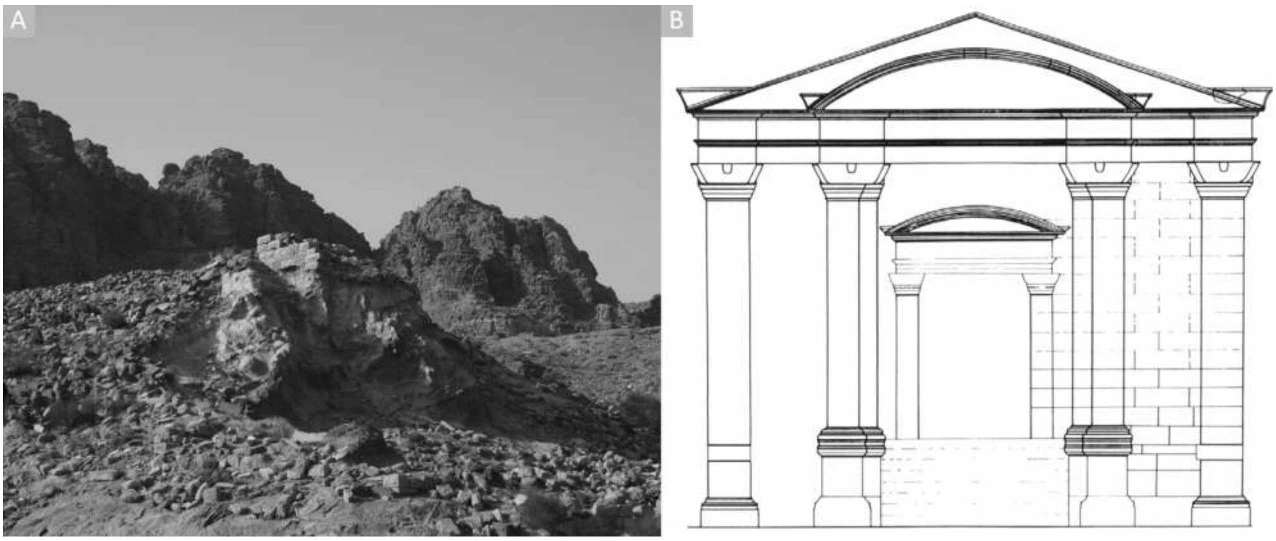


FIG. 340 A: The temple of Sabra. View to the northeast. B: Hypothetical reconstruction of the eastern façade of the temple after Lindner – Zeitler 1997, 556, Abb. 38.

parts: one central room measuring c. 4,10 × 2,7 m as well as a corridor-like room around it.[1776]

In addition to the temple, the French archaeological mission identified another c. 15 × 10,15 m large structure along the southern side of the *temenos*. This may be interpreted as another Nabataean temple (FIG. 341).[1777] The surveyors assume that the temple was articulated by a *distylos in antis* façade, which opened into three rooms with a potential *naos* in the middle (framed by two half-columns). This presumed *naos* is flanked by a small room on both sides. In the north, two column drums found still *in situ* have led to the proposition that the northern part of the temple may have been a small *hypostylos*.[1778]

1776 On the architectural details, see Lindner – Zeitler 1997, 553–556.

1777 Tholbecq et al. 2016, 284.

1778 Tholbecq et al. 2016, 285. Architectural comparisons are

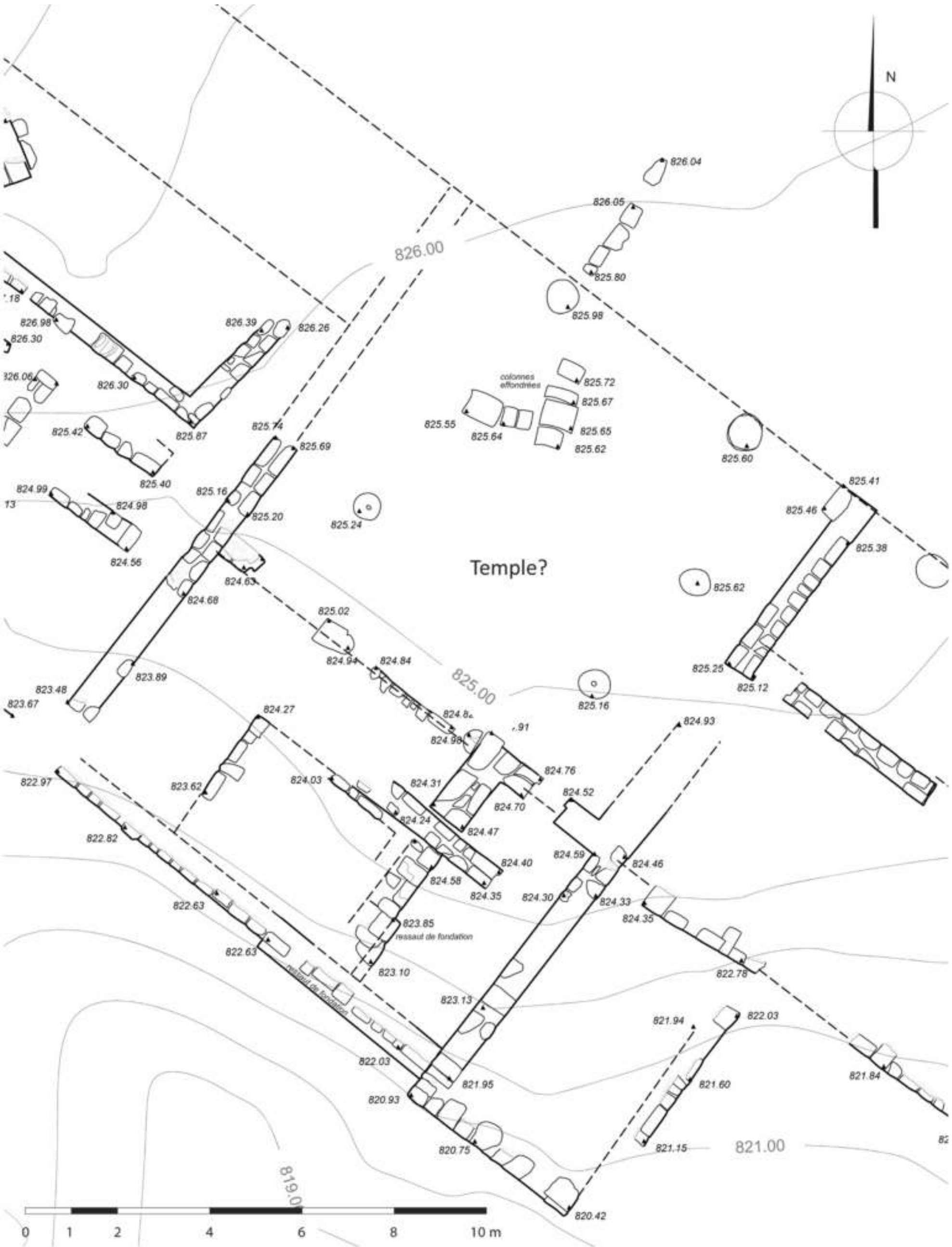


FIG. 341 Detailed plan of the presumed second temple within the *temenos* of Sabra after Tholbecq et al. 2016, 284, fig. 7.

Based on previous excavations results, as well as surface pottery recorded from the *temenos* area, the complex can generally be dated to the end of the 1st century BC and the Late Roman period.[1779] Tholbecq et al. state that the central temple was constructed in the mid-1st century AD, while further extensions of the *temenos* area were supposedly added at some point between the late 1st and early 2nd century AD.[1780]

The Sanctuary at Khirbet Braq

In the spring of 2018, a joint project of the *Mission Archéologique Française à Pétra* and the *Al-Hussein Bin Talal University* (Ma'an) initiated a reinvestigation of the sanctuary at the spring of Khirbet Braq. It is situated along the slopes of the Jabal Shara c. one kilometer southwest of modern Wadi Musa along the

drawn to the Qasr al-Bint and the Temple of the Winged Lions in Petra as well as Khirbet edh-Dharih. Also, Tholbecq et al. 2016, 284 follows up on Zeitler's original observation that Sabra's supposed 'central' temple is placed slightly off-center of the *temenos*. According to Tholbecq et al. 2016, 285, the existence of the newly identified temple may be the reason for this.

1779 Tholbecq et al. 2016, 292; Nehmé 1997a, 1042.

1780 Tholbecq et al. 2016, 293. In addition to the large sanctuary, an 'acrosolium' is cut into the face of Jabal al-Jahthum in Sabra (Lindner – Zeitler 1997, 544). It was excavated by Lindner who describes it as a possible isolated funerary monument. The site consists of a 2 × 1,5 m large, rock-cut room with a central niche carved into the back of the room.

FIG. 342 Plan of the sanctuary at Khirbet Braq after Tholbecq et al. 2018, 128, fig. 15.

road to Tayyiba (FIG. 342).[1781] Known foremost for its perennial spring that supplied Petra with fresh water, Khirbet Braq gained scholarly attention after the discovery of Nabataean statue fragments and monumental architectural building elements dating the 1st/early 2nd century AD.[1782] These finds include high-quality blocked busts, reminiscent of the pedestal-blocks from the Qasr al-Bint at Petra, the limestone head of a female deity with vegetal face (so called 'Atargatis') with parallels at Khirbet et-Tannur as well as a monumental lintel fragment depicting a winged Victoria, a pseudo-ionic capital fragment with elephant heads and other decorated architectural and statuary fragments.[1783] Some of these finds were documented in the course of rescue excavations conducted by the Department of Antiquities at an isolated courtyard building northwest of the main *temenos* area in 1994/1995. Presumably, this structure dates to the 1st century AD.[1784] It lies immediately northwest of two independent complexes, consisting of a possible central courtyard (southwards towards the spring of Khirbet Braq) and an elongated building constructed along the naturally declining slope in direction of the modern road. It is possible that these complexes served as reception areas to the main sanctuary, which is situated centrally in front of the spring.[1785] The sanctuary most likely consisted of a flat, open courtyard which was accessed from the west by a gateway (*propylaeum*?) that was flanked by two cisterns.[1786] Substantial walls that enclosed partially paved areas (one of them accessible by a stairway) immediately south of the courtyard, suggest the existence of a monumental building. This was probably a (*podium*?) temple. This entire sector yielded the highest concentration of decorated blocks. The sanctuary of Khirbet Braq therefore seems to have encompassed the spring itself, a temple, courtyard and *propylaeum*.

The proximity to the continuously active spring has resulted in significant alterations of the sanctuary through time. Despite various later constructions, however, particularly the presumed *podium* might still be preserved to its original height.[1787] Significant looting activities were also observed along the presumed *propylaeum* where most of the statuary was discovered.[1788] The looter's holes revealed the northern corner of the gate with its pilaster-on-pedestal decoration, as well as a second pilaster base further north that decorated the façade of the *propylaeum*. Surface material from Khirbet Braq suggests a dating range from the Nabataean-Byzantine periods.[1789]

Significant Religious/Cultic Structures

No isolated significant religious/cultic structures are known in the Petraean hinterland. All major religious structures were situated in Petra, highlighting the city's central religious function. However, there are significant religious/cultic structures at larger settlements. For example, Nabataean temples are presumed at Abu Khusheiba and as-Sadeh.

At Abu Khusehiba, Lindner identifies 'Building No. 2' as a temple.[1790] He briefly describes the building as consisting of "[…] *two structures with tumbled drums of plain columns, cornice (?) fragments and ashlars bearing diagonal tool marks*" (FIGS. 343 and 344).[1791] Surface pottery dates between the 1st and 2nd century AD.[1792] There is no additional evidence that would support Lindner's claim that this structure is of religious nature. As the architectural remains may easily indicate a monumental non-religious structure as well, this interpretation must therefore be questioned. However, it is likely that the community of Abu Khusheiba would have had its own temple or sanctuary as is the case at Sabra.

Lindner also postulates to have identified a temple on a hilltop at as-Sadeh (FIG. 345).[1793] Accessed by a stairwell, the hilltop features a c. 17 × 6 m large, heavily disturbed structure. Its general orientation is north-south and, as Lindner points out, is the only place at as-Sadeh from where Jabal Harun is visible.[1794]

1781 Tholbecq et al. 2019, 28 and, most importantly, Tholbecq et al. 2018.

1782 Parr 1960; Glueck 1939, 44–49. For a more detailed account of the research history of Khirbet Braq, see Tholbecq et al. 2018, 117–126.

1783 Cf. the list and figures (nos. 6–14) offered in Tholbecq et al. 2018, 123–125 and 133–135.

1784 Although there is still no comprehensive study of the ceramic material. Cf. Tholbecq et al. 2018, 121–123.

1785 Tholbecq et al. 2018, 127.

1786 It currently cannot be determined whether the cisterns are part of the original *propylaeum* or not (Tholbecq et al. 2018, 132).

1787 Tholbecq et al. 2018, 132.

1788 Tholbecq et al. 2018, 132.

1789 Tholbecq et al. 2018, 135. MacDonald et al. 2016, 150–151 (ShamAyl Site No. 030) list one Late Islamic handle and 'Amr et al. 1998, 533 ("Tayyiba 6") date the site to the Early Islamic and Ayyubid/Mamluk periods as well. Both surveys list Khirbet Braq as an "extensive village site."

1790 Nehmé 1997a, Lindner 1992b, 264.

1791 Lindner 1992b, 264. Also see Lindner 2003a, 66.

1792 Lindner 2003a, 66–67 bases the temple-hypothesis for Building No. 2 on the pottery finds. He also mentions the possibility that the structure may be a *villa rustica*. Cf. Nehmé 1997a, 1042 and Lindner 1992b, 264.

1793 Lindner 2003a, 47; Lindner et al. 1990, 211–213, pl. X.1; Lindner et al. 1988, 85, fig. 6.

1794 Lindner 2003a, 47. Iron Age pottery was also excavated. The elongated shape of the presumed temple is unique among other known Nabataean temples. This is probably due to the topographical conditions.

FIG. 343 The presumed temple at Abu Khusheiba (Lindner's Building No. 2).

FIG. 344 Architectural members from the presumed temple at Abu Khusheiba.

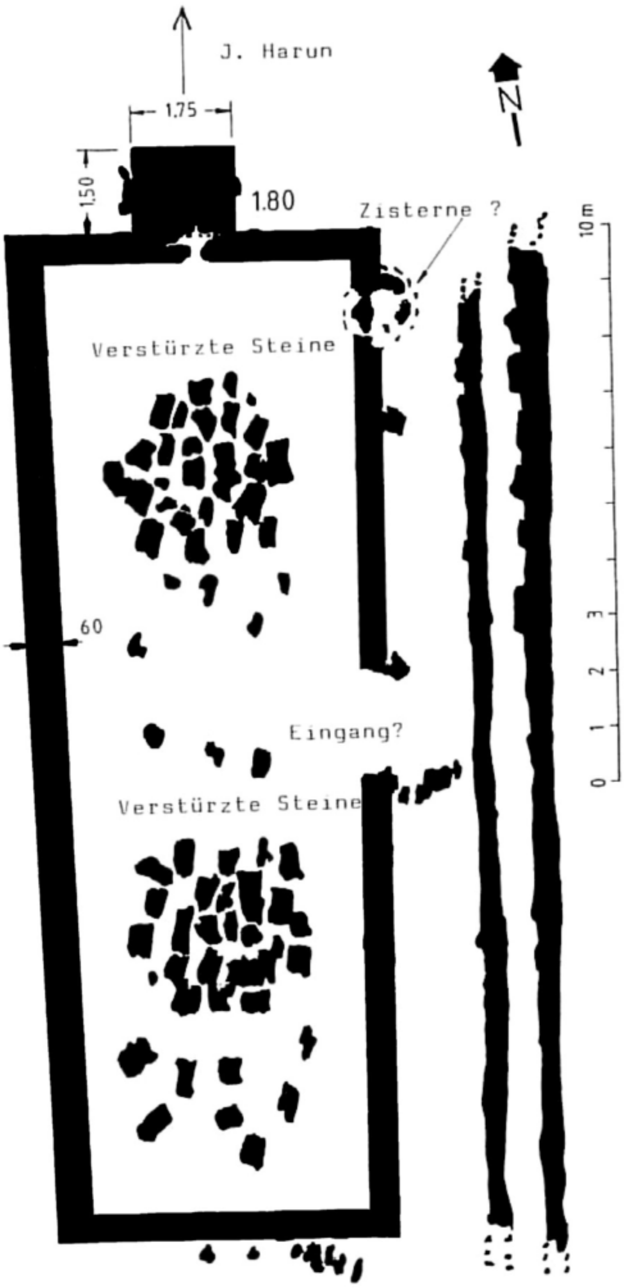


FIG. 345 Plan of the presumed temple at as-Sadeh after Lindner 2003a, 46, Abb. 36.

Lindner opened a small test-trench in the northern part of the structure which revealed a well-preserved foundation of good quality ashlars, which he tentatively interpreted as a small altar. Pottery material from this test-trench dated between the 1st century BC and 1st/2nd century AD.[1795] If Lindner's identification of the foundation as a possible altar is correct, its orientation towards Jabal Harun may indeed imply a "borrowed sanctity" of the site.[1796] While the identification of this structure as a temple must remain preliminary, it is nevertheless likely that the community of as-Sadeh had its own temple that served the cultic needs of its inhabitants. The structure identified by Lindner is so far the best candidate.

Gaia (Wadi Musa) had a temple as well. It was uncovered during rescue excavations in 1977, but is now lost.[1797] However, the dedicatory inscription of the temple was reused as building material in the modern village. According to the inscription, the temple was dedicated to "Baalshamin, the god of Manku."[1798] The cult of Baalshamin seems to have been specifically tied to the area of Wadi Musa.

While realizing that the chronology of rural religious structures is based mostly on surface material (with the exception of the excavated structures at Jabal Harun and the Obodas Chapel), the only sanctuary that might have been in continuous use during the Roman periods is Jabal Harun. There is also very little material evidence suggesting that the sanctuaries at ad-Dahhune Slaysil and Jabal Qarun were sporadically used in the Roman periods as well.

In the Byzantine period, the monastic complex on Jabal Harun was the most important religious structure outside Petra. A church was constructed at Udruh in the 4th century AD, but it was only of local importance.[1799] Although not yet confirmed by excavation results, major towns such as Saddaqa built churches during the Late Byzantine period, mirroring the generally intensified construction of churches in Late Byzantine settlements.[1800] However, Petra remained the major religious focus point in the region during the Roman and Byzantine periods. This is attested by the continuing cult practices in the city's major temples in Roman times (e.g. the Qasr al-Bint and the Temple of the Winged Lions) and by the construction of at least four churches in the city center in the Byzantine periods.[1801]

1795 Lindner 2003a, 47; Nehmé 1997a, 1042; Lindner et al. 1990, 213.
1796 Lindner 2003a in reference to Crawford 1930, 292–297.
1797 Tholbecq 1997, 1090.
1798 Wenning 2011, 287 after Milik's reading in Khairy – Milik 1981, 25–26. Presumably, the inscription dates to the 34th year of Aretas IV, thus to 25/26 AD. However, the exact reading of the date is debated. Following the *terminus post quem* of 36 AD given by Zayadine 1981, 350, and based on the epigraphical evidence of the inscription, Nehmé also states that Baalshamin was venerated at Wadi Musa (Nehmé 1997a, 1043–1044).
1799 Abudanh 2006, 425–426: Abudanh 2006 Site No. 051; Fiema 2002a, 209–211; Killick 1986b.
1800 Fiema 2002a, 222 lists e.g. Umm al-Jimal, Umm ar-Rasas or Khirbet as-Samra. Specifically on Saddaqa, see Fiema 2002a, 211–212; Graf 1995a, 250. Graf 1995a, 251 hypothesizes that the Byzantine settlement of 'Pentakomia' could be associated with Basta. However, no churches are known there so far. Also note that Kouki 2013c claims to have discovered a possible mosque in FJHP Site No. S136. A possible Byzantine church was discovered at Beidha (Bikai et al. 2008, 466).
1801 Fiema 2002a, 195–201, 217–218.

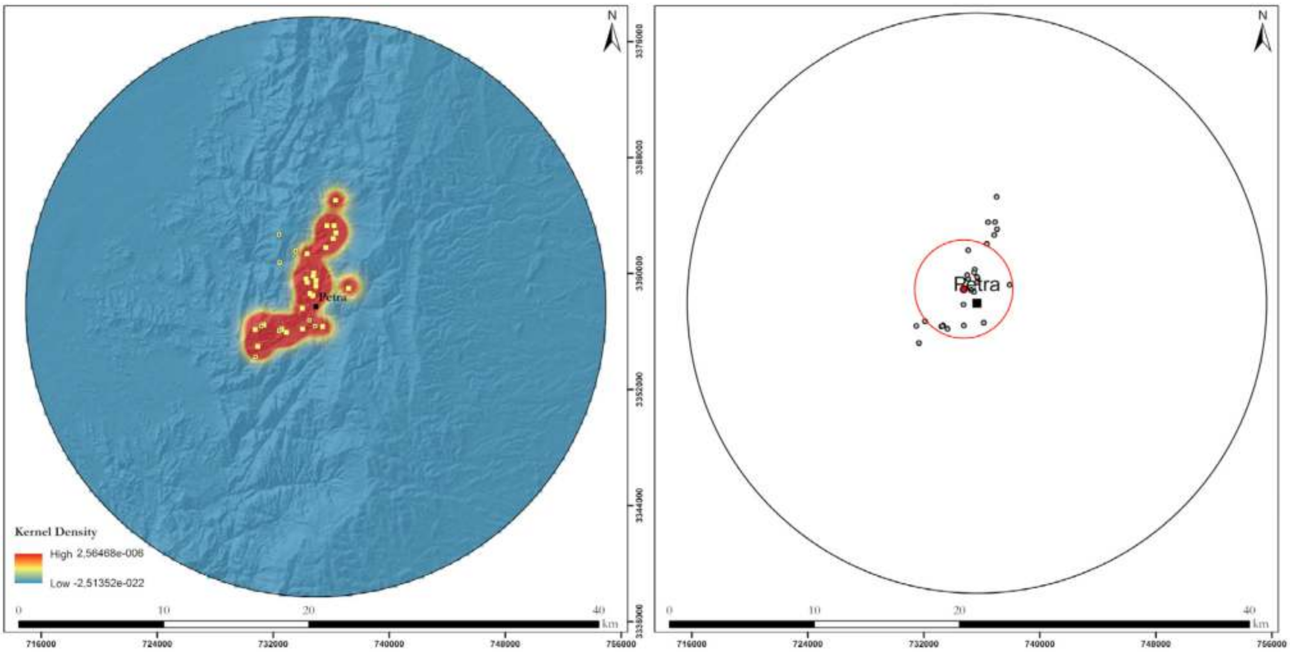


FIG. 346 Left: Kernel density map of 1st century AD isolated cultic installations in the Petraean hinterland. Right: Isolated cultic installations within the study area dating to the 1st century AD. The red point marks the mean center of the point pattern encircled by the standard distance between all isolated cultic installations.

Isolated Cultic Installations

As observed for 1st century AD sanctuaries, the kernel density estimation and the point pattern analysis clearly show that isolated cultic installations are highly clustered in the Beidha area and as-Sto'e and al-Farasha plains (FIG. 346). [1802] The standard distance of just over 3 km between the individual cultic structures is relatively low, which also points to a high degree of clustering (cf. TABLE 35).[1803]

Isolated Cultic installations were not recorded along the Jabal Shara or eastern high plateau, nor westward towards the Wadi Arabah. They concentrate on elevated hilltops and mountainous gorges in and around Petra with an average elevation set at 1043,82 m a.s.l. (cf. TABLE 36). The Pearson coefficients generally attest to very weak or moderate spatial correlations to other archaeological categories (cf. TABLE 37).[1804]

The earliest isolated cultic installations date to the 1st century BC. In total, the original surveys identified 24 cultic installations. Most sites (14) are cultic niches for placing *baetyli* as well as rock-cut *nephesh*. A good example for isolated cultic niches is PRP Site No. wme8 with triple *baetyli* carved into the bedrock along Wadi al-Mu'aysirah East.[1805] A prominent example for depictions of *nephesh* is WMWS 1996 Site No. Bayda 17.[1806] These are only two examples of an overwhelmingly large quantity of such installations in and around Petra. This section can therefore only give an extremely simplistic indication of the isolated cultic installations in the Petra area. For a comprehensive overview on the nearly 1000 *baetyli* and other cultic installations documented in urban Petra alone, R. Wenning's *Petra Niches Project* as well as L. Nehmé's archaeological atlas of Petra are invaluable contributions for a more in-depth study of these installations.[1807] As the sanctuaries, the cultic installations recorded by the original surveys are situated along particular routes. While this may be a result of varying survey intensities, the density of cultic niches is particularly high along the routes of Wadi al Mu'aysirah East and West.[1808]

1802 The analyses were conducted for the 1st century AD only, when all isolated cultic installations were in use.

1803 The low GIV in TABLE 35 is due to low number of isolated cultic installations.

1804 There are also strong correlations to agricultural terraces/fields, industrial/exploitation installations (cf. sanctuaries above), isolated funerary monuments, epigraphical sites or locations, natural and/or rock-cut structures of undetermined function as well as dams/barrages.

1805 Berenfeld et al. 2016, 97. Berenfeld et al. 2016, 97–100 associate a large rock-cut *nephesh* (PRP Site No. wmw18) with a small private sanctuary along Wadi al-Mu'aysirah West.

1806 'Amr et al. 1998, 511.

1807 Nehmé 2012b. On Wenning's 'Petra Niches Project,' see for example Wenning 2012 with further references.

1808 Cf. Berenfeld et al. 2016, 95–100.

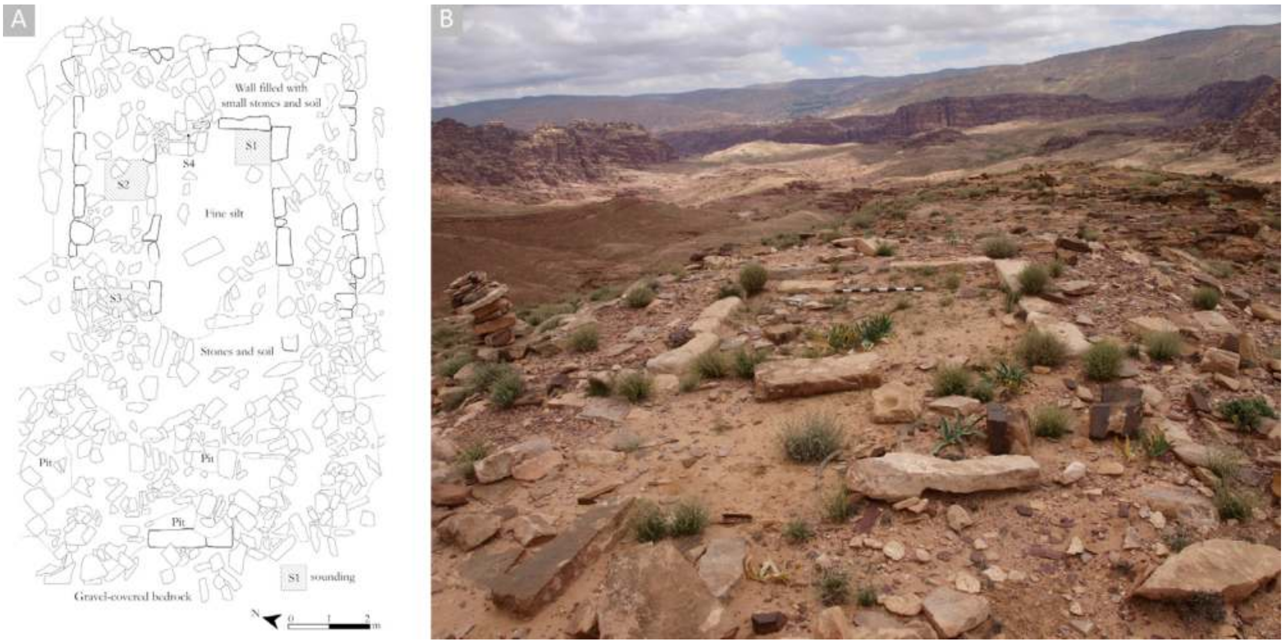


FIG. 347 A: Plan of the isolated *triclinium* on the summit of Jabal al-Farasha south of Jabal Harun after Kouki – Silvonen 2013b, 313, fig. 26. B: View of the *triclinium* to the west.

In addition to isolated cultic niches, seven isolated installations for ritual banqueting and social gatherings were identified. Two were identified as *stibadia*: The unique *stibadium* complex at the beginning of Wadi al-Mu'aysirah West (cf. chapter 6, FIG. 244) and another possibly along Wadi al-Mu'aysirah East (PRP Site No. wme79).[1809] The remaining five structures were documented as potential *triclinia*. As there is an extremely high density of such installations within Petra's urban limits, it is likely that more installations are to yet to be discovered in the Petraean hinterland.[1810] Nevertheless, the isolated *triclinium* of FJHP Site No. S124 on Jabal al-Farasha (FIG. 347) or WMWS Site No. Bayda 22 attest well to the significance of such structures within the religious and social landscape of Petra's rural surroundings. The *triclinium* of FJHP Site No. S124 was partly excavated by the FJHP, which confirmed a dating between the 1st century BC and the 2nd century AD. Due to the close vicinity and good visual contact to Jabal Harun, a cultic relation between the *triclinium* and the Nabataean sanctuary has been assumed.[1811] The *triclinium* of WMWS Site No. Bayda 22 dates to the 1st century AD.[1812]

While some date as early as the 1st century BC, all isolated cultic installations were in use during the 1st century AD. With the beginning of the 2nd century AD, however, they appear to have been abandoned as there is no material evidence for their use in later periods. Although these banqueting installations are not accompanied by additional epigraphical evidence that could provide information on the groups using them, the clear parallels between the various *triclinia* associated with different social groups as evidenced by Nehmé (cf. above) indicate a similar use of such rural structures.

1809 The *stibadium* complex along Wadi al-Mu'aysirah West is documented here as PHSP Site No. 005-ST021, but it is already well-known, as recently summarized in Tholbecq 2018, 22–24. On the possible *stibadium* along Wadi al-Mu'aysirah East, see Berenfeld et al. 2016, 105, Appendix 1. Tholbecq 2018, 28–31 also lists two additional rock-cut *stibadia* in the Beidha area: One at Jabal Umm al-Wutad and another at at-Tnub.

1810 Cf. Tholbecq 2018; Nehmé 2013 and 1997a as well as Tarrier 1995 and Brockes 1994. Particularly on the importance of *triclinia* and *stibadia* in a Nabataean funerary context, see Wadeson 2013 and 2011; Sachet 2010a and 2010b as well as Schmid 2009. For a good and brief overview of *triclinia* within Nabataean culture in general, see e.g. Durand 2017 and Charloux et al. 2016.

1811 Kouki – Silvonen 2013b, 312–314. For a general overview of ritual sites documented by the FJHP, see Kouki – Silvonen 2013b. Also note FJHP Site No. S037, which is tentatively interpreted as a built *stibadium* (Tholbecq 2018, 34; Kouki – Silvonen 2013b, 311–312).

1812 Kouki – Silvonen 2013b, 311–312; 'Amr et al. 1998, 512.

Chapter 9
Terra Petraea through Time. A Synthesis

After the preceding chapters presented the individual archaeological site types, the following critically discusses the relevant archaeological data and assesses the Petraean hinterland through time. While the findings for the Iron Age periods were synthesized in chapter 3, this chapter begins with a reassessment of the Petraean hinterland in the Hellenistic period. The main chronological focus of this study (the Nabataean and Roman periods) is evaluated subsequently. As the chronological 'outlook,' this chapter ends with the discussion of the Petraean hinterland during the Byzantine period. The synthesis of all periods is structured by the same superordinate topics: 'Subsistence strategies and communication,' 'society and culture,' and 'the military disposition.'

Terra Petraea in the Hellenistic Period

The first historical account of the Nabataeans is provided by Diodorus' description of Antigonos Monolphthalmos' attempt to conquer Nabataean territories in 311 BC.[1813] There is no indigenous Nabataean historiography providing information on their early history. The reconstruction of the origins of the Nabataeans remains obscure and is based predominantly on later Greek and Roman sources. Diodorus describes the Nabataeans as a nomadic people with no permanent dwellings relying entirely on pastoral nomadic subsistence strategies, supposedly eating only raw meat and preferring milk over wine.[1814] They are also reported to have been skillful traders throughout southern Arabia and the Syro-Phoenician coastlines. This is indicated by fragments of other, largely lost, Hellenistic authors writing about Arabia and its population (*Arabika*) as well.[1815]

Diodorus also attests to the nomadic lifestyle of the Nabataeans when describing that, in light of the Antigonid attack, they retreated on a rocky outcrop (πετρα) which, depending on scholarly interpretation, can be associated with Umm al-Biyara or as-Sela. As there is little to no archaeological evidence pertaining to a continuity of Edomite and Nabataean material culture (the latter evidenced securely only in the 1st century BC), it seems that the early Nabataeans indeed followed a nomadic lifestyle. However, historical accounts from the late 4th century BC onwards place the Nabataeans in central and southern Jordan[1816] and recent archaeological investigations at Petra revealed "[…] *small-scale domestic quarters and/or industrial activities* […]" with associated Mediterranean ceramic material and numismatic evidence suggesting a continuous occupational sequence in urban Petra from the later Persian to the Late Hellenistic period. Nabataean settlement activities in Petra can therefore be traced back to the Hellenistic period.[1817] Ceramic material from Petra's earliest funerary monuments, the 'Block Tombs,' date back to the 3rd century BC as well.[1818] This further suggests a permanent settlement of Petra early on.

Nevertheless, the Hellenistic period remains highly elusive. Additional historical references such as the early 3rd century BC epigram of Poseidippus of Pella mentioning a Nabataean 'king' have led some scholars to assume that a Nabataean social structure similar to that of the later Nabataean period already existed in Hellenistic times.[1819] However, only fragments of the relevant passage of the epigram are preserved.[1820] Literary sources on the early history of the Nabataeans are indeed

> […] *stylized account*[s] *filled with stock motifs to describe peripheral peoples typical to Greek historiography* […]. *It is a complex narrative, with clear exaggerations and disturbing silences that 'evoke disquiet rather than confidence'* […] *for the chronology and context* […].[1821]

1813 Diod. Sic. 19, 94, 1 and 95, 1 – 97, 6.
1814 Cf. Graf 2013, 35 and Schmid 2008a, 360.
1815 On the *Arabika*, see Graf 2013, 35–38.
1816 Diod. Sic. 3, 42, 5; 3, 43, 4–5; 2 Macc. 5, 8; 1 Macc. 5, 25; 9, 35; Jos. Ant. Iud. 12, 8, 3 (after Schmid 2008a, 360).
1817 Cf. the *Hellenistic Petra Project* (e.g. Graf 2013, 38–45). The French excavations of the Qasr al-Bint also demonstrated that the earliest strata date to the 3rd century BC. This is not only attested by Mediterranean ceramic assemblages, but corroborated by radiocarbon dates as well (cf. e.g. Renel – Mouton 2013).
1818 Cf. e.g. Mouton – Renel 2013.
1819 Schmid 2008a, 361 with further references. On the epigram of Poseidippus, also see chapter 6.
1820 Following Schmid 2008a, 361. In contrast, see Graf 2013, 38 who takes the epigram as an indication for early Nabataean 'kingship.'
1821 Graf 2013, 35.

While there is more convincing epigraphical and numismatic evidence for the late 2nd century BC, it is not before the 1st century BC that the Nabataeans can be definitively identified in the historical and archaeological records.[1822] It is in this context that the following discussion of the archaeological evidence from Petra's surroundings should be considered.

Subsistence Strategies and Communication

Following the sudden abandonment of rural settlements in the 5th century BC (apart from Tawilan and Abu Danna; cf. chapter 3), a very slight increase of rural agricultural settlements was observed during the Hellenistic period. Only two clusters of buildings, the farm at Abu Danna and four villages date to the 4th century BC. The Petraean hinterland is still largely void of rural settlements. The further development of rural settlements seems unstable (only two clusters of buildings and three villages are known for the 3rd century BC). This possibly reflects the political vacuum and overall instability of the area after the collapse of the Edomite kingdom. The situation remained unchanged in the 2nd century BC, although a slight increase of rural settlements can be observed (three clusters of buildings and villages as well as one farm are now documented). Tentatively, this may suggest that at least a very select few practiced agriculture in the Petraean hinterland between the 5th and 2nd centuries BC.

In accordance with the almost complete abandonment of all archaeological sites by the 5th century BC, the archaeological evidence for agricultural activities during the Hellenistic period (4th – 2nd centuries BC) is basically non-existent as only one threshing floor is documented to this time.[1823] However, early Aramaic *ostraca* (4th – 3rd century BC) discovered in southern Palestine and Idumaea attest to Arabs being strongly involved in an agriculture-based, sedentary society.[1824] For example, the majority of the legible *ostraca* found at Arad seem to be "[…] *dockets indicating barley supplied to horsemen and ass-drivers perhaps involved in the Persian communication system*."[1825] Also, *ostraca* discovered at ancient Beersheba record possible tax payments of barley provided by private estate owners to garrison storehouses.[1826] The *ostraca* record an agricultural society and refer to the cultivation of fields and orchards as well as the payment of land taxes (paid mostly in barley and wheat) as well as poll taxes (paid mostly in silver coinage).[1827] Recalling Strabo's statement that "the Idumeans were Nabataeans" who were exiled from the Nabataean main territories, Graf explains that the *ostraca* indicate the close similarities between Hellenistic Idumaean and Nabataean culture.[1828] One *ostracon* from Mareshah even mentions an individual from Petra.[1829] The Idumaean examples list many Arabic names, which Graf refers to as "proto-Nabataean" and therefore postulates that an agriculture-based society could have existed in southern Palestine already in the 4th century BC.[1830] On this basis, Graf argues that there is no reason why early Petra could not have been organized similarly, thus portraying the early Nabataeans as "[…] *an integral part of the heterogeneous rural population engaged in agriculture, just like other settled ethnic groups in the region*."[1831]

While the few rural settlements as well as the above-mentioned threshing floor may serve as tentative archaeological indications that the rural population of Petra's hinterland at least partially practiced agriculture, the overall absence of evidence still points to a large-scale abandonment of rural agricultural settlements after the collapse of the Edomite kingdom. It must therefore be assumed that the early Nabataeans followed mainly pastoral nomadic subsistence strategies. This is further supported by the discussed camp sites and corrals (chapter 4), although the recorded surface material does not indicate a use during the Hellenistic period.

No industrial/exploitation installations were documented for the 5th – 2nd centuries BC and there is no evidence to suggest that the Iron Age copper mining activities at Umm al-'Amad continued in the Hellenistic period. However, Killick's excavations of the presumed Nabataean ceramic kilns at Udruh revealed 2nd century BC to 1st century AD numismatic evidence that may suggest at least small-scale and local industrial production of ceramics commencing in the Late Hellenistic period.[1832]

There is no direct archaeological evidence that suggests the continuance of long-distance trade during the Hellenistic period. No road/route-related sites recorded in the Petraean hinterland date between the

1822 Schmid 2008a, 361–364.
1823 ShamAyl Site No. 089 (MacDonald et al. 2016, 210).
1824 Graf 2013, 46–48 and 2012b, 55: The same goes for *ostraca* found at Mareshah.
1825 Graf 2013, 47 and 2012b, 53–56.
1826 Graf 2013, 47. *Ostraca* of similar content were apparently discovered at Tell el-Far'ah, Tell 'Ira, Yatta as well as Raphia, Tell Jemmeh and Khirbet al-Kom (ancient Maqqdeh).
1827 Graf 2013, 48 and 2012, 53–56.
1828 Str. 16, 2, 34; Graf 2013, 48 and 2012b, 53–56.
1829 Graf 2012b, 55.
1830 Graf 2013, 48.
1831 Graf 2013, 48.
1832 Wenner 2015, 120; Killick 1987, 173–174; Killick 1986b, 51–52.

5th and 2nd centuries BC. However, it is argued that Nabataean control of the Negev and therefore of the trade routes to the Mediterranean was challenged by the Ptolemies as early as the 3rd century BC.[1833] This would suggest that the early Nabataeans were already involved in long-distance trade.[1834] The fort at Moyat 'Awad along the Petra–Gaza road supposedly dates as far back as the 3rd century BC as well.[1835] Additionally, excavations suggest that the large Nabataean caravanserai at Horvat Ma'agurah on the way to Elusa dates to the 2nd century BC, thus being the earliest example of Nabataean caravanserais known to date.[1836] Despite the fact that the evidence from Petra's hinterland only attests to a more developed communication network from the 1st century BC onward, it must therefore be assumed that the Nabataeans were highly involved in long-distance trade during the Hellenistic period.

This seems corroborated by the Hellenistic finds discovered in urban Petra.

Society and Culture

The original surveys provided no information on the funerary landscape of the Petraean hinterland during the Hellenistic period. Only two presumed burial cairns were documented on the eastern high plateau, which are coarsely dated between the 4th century BC and 7th century AD.[1837] However, as these cairns are located in cultivated areas, the surveyors admit that they could also be modern field clearances. Their identification as 'burial cairns' is therefore not secure. Nevertheless, as burial cairns are common funerary structures in the Near East dating from the Chalcolithic to the modern era, the possibility that burial cairns were also built in the Hellenistic period cannot be dismissed entirely.

The only (late) Hellenistic religious structure recorded in the Petraean hinterland is the Obodas Chapel dating as early as the late 2nd century BC.[1838] With its dedicatory inscription, numerous Nabataean graffiti, its ritual banqueting installations as well as the large quantity of stratified ceramic evidence, the Obodas Chapel is one of the best examples for a continuously used Nabataean family and/or tribal sanctuary.[1839] This attests to the strong family or tribal-based social structure of the study area as early as the Late Hellenistic period.

The Military Disposition

Apart from the possible fortlet/road station of at-Tiyir (ARNAS Site No. 192) which seems to have been occupied from the 4th – 2nd centuries BC, no military structures are recorded between the 5th and 2nd centuries BC.[1840] However, describing how the Nabataeans fended off the Antigonid attempt to conquer Petra in 311 BC, Diodorus attests to a large Nabataean force of 8000 men.[1841] By supposedly mustering 6000 men in the Dead Sea region, the Nabataeans successfully engaged Antigonos again. While these numbers are most certainly exaggerated, Graf's appraisal of other historical accounts on the Nabataean army demonstrates a highly efficient and well-organized Nabataean military based largely on Hellenistic models.[1842] The Nabataean military did not consist of a large standing army, but of a small number of long-serving troops (more below). Short-term units were most likely levied only in times of war. In peacetimes, the Nabataean military was probably mainly tasked with policing the countryside. This is known from other regions of the Hellenistic East as well. The absence of military structures in the Petraean hinterland before the 1st century BC (with the exception of at-Tiyir), may lead to the assumption that the early Nabataean army relied even more on "short-term levies"[1843] than in later periods. This seems confirmed when considering Diodorus' accounts of the Nabataean σκοποί who, in the late 4th century BC, observed the activities of the oncoming Antigonids from hilltops in the Petra area (more below). However, none of the presumed Nabataean military sites in the Petraean hinterland have been excavated. Future archaeological research (particularly at at-Tiyir) may therefore shed more light on the region's military disposition during the Hellenistic period.

Terra Petraea in the Nabataean Period

This section presents an extensive discussion of the Petraean hinterland during the Nabataean period (1st centuries BC and AD). As the Nabataean realm was annexed by the Roman Empire in 106 AD, the 2nd century AD is assessed in the next section.

1833 Cf. e. g. Erickson-Gini 2007, 91.
1834 As they arguably still followed a predominantly pastoral nomadic way of life, these trade activities were most likely only small-scale in comparison to the later periods.
1835 Erickson-Gini – Israel 2013, 44; Erickson-Gini 2007, 93.
1836 Erickson-Gini – Israel 2013, 34.
1837 ShamAyl Site No. 095: MacDonald et al. 2016, 272.
1838 Tholbecq – Durand 2013.
1839 Tholbecq 2011b, 31, 43–44; Tholbecq et al. 2008, 247.
1840 MacDonald et al. 2012, 192.
1841 Diod. Sic. 19, 95, 5. Cf. also Kennedy 2004, 44–47; Hackl et al. 2003, 66–69 as well as Graf 1994b.
1842 Graf 1994b, 270–274.
1843 Kennedy 2004, 45.

Subsistence Strategies and Communication

As P. Kouki's research on rural agricultural settlements included less archaeological sites than was available to this study, it seems appropriate to compare her results with this study's findings in more detail.[1844]

To further classify the recorded settlements in terms of size, Kouki proposed three size categories for rural settlements. 'Small sites' consist of one isolated building (i. e. a single farmstead). 'Medium-sized sites' are a cluster of at least two buildings and thus also referred to as hamlets or large farmsteads. 'Large sites' include "extensive" settlements consisting of many buildings (i. e. villages, "suburbs" or small towns).[1845]

This study's classification of settlements differs somewhat from Kouki's. The different settlement classifications can generally be related to her size categories as follows:

Small sites = Farms, rural mansions
Medium-sized sites = Cluster of buildings
Large sites = Towns, villages

Kouki observed only four sites in the Jabal Shara region that date to the 1st century BC. No settlements were discussed in the eastern periphery of the Petra area. The FJHP identified four sites west of Petra, close to routes leading to the city. Despite this relatively low number, Kouki argues that the emergence of rural settlements is a result of the gradually sedentarizing Nabataean society, triggered by the increase of trade and the general contact with other parts of the (sedentary) Hellenized East. The increasing sedentary rural population consequently caused a high demand for agricultural goods leading to an intensification of crop cultivation. While this is generally supported, this study has shown a different picture for the 1st century BC. While Kouki lists only eight settlements, this study presents an explosive increase in the overall count of rural settlements with 214 settlements dating to the 1st century BC. The Nabataean sedentarization process and increasing need for agricultural goods to meet the demands of heightened trade activities seems far more developed in the Petra area during the 1st century BC than previously assumed.

This development continued in the 1st century AD, as shown by a significant increase of rural settlements of all sizes (in total 268), and culminated in the 2nd century AD (270 settlements).[1846] Settlements concentrate in the Jabal Shara area, which receives the highest rainfall. Wadi Musa can be characterized as a 'suburb' to Petra.[1847] While the comparatively few sites in the western periphery of the Petra area were along routes (mostly medium-sized sites), a vast expansion towards the eastern peripheries was observed, mostly around Udruh as well as a scatter of sites to the south around Ayl and Saddaqa. This is largely confirmed in this study, but a particularly high concentration of clusters of buildings was observed in areas north of Beidha as well. This suggests an even denser and more widespread distribution of rural settlements than previously assumed.

Kouki argues that most of the sites east of Petra are reportedly small, but there are also medium-sized sites and the possibility that large sites were settled as well is considered likely, although the high activity during later periods (e. g. at Udruh and Jarba) renders this difficult to establish.[1848] This study also demonstrates a noticeable increase of smaller settlement types that significantly exceed the number of larger settlements such as villages or clusters of buildings. This development can now already be observed for the 1st century BC.

The rapid expansion of rural settlements, and thus agriculture, is directly associated with the economic and political peak of the Nabataean realm during the 1st century AD and reflects the need to supply both the growing population in urban Petra as well as the caravans that travelled through the region with agricultural goods.

Based on 1st and early 2nd century AD sites, Kouki proposes a three-tiered settlement hierarchy of "consecutively smaller communities" that radiated around Petra. These are mostly small sites (=single farmsteads), a smaller number of medium-sized sites and only a few large sites.[1849] The findings of this study fully support this settlement hierarchy, although predate it by a century. From the 1st century BC until the 2nd century AD, there is a dominant increase of farms, which are far more numerous than clusters of buildings (= Kouki's medium-sized sites), villages or towns (= Kouki's large sites). Not only do the kernel

1844 For a synthesis of Kouki's results, see Kouki 2012, 129–133.
1845 Kouki 2012, 79.
1846 Kouki 2012, 84–85 as well as Graf 1992 and Fiema's doctoral thesis from 1991 *Economics, administration and demography of Late Roman and Byzantine Southern Jordan* (Department of Anthropology, University of Utah).
1847 Kouki 2012, 84 with reference to ʾAmr – al-Momani 2001, 266–267 and ʾAmr et al. 2000 particularly referring to the luxurious villas of the 1st century AD.
1848 Kouki 2012, 97, 129.
1849 Kouki 2012, 97, 129.

density estimations show similar distribution patterns of these settlement types, the Pearson correlation tests demonstrated that there is no noteworthy spatial relation between towns, villages or clusters of buildings. This indicates that these sites are less important in this period and highlights the significance of smaller settlements such as single farms. Despite the emergence of major Nabataean settlements such as Sabra, Abu Khusheiba, as-Sadeh or even Udruh, Saddaqa and Khirbet Jarba, the settlement pattern does not suggest a large concentration of rural sites around these places during the Nabataean period. It thus seems that their development is mostly due to their location along important trade routes, therefore serving as potential transshipment centers for trade goods. However, smaller settlements provided the economic and agricultural backbone of the Petraean hinterland in the Nabataean period.

The point pattern analyses nevertheless highlight an interesting phenomenon concerning the area of Wadi Musa (FIGS. 348–355). While the mean center of the settlement distribution is northeast of Wadi Musa during the 12th and 11th centuries BC, it moves further south during the 10th century BC and remains there during the entire course of the Iron Age period (cf. chapter 3). Since the 1st century BC, the mean center is now clearly placed at Wadi Musa, thus emphasizing the frequently underestimated importance of the town as it remained the mean center of all settlements until the 3rd century AD.[1850] From the 4th century AD onwards, the mean center moves gradually to the south-southeast. This is an important observation, as Petra itself was clearly never in the focus of its surrounding settlement pattern – unlike Wadi Musa. While there were most likely only modest settlement activities in Petra before the 1st century BC, the area of Wadi Musa was already densely settled. This indicates that settlements around Wadi Musa supplied agricultural goods and other products to Petra.[1851] The town's economic importance for Petra and its hinterland was also due to its advantageous position along the Darb ar-Rasif and later *via nova Traiana*. Arguably, Wadi Musa was the most important transshipment center of trade goods in Petra's immediate eastern hinterland. It is therefore unsurprising that several luxurious Nabataean *villae* were built at Wadi Musa. Members of the local elite certainly acquired significant wealth through trade activities.

In addition to the pattern of rural agricultural settlements, the documented agricultural installations provide further archaeological evidence that rural Petra's economy was predominantly based on agriculture. While the evidence for the practice of agriculture is extremely limited for the Iron Age and Hellenistic periods, a conspicuous increase of all categories of agricultural installations can be observed by the 1st century BC. This particularly concerns agricultural processing installations as well as terraces and barrages. As shown by the kernel density estimations, there are three distinct clusters of agricultural terraces and barrages in the as-Sto'e and al-Farasha plains (extended Jabal Harun area), the al-Begh'ah plain in the Beidha area as well as in the ad-Thankia region north of Baja. This indicates that run-off cultivation was predominantly practiced along the slopes of these areas. These distinct clusters of run-off systems correlate with the results of the kernel density estimations of agricultural processing installations as well. By the 1st century BC, numerous rock-cut wine presses of various sizes and types are particularly known in the extended Beidha and ad-Thankia regions. Olive presses are mainly evidenced in the Wadi Musa area and further along the western slopes of the Jabal Shara escarpment. Threshing floors concentrate mostly along the eastern high plateau.

The distribution of agricultural processing installations and terraces/barrages thus allow to tentatively propose a rough map of different cultivation zones for the Petraean hinterland (FIG. 356). The threshing floors along the eastern high plateau suggest that this area was mainly used for cereal cultivation, while the western slopes of the Jabal Shara escarpment may have been used mostly for the cultivation of olives. These were most likely grown predominantly for local use and/or as components for processed products.[1852] The fact that cereals were cultivated on the eastern high plateau and olives along the Jabal Shara escarpment is not surprising as these areas enjoy the highest annual rainfall rates in the Petra area.[1853]

Arguably, the extended ad-Thankia and Beidha areas were mostly used for viticulture as evidenced by the numerous wine presses. The areas north and west of the Beidha region (particularly the al-Farsh area) may have also produced cereals as modern fields can still be observed in the area today. While one wine press is documented in the eastern as-Sto'e

1850 The G-, F- and K-functions suggest a heightened clustering of settlements from the 1st century BC onwards as well.
1851 Cf. e.g. 'Amr 2012.
1852 On the cultivation practices of the eastern study area, cf. Driessen – Abudanh 2018, 137–140.
1853 Future archaeobotanical studies planned by the UAP in the Udruh area will have to confirm this assumption. Cf. Driessen – Abudanh 2018, 149.

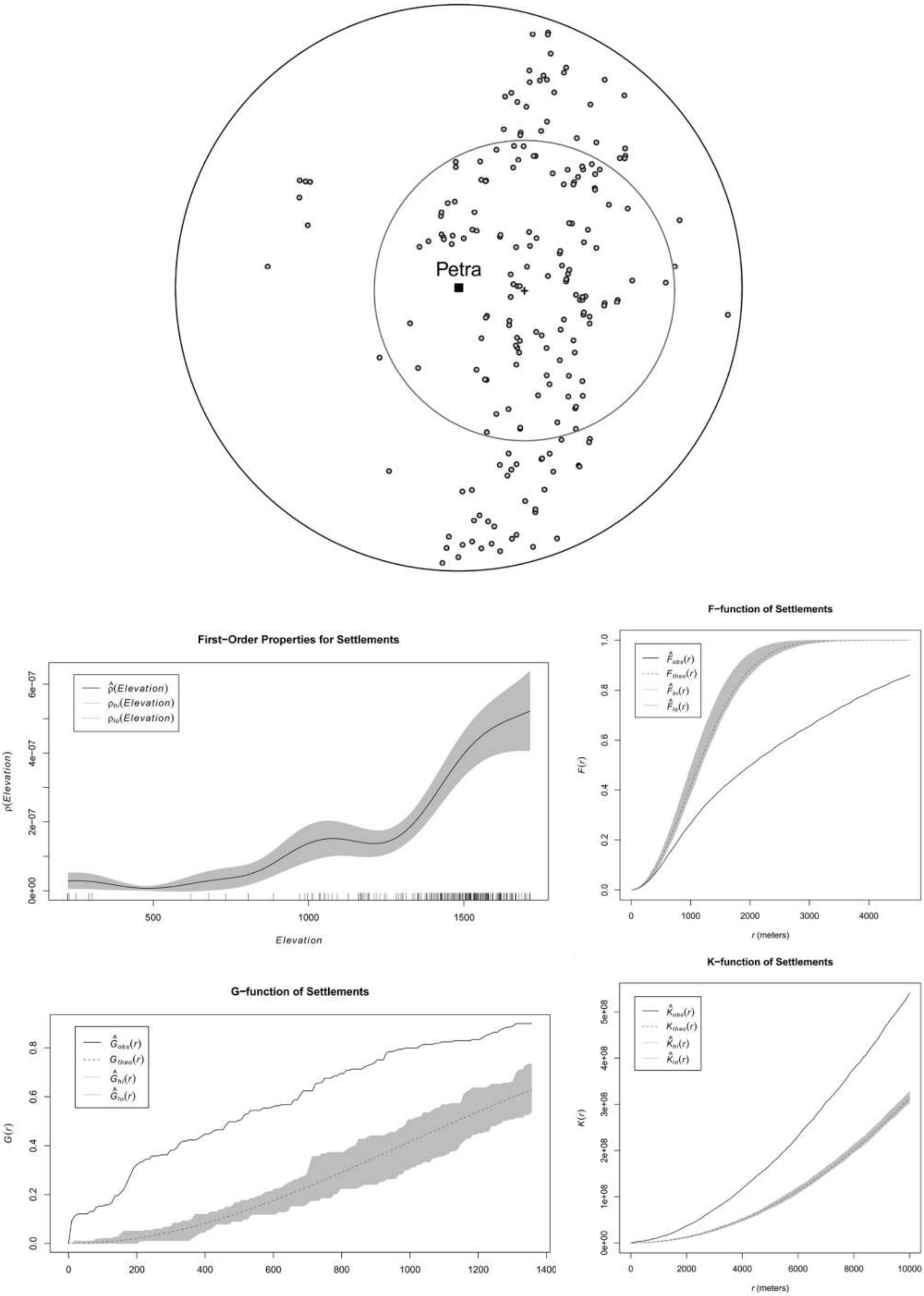


FIG. 348 Point pattern analyses of settlements dating to the 1st century BC. Above: All evidenced settlements in the study area with mean center of the pattern (cross) encircled by the standard distance between all settlements. Upper left: Intensity function of terrain elevation for all settlements. Lower left: G-function. Right: F- and K-functions.

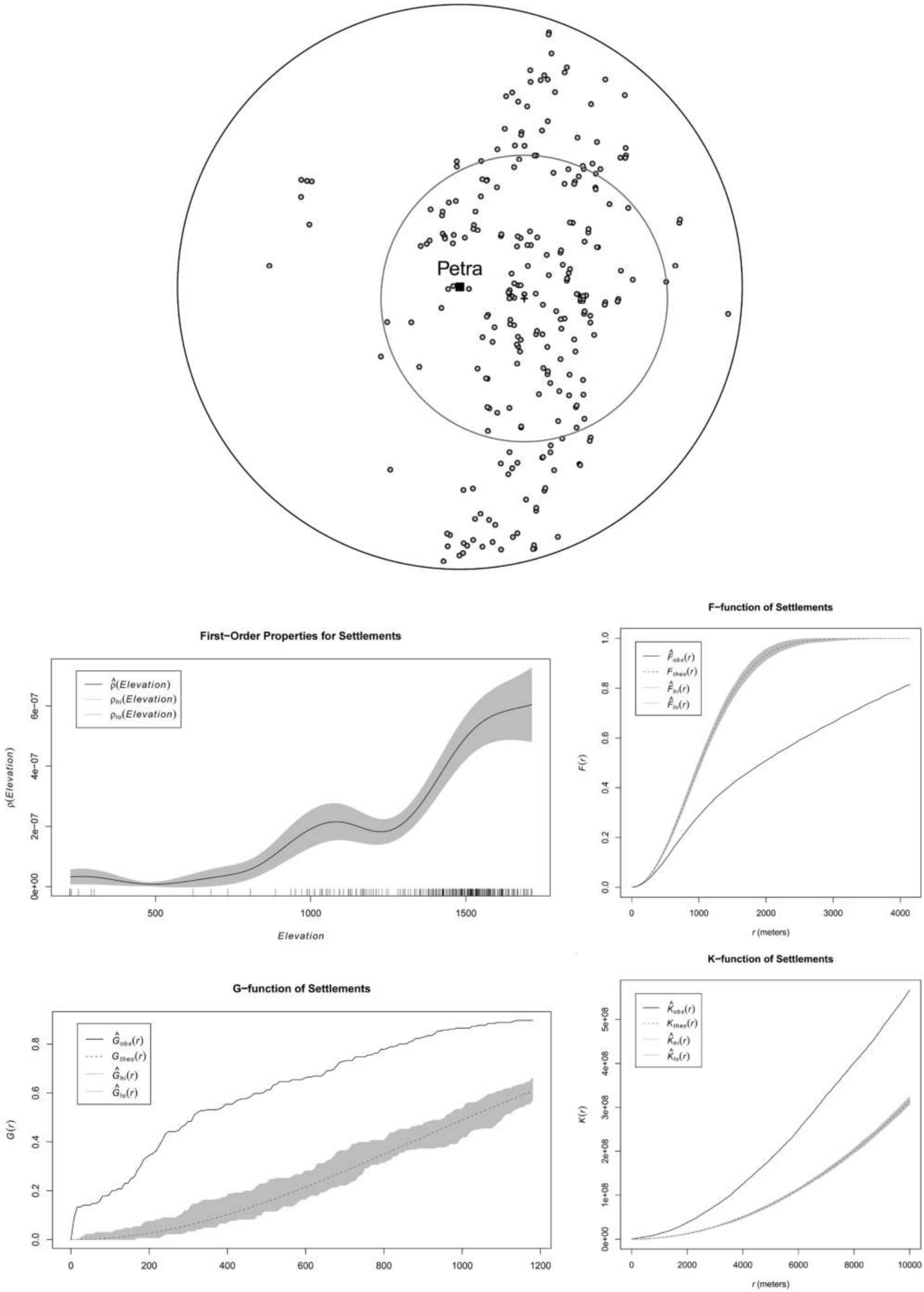


FIG. 349 Point pattern analyses of settlements dating to the 1st century AD. Above: All evidenced settlements in the study area with mean center of the pattern (cross) encircled by the standard distance between all settlements. Upper left: Intensity function of terrain elevation for all settlements. Lower left: G-function. Right: F- and K-functions.

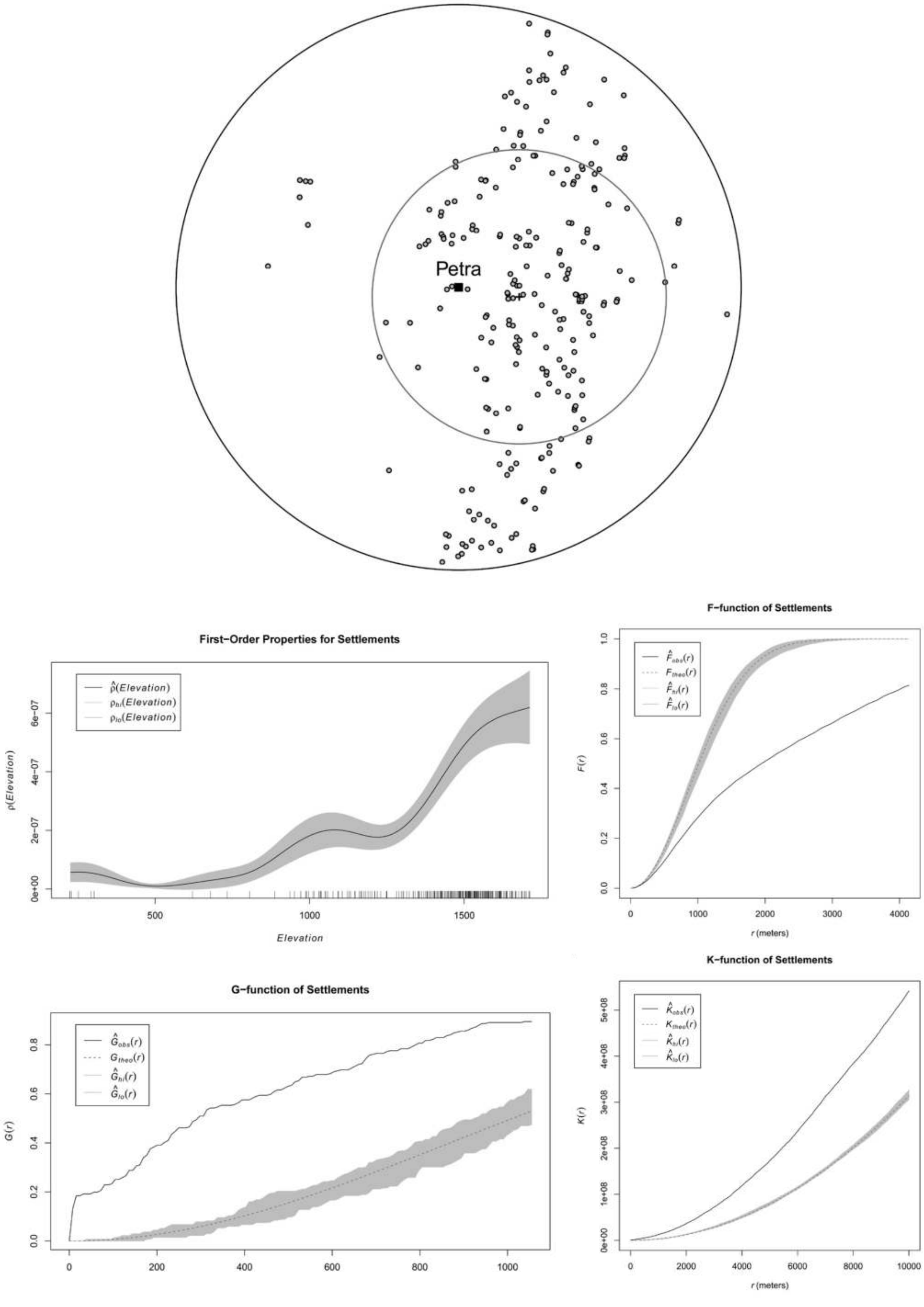


FIG. 350 Point pattern analyses of settlements dating to the 2nd century AD. Above: All evidenced settlements in the study area with mean center of the pattern (cross) encircled by the standard distance between all settlements. Upper left: Intensity function of terrain elevation for all settlements. Lower left: G-function. Right: F- and K-functions.

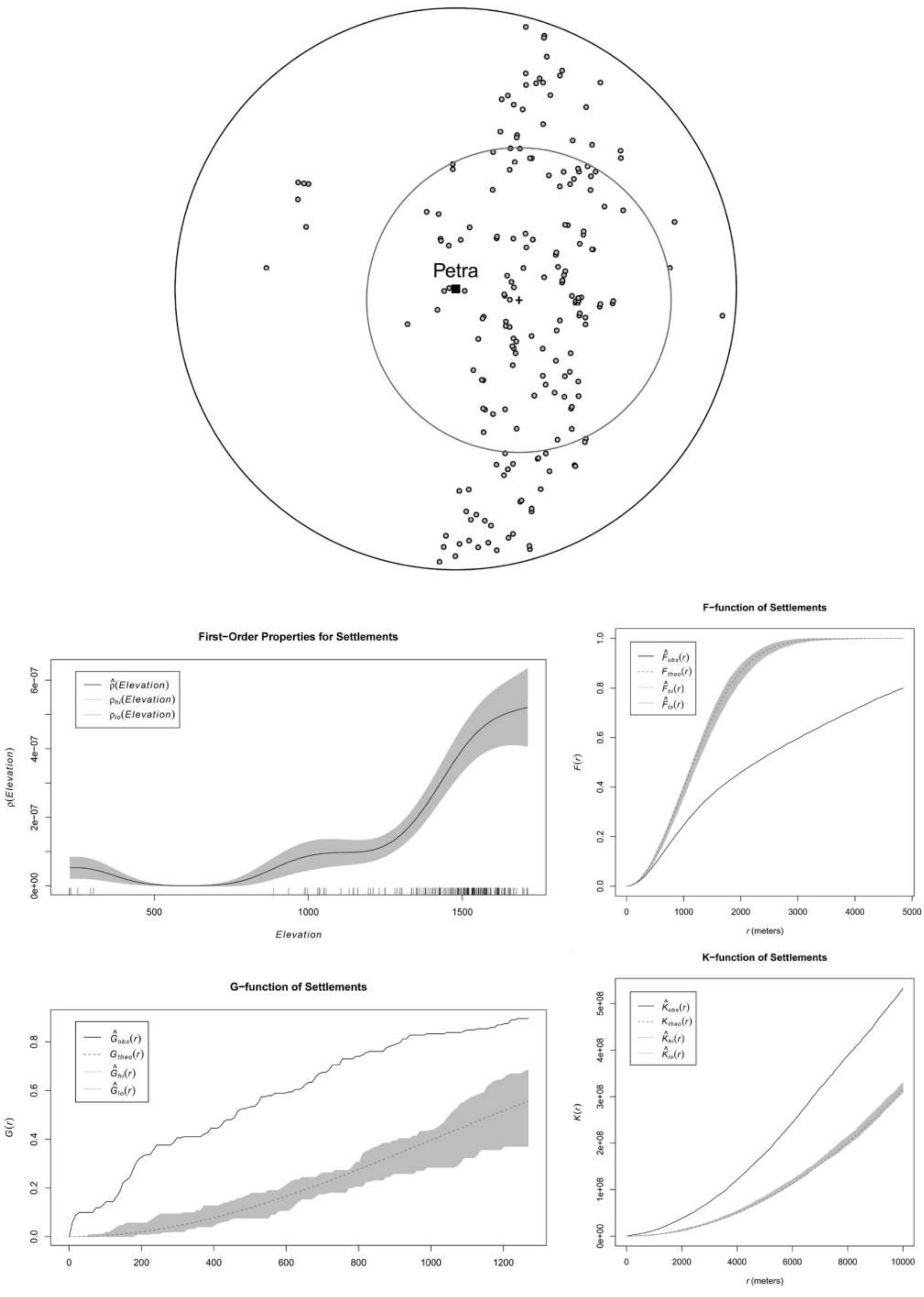


FIG. 351 Point pattern analyses of settlements dating to the 3rd century AD. Above: All evidenced settlements in the study area with mean center of the pattern (cross) encircled by the standard distance between all settlements. Upper left: Intensity function of terrain elevation for all settlements. Lower left: G-function. Right: F- and K-functions.

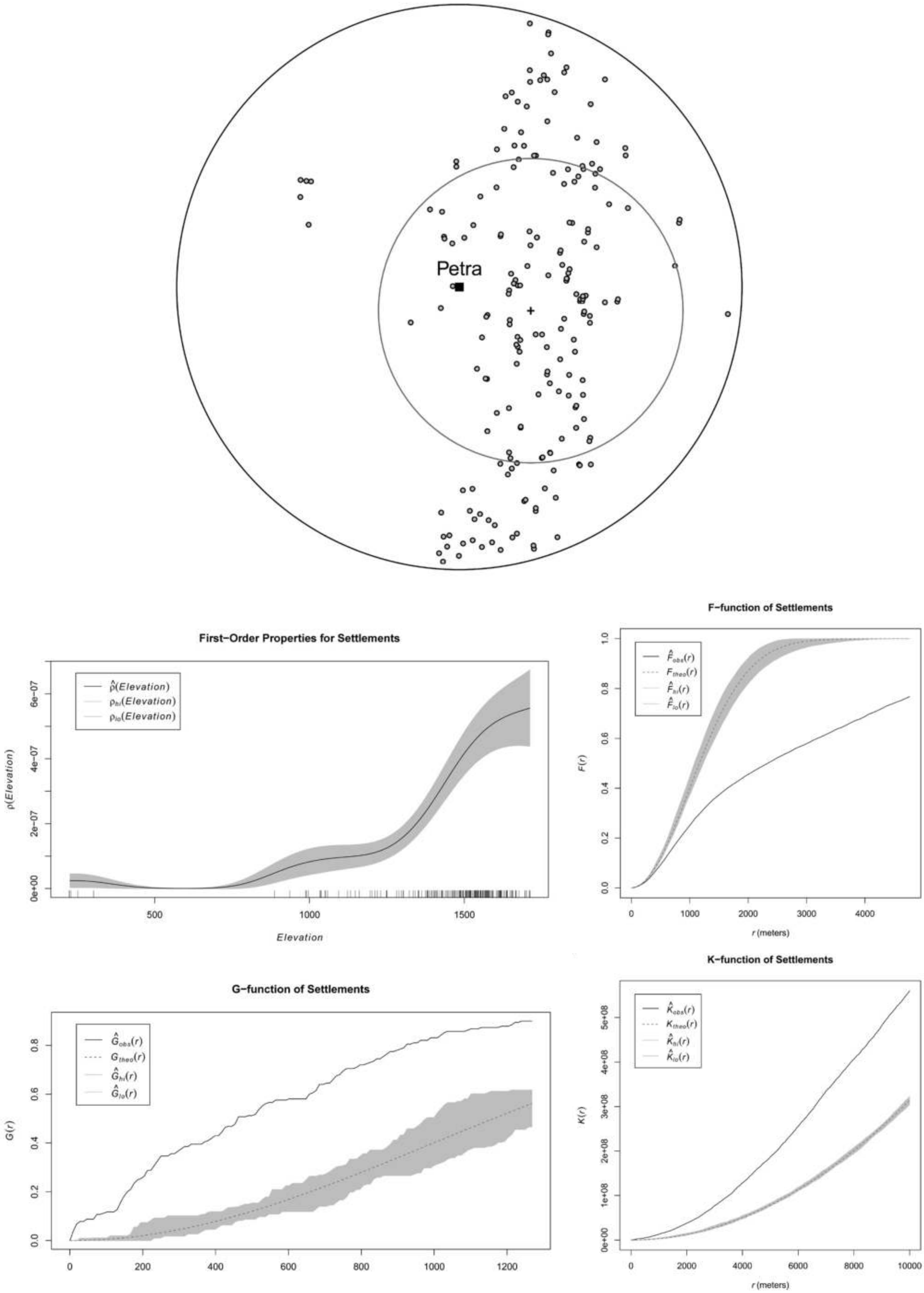


FIG. 352 Point pattern analyses of settlements dating to the 4th century AD. Above: All evidenced settlements in the study area with mean center of the pattern (cross) encircled by the standard distance between all settlements. Upper left: Intensity function of terrain elevation for all settlements. Lower left: G-function. Right: F- and K-functions.

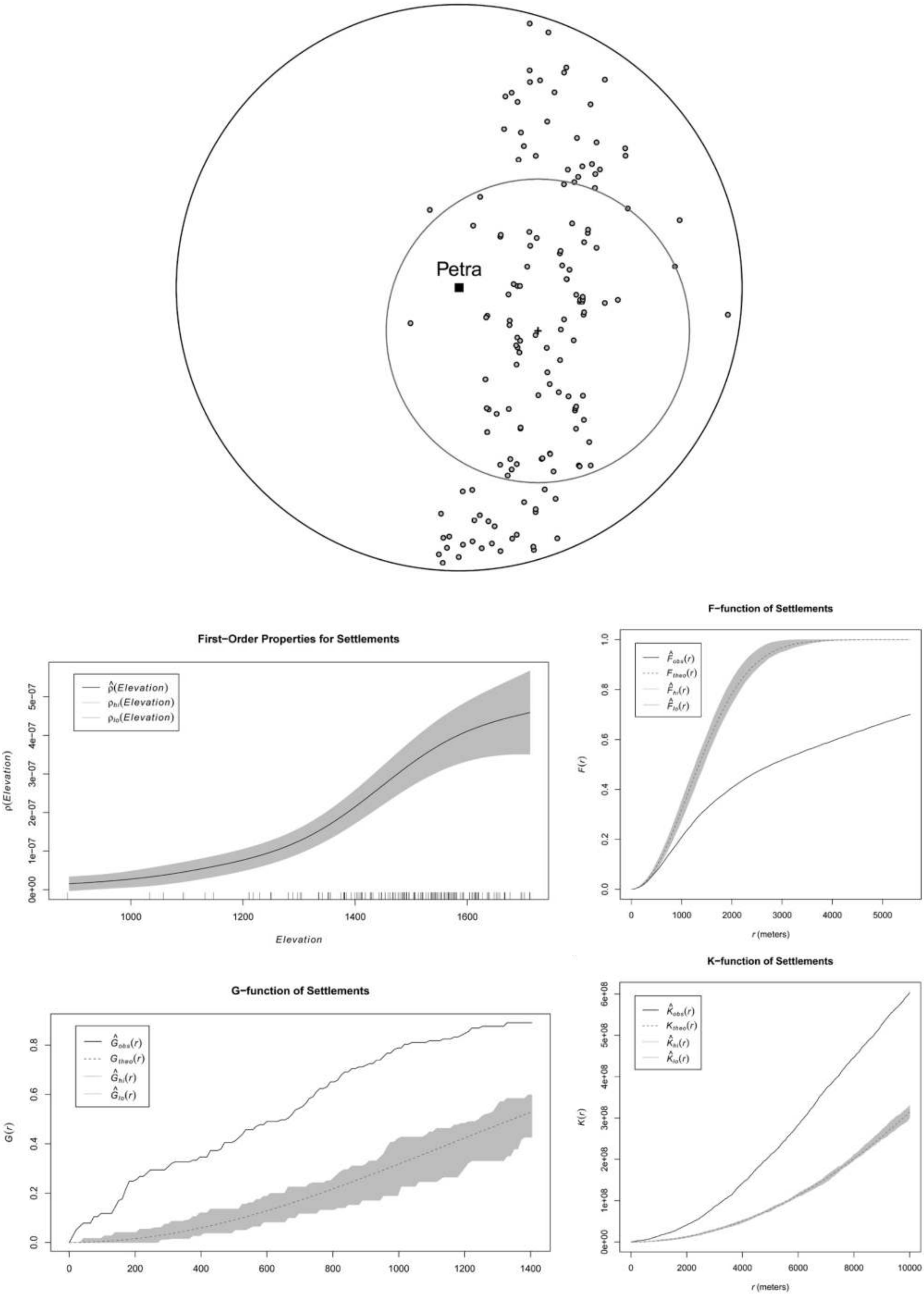


FIG. 353 Point pattern analyses of settlements dating to the 5th century AD. Above: All evidenced settlements in the study area with mean center of the pattern (cross) encircled by the standard distance between all settlements. Upper left: Intensity function of terrain elevation for all settlements. Lower left: G-function. Right: F- and K-functions.

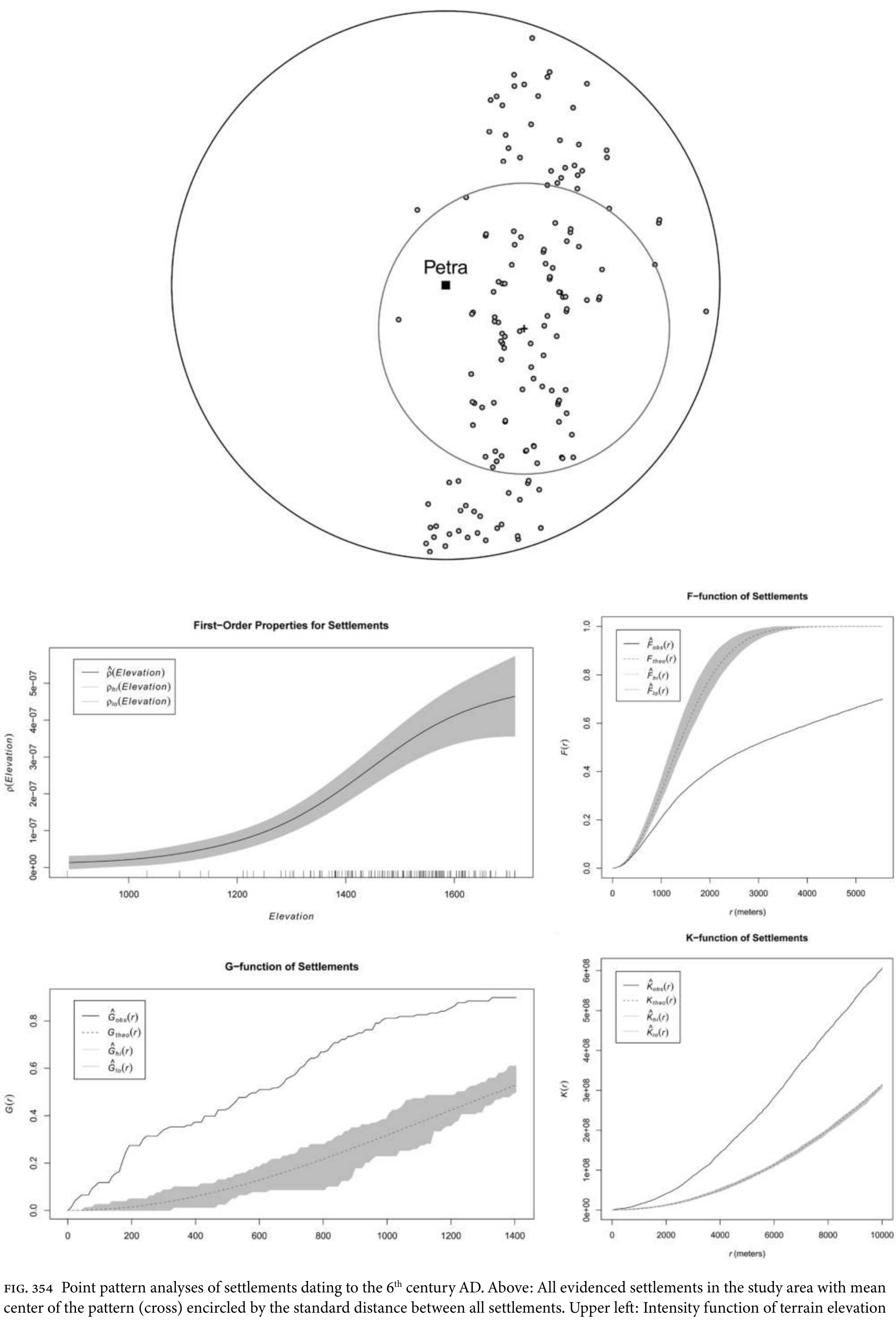


FIG. 354 Point pattern analyses of settlements dating to the 6th century AD. Above: All evidenced settlements in the study area with mean center of the pattern (cross) encircled by the standard distance between all settlements. Upper left: Intensity function of terrain elevation for all settlements. Lower left: G-function. Right: F- and K-functions.

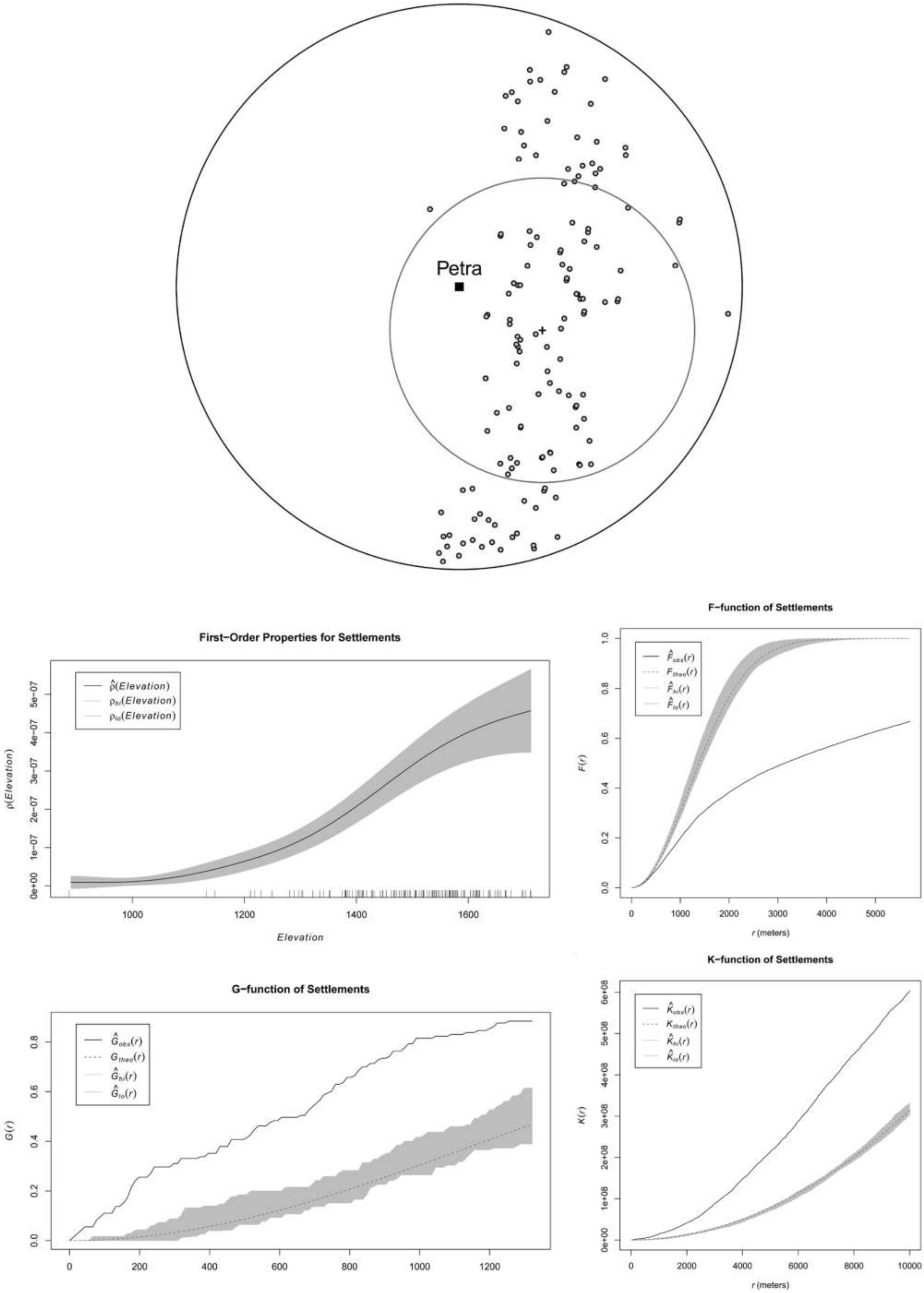


FIG. 355 Point pattern analyses of settlements dating to the 7th century AD. Above: All evidenced settlements in the study area with mean center of the pattern (cross) encircled by the standard distance between all settlements. Upper left: Intensity function of terrain elevation for all settlements. Lower left: G-function. Right: F- and K-functions.

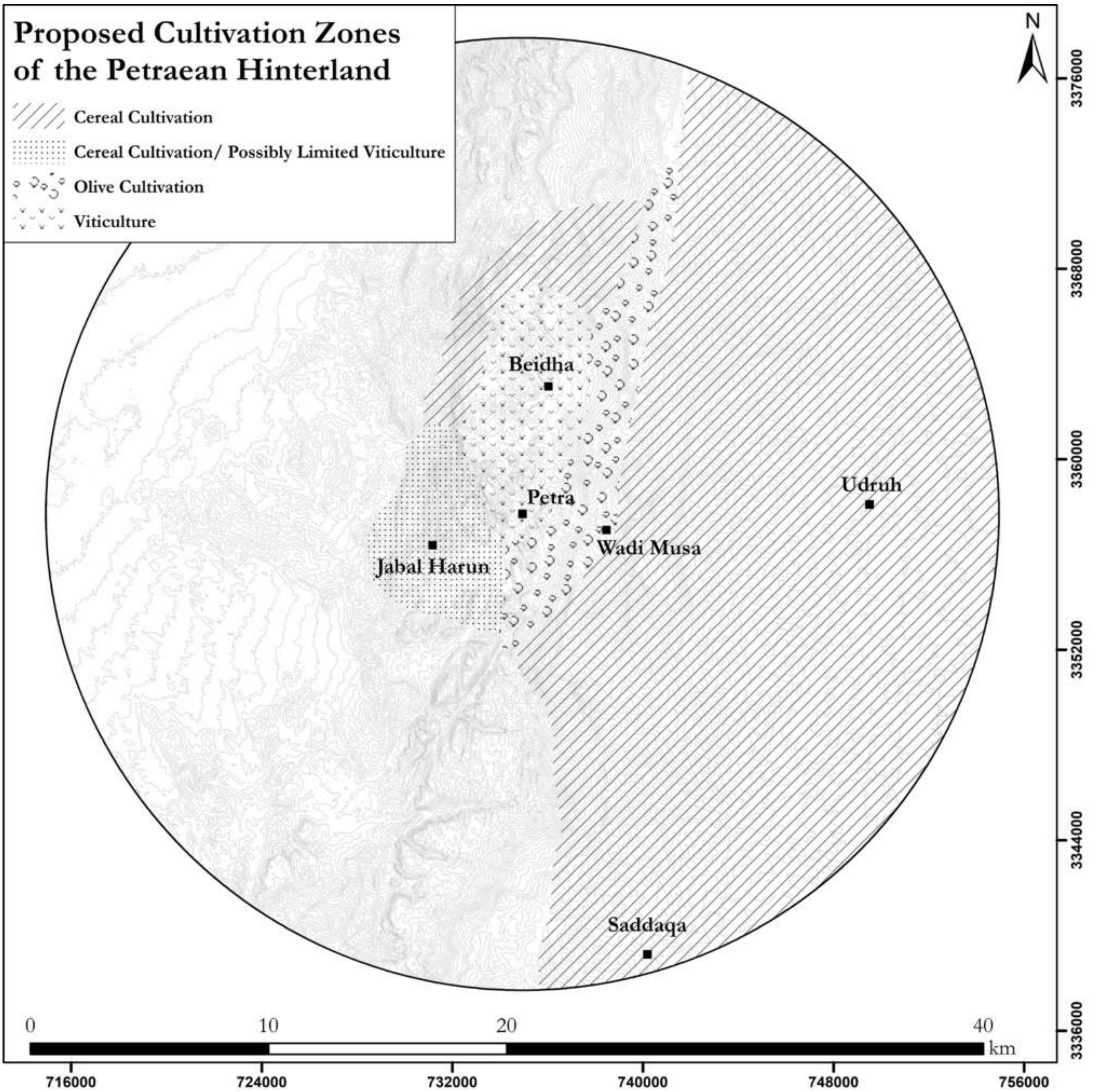


FIG. 356 Rough map of possible cultivation zones in the Petraean hinterland based on the distribution of agricultural processing installations, terraces and barrages.

area, threshing floors are predominantly documented in the extended Jabal Harun area southwest of Petra. This indicates that the area was mainly used for cereal production by means of run-off cultivation. It is likely that viticulture was also practiced in the area, although probably only on a limited scale.

While the proposed cultivation zones are likely to represent the *general* reality, the accuracy of the mapped zones is far from precise and therefore only suggestive. For example, in addition to the many terraces and wine presses around Beidha, modern cereal crops (mainly barley) can also be observed in the area today.[1854] It is therefore possible that the area was used for cereal cultivation in antiquity as well – in addition to viticulture.

Nevertheless, archaeobotanical evidence from Petra supports the three main cultivation practices suggested by the archaeological evidence in the city's hinterland. The clear majority of barley grains in archaeobotanical samples from the villa of ez-Zantur clearly suggest that, from the 1st century BC to the 4th century AD, barley was the most cultivated cereal for human

1854 Cf. e.g. Russel 1995, 696–699.

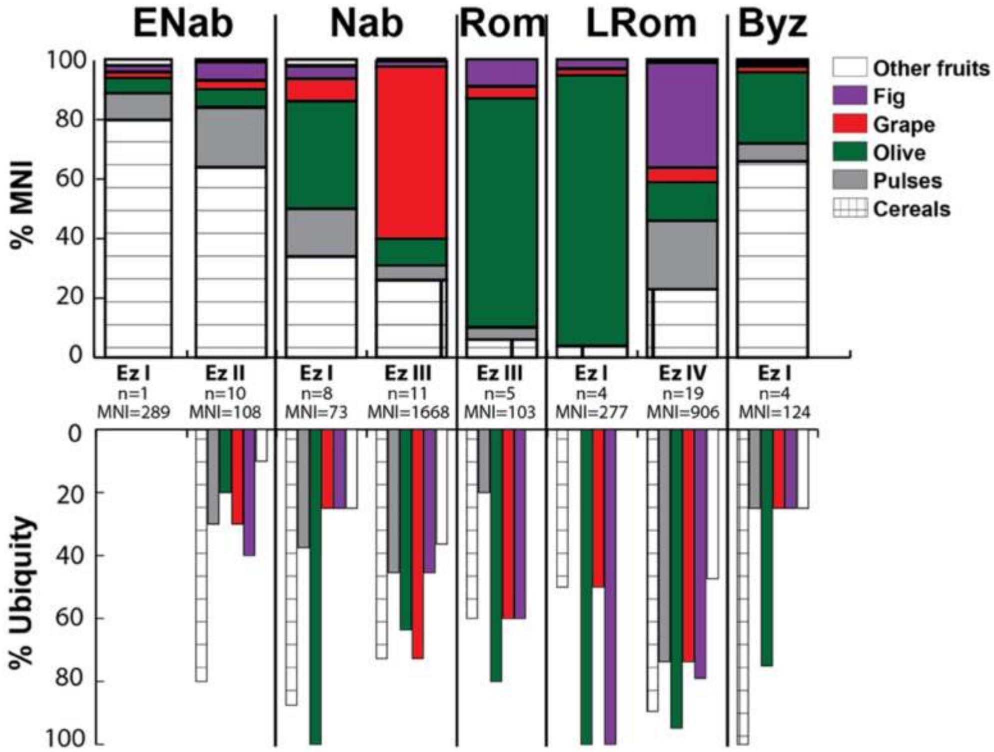


FIG. 357 Diagram of the 7640 analyzed archaeobotanical remains from ez-Zantur in Petra after Bouchaud et al. 2017, 232, fig. 4. MNI=minimum number of items; n= number of samples. ENab= mid-2nd – mid-1st century BC; Nab= mid-1st century BC – 1st century AD; Rom= 2nd – 3rd century AD; LRom= 1st half 4th century AD; Byz=early 5th century AD.

consumption in the Petra area.[1855] Similar finds in Late Byzantine/Early Islamic deposits at Jabal Harun support this.[1856] The dominance of barley is not surprising as it is better suited for arid and hot climates in comparison to other cereals such as wheat. However, the archaeobotanical remains from ez-Zantur revealed at least three different cereal species (FIG. 357).[1857] In addition to barley and other cereals, samples from all phases of ez-Zantur (1st century BC to the 7th century AD) also contained remains of pulses such as lentils. Macrofossil analyses from Byzantine/Islamic contexts at Jabal Harun achieved similar results.[1858]

There is clear evidence for the cultivation of olives as well. This is suggested by pollen of olive trees dating to the Nabataean-Roman as well as Byzantine periods, crushed olive stones discovered at ez-Zantur from the Nabatean to Byzantine periods as well as olive stones discovered in the archaeobotanical samples from Jabal Harun.[1859] In combination with the olive presses at ez-Zantur as well as those recorded in Petra's hinterland, this gives reason to seriously doubt Strabo's account that olive trees did not grow in the Petra area.[1860]

Archaeobotanical samples from Nabataean to Late Roman contexts of the ez-Zantur villa also contained grape pips. This offers additional evidence for viticulture in the Petra area. As for the recorded olive stones, the grape pips were most likely used as fuel.[1861] Early Nabataean to Late Roman contexts at ez-Zantur also indicate that figs and dates were consumed. The run-off systems in the Beidha area could have been used for the cultivation of more demanding fruit trees as well.[1862] The archaeobotanical analyses of the taxa from ez-Zantur have shown a clear increase in the cultivation of fruits (particularly olives and grapes) between the Early Nabataean and Late Roman periods.[1863] The

1855 Bouchaud et al. 2017, 228.
1856 Lavento et al. 2013, 225; Kouki 2012, 108 with further references.
1857 Bouchaud et al. 2017, 228.
1858 Bouchaud et al. 2017, 230: Lentils are not evidenced in EZ II during the 1st century BC and in EZ I not during the Late Roman period. For the evidence from Jabal Harun, see Kouki 2012, 109 with further references.
1859 Bouchaud et al. 2017, 231, 232; Lavento et al. 2013, 226; Kouki 2012, 109; Karg 1996, 357; Fall 1990, 227.
1860 Str. 16, 4, 26. Cf. also Bouchaud et al. 2017, 236.
1861 Bouchaud et al. 2017, 234; Lavento et al. 2013, 226; Kouki 2012, 110.
1862 Bouchaud et al. 2017, 231, 234; Kouki 2012, 109; Jacquat – Martinoli 1999, 29; Karg 1996, 358.
1863 As noted by Bouchaud et al. 2017, 236, other archaeobotanical studies from different archaeological contexts in

wine and olive presses in Petra's hinterland confirm this. This is also supported by the development of Petra's intricate water management system during the 1st century BC. Moreover, the rapidly developing urbanization process of Petra in the course of the 1st century BC as well as the contemporary increase of farms and the appearance of agricultural terraces/barrages and agricultural processing installations clearly indicate a shift to a more agriculture-based society specialized in growing well-known fruits, pulses and cereals for mainly local use.[1864]

While the water management system in the study area was largely based on the collection and storage of run-off water in cisterns during the Iron Age, by the Nabataean period the technologically highly developed aqueducts supplied not only Petra with fresh water, but also other, more remote Nabataean sites such as Qasr Umm Rattam, Sabra or as-Sadeh. Fresh drinking water was directly tapped from the numerous springs that are distributed along the Jabal Shara escarpment. The watershed of all recorded springs has confirmed previous assumptions that the most water-bearing areas of the Petraean hinterland are the extended ad-Thankia, Beidha and Jabal Harun regions where archaeological evidence for run-off cultivation is abundant. It was also shown that the watershed extended further southeast between Wadi Musa and Ayl as well as areas immediately north of Saddaqa along the eastern high plateau. This correlates largely with main clusters of rural settlements. The proposed watershed thus emphasizes that, from a hydrological point of view, Petra is located in an advantageous position – however, only as long as water flow is controlled and managed. Intricate systems of barrages and dams protected rural areas from devastating flash floods and significantly aided agricultural run-off cultivation.

While the rural settlements, agricultural installations and water structures clearly suggest a predominantly agriculture-based economy of the Petraean hinterland since the 1st century BC, a significant number of sites were identified that may be interpreted as material evidence for alternative, *pastoral* subsistence strategies in addition to farming.[1865] This includes the possibility of pastoral nomadism and seasonal pastoralism practiced by sedentaries. Admittedly, the evidence for ancient pastoralism in the Petraean hinterland is debateable, by nature problematic, and certainly suggestive rather than conclusive at this point (cf. chapter 4). Nevertheless, when considering all the evidence, it may be proposed that a pastorally organized rural population constituted a significant part of the Petraean hinterland through all periods. Particularly concerning the Nabataeans, such 'mobile' subsistence strategies are often neglected in the scholarly discourse as the focus is predominantly set on the Nabataean sedentarization process evidenced by the rapid development of urban Petra and the explosive increase of permanent agricultural rural settlements. However, pastoralism was a significant subsistence strategy in the Petraean hinterland in addition to farming. Not only is this a major economic factor to consider, but it emphasizes a heightened aspect of mobility which has important *social* implications as well.

The archaeological evidence for ancient pastoralism in the Petra area includes numerous (42) camp sites that are distributed throughout the entire study area and which, if datable at all, date predominantly to the 1st and 2nd centuries AD. If the discussed structures are indeed camp sites – as the parallels from the Negev suggest (cf. chapter 4) – there is no way of knowing whether the camps were pitched by non-sedentary nomadic pastoralists traveling through the study area or whether they represent temporary tent dwellings of mainly sedentary peoples living in the Petraean hinterland. The camp sites are nevertheless so far unrecognized, direct archaeological evidence for pastoral subsistence strategies in the study area. They indicate that pastoralism was a vital additional component of the agriculture-based economy that peaked from the 1st century BC onwards. This is supported by the 50 corrals that are distributed throughout the entire study area. If datable, surface material suggests a date mainly between the 1st century BC and 4th century AD.

Additionally, a total of 24 sites were surveyed by ARNAS and ShamAyl along the Jabal Shara escarpment and the eastern high plateau which are referred to as "seasonal farmsteads" or "seasonal, pastoralist camps (?)" (FIG. 358).[1866] These sites are structures

Petra generally confirm these results. Cf. e.g. Ramsay – Bedal 2015; Sachet et al. 2013 or Tholbecq et al. 2008.

1864 It is also possible that the agricultural produce was traded on a small scale as well.

1865 For some comparable methodological approaches on how to deal with ancient pastoralists and nomadism in the archaeological record (particularly in the Near East), see e.g. Potts 2014; Szuchman 2009; Bernard – Wendrich 2008; Hauser 2006; Bradley 1992; Cribb 1991.

1866 These are ARNAS Site Nos. 151, 185, 187, 210, 213 (MacDonald et al. 2012, 160, 183, 185, 211, 212) and ShamAyl Site Nos. 14, 41, 46, 47, 55, 56, 73, 77, 92, 127, 128, 129, 181, 264, 333, 343, 344, 364 (MacDonald et al. 2016, 135, 161, 167–168, 174–175, 177, 192, 195, 212, 242–244, 296, 372, 426, 433–434, 448). PHSP Site No. 159 may be such a site as well.

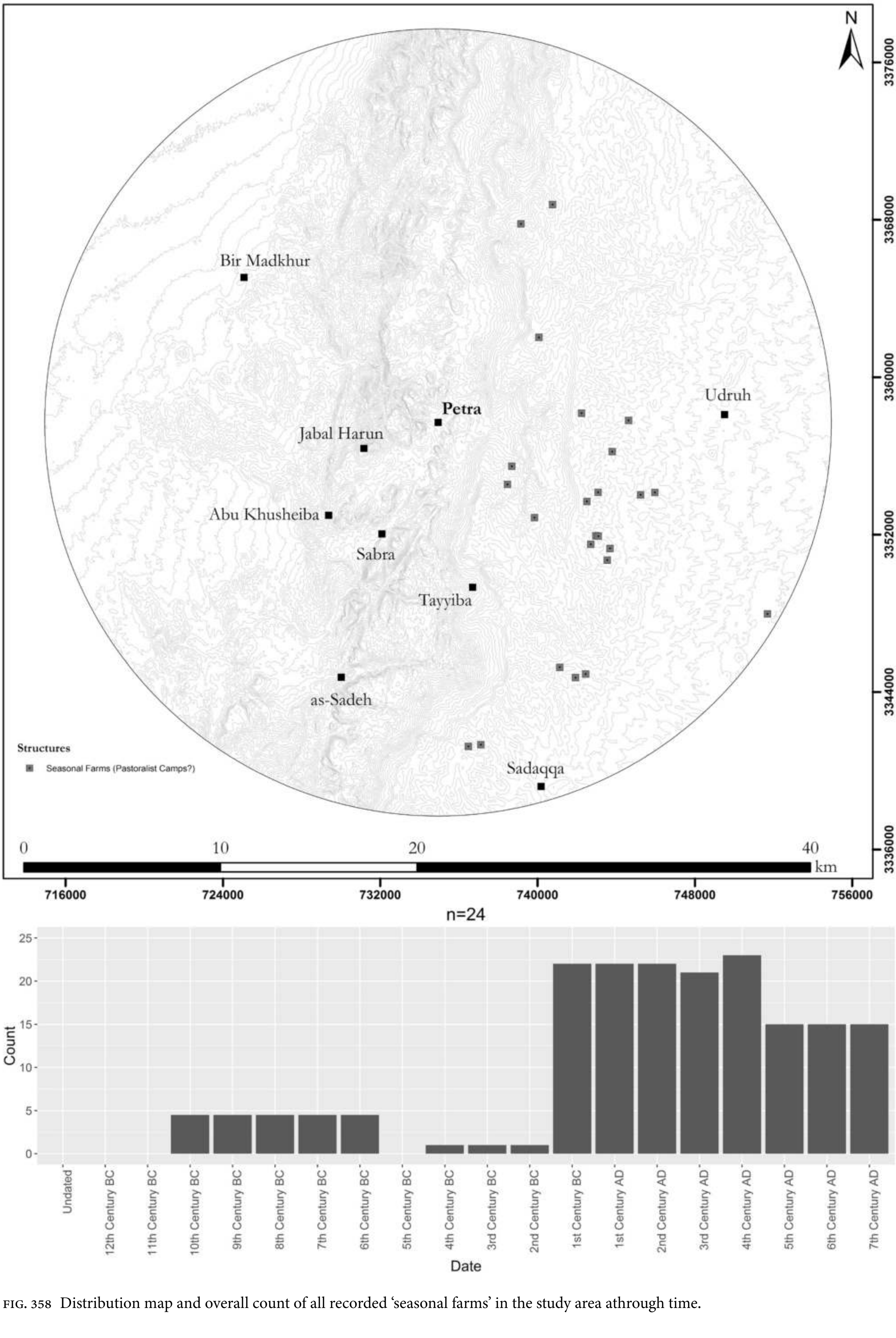


FIG. 358 Distribution map and overall count of all recorded 'seasonal farms' in the study area athrough time.

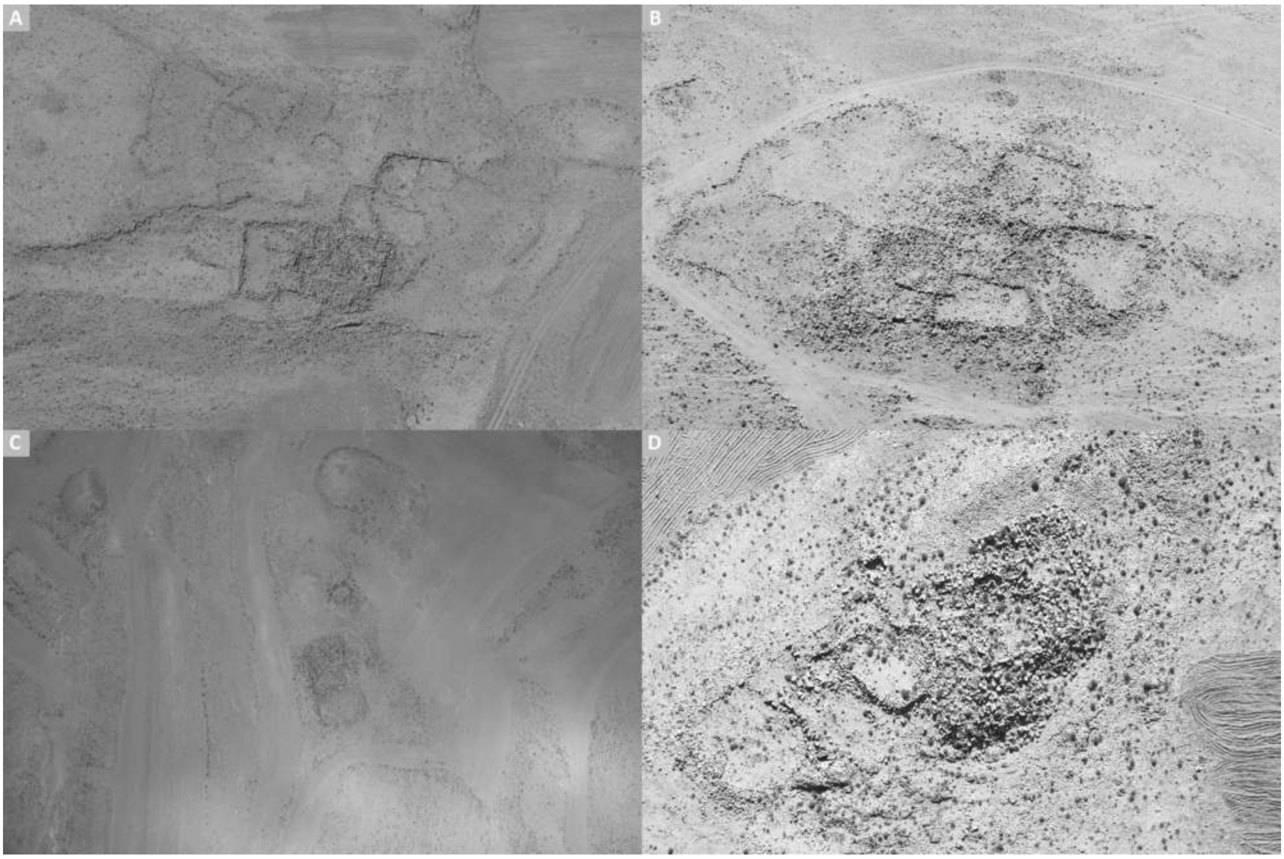


FIG. 359 Aerial views of selected farms with possible corrals. A: ShamAyl Site No. 338. B: ShamAyl Site No. 127. C: ShamAyl Site No. 343. D: ShamAyl Site No. 341. Photos: APAAME.

of various shapes and dimensions and interpreted as possible corrals or camp sites. They were often directly associated with larger, more substantially built structures located within cultivable lands. While such sites are best identified primarily as farms, the documented corrals and possible camps further suggest that seasonal pastoralism was practiced in addition to farming (FIG. 359). Surface material suggests a predominant date between the 1st century BC and 4th century AD (cf. FIG. 358).

In addition to camp sites, corrals and "seasonal farms," concentrations of rock art and find clusters etc. further indicate heightened mobility in the study area and that pastoralism was a viable subsistence strategy in the Petraean hinterland through time. Previous scholars also suspected that rural Petra's sedentary population may have constituted only one part of the overall rural population and postulated that sedentaries could have practiced seasonal pastoralism as well. Specifically concerning the Nabataean period, it was suggested that

> […] *the sedentary settlement does not represent the whole of the Nabataean society, but a mobile element was retained among the population of the Petra region throughout the existence of the Nabataean kingdom, perhaps specializing in herding in the areas outside the permanent settlement and agricultural land, and/or practicing a form of tethered mobility reminiscent of the historical Petra Bedouin.*[1867]

Although drawing parallels between premodern Bedouin societies and ancient mobile peoples may be problematic,[1868] such assertions that a "mobile element" continued to characterize the population of rural Petra are nevertheless emphasized here as well. While earlier claims lacked direct archaeological evidence, this study presents considerable archaeological indicators from the Petraean hinterland that suggest that the rural population remained, at least in part, mobile and possibly practiced extensive seasonal pastoralism.

Importantly, the evidence does not support earlier claims for an external nomadic threat from the east that supposedly was the reason for a linear defensive line of the eastern Roman frontier particularly during the 3rd and 4th centuries AD (more below).[1869] This is

1867 Kouki 2012, 99.
1868 Cf. Macdonald 1991.
1869 Parker 1986, 642–643. Particularly on this issue, consider the important scholarly discussion between Banning and Parker (Banning 1986 and 1987; Parker 1987b). A similar

not reflected by the distribution of military sites in the Petraean hinterland. Additionally, there is no spatial separation between the presented 'temporary' structures (i. e. particularly seasonal farms, corrals and camp sites) and permanent settlements. When laying all temporary structures over the kernel density map of all permanent settlements, the picture is particularly blurry in the Petra area (FIGS. 360 and 361). While the dating quality of such 'temporary sites' is problematic, it can nevertheless be observed that they are situated among both very strong and less significant clusters of rural sedentary settlements. This does not seem to change through time. There is no clear spatial division between a strictly sedentary and non-sedentary population in the Petraean hinterland, which supports the argument that seasonal pastoralism was practiced in addition to farming. Although there is no way of determining this for certain, the 'temporary sites' could have also been used by non-sedentary, nomadic pastoralists as well. While it is impossible to trace their origins, it is likely that many came from the vast eastern desert areas. At any rate, this indicates that a segment of Petra's rural population led a combination of a sedentary and non-sedentary life.

Furthermore, following recent studies on the Khatt Shebib wall, this study dismisses the assumption that it served any defensive purposes against potential nomadic raids from the east. Instead, the wall most likely served as a demarcation line between a predominantly settled community to the west and predominantly pastoral nomadic peoples to the east. It arguably regulated and monitored activities of pastoral nomadic peoples coming from the vast eastern desert areas. The 6 km long opening of the wall in the Udruh area does not suggest that these peoples should be kept away from the settled community. It rather directed their movement to selected meeting areas, possibly for commercial trading purposes. It seems difficult to imagine that this opening of the Khatt Shebib, at an intersection of important trade routes, is coincidental or related to the wall's poor state of preservation. Instead, nomadic pastoralists from the east may have entered the Petraean hinterland in the Udruh area to trade livestock with agricultural and other commercial goods produced in the more settled areas in the west. The large stone circles J5 and J6 are certainly not coincidentally located at both ends of the Khatt Shebib's opening and may be considered as 'open market areas' (cf. chapter 4). This interpretation of the Khatt Shebib wall further indicates a mutually beneficial relationship between sedentaries and non-sedentaries in the Petraean hinterland as postulated for the Wadi al-Hasa area and other regions of the ancient Near East.[1870] Occasional disputes and conflicts surely arose, but literary evidence indicates that these were mostly singular incidents and far from a full invasion of nomadic forces that threatened sedentary settlements.[1871]

In addition to farming and pastoralism, the industrial/exploitation installations documented in the Petraean hinterland suggest further – although arguably only small-scale – 'industrial' activities pertaining to the exploitation of natural resources and the production of commercial goods, particularly during the Nabataean and Roman periods.

The largest category of these installations are quarries. As there is no evidence for large-scale, industrial quarrying activities, the quarries were most likely worked for local constructional purposes only. The differing size of the quarries depended on the particular site for which stone material was required. For example, it is obvious that larger settlements such as Udruh, Muhaidhrat or Fardhakh necessitated more stone material than smaller sites, thus explaining the large quarries (c. 7500–10,000 m^2) identified near these settlements.

In addition to the well-known ceramic workshop at az-Zurraba in Wadi Musa, Nabataean ceramic workshops were also documented at Udruh, and possibly at Khirbet al-Fiqai. While it cannot be determined whether the clay originated from the only known clay pit at 'Ain at-Tinah near Wadi Musa, it seems unlikely that regional ceramics (particularly Nabataean fine ware) were produced exclusively at one large production site (e. g. az-Zurraba). Ceramic goods may have been produced at other locations as well, e. g. at Udruh and Khirbet al-Fiqai. Whether these workshops produced commodities for local needs only or also contributed to regional trade cannot be determined.[1872] However, while the few kilns do not suggest any large-scale production, the possibility cannot be excluded that products were also traded.[1873]

The copper mines of Umm al-'Amad in the Wadi Arabah provide further insights into small-scale in-

debate was subsequently carried out between Mayerson (1989) and Banning (1992).

1870 For the Wadi al-Hasa area, see Banning 1986. For other examples of mutually beneficial relationships between settled communities and mobile nomadic pastoralists, see e. g. Kouki 2012, 99–100 with further references.

1871 The viewpoint that the eastern Late Roman frontier was threatened by an invasion of external nomadic tribes is mostly claimed by Parker (e. g. Parker 1987b and Parker 1986, 642–643). This was refuted by Graf 1989, 344–400 and Macdonald 1993, 323–352.

1872 On the distribution of Nabataean fine ware pottery, see e. g. Schmid 2007a.

1873 For example, the lime kiln discovered by the FJHP west of Jabal Harun indicates only local production of lime-based products such as mortar.

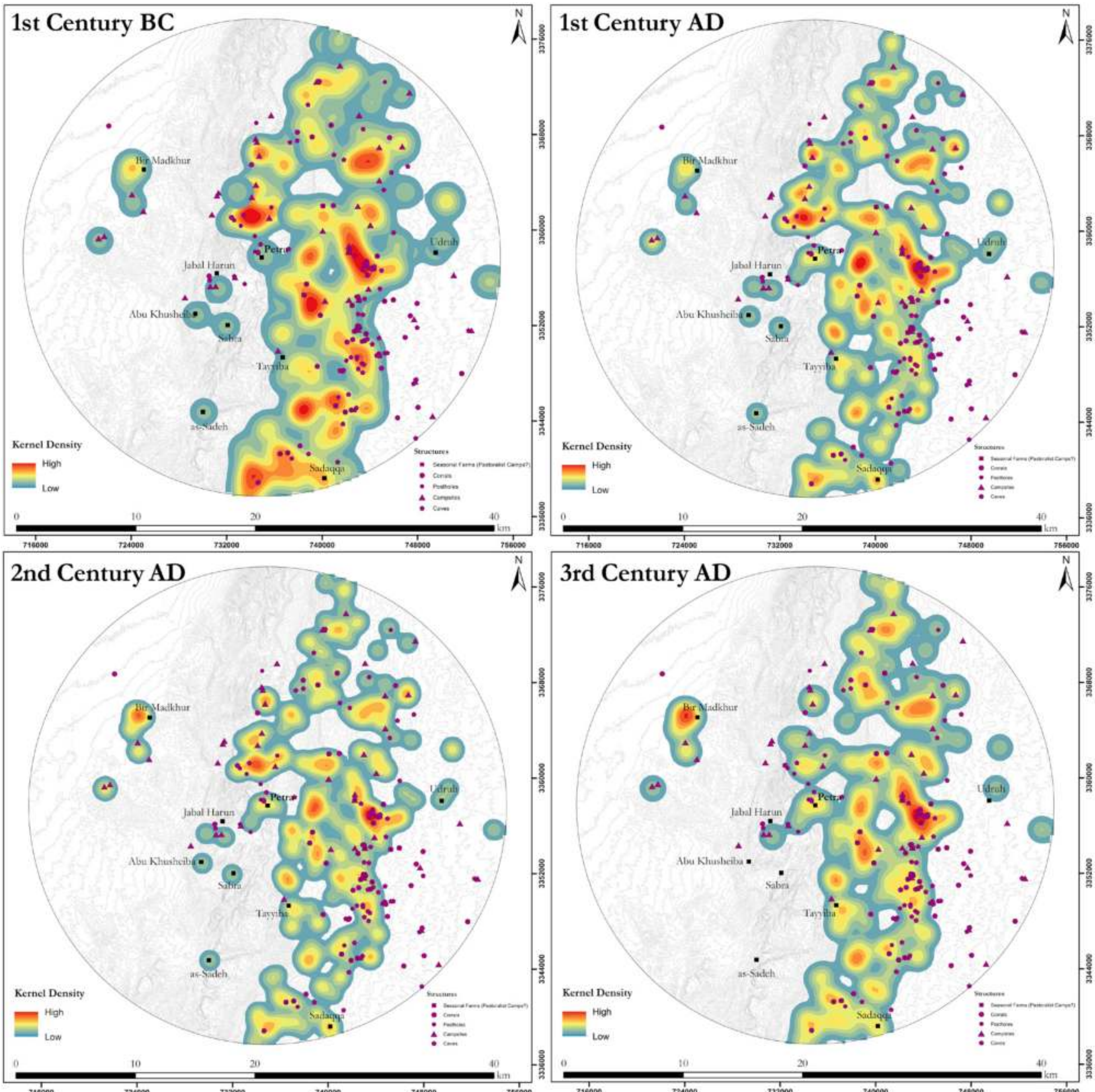


FIG. 360 All 'temporary structures' laid over the contemporary kernel density maps of all rural settlements in the Petraean hinterland from the 1st century BC to the 3rd century AD.

dustrial activities in the study area. While the limited copper deposits did not allow any large-scale copper mining activities as at Timnah or Faynan, the effort to extract the copper in the Umm al-'Amad area nevertheless demonstrates the attempt to exploit the region's economic opportunities to the fullest extent. As the general absence of furnaces and the singular copper slags discovered at Sabra does not indicate direct smelting activities in the Petraean hinterland, it may be suggested that the Umm al-'Amad copper was traded at nearby settlements along major trade routes such as Sabra or Abu Khusheiba. While this remains speculative, the copper mining activities in the Umm al-'Amad area are a yet under-researched aspect of the economic potential of the Petraean hinterland.

The detailed study of the communication network of the Petraean hinterland has established that routes for larger camel caravans avoided steep slopes and circumvented the difficult volcanic al-Somrah stone when possible. While the various naqb nevertheless often cut through difficult terrain, they are stabilized by curbstones and avoid wadi bottoms that can flood during wetter periods.[1874] Such camel routes are classified as *Class A routes* (TABLE 38). Other routes, which

1874 Ynnilä 2013, 257.

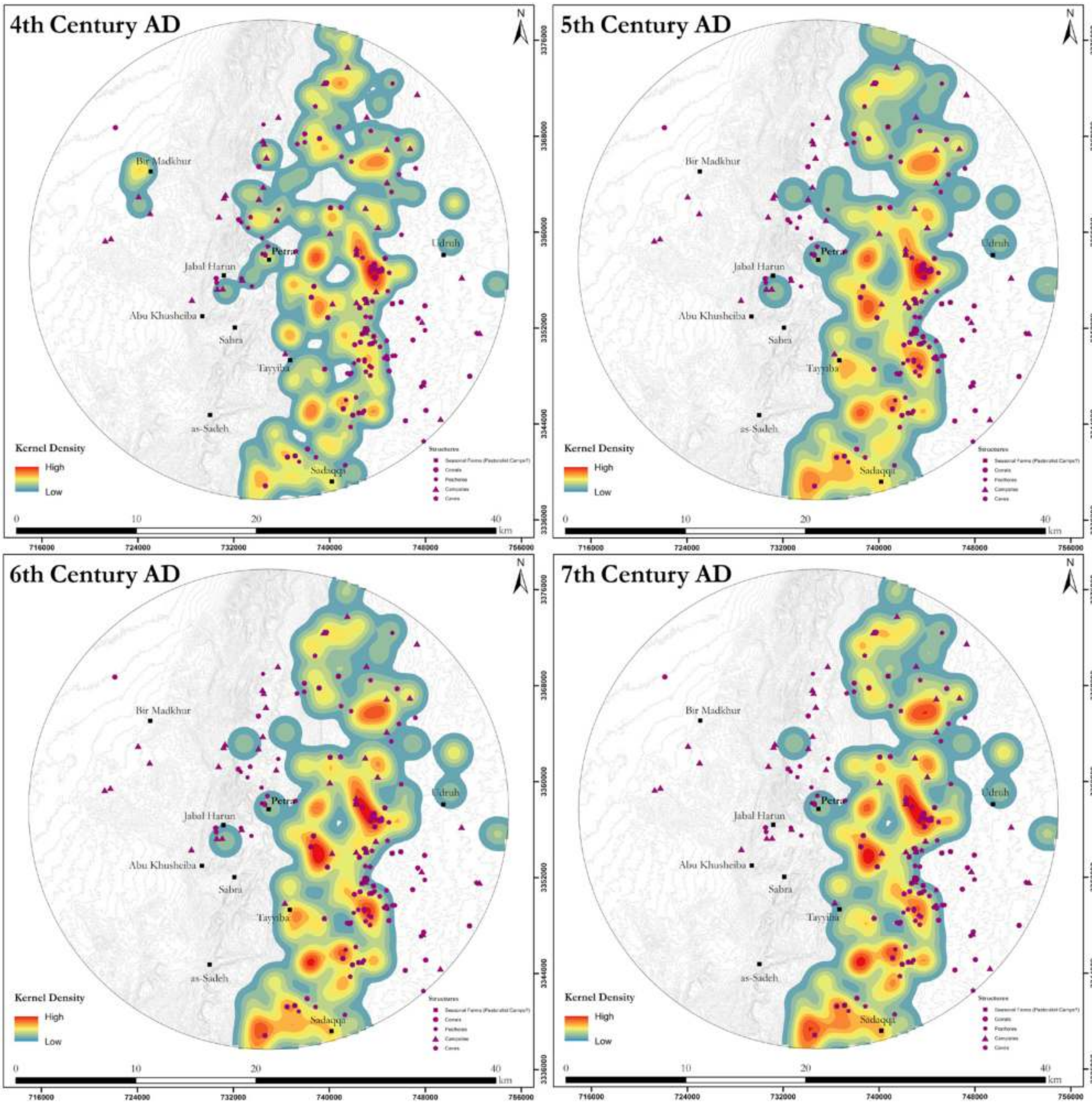


FIG. 361 All 'temporary structures' laid over the contemporary kernel density maps of all rural settlements in the Petraean hinterland from the 4th to 7th century AD.

only allowed pedestrian, donkey and/or mule travel, cross more difficult terrain and pass through volcanic stone more frequently. Such routes are defined as *Class B routes* (TABLE 39). In total, 15 Class A and 14 Class B routes were identified.

Class A routes have minimal slope values of 0,023 % and maximal values of 44,65 %. The average slope value is 9,33 %. Considering the extreme topographical situation of the Petra area, this is low and allows comfortable travel with all beasts of burden – including the camel. This conclusion is confirmed when examining the mean geological zones covered by Class A routes: Only 4,29 % of all Class A routes run across the difficult volcanic al-Somrah formations, while 58,09 % cross over sandstone, followed by fluviatile (14,30 %) and limestone (14,18 %).

In contrast, the maximal slope value for Class B routes is 77,26 %. The average slope value of 17,20 % is far higher than that of Class A routes. Additionally, while sandstone is the most frequented geological zone covered by Class B routes with a mean percentage of 43,42 %, the second most covered geological zone is the volcanic al-Somrah with an average coverage of 33,70 %, thus significantly higher than that of Class A routes. Limestone is the third most covered geological zone of Class B routes (11,56 %).

These environmental differences between Class A and B routes affected the mode of travel, i.e. the selection of the appropriate beast of burden (if any at all). Seasonal conditions were also important.

Particularly for larger caravans, advantageous time periods for taking on longer journeys greatly depends on the availability of water. Based on modern climate data, the highest precipitation in the Petra area occurs between November and April.[1875] This is the period with increased water availability and the best vegetation conditions. However, as precipitation rates decline from average annual rates of 250 mm in the Jabal Shara region to c. 50 mm in the Wadi Arabah, water becomes increasingly scarce when travelling further west from Petra.[1876] The hot summer months therefore did not offer good conditions for travelling long distances. This could lead to the conclusion that Petra's western routes were travelled only in cooler months. However, ethnographic studies on modern-day donkey caravans in the Sudanese Sahara region have shown that there are *two* travel seasons: One during the winter months with greater precipitation when caravan drivers are able to travel more frequently with more animals, and the other during the summer months with fewer animals and additional fodder and water.[1877] Modern camel caravans crossing Libya and Chad are also guided through vast desert areas every month of the year – independent of weather conditions.[1878] This recalls Pliny's accounts that a second spring harvest of incense took place in southern Arabia, thus presumably allowing Nabataean caravans to proceed along inland routes all year round and therefore maintaining a viable competition against the increasing seaborne trade during the Augustan period.[1879] Local Bedouins also confirmed these ethnographic observations for Class A routes in the Petraean hinterland. There appear to be no seasonal constraints for Class A routes (cf. TABLE 38).

This is not the case for Class B routes. Routes with higher slope values such as Naqb Slaysil or Wadi Marwan (average slope values of 28,07 % and 22,63 %) tend to run over longer stretches of the volcanic al-Somrah (64,79 % in the case of Naqb Slaysil and 51,56 % for Wadi Marwan). The al-Somrah breaks into sharp shards making it extremely uncomfortable to cross and when wet, it turns dangerously slippery. In combination with the steep slope values, such routes are impossible to pass during wet weather (cf. TABLE 39).[1880] These conditions are most dramatic for Naqb Seir al-Begh'er, connecting Seir al-Begh'er (the 'Pond Temple') with Naqb Slaysil. As the route has an average slope value of 42,20 % and runs completely over the al-Somrah, it is not passable during wet seasons.[1881]

Natural constraints particularly affected the accessibility of Class B routes. This greatly impacted the infrastructural development of Petra's western hinterland and had a major effect on the overall practical organization of caravan trade in the region. The western routes descending towards the Wadi Arabah were most likely used with varying frequency. As Lindner and others have already noted, the various routes/tracks (naqb) in the Petra area were used "[a]*t different times with different animals, different loads, different people* […]" corresponding to the varying functions of caravan activities.[1882]

Different routes of varying quality and function connected different route-related structures. Establishing the qualitative differences and assessing the quantity of routes that intersected at specific route stations reveals particular infrastructural hubs in Petra's hinterland (TABLE 40). For example, the most direct way to reach Beidha from Petra is via the Class B route Naqb Namala, which is generally unsuitable for large camel caravans.[1883] The structural advancement of Beidha during the Nabataean period (the various *triclinia*, water-related structures, the rural mansion of Umm Qussah etc.), was therefore perhaps not only linked to caravan trade, but more to the agricultural potential of the Beidha area. While this was certainly a major factor for explaining the site's development, Beidha was nevertheless a central node within Petra's camel caravan route network. Caravans that passed from the Class A routes of Wadi Musa to Dawrum Dey, up Naqb Abu Mrerah and then along Naqb al-Farsh and Wadi Siq al-Ghurab eventually ended at Beidha.[1884] Therefore, while Naqb Namala was not the

1875 Cf. for example Banning 1986, 43, fig. 1.
1876 Beckers et al. 2012.
1877 Förster et al. 2013, 201–202. Animals must be watered daily during the summer months.
1878 Meerpohl 2013, 173.
1879 Plin. HN 12, 32, 5, 60. For more, see e.g. Fiema 2003, 41.
1880 Even more reason to contradict previous claims that Naqb Slaysil was the direct way to the Wadi Arabah and integral part of the Petra–Gaza road as, for example, proposed by Kloner 1996.
1881 The only other access to the 'Pond Temple' is through Wadi Marwan and Wadi as-Siyyagh from the south, both of which are difficult to pass in wet weather as well. Therefore, Seir al-Begh'er was probably accessed mainly during the dry seasons. The site's interpretation of a temple is therefore difficult (cf. chapter 5).
1882 Lindner et al. 2000, 545. Cf. also Ben David 2007, 103.
1883 Cf. also Horsfield – Conway 1930, 383.
1884 In contrast, only one Class A route (Naqb al-Farsh) and two Class B routes (Wadi al-Mu'aysirah East and West) connected the possible rural mansion of Shammasa. In this case, the agricultural potential of the area seems to have outweighed the infrastructural connectivity.

main camel route, Beidha was very much a central focal point for Nabataean caravan trade.[1885]

This was not the case for Qasr Namala, the small Nabataean-Roman structure along the last stretches of Naqb Namala before the route reaches the open Arabah. It is surrounded by the high cliffs of the al-Somrah where only limited caravan traffic could have been expected. Thus, no major infrastructure was required and the site probably served only as a minor relay station.

Continuing along Naqb Namala into the Arabah, the site of Bir Madkhur is different. Although the nature of the site in the Nabataean period remains unclear, the construction of the Late Roman fort and its associated agricultural installations clearly attest to the importance of the site's location.[1886] However, due to the unfavorable environmental conditions of Naqb Namala, Bir Madkhur is not, as previously assumed, related to major camel caravan trade via the *main* course of the Petra–Gaza road. Instead, its importance as a major caravan halt is more associated with the major north-south running roads in the Arabah, most notably connecting Bir Madkhur with the Roman fort at Gharandal in the south and the copper sources of Faynan to the north. It was also easily possible to cross the alluvial plains of the Arabah to Khirbet Umm Qhuntera and/or Khirbet as-Faysif, arguably the best-connected site in the western hinterland of Petra (cf. FIG. 182). Coming from Petra, Khirbet as-Faysif was the primary destination in the Arabah for continuing along the Petra-Gaza road via the Class A routes of Naqb ar-Ruba'i and Wadi Jawf Ahmar. The Class B Umm Qamar pass also led to the site from Seir Umm Qamar. Therefore, large camel herds passed the site as well as minor donkey caravans. Once at Khirbet as-Faysif, it was possible to continue west to Gaza via Khirbet Umm Qhuntera and Moyat 'Awad, or to take the north-south roads in the Arabah either to Qaa' as-Sayidiyeen in the south or Bir Madkhur in the north. Although the site has not been completely excavated, it is clear that it is a substantially built, rectangular structure (21 m × 26 m) with interior rooms surrounding a large courtyard. No definite sleeping quarters were identified, but a presumed kitchen area was excavated that may have served the needs of travelers.[1887] The site is located near high ground water along the banks of Wadi Umm Qamar. The vegetation also offers good grazing opportunities for camels and other beasts of burden.[1888] The site's structural development therefore corresponds well with its high level of connectivity within Petra's communication network.

The same can be assumed for Qasr Umm Rattam along the Wadi Musa (cf. FIG. 186). Significant efforts were made to maintain this important site over centuries, which attests to the *longue durrée* of the main caravan routes well after the Roman annexation in 106 AD. As the Class B route Naqb Mistalgile connects the al-Farasha plain below Jabal Harun with Qasr Umm Rattam, the structure was not only important for major camel caravans, but also for smaller groups of pedestrians and/or donkey caravans with different loads. Generally, due to its location in the middle of the Wadi Musa, it is well connected with Petra's wider route system.[1889] Qasr Umm Rattam probably served as a control and/or resting post for both supraregional trade and for local/regional purposes.

The same applies to Dawrum Dey, situated only a few kilometers east of Qasr Umm Rattam along Wadi Musa (cf. FIG. 185). With the exception of the aqueduct leading to Qasr Umm Rattam and the agricultural terraces known locally as the 'Roman Gardens,' Dawrum Dey shows no signs of structural development.[1890] However, the fact that the site lies at the intersection of three Class A routes (Wadi Musa, Naqb Abu Mrerah and, by extension, Naqb al-Aqab) and two Class B routes (Naqb al-Ghirbe and Naqb Slaysil) declares Dawrum Dey a major caravan halt in antiquity, potentially serving as a transfer point for animals and goods. Here, ancient merchants travelling along the Wadi Musa from the Arabah decided how to continue their travel. This depended on the loads they were transporting. If transported by camel, travelers were forced to use Naqb Abu Mrerah and continue via Naqb al-Aqab until reaching the al-Farsh plain in the east. Donkeys could have carried smaller loads, as it was possible to ascend Naqb al-Ghirbe and reach the Petra area from the south.

This combination of Class A and B routes can also be observed at Seir Umm Qamar (cf. FIG. 213). This site most likely served as a small relay station at the intersection of Naqb ar-Ruba'i, Wadi Jawf Ahmar and Naqb Mistalgile.

In contrast, Sabra was not accessible by Class B routes. Instead, four Class A routes (Naqb ar-Risha' rish, Wadi Sabra, Naqb ad-Beidab and Naqb ad-

1885 Cf. Horsfield – Conway 1930, 383. The Beidha area would have provided enough water and fodder sources for caravan animals as well.

1886 Smith 2010, 29–42.

1887 Hughes 2014; Smith 2010, 37–39.

1888 Ben David 2013, 273; Smith 2005, 70.

1889 Cf. also Lindner et al. 2000, 538–545, 563 stating that the site was connected with Bir Madkhur, Beidha, Wadi as-Siyyagh, Ras Slaysil, Wadi an-Naqb, Wadi Adulaiya, Qasr Namala and Jabal Qarun.

1890 Cf. Gentelle 2009, 140–141; Lindner et al. 2000; Russel 1995, 695.

Dab'e) connected the settlement with the al-Farasha plain below Jabal Harun, with the major roads in the Arabah and as-Sadeh further south as well as with Abu Khusheiba. This high number of Class A camel routes sets Sabra at a location predestined for heightened trade activities, which may explain the monumentality of the site.[1891]

Abu Khusheiba is well connected with Sabra via Naqb ad-Beidab and has easy access to the major roads in the Arabah. In addition, the Class B route of Naqb Saqqara connects the site with the al-Farasha plain for smaller (non-camel) caravans.

Concerning the southern access to Petra, it has been suggested that Sabra had a direct connection with the Wadi Arabah and major north-south roads via Naqb ar-Risha' rish. Along this Class A route it was not only possible to intersect with the trade routes coming from Sinai, but also to reach as-Sadeh further to the south. Continuing from as-Sadeh southeastwards, ancient caravans could have easily reached Wadi Rum and Humeima (ancient Hawara), intersecting the major incense route coming from South Arabia.

Generally, caravans coming from South Arabia accessed Petra from the southeast continuing northwards from Hawara and eventually reaching the eastern high plateau of the Jabal Shara region. Arguably, caravans could have also headed (north-)westwards from Hawara via as-Sadeh, the Wadi Arabah and eventually Sabra. Once at Sabra, the wide alluvial plain of the settlement may have offered enough camping space for both caravan animals and their drivers. After a short repose at Sabra, caravans continued via Wadi Sabra to the al-Farasha and as-Sto'e plains southwest of Petra to unload their trade goods. Alternatively, larger groups of caravan animals were left at Sabra and the commodities were redistributed to smaller groups of pack animals. While this remains speculative, it nevertheless highlights the significance of Sabra as a central node in the communication network of the Petraean hinterland.

However, the most direct way over the eastern high plateau (via the Darb ar-Rasif and later the *via nova Traiana*) was undoubtedly the major communication line for reaching Petra from the southeast. Before reaching the city, caravans proceeding along this major route would have passed Wadi Musa (Gaia) first. The settlement was therefore a significant station along the incense route.

In contrast to Wadi Musa, Beidha has always been considered a major stop along regional caravan routes. However, the discussion of Naqb Namala has shown that the natural landscape conditions of the route did not favor large-scale caravan traffic from the north.[1892] Additionally, the steep volcanic slopes north of Beidha and the ranges of the Jabal Shara to the east made it impossible for large caravans to reach the site directly from the southeast. Although Beidha's significance as a caravan halt should not be downplayed, caravans from the southeast probably had to halt at Wadi Musa first. It is possible that they unloaded at Wadi Musa and then transported the trade goods by smaller groups of camels and/or donkeys to Petra. While it is possible that caravan animals found place to rest in and around Wadi Musa, the wide and flat plains of the Beidha area probably offered far better watering and grazing opportunities for larger groups of animals. In support of this hypothesis, Horsfield and Conway observed a camel caravan group of 300 animals coming from Ha'il via Ma'an and Petra on its way to Egypt in 1929:

> *From Ma'an they made a long detour to the north, passing above Petra along the southern slope of Jebel Shera to the rock-hewn suburb of El Bared, where they halted for the night. The reason they gave for the detour was the comparative flatness of the ground. They entered Petra by the Wadi Turkimanye, crossed the city at Zibb Far'on, and went out to the south under El Biyara, on the road to Egypt via Sinai, where they hoped to arrive in five days.*[1893]

Arguably, this was Beidha's role in the supraregional trade network. Caravans coming from the southeast halted first at Wadi Musa, unloaded their goods for further transport to Petra and then gradually continued westwards toward Beidha – perhaps even along the same course as the modern road connecting the Beidha area with the Jabal Shara region. Once in the Beidha plains, both animals and caravan drivers found adequate space and infrastructure for rest. Horsfield and Conway adequately refer to the site as "the ancient sorting-place for caravans."[1894] From Beidha, caravans could continue northwestwards via Naqb Namala to

1891 Cf. chapter 4. For example, the degree of connectivity of Sabra stands in stark contrast to that of Ras Slaysil, which Kloner 1996 described as a major focal point along the main caravan route from Petra to the Arabah. However, the direct link between Ras Slaysil and the Wadi Musa is via Naqb Slaysil, one of the most difficult Class B routes in the study area. This contradicts Kloner's claim. Nevertheless, the strategic position of Ras Slaysil is striking and it may have profited by caravans passing by Naqb al-Farsh.

1892 Cf. also Horsfield – Conway 1930, 383.

1893 Horsfield – Conway 1930, 383.

1894 Horsfield – Conway 1930, 383. Cf. also Heinzelmann – Erickson-Gini 2015, 119 mentioning a large open area outside Elusa, which may have offered space for (un-)loading caravan animals as well.

the Arabah (although, most likely in small groups only) and from there either southwards towards the main course of the Petra–Gaza road or northwards towards Faynan.

As the passages above have shown, there seems to be a direct correlation between the nature of routes and the sites they connected. The more Class A routes pass through a site, the more likely it is to be structurally developed and functionally significant. This is not surprising. The high number of Class B routes, however, is striking and raises questions concerning practical issues of caravan trade in the study area.

While there is no direct historical information on the required management and necessary logistical organization for ancient caravan trade in the Petraean hinterland, modern ethnographical comparisons may shed some light on possible practical details.

The process of organizing and successfully managing (camel) caravans begins as early as selecting the beasts of burden. For modern-day caravans the first key person in the organization of larger caravan journeys is the animal *trader*.[1895] Based on his experience and expertise, the quality of the beasts of burden is assessed.

As long-distance desert travel was risky and exhausting, the safe delivery of trade goods depended greatly on the overall physical fitness of the animals. Several *herders* accompanied the caravan and closely watched the health and physical conditions of the animals. The responsibilities of herders included the management of the animal's daily needs as well as those of the drivers, to keep individual animal groups together and to ensure that no animals were lost along the way. Their abilities were therefore essential to the successful undertaking of the journey.[1896]

The most important position was held by the *khabīr*.[1897] A poorly skilled khabīr could potentially endanger the entire operation. As the group's leader, the khabīr was responsible for guiding the caravan along the journey, deciding when, where and how long to rest and when to continue. He also ensured harmony among the group as quarrels among the drivers could also endanger the journey. The khabīr's knowledge of landscape features, the routes' general course, potential risks, and his ability to navigate landmarks was vital to the overall success of the journey.[1898] This 'mental map' also included the locations of water sources and vegetation zones.[1899] Water being the most precious resource for desert travel was used extremely economically. Carried water was used sparingly for preparing food and tea and was consumed directly only when necessary. Both drivers and animals were dependent on natural water sources, which varied depending on the specific aridity of the region and seasonal weather conditions. The course of ancient routes was greatly impacted by known natural water sources, explaining why routes often did not follow the shortest distance, but rather available water points.[1900]

Depending on the overall size of the caravan, which could vary from a hundred to even thousands of camels, modern drivers divide a herd into smaller groups ranging between 100 and 150 animals. Apparently, this requires four herders to manage one group.[1901] A better overview of the herd is provided by keeping a distance between the groups. This is important as straying animals can potentially delay the entire journey significantly. In Assyria, the so-called *bātiqum* ensured a similar practice of keeping distances between subgroups of the larger caravans.[1902]

Ancient donkey caravans could encompass up to 1000 animals. This very large number is known for the vast desert areas of Pharaonic Egypt, but does not necessarily apply to the study area and its particularly difficult topography. However, textual sources suggest that Assyrian caravans preferred to travel in larger groups as they were less vulnerable against potential attacks.[1903] Nevertheless, while caravans could travel as far as approx. 35 km a day, larger caravans tend to move more slowly and therefore cover less distances per day.[1904] If speed was crucial, it is more likely that travelers journey alone or in smaller groups.[1905] The Assyrian bātiqum (loosely translated as "the cutter") purposely distanced themselves from the larger caravan to convey messages or small goods to the bātiqum of the next caravan. This attests to a generally well-structured organization of caravan travel, and

1895 Meerpohl 2013, 173.
1896 Meerpohl 2013, 174, 179. There is a graffito in Hegra presumably dating to the 1st century AD that mentions a possible camel driver commuting from Petra to Hegra, but this remains uncertain (Durand 2017, 97).
1897 Förster et al. 2013, 203–204; Meerpohl 2013, 174.
1898 Meerpohl 2013, 179–180; Förster et al. 2013, 203–204.
1899 Meerpohl 2013, 181.
1900 Meerpohl 2013, 183–184, 186.
1901 Meerpohl 2013, 174–175. The number of modern-day camel caravans derives from Riemer – Förster 2013, 44 who refer to Saharan camel caravans.
1902 Derckson 2004, 256–257.
1903 Derckson 2004, 256. According to Derckson, another potential reason for travelling in large numbers may also have been the apparently good opportunity for exchanging news and current events among the animal drivers.
1904 Meerpohl 2013, 175–176, 178: In terms of supplies, for each herder there was also one pack animal carrying the most important essentials: a minimum of food and water, firewood and utensils.
1905 Derckson 2004, 256.

serves as a good parallel to modern habits of travelling in smaller groups.[1906]

Information pertaining to exact daily start and end points of caravans is also limited. Assyrian texts set the travel time of caravans between dusk and dawn and may even include night travel.[1907] Similar routines are still maintained for modern caravans, which start early in the morning and end late in the evening with longer breaks during the hot afternoon hours.[1908] Particularly during the summer months, the modern khabīr, who are able to navigate by the stars and can orient themselves along important landmarks, lead caravans by night.[1909] Night travel must have been a common practice in antiquity as well, as it is referenced by Assyrian and Old Babylonian sources.[1910]

Based on these ethnographic accounts, main aspects for successfully managing caravans include physical qualities of the beasts of burden, overall caravan size, quality and weight of loads, management skills of caravan leaders and associates, travel time and distance, environmental constraints and the availability of food and water. The ethnographic parallels may suggest some tentative hypotheses on the practical management of caravans in the Petra area: Due to the narrow widths of many regional routes and the difficult natural landscape conditions (particularly concerning Class B routes), it is highly unlikely that large caravan groups traveled the western naqb of the Petraean hinterland simultaneously. Larger groups were most likely divided into smaller subgroups, and these subgroups may have been led by herders as the modern examples suggest. Responsibilities similar to those of the Assyrian bātiqum could have been assigned to individuals for maintaining communication between the different groups. Such tasks must have been particularly important when travelling along Class B routes. Similar to the modern khabīr, there was most likely a caravan leader who was well acquainted with Petra's difficult terrain and the course of the various routes. If read correctly, a certain *ngd'* is mentioned in three inscriptions from Petra, which translates as the "(caravan) leader," thus possibly attesting to a 'Nabataean khabīr.'[1911] The general knowledge of the landscape and his mental map was particularly important when crossing through the extreme environmental constraints of the Petraean hinterland. Good knowledge of the natural landscape of the Petra region was a prerequisite for the success of any caravan.

Due to the topographical and geological conditions, there is a large number of route-related structures in the Petraean hinterland. Route stations are positioned no more than 10 km apart. The longest course without passing a route station is along Naqb Namala between Beidha and Qasr Namala. The average distance between route stations is around 5 km, and therefore easily manageable for caravans in one day. As smaller caravan groups most likely travelled along the routes successively, route stations (except those with a high degree of intersecting routes such as Khirbet as-Faysif, Qasr Umm Rattam or Sabra) probably did not experience much traffic at once, but rather little at regular intervals. As long as the stations were able to provide basic water and food supplies, large structural accommodations were mostly not required. They may have simply served for controlling and observing caravan traffic along the routes.

Dawrum Dey seems to have been particularly important. Although the site does not show signs of any large-scale structural development, the availability of water sources (evidenced by the aqueduct leading to Qasr Umm Rattam) and food (as suggested by the numerous agricultural terraces), renders Dawrum Dey the perfect resting place and potential transshipment center of animals and loads in the Petra area. At Dawrum Dey, the banks of Wadi Musa are wide and flat. Even during floods, the elevated slopes would still have provided enough space for large groups of animals and people. The various (donkey) caravan groups traversing along the difficult Class B routes of Naqb Slaysil and Naqb al-Ghirbe must have needed rest, water and food. For larger camel caravans coming from the Arabah via Qasr Umm Rattam, Dawrum Dey was the last opportunity to rest or to transfer goods before heading up Naqb Abu Mrerah to the al-Farsh plain and then to Beidha in the east. The loads of camel caravans could also be redistributed onto the backs of donkeys that continued up the Class B routes.[1912] This would have spared the more valuable camels and possibly expedited the delivery of trade goods.

1906 Derckson 2004, 256–257.
1907 Derckson 2004, 255.
1908 Förster et al. 2013, 203. Normally, modern herds travel from the early morning to the evening. In areas with little vegetation and water sources, modern caravans are pushed to walk as long as 16 hours a day in order to get closer to the next water source and the possibility to feed the animals. There is only a short break at mid-day to rest and eat.
1909 Meerpohl 2013, 180; Förster et al. 2013, 203–204.
1910 Derckson 2004, 256; Siroux 1949, 34.
1911 Nehmé 2020, 220.
1912 Although as the 'ship of the desert,' the camel was the more advantageous animal for travelling long distances in desert landscapes, Rosen and Saidel (2010, 73) draw attention to the inefficiency of packing and unpacking loads, which could have taken up a considerable amount of time. This may have also been a reason to maintain donkeys as beasts of burden.

Another important aspect to be considered when discussing practical issues of caravan trade in the study area is the issue of different tribal territories. There are several indicators suggesting that the Petraean hinterland was divided into different social districts or communities. For example, it may be assumed that Sabra and Abu Khusheiba were central places for specific social groups that had excessive control over important caravan routes in the area. While these groups may have been subjected to the Nabataean kings, Petra most likely had to maintain good and stable relations with them in order to secure a functioning and successful route system.[1913] Interestingly, there was a distinct difference in the organization of caravan trade between South Arabia and its northern counterparts.[1914] In South Arabia, tribal camel breeders controlled and owned the caravans and guided them across their tribal territories. Before crossing tribal borders, the goods were loaded to the respective caravans of the next tribe and so on. In contrast, North Arabian caravans were centrally organized by urban merchants. This required that local guides and security personnel had to be hired and payed for crossing the caravans through different tribal territories. This practice may have been applied in the Petra area as well, although this remains speculative without explicit historical sources. The issue of crossing through tribal territories and the impact this had on the infrastructural organization of the Petraean hinterland is nevertheless an important topic to address, as is attempted in the following section.

Society and Culture

The relationship between the natural environment and funerary structures in Petra's hinterland has not yet been comprehensively studied.[1915] In urban Petra, it is well known that the geology impacted the choice of tomb types.[1916] Most of the rock-cut monuments were carved into the 'Tear sandstone' as its friable quality is a perfect working material.[1917] The monumental façades of the ad-Deir or the al-Khazne, however, were carved in the harder 'Honeycomb sandstone.' This explains the good preservation of the tombs and demonstrates that the Petraean elites were also concerned about the stone quality of their funerary monuments. However, placing the tombs at prominent locations seems to have been prioritized as can be observed for the 'Royal Tombs' carved into the Tear sandstone of the Jabal al-Khubtah.[1918] For Petra, it can certainly be assumed that

> [...] *stonemasons and architects had a significant understanding of the geology of the site and cleverly adapted ideological concepts related to funerary architecture to the rocky landscape.*[1919]

The archaeological evidence in Petra's hinterland suggests similar conclusions.

The majority of all funerary structures (58,62 %) are built or carved into the Umm 'Ishrin sandstone (FIG. 362 and TABLE 41). This is the most prominent geological formation of the central plateau. Most funerary structures are clustered in the as-Sto'e, al-Farasha and al-Begh'ah plains (FIG. 363).[1920] Façade tombs, shaft tombs and rock-cut pit graves are all carved in sandstone. In addition to shared funerary traditions, the similar environmental conditions to urban Petra explain the large quantity of similar funerary structures in Petra's hinterland. It is certainly no coincidence that façade tombs and other monumental rock-cut tombs such as Mukheifer in the Wadi Arabah are located where the sandstone prevails.[1921] The FJHP documented many cemeteries around the 'Snake Monument' southwest of Petra, which is a predominantly sandstone area. This explains the high percentage (70 %) of cemeteries located in sandstone formations (TABLE 41).

Only 10 % of all cemeteries are situated in alluvium. This geological formation is most prominent in the Wadi Arabah. This may be one reason why the cemeteries at Bir Madkhur and Khirbet as-Faysif

1913 The close interaction with local tribes in the context of larger caravan routes is also attested in Strabo's passage on the campaign of Aeilus Gallus (Str. 16, 4, 24).

1914 Köhler-Rollefson 1993, 187. Cf. also Pliny's accounts on caravan protection (Plin. HN 12, 32, 65).

1915 This study does not claim to present a complete overview of funerary structures in the Petraean hinterland. While the original surveys may refer to possible burial sites, their initial identification is not always followed here. For example, Abudanh Survey Site Nos. 021, 061, 108 and 197 (Abudanh 2006, 408, 431, 455 and 507) are documented as 'structure(s) of undetermined function' or 'watchtowers.' Abudanh mentions possible burials that are associated with these sites, but they could not be systematically included into this study's analysis. The dataset provided by PAWS may yield additional information on the mortuary landscape of the Beidha area as well (cf. Knodell et al. 2017). The presented evidence is nevertheless representative and may serve as the basis for the following discussion.

1916 Wadeson 2012a, 104–105 with further references

1917 Following Rababeh 2005, 35–39, Wadeson 2012a, 105 lists four main sandstone types in Petra: The Umm 'Ishrin formation includes the 'Smooth' (lower), 'Tear' (middle), and 'Honeycomb' (upper) layers. The Disi formation lies above the Umm 'Ishrin layers.

1918 Wadeson 2012a, 105 following Pflüger 1995, 285–287.

1919 Wadeson 2012a, 105.

1920 Cf. e. g. also Kouki – Silvonen 2013b, 305.

1921 The large sandstone outcrop of Mukheifer stands out between the volcanic al-Somrah and the alluvial plain of the Arabah.

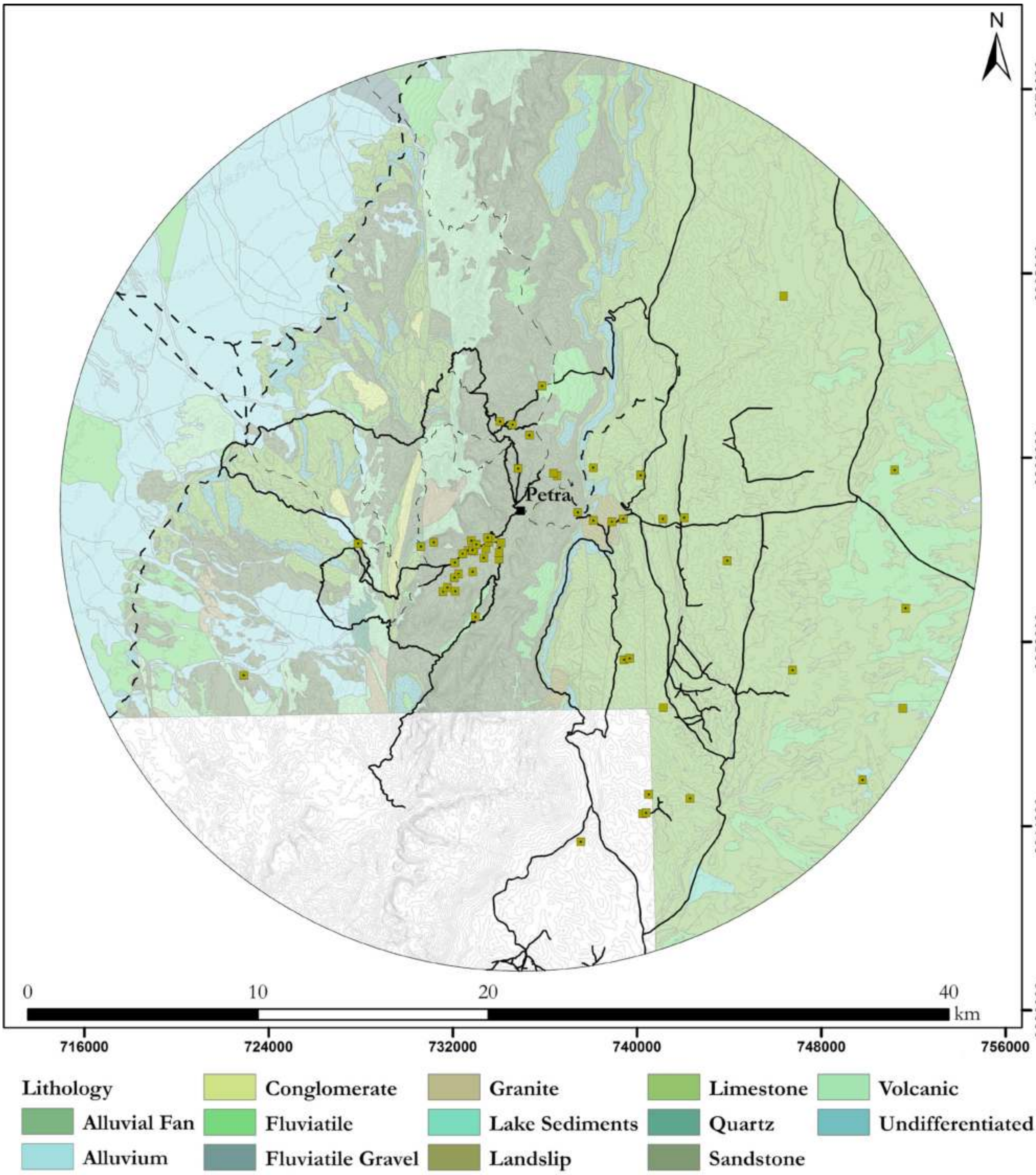


FIG. 362 All funerary structures plotted over the geological map of the study area.

mostly consist of small cairns or stone rings. The only available stone in the Arabah are small to middle-large wadi boulders, which marked the various pit graves and cairns of the cemeteries.

The geological conditions also impacted the nature of funerary structures along the Jabal Shara range and the eastern high plateau. Three geological formations are known in these areas: Landslip, fluviatile and limestone. The area of central Wadi Musa is situated in a large landslip zone. Limited stone material is available in the town center itself and building material had to be brought from the surrounding areas. The local geological conditions may be one reason for the construction of the *built* monumental *hypogea* (WMWS 1998 Site No. Wadi Musa 25 and PHTP Site No. 002), which are located in the landslip zone. In contrast, the *rock-cut hypogeum* of WMWS 1998 Site No. Wadi Musa 33 is situated in the extensive limestone zone of the eastern high plateau and was carved into the naturally descending slope of the Wadi Musa basin. While the

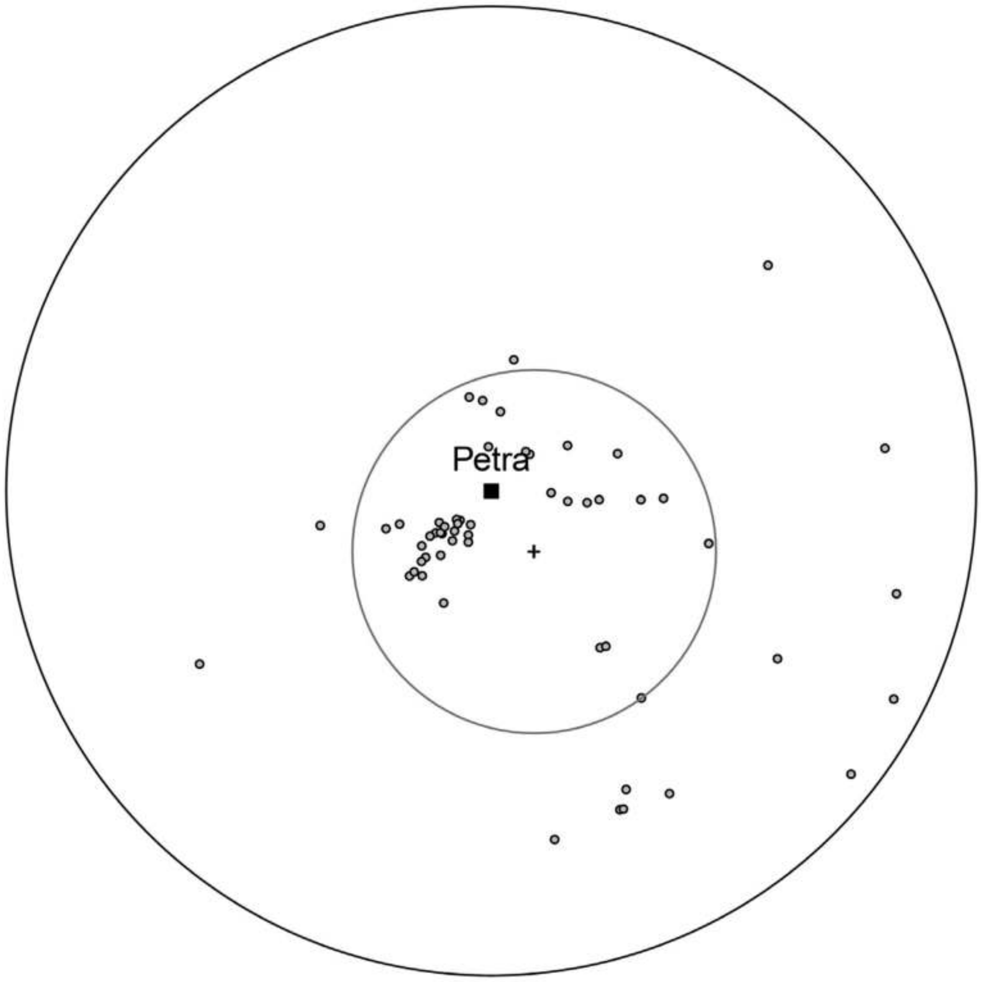


FIG. 363 Distribution of 1st century AD funerary structures. The cross marks the mean center of the point pattern encircled by the standard distance (7,5 km) between all funerary structures.

other built *hypogea* are located along the limestone formations as well, they are built on ledges of prominent high points of the Jabal Shara range. In these cases, the burial chambers were cut directly into the ledge and the extracted limestone was used as building material.

The availability of limestone as good quality working material also explains the location of other monumental funerary monuments, i. e. ShamAyl Site Nos. 109, 136 and 148 (cf. chapter 8). The two tombs of Abudanh Site No. 173 were sealed by large limestone slabs simply because the material was available. The location of the vaulted burial site at Khirbet Suboor was probably also determined by its direct access to the good quality limestone.

The only funerary structure located in fluviatile is the presumed 'tomb' of ShamAyl Site No. 155. No funerary structures were recorded along the volcanic al-Somrah.

While natural landscape features undoubtedly impacted the location and nature of rural Petra's funerary monuments, their archaeological context must be analyzed as well.

The Pearson correlation test suggests a strong spatial correlation between funerary structures and exploitation/industrial sites as well as religious and water structures (TABLE 42). The strong correlation to exploitation/industrial sites is not surprising when considering that these are mostly quarries. The same observations were made for religious structures. Most funerary structures are rock-cut. This explains why quarry sites are found nearby or even associated with rock-cut funerary structures.

The strong spatial correlation between funerary and religious structures can be explained by the fact that most funerary structures were documented in the al-Farasha and as-Sto'e plains where many rural religious structures were recorded as well. The FJHP argues that "[f]*rom the viewpoint of the burial and cultic sites, the Jabal Harun area forms a sacred landscape centered on the mountain* [...]."[1922] However, as both religious structures (e. g. Ras Hamra, the Isis sanctuary in the Wadi Abu Olleqah, Jabal Harun or Jabal Numayr) and most funerary structures are situated close to ancient routes, the spatial correlation between

1922 Kouki – Silvonen 2013b, 314.

the two categories is not surprising. While burying the dead in such a 'sacred landscape,' may have been an incentive, there are no indications that there is a functional association between funerary and religious structures in the Petraean hinterland.

Many water structures (most notably water conduits and water storage installations) are documented in the extended Jabal Harun area as well. A strong spatial correlation with funerary structures in the area is therefore expected. The water structures are certainly associated with the many agricultural installations in the area (cf. chapter 4). There is no functional relationship between water structures and funerary monuments.

Importantly, many funerary structures in Petra's hinterland are situated in close vicinity to ancient routes. This is the case of the structures recorded by the FJHP (isolated funerary monuments and cemeteries), the PRP and the PHTP.[1923] The FJHP reports that almost all funerary structures are located less than 100 m to the northern as-Sto'e route. This is also known as the *Darb an-Nabi Harun*, the presumed pilgrim route to Jabal Harun. All funerary structures documented by the PRP are situated along the Class B routes of the Wadi al-Mu'aysirah East and West and the PHTP highlights the position of the monumental *hypogea* along ancient routes in the Jabal Shara region, most notably the Darb ar-Rasif. Among the funerary structures situated along ancient routes, no distinction between burial types can be made. It seems that the vicinity to roads and routes was an important aspect for selecting the location of burials in general, with visibility and exposure to by-passers being of central importance within rural Petra's funerary culture. This seems to be the case particularly along the pilgrim route of the Darb an-Nabi Harun. In comparison with other contemporary examples in the Near East, the fact that funerary monuments are situated along important routes is not surprising. However, this particularity of rural Petra's funerary landscape is just beginning to find scholarly attention.[1924] A prominent comparative example is the Wadi al-Qubur, or 'Valley of Tombs,' at Palmyra. Not only does the wadi feature a large number of funerary monuments, it also formed the main access route into the city from Emesa.[1925] The Palmyrene tombs were deliberately placed along this route to achieve optimal visual exposure to by-passers. However, the Wadi al-Qubur featured mainly monumental tower tombs and other impressive funerary monuments that belonged to members of the Palmyrene elite. Apart from the *hypogea*, this is not reflected in the Petraean hinterland. In Petra, the tombs of the elite concentrate in the city. The principle of burying the dead in prominent positions along important access routes can nevertheless be observed in both cities, which is a common feature within contemporary ancient societies in general.

In addition to their location along important routes, some isolated funerary monuments are also positioned on ridges, ledges or slopes with good visibility over their surrounding landscape. Tentatively, such structures may be interpreted as potential 'territorial markers' of specific social groups. In the Petra area, these structures include the monumental *hypogea*, isolated burial cairns, as well as the façade tombs.[1926]

Wadeson and Abudanh postulate that the *hypogea* most likely served as territorial markers of wealthy land-owning families, clans or tribes.[1927] This is based on the tombs' location in an area with a high density of rural settlements and agricultural installations. For example, the closest settlement to the *hypogeum* of WMWS 1998 Site No. Wadi Musa 33 seems to be the contemporary farm of ShamAyl Site No. 314. Settlements near to the *hypogeum* of PHTP Site No. 001 are the two farms of WMWS 1998 Site No. Wadi Musa 26 and JSS Site No. 082, as well as the possible hamlet of ShamAyl Site No. 59. The *hypogeum* of PHTP Site No. 002 may be associated with the village of JSS Site No. 080. The closest settlements to the *hypogeum* of PHTP Site No. 012 are the possible hamlet of ARNAS Site No. 038 or the farm of ShamAyl Site No. 009. However, whether the *hypogea* were indeed associated with these settlements remains hypothetical. The tomb owners may have also belonged to a community from an entirely different area and the location of their communal tomb was chosen for representative reasons, i.e. displaying the monumental tombs along ancient routes with good visibility from and to their immediate surroundings. There is thus no way of identifying the tomb owners for certain.

Isolated burials cairns may have also served as potential territorial markers (cf. FIG. 312). These cairns are located along routes and placed on hilltops or prominent ridges commanding an excellent view across the landscape. Burial cairns are common funerary structures in the Near East and date extremely

1923 Berenfeld et al. 2016, 94; Wadeson – Abudanh 2016, 91, 92, 97; Kouki – Silvonen 2013b, 307.

1924 Cf. e.g. Wadeson – Abudanh 2016 and Kouki – Silvonen 2013b.

1925 E.g. see Gawlikowski 2005, 44.

1926 The vaulted shaft tomb of FJHP Site No. Ext120 may also be regarded as a possible territorial marker of a specific social group. Possibly, this was a land-owning family, clan or tribe of the al-Farasha plain.

1927 Wadeson – Abudanh 2016, 92.

broadly. There are, however, numerous parallels that are culturally and temporally closer to this study. For example, various burial cairns were recorded in the Jabal Qurma region in north-eastern Jordan's basalt desert and over 400 burial cairns were surveyed in the hinterland of Palmyra along wadis and routes as well as on ridges or hilltops.[1928] Particularly in the Jabal Bishri area, surface pottery indicates that some of the cairns were used in the Roman periods as well. As the Palmyrene cairns are considered indicators for pastoral nomadic activities or prevailing nomadic traditions in the region, the same could apply to the cairns in the Petra area. Similar to the Palmyrene examples, differences in size and construction effort may reflect social stratification.[1929] Certainly, the large quantity of Nabataean fine and coarse ware discovered at the burial cairn of PHSP Site No. 131 on the an-Jur hilltop overlooking the route along the Wadi Siq al-Ghurab indicates that the individual(s) buried there were not of poor social standing. The prominent position of PHSP Site No. 117 along Naqb Mistalgile suggests the same.

Situated on a ridgetop along Wadi Sabra, the large burial cairn of PHSP Site No. 038-ST047 may have marked the territory of the settlement. This is particularly interesting as there are no monumental tombs known in Sabra.[1930] While it has long been speculated that at least the wealthy inhabitants of Sabra were buried in Petra, it nevertheless remains curious that no monumental tombs were discovered at a site, where it was possible to erect a major sanctuary, a theater and heated baths.[1931] Although entirely speculative, it may be hypothesized that the large burial cairn above Wadi Sabra represents the only 'monumental' tomb, perhaps even associated with an ancestral leader affiliated with the settlement.

Although far older, a passage from the archive of the Old Babylonian city of Mari (c. 1810–1760 BC) may yield interesting parallels of large cairns (the so-called *hamusûm* or *râmum*) being used as burial grounds for pastoral nomadic tribal leaders and the significance these monuments had on demarcating tribal territories.[1932] The Akkadian clay tablets generally attest to the good relations between the region's nomadic tribes and the 'city-state' of Mari, particularly during the reign of its king Zimri-Lim. The following passage records a complaint addressed to Zimri-Lim by a certain Dâdî-hadun, a leader of the Rabbean tribe.[1933] Dâdî-hadun had previously allowed the Uprapean tribe to erect a burial monument of their leader Lahun Dagan within the territory of the Rabbeans. The burial cairn of his ancestor, Ayalum, was then destroyed by members of the Uprapean tribe, for which Dâdî-hadun has sought revenge and informed Zimri-Lim:[1934]

> *About the hamusûm-monument of which I have talked to you – it is a funerary monument (râmum); it is five years ago that this hamusûm-monument was erected, and since then I have passed by ten times from upstream or from downstream: never did I touch this hamusûm-monument. During my present journey when I left you, I had reached Muban when I was told: 'The hamusûm-monument of Ayalum has been destroyed.' I did not want to believe it. I arrived in Halabit and received confirmation of it. Even then, I refrained from believing it until I sent two servants and they saw this hamusûm-monument. Then I grew very angry and held my hand over the hamusûm-monument of Lahun-Dagan. They certainly destroyed the one that was erected on a territory that was not their own, whereas I did not destroy the one that was erected on my own territory, before they commenced. Now my father is informed about their aggressive act. The Rabbeans had not been hostile.*

Not only does this passage highlight the tribal character of such burial cairns, it also emphasizes the monuments' importance for marking tribal territories in the landscape. Although speculative, this may have been the case for the burial cairn in the Wadi Sabra and for other large burial cairns in the Petraean hinterland as well. For example, the cairns along Naqb Mistalgile, Naqb Saqqara or the Umm Qamar pass (cf. chapter 8) could be considered as possible archaeological indications that the respective routes crossed through different (tribal?) territories.

Rural façade tombs, particularly the single pylon tomb along the Darb al-Lethie (PHSP Site No. 127)

1928 Specifically note two 'tower tombs' dating between the 1st centuries BC and AD in the Jabal Qurma region (Akkermans – Huigens 2018, 509–510; Akkermans – Brüning 2017, 137–139). Cf. Hesse 2016, 3–4 for the Palmyrene examples. Also consider the 'Cairn of Hani' in the Basalt Desert (Kennedy 2012).

1929 Hesse 2016, 3 mentions that larger cairns could have been "[…] *part of complexes, including walls and other cairns*" in the Palmyrene hinterland. Such examples may perhaps serve as parallels to ShamAyl Site No. 001 where "tombs" (possible cairns?) were observed together with an associated wall.

1930 Lindner – Zeitler 1997, 558–559 estimates that only 20 individuals could be buried in the pit graves below the Jabal Mutheilya at Sabra. To date, no tombs were documented at other larger Nabataean settlements such as Abu Khusheiba or Ras Slaysil. This is most likely due to the still relatively poor state of research on the settlements, particularly Abu Khusheiba. However, burials are certainly to be expected at these sites.

1931 Lindner – Zeitler 1997, 558–559.

1932 Hesse 2016, 3–4.

1933 Hesse 2016, 4.

1934 For more on this passage, see Charpin 2010, 245 and Durand 2005, 30.

and the step tomb along Wadi al-Mu'aysirah East (PRP Site No. wme013) could have served as potential territorial markers as well. Particularly the latter site was surrounded by agricultural fields and other agricultural installations. Although there is no way of confirming this, the tomb may have been associated with an (elite) individual or family who managed the local agricultural system.[1935]

Surveys documenting Nabtaean façade tombs outside Petra have not taken into consideration that these funerary monuments may have been integrated into larger funerary *complexes*. This would further emphasize the elite status of the tomb owners. However, K. Petrovszky has shown that monumental Nabataean tomb complexes are also located on the outskirts of Petra. For example, carved into the northeastern slope of Umm al-Biyara, Petrovszky has reexamined the hegr-type façade tomb BD 361 and demonstrated that the tomb was separated from the adjacent tombs by a partly rock-cut and freely built forecourt.[1936] It also had a large cistern. BD 361 thus features important elements that characterize Nabataean tomb complexes (cf. chapter 8).

The question whether the façade tomb in the Wadi al-Mu'aysirah East or the double pylon tomb of FJHP Site No. Ext 155 below Umm Barra are Nabataean tomb *complexes* cannot be concluded without further investigations. However, this seems likely. In addition, while the monumental rock-cut tomb at Mukheifer cannot be classified as a typical Nabataean *façade* tomb, it may have served as a territorial marker and it would not surprise if future investigations would reveal features that are typical to Nabataean funerary complexes.

The fact that PHSP Site No. 127 is carved high into the sandstone outcrop along the Darb al-Lethie does not suggest that the tomb is associated with other features and does not qualify as a possible funerary complex. Nevertheless, the façade tombs – incorporated into larger complexes or not – clearly indicate that these monumental funerary monuments were reserved for a Nabataean elite active in the Petra hinterland.

Similar assumptions can be made about the tomb owners of the monumental *hypogea* in the Jabal Shara region. Their obvious structural differences aside, one major differentiation between the rural façade tombs and the *hypogea* (considering both as monumental funerary monuments of an elite social group) is their chronology: Apart from the few problematic structures documented by ShamAyl, the latest funerary monuments identified in the Petraean hinterland are the monumental *hypogea*.[1937] While other monumental burial types do not date later than the 2nd century AD, surface pottery from the *hypogea* suggests that these monuments were in continuous use until the 3rd century AD. In Petra's hinterland, simpler burial types such as shaft tombs, pit graves or cairns were definitely used in later period, although the pottery readings are most likely based on material discarded after the looting of the structures.[1938] The burials are heavily disturbed and the pottery readings may rather suggest the main dating phase instead of the entire dating *range* of the tombs. For example, Sachet's excavation of shaft tombs near the 'Snake Monument' has shown that burials continued there into the 2nd century AD and possibly even as late as the 4th century AD.[1939] It thus seems unlikely that simpler burial types in Petra's hinterland did not continue in later periods – unlike the shaft tombs along the North Ridge in urban Petra, which go out of use during the late 1st/early 2nd century AD.[1940]

Nevertheless, one is inclined to draw parallels between the presumed end or at least limited use of Nabataean tomb complexes in Petra (or the shaft tombs along the North Ridge) shortly after the Roman annexation in 106 AD and the lack of monumental funerary structures in Petra's hinterland after the 2nd century AD. Nabataean *heterotopiai* – i.e. structures enabling regular gatherings of distinct social groups, most notably ritual banqueting installations within tribal sanctuaries and Nabataean tomb complexes – were either abandoned or significantly altered in the 2nd century AD (cf. chapter 8). In fear of potential political uprisings that could have been fostered by such regular meetings of indigenous social groups, such gatherings were likely prohibited by the Romans. Other Nabataean *heterotopiai*, i.e. rural religious structures, arguably went out of use by the 2nd century AD as well.

In urban Petra, religious structures increased since the 1st century BC. This is mirrored in the city's hinterland (cf. chapter 8). Petra's growing supraregional religious significance has arguably attracted numerous local and regional tribes to gather in Petra and the religious structures in the city's surroundings attest to the overall sanctity of the landscape.

1935 Berenfeld et al. 2016, 94.
1936 Petrovszky 2013a, 197–198.
1937 The problematic funerary structures recorded by ShamAyl are Site Nos. 001, 049, 095, 096, 109, 135, 148 and 155. The cemeteries documented by ShamAyl are Site Nos. 015, 103 and 245 (cf. chapter 8).
1938 Cf. Kouki – Silvonen 2013b, 303.
1939 Sachet 2009, 100.
1940 Perry 2017, 103–106.

All religious structures dating to the pre-annexation period and not directly associated with settlements such as Wadi Musa, Sabra, Abu Khusheiba or as-Sadeh are located near Petra. While this may be due to the differing survey intensities, it nevertheless highlights the religious significance of Petra and its immediate hinterland. The Pearson correlation test of sanctuaries and isolated cultic installations furthermore suggests a strong spatial correlation with industrial/exploitation installations. There are also strong spatial correlations to agricultural terraces/fields, dams/barrages as well as isolated funerary monuments. The correlation to agricultural terraces/fields as well as dams and barrages may be explained by the fact that most of the isolated cultic installations were originally recorded by the PRP along the Wadi al-Mu'aysirah East and West. The PRP documented many agricultural terraces and potential dams or barrages along the two wadis as well, most likely explaining the result of the correlation test. The same applies to the supposed strong correlation to isolated funerary monuments. Finding cultic installations at funerary monuments, particularly Nabataean tomb complexes, is not surprising and attests to the ritual significance of Nabataean funerary complexes in Petra's hinterland.

The strong spatial correlation between sanctuaries as well as isolated cultic installations and industrial/exploitation installations does not surprise as the industrial/exploitation installations are mainly quarries. All rock-cut features at religious structures, no matter if within a sanctuary or part of an isolated cultic installation, naturally show evidence of quarrying activities. Wenning and Merklein have observed many signs of quarrying during their survey of the Isis sanctuary in the Wadi as-Siyyagh. As local stone was used as building material for the freely built structures of the sanctuaries, small-scale quarries can be expected. This may explain the cuboid rock on the southern edge of Jabal Numayr, which Dalman suggested to have cultic meaning, but was dismissed by Tholbecq (cf. chapter 8).

In addition to this practical reason for explaining the spatial correlation between quarries and religious structures, the relationship is arguably also of cultic nature. Lindner mentioned conspicuously large quantities of fragmented 1st and 2nd century AD Nabataean pottery at quarries near Sabra and tentatively suggests that this may represent a form of ritual 'smashing' of vessels.[1941] It is postulated that this practice was conducted by stone-cutters for giving thanks to the gods for being able to cut away the sacred rock and allowing them to work safely and without incident.[1942] Similarly, while the 'Eagle Niche Valley' below the Jabal al-Khubtah is mainly referred to as a large quarry site, the numerous niches and the *triclinium* suggest that the place was used as a tribal gathering place or a fraternal *marzeah* of stonemasons as well.[1943] Additionally, it is well known that Petraean stonemasons carved small altars, *baetyli*, palm trees and other symbols into the bedrock after the completion of the quarrying. This was presumably an expression of gratitude.[1944]

The fact that all religious structures are situated along Class A and B routes is striking. More 'public' sanctuaries of regional significance, such as Jabal Harun and (possibly) Ras Hamra, were important local focal points and therefore situated along Class A routes. The same has been observed for other religious structures, such as ad-Dahunne Slaysil or Jabal Qarun. In contrast, 'private' sanctuaries, such as the Obodas Chapel and the Isis sanctuary in the Wadi as-Siyyagh, are not as easily accessible.[1945] Good accessibility to the public religious structures was a key aspect in the Petraean hinterland and may be seen in the context of potential religious pilgrimages. El-Khouri correctly correlates isolated cultic installations (e.g. *triclinia* or cultic niches) along certain processional routes that lead to more significant religious structures such as the 'high places' in Petra with ritual pilgrimages.[1946] The Nabataean sanctuary at Khirbet et-Tannur was also an important pilgrimage site and was only visited for religious purposes. The caravanserai and Nabtaean-Roman temple at Khirbet edh-Dharih may have served as a pilgrimage site as well.[1947]

The fact that pilgrimages were an important feature of rural Petra's sanctuaries is confirmed by their location along Class A routes. The numerous 'footprints' carved into the bedrock along specific routes and near rural sanctuaries such as Jabal Harun, ad-Dahhune Slaysil or Jabal Numayr are additional archaeological indicators for ritual pilgrimages (cf. FIG. 326).[1948]

1941 Lindner 2006, 120.
1942 Lindner 2003a, 160. This was also proposed by Merklein – Wenning 2001, 426 when discussing the quarries in the Isis sanctuary of the Wadi as-Siyyagh.
1943 Lindner 2003a, 155–164.
1944 Wadeson – Wenning 2015 and 2014.
1945 For a definition of 'public' and 'private' religious structures, see n. 1702.
1946 Fiema 2012b, 31; el-Khouri 2006, 332. On processional ways in Petra and its rural environment in general, see e.g. Alpass 2013, 66–73 and Dentzer 2010, 193–196.
1947 Schmid 2016, 69; McKenzie et al. 2013, 233, 264–266; Villeneuve – al-Muheisen 2008, 1498–1500, 1506.
1948 Fiema 2016, 542; Kouki – Silvonen 2013b, 310–311, Eklund 2013, 284–285, 292 and Miettunen 2008, 39. Footprints can also be observed on mountaintops at Petra, such as the ad-Deir plateau, Jabal al-Khubtah or Umm al-Biyara.

As mentioned above, the abrupt end of religious structures considered as *heterotopiai* or showing heterotopical features in the early to mid-2nd century AD, immediately after the Roman annexation of Nabataea, is striking. [1949] The excavations of the Obodas Chapel have shown that the site was destroyed in the mid-2nd century AD. Other heterotopical religious structures such as Jabal Numayr, the Isis sanctuaries at the Wadi Abu Olleqah and Wadi as-Siyyagh, FJHP Site No. Ext.103, the sanctuary of en-Nu'eira as well as smaller isolated cultic installations (most notably banqueting installations), were all abandoned at this time.[1950] Similar observations are made at other heterotopical sites in Nabataea, such as the monumental *triclinia* at Hegra and Dumat al-Jandal. Both sites were abandoned by the early 2nd century AD.[1951] While the preliminary dating of the heterotopical religious structures in the Petraean hinterland must be confirmed by excavations, the fact that no surface material was recorded at any of these sites that dates later than the mid-2nd century AD, is conspicuous and does not seem coincidental.

Ritual gatherings at private sanctuaries or isolated cultic installations, particularly in form of fraternal *marzeah*, were also important *social* gatherings where Nabataen tribes, families or other social groups regularly convened. Arguably, this fundamental *social* element of elite Nabtaean culture (at least in Petra and its immediate environment) threatened Roman rule after 106 AD.[1952] Heterotopical associations mirror the fundamental family- or tribal-based society of Nabataean Petra and its hinterland and had important cultic as well as socio-political meaning. For the Romans, it was difficult to exert power and control over these associations. As they could potentially undermine Roman authority, they were not tolerated.

As public sanctuaries such as Jabal Numayr, ad-Dahunne Slaysil, en-Nu'eira or Jabal Qarun vary in their architectural design, it may be tentatively assumed that this reflects family- or tribal particularisms in the structural appearance of religious structures.[1953] However, they were all central focal points in Petra's hinterland. They were easily accessible and throned over their environs overlooking large areas of their own 'hinterlands.' This leads to a further and potentially important aspect of religious structures in rural Petra:

Based on the extensive archaeological evidence for runoff cultivation in the Jabal Harun area and finds from the Nabataean sanctuary indicating that agricultural products were processed there, it is assumed that the sanctuary also had economic importance (cf. chapter 4).[1954] Although there is neither evidence for landownership nor for the sanctuary's direct involvement in economic activities, it is nevertheless possible that the sanctuary administered a larger, agricultural estate that accommodated the needs of local inhabitants and/or those of pilgrims and other visitors to the sanctuary.

The Nabataean-Roman sanctuary at Khirbet edh-Dharih was also the center of a large agricultural area or village with agricultural processing installations such as olive presses as well as a luxurious villa dating from the 1st – 4th century AD.[1955] The site also encompasses a late 1st century AD caravanserai with associated baths, thus offering enough place and recreational opportunities for travelers.[1956] The agricultural area most definitely served for supplying sufficient foodstuffs for the many pilgrims visiting the sanctuary, which may have acted as the administrator of its associated lands.

Arguably, if major Nabataean sanctuaries such as Jabal Harun or Khirbet edh-Dharih administered larger estates, parallels may be drawn to Hellenistic temple estates as known, for example, in Pontos, Cappadocia or Cilicia.[1957] Hellenistic temple estates organized local inhabitants to ensure sufficient irrigation and agricultural surplus on the temple-owned land and were strongly involved in religious, political and economic matters.[1958] Although possible parallels between Hellenistic temple estates and Nabataean sanctuaries require further exploration, they may nevertheless indicate that large Nabataean sanctuaries could have been involved in economic activities.

The tribal significance and prominent physical location of public sanctuaries, as well as the possibility

1949 Cf. Tholbecq et al. 2019, 21; Durand 2017, 95–98; Renel – Monchot 2017, 70; Charloux et al. 2016, 29; Tholbecq 2016, 1066–1067; Schmid 2013a, 259–261, 265.

1950 Fiema 2016, 544; Hertell et al. 2013, 338; Tholbecq – Durand 2013, 211; Tholbecq 2011b, 43; Tholbecq et al. 2008, 241.

1951 Durand 2017, 90–93.

1952 Cf. Durand 2017, 95–98; Renel – Monchot 2017, 70; Charloux et al. 2016, 24–29; Tholbecq 2016, 1066–1067 and Schmid 2013a.

1953 Cf. Schmid 2016, 68 who refers to similar phenomena in southern Syrian rural sanctuaries such as Khirbet al-Masakeb.

1954 Fiema 2016, 543–544. The agricultural area was continuously cultivated in the Roman and Byzantine periods, although presumably not as extensive as in Nabataean times.

1955 Villeneuve – al-Muheisen 2008, 1499, 1516–1517.

1956 Durand et al. 2014; Villeneuve – al-Muheisen 2008, 1499, 1504–1506.

1957 For details, cf. Kropp 2013a, 229–230 with further references.

1958 Cf. e.g. Sökmen 2009.

that major religious sites acted as estate administrators, suggests that these structures held spatially defined territories. Additionally, the fact that major settlements such as Wadi Musa, Sabra, Abu Khusheiba and as-Sadeh had their own temples, indicates that these sites were inhabited by distinct social groups.[1959] This reflects a highly diverse social structure of the Petraean hinterland.[1960]

The monumental *hypogea*, isolated burial cairns, as well as the façade tombs were also discussed as possible territorial markers. This supports the argument that specific structures demarcated distinct social landscapes.

Further attesting to the diverse social structure of the Petraean hinterland are the discussed tribal markings (*wusūm*) indicating that people interested in marking their specific tribal affiliations (cf. chapter 4) roamed extensively through the study area. As there are no distinct similarities between the different *wusūm*, this may suggest that different tribal social groups left their marks in Petra's hinterland.[1961] While it remains unknown whether these were exterior groups only traveling through the study area, or if they represent activities of locals, the *wusūm* nevertheless highlight the tribal character of the Petraean hinterland through time. They also point to more general aspects of mobility in the Petra area.[1962]

This was also concluded when considering isolated rural cisterns, which were widely distributed along the eastern high plateau (chapter 4).[1963] The numerous isolated rural cisterns may reflect the restricted and exclusive use of the 'hidden' Nabataean cisterns by mobile peoples as described by Diodorus. This would highlight the continuing semi-nomadic, pastoralist aspect of Nabataean society despite the increasing sedentarization process observed by the 1st century BC onwards when agriculture became the dominant subsistence strategy. Further indications for heightened mobility in the Petra region are the numerous concentrations of petroglyphs and find clusters. They suggest that specific locations seem to have been revisited repeatedly over time by people travelling through the study area and were therefore deemed as suitable resting and gathering places.[1964] Additionally, pilgrims most likely carved the various commemorative inscriptions on their way to important religious sites (e.g. Jabal Harun). This indicates a great deal of mobility in the Petraean hinterland as well. Particularly *wusūm*, concentrations of rock art and commemorative inscriptions are

> […] *complex iconographies, personal graffiti left behind by lonely travelers, and also manifestations of a more official character, such as a scene or inscription commemorating an activity or the aims of specific journeys.*[1965]

These are loaded with various meaning and significance, and served different purposes in different places. Inscriptions, petroglyphs and other forms of rock-art generally served as land markers or human signifiers within a landscape.[1966] Depending on the context, the role or social standing of their author(s) can vary. One common denominator, however, was the aim to communicate to outsiders and to convey messages as simple as transmitting a simple *"I was here"* or more complex accounts of lineage. The placement of such sites was therefore not arbitrary. It rather appears to have been a very selective process where people chose to convey a distinct and deeper meaning to a particular place or region within rural Petra's landscape.[1967]

Since the 1st century BC, Petra's growing political stability and economic opportunities associated with long-distance trade as well as with agricultural and industrial produce led to an increasing social stratification. This is particularly mirrored by the large number of small settlements that "[…] *range from simple houses with one or two rooms, to multiroom mansions with courtyards* […],"[1968] thus suggesting a difference in wealth.

This is further supported by the rural mansions of Umm Qussah (Beidha), Seir al-Begh'er or WMWS 1996 Site No. Bayda 20 and Shammasa. These struc-

1959 Similar assumptions can be made for the major Nabataean sanctuaries of Khirbet et-Tannur, Khirbet edh-Dharih or Dhat Ras. At Dhat Ras, the three (presumably) Nabataean-Roman temples were definitely amidst a large settlement, which remained a significant site along the *via nova Traiana* throughout the Roman and Byzantine periods (Alpass 2013, 214–217; Wenning 2003). However, the site was never excavated and only briefly explored by Wenning and Merklein (Wenning 2003).

1960 Cf. Tholbecq et al. 2019, 22; 2017b, 43–44, 45 and 2016, 1060–1061 who also points out the various epigraphically evidenced tribal sanctuaries of Palmyra (in reference to Yon 2002, 66–87). Importantly, also consider Dentzer 2010; 2009 and 1999, particularly 237–239.

1961 In total, 24 *wusūm* were recorded in the study area.

1962 These include possible seasonal and/or nomadic pastoralists or sedentaries.

1963 These were reportedly supplied with water by various cisterns within the respective settlement limits.

1964 Cf. also Eklund 2013, 291–292.

1965 Riemer – Förster 2013, 40.

1966 Riemer – Förster 2013, 42 with further references.

1967 Freedman et al. 2011, 243 cited after Riemer – Förster 2013, 42.

1968 Kouki 2012, 97.

tures possibly served as local 'centers' of a rural elite, who may have been responsible for the maintenance and administration of local lands. If so, it is possible that tribal associations or kinship spatially defined these lands with the rural mansions as their centers.[1969] Hellenistic and Roman period epigraphical evidence from the Hawran suggests that specific territories were controlled by local *ethnarchs* or *phylarchs*. In addition to their reported military responsibilities, they may have also acted as local administrative leaders.[1970] Although entirely speculative, a similar situation may be assumed for the Petraean hinterland as well.

The Nabataean water management system offers additional indications that administrative responsibilities were assumed by a rural elite. In terms of water rights, Canaan has provided interesting ethnographical insights into how the inhabitants of early 20th century Wadi Musa distributed water from the various local springs.[1971] While seasonal agriculture was practiced in and around Wadi Musa, the springs were owned by different tribes. Most notably, 'Ain Musa belonged to the tribe of the al-'Alaya which managed the town's distribution of spring water for both domestic and agricultural use. Other ethnographic accounts state that local tribal leaders of Wadi Musa distributed spring water alternately to the inhabitants as disputes over water usage and distribution were supposedly frequent in the 19th and early 20th century. Local judges determined water rights. They were probably of good local repute and issued distribution rights to land properties. [1972] Although drawing parallels from modern Bedouin societies to antiquity may be problematic, similar water- and land-related disputes in the Petra area are also reported in the 6th century AD Petra Papyri and it is likely that there were similar cases during the Nabataean period as well. Specifically, the Petra Papyri document a long settlement dispute between two landowners (a certain Theodoros, son of Obodianus and Stephanos, son of Leontios) concerning usage rights from nearby spring water and its further distribution.[1973] The papyri also mention a similar dispute at ancient Saddaqa (*Zadacathon*). This was mediated by the Ghassanid *phylarch* Abu Karib (Abochorabos) who probably enjoyed a good reputation and was well acquainted with local customs and traditions. He thus served the Byzantine authorities as a valuable intermediary for resolving such local disputes.[1974] As the modern example from Wadi Musa fits similar habitual traditions from the 6th century AD, it does not seem too far-stretched to assume the same for the Nabataean period. The little epigraphical evidence suggests that Nabataean water rights were most likely issued by specific water authorities or officials. For example, a Nabataean dedicatory inscription dating to 8/7 BC from Khirbet et-Tannur mentions a supervisor of the site's nearby spring of 'Ain al-La'aban:

> *Which Natir'el son of Zayd'el, head of the La'aban spring, built for the life of Aretas, king of the Nabataeans, lover of his people, and (for) the life of Huldu, his wife, in the year 2.*[1975]

Although it remains unclear to which structure the inscription is referring, *Natir'el* probably belonged to a priestly class as the inscription was dedicated to the sanctuary.[1976] In addition to this 'Natir'el inscription,' two of the six Nabataean legal documents of the Babatha archive mention a land-holding Nabataean official who was also in charge of water distribution.[1977] Both documents refer to the sale of palm groves and date to 97/98 AD. Papyri Yadin 2, however, specifically suggests that watering periods were also up for sale, in addition to the groves themselves:

> *On that day (He) purchased (namely) Archelaus, Son of 'Abad-'Amanu* [...], *The commander, from me, I, Abi-Adan daughter of 'Aftah, son of Manigares, a plantation of date palms which is in Mahoz 'Eglatain, including irrigation ditches and assigned watering periods.*[1978]

Furthermore, a short Nabataean memorial inscription at the spring of Jabal Qalha near ancient Hawara (Humeima) mentions a local Nabataean hydraulic engineer who was seemingly responsible for the construction of the channel that diverted spring water into a nearby cistern.[1979]

Dating to 32/33 AD, another Nabataean inscription was recorded near the Nabataean dams along the

1969 While previously perceived as communal property, it is likely that these lands were increasingly privatized during the Nabataean period (Kouki 2012, 129).
1970 Cf. e. g. Teixidor 1995, 116–117.
1971 Canaan 1930, 198. Cf. most recently al-Salameen et al. 2019, 305–306 as well as al-Muheisen 2009, 172–173.
1972 Nasarat et al. 2012, 111.
1973 Nasarat et al. 2012, 111; Kouki 2012, 125–126 with further references.
1974 Fiema 2007, 314–317.
1975 McKenzie et al. 2013a, 49; Healey 2013; al-Muheisen 2009, 173; Savignac 1937. Three supervisors or 'tribal heads' of the 'Ain Afqa spring are also known from Palmyra, who charged payment for the use of spring water (al-Muheisen 2009, 173).
1976 McKenzie et al. 2013a, 49, 191–192.
1977 Papyri Yadin 2 and 3: Nasarat et al. 2012, 108–109; Kouki 2012, 124; Yadin et al. 2002, 201–244.
1978 After Nasarat et al. 2012, 108–109.
1979 Hackl et al. 2003, 280–282 with further references. Also note the arched Nabataean dam at al-Kharaza near Jabal Ratama between Wadi Ramm and Humeima, which bears the owner's name and date of construction (32 AD) (Oleson 2018, 35).

slopes of Jabal Haraza in the northern Hijaz, which memorialized the builder of the dams.[1980] While it is unlikely that these engineers were also responsible for the distribution of water, the inscriptions emphasize the professional organization of Nabataean hydro-technological engineers.[1981]

Although the epigraphical evidence only offers a glimpse into Nabataean water distribution rights in the Petraean hinterland, it nevertheless seems that the right to draw spring water was bestowed on local leaders who were also responsible for further water distribution. As suggested by the Petra Papyri, water-related disputes were common in the Byzantine periods. A similar situation can only be assumed for Nabataean times as well. Local supervisors or water-related administrators were certainly necessary to maintain a functional water management system. Without a clear management of water distribution rights by water officials, disputes over the limited water sources could have otherwise brought the frail system quickly to a collapse. The role of such supervisors becomes even more important when considering that water distribution rights were also a deeply *social* issue. This is reflected by the archaeological evidence from urban Petra, particularly concerning the end consumers of the fresh water aqueducts. For example, the Khubtah fresh water aqueduct ended in a large reservoir below the 'Palace Tomb' in an area where it is assumed that the Nabataean royal residences are situated.[1982] The Nabataean kings were presumably the first in Petra to have benefitted from the fresh water provided by this aqueduct. It is also assumed that the ʾAin Braq aqueduct first supplied the elite Solider Tomb Complex in the Wadi Farasa with fresh water before it continued further into the city's center and subsequently branched off towards the Nabataean luxurious villa of ez-Zantur and the *paradeisos* of the so-called 'Great Temple.'[1983] Water distribution rights in urban Petra were therefore strongly tied to the social status of the end user as the availability of fresh water was a highly valued luxury good in such an arid climate. While smaller or less sophisticated Nabataean tomb complexes in Petra were mostly supplied with run-off water, fresh water was first distributed to the Nabataean kings and members of the local elite.[1984] This strongly socially structured water distribution system in Petra was probably managed by Nabataean supervisors of local springs. It can only be assumed that a similar social stratification of water rights also extended into the city's hinterland as well.

Rural life in the Petraean hinterland bordered on both sedentary and nomadic lifestyles reflecting the tribal-based social background of the study area through time. For the Nabataean period this is clearly suggested by the archaeological evidence for seasonal and/or nomadic pastoralism, the heterotopical funerary and religious structures, the *wusūm*, conspicuous find clusters and other concentrations of rock art, rural mansions as well as indications derived from the Nabataean rural water management system. This highlights the particular complexity of Nabataean society and culture characterized by the constant 'back-and-forths' between Hellenized and Oriental, mobile and sedentary material culture.[1985] Additionally, Strabo's description of the Nabataean king as a *primus inter pares* who regularly had to account for his actions publicly further underlines the community-based and tribal-rooted socio-political organization of Nabataean society.[1986]

The central argument that the Petraean hinterland was spatially divided into socially distinct territories is clearly mirrored by L. Nehmé's comprehensive analysis of the epigraphic evidence from Petra (cf. chapter 8). Nehmé identified different social groups that collectively commemorated a specific deity and were organized within spatially distinct districts within the city. As most of these groups were directly associated with ritual banqueting installations (mostly *triclinia*), these designated 'social spaces' in urban Petra can be referred to as Nabataean *heterotopiai* as well. Thus, as is presumed for urban Petra, the heterotopical structures identified in rural Petra possibly demarcated specific social landscapes within the wider Petraean hinterland.[1987] Similar assumptions can also be made for the larger and more significant settlements in the study area such as Sabra, Abu Khusheiba, Wadi Musa and Udruh, or the discussed rural mansions such as Umm Qussah (Beidha), Seir al-Begh'er and Shammasa. Possible territorial site-catchments were therefore modelled around these presumed markers.[1988] Although such modelled territories remain completely hypo-

1980 Hackl et al. 2003, 283–284 with further references.
1981 Cf. further epigraphical evidence on Nabataean agricultural and pastoral 'professions' in al-Salameen 2004, 140.
1982 Schmid et al. 2012, 85–93; Fiema 2012a, 123. On the water management system of the presumed Nabataean *basileia* at Petra, cf. Weis 2016.
1983 Bellwald 2008, 123; Schmid 2008b, 110–115.
1984 On the water installations of the various Nabataean tomb complexes, see e.g. Schmid 2009.
1985 Cf. e.g. Schmid 2013a and 2001 with further references.
1986 Str. 16, 4, 26.
1987 Among others, such heterotopical structures are most notably rural sanctuaries such as the Obodas Chapel, the Isis sanctuary in the Wadi as-Siyyagh, ad-Dahune Slaysil, Jabal Numayr or Jabal Qarun.
1988 Cf. chapter 2 for a detailed description of the GIS-based site-catchment analysis.

thetical and suggestive without further archaeological research, the site-catchment analyses nevertheless visualize the complex social structure of Petra's hinterland, which was presumably deeply rooted in tribal traditions. When contrasting this with L. Nehmé's map of the social groups in Petra, the parallels are striking (FIG. 364). As urban Petra, the Petraean hinterland was an intricate patchwork of various social groups that, although dominated by Petra, were strongly bound by local 'tribal' affiliations. If so, the Nabataean kings in Petra certainly maintained good relations to these groups because important trade routes ran through their presumed territories, which again highlights the important administrative and economic role of these communities. Without the constant appeasement of these groups by the Nabataean rulers in Petra (cf. Strabo's accounts above), it is quite possible that the city could never have developed as it did.

The Military Disposition

This study's critical re-assessment of the presumed military structures presents a first comprehensive overview of all structures with possible military function in the Petraean hinterland. Based on the provided archaeological information for the individual sites it was possible to create comparative plans of most of the discussed structures (FIG. 365). While a clear differentiation in terms of site size is apparent, there is no evidence to suggest that this reflects a temporal development. The varying site sizes rather correspond to the different functions of military sites: The largest structure is the Late Roman *castrum* at Udruh (c. 4,7 ha). In terms of size, the fortress is followed by large forts (greater than 0,4 ha),[1989] medium-sized forts (between 0,4 and 0,2 ha)[1990] and small forts (between 0,2 and 0,1 ha).[1991] Independent of site size, most of the pre-Roman forts are rectangular structures with internal divisions and a single tower enclosed by exterior walls.[1992] Whether such structures can be considered as examples of a local type of military architecture is difficult to determine without excavations. It rather seems that pre-Roman forts vary in their structural layout and correspond to their different environmental contexts. The only examples that follow overall military architectural designs are the Late *Roman* forts at Bir Madkhur, Saddaqa as well as the early Roman temporary fort at Tell Abara.

For structures measuring 0,1 ha or smaller, it is difficult to confidently assign a military function. Possible fortlets and/or road stations are rectangular or square and are characterized by thick exterior walls with possible internal divisions. Most of these structures have possible courtyard or forecourt areas. They are mainly located on hilltops or slopes and are mostly placed in close vicinity to roads.

Isolated rectangular or square structures smaller than c. 90 m² that are positioned on hilltops or slopes are considered to have functioned as potential watchtowers. The 32 identified watchtowers are the most common type of military sites discussed in this study. These are followed by 15 possible fortlets/road stations, 11 forts and the Late Roman *castrum* at Udruh as the only fortress.

While only few military structures are recorded for the Iron Age periods (cf. chapter 3), the majority was constructed in the Nabataean period (1st centuries BC and AD) (FIG. 366). Most Nabataean structures were in continuous use during and after the Roman annexation in the 2nd century AD, but military sites were gradually abandoned towards Late Antiquity. Although a few new forts and watchtowers were constructed during the 4th century AD, the downward trend continues. Despite this gradual decrease of military sites from the 2nd century AD onward, the continued use of Nabataean structures as well as the absence of new military structures (at least for the Early Roman period)[1993] suggests that the original Nabataean system remained mostly intact. Nabataean military structures are mostly associated with the road network, civilian settlements as well as water sources. GIS-based visibility analyses have exposed a 'visual hierarchy' of the discussed military sites. For the 1st century AD when most of the military sites are occupied, visual control from forts encompasses only comparatively small areas of the Petraean hinterland, but includes predominantly civilian settlements and the road network (FIG. 367). However, forts are not intervisible.

Particularly in the southeastern quarter of the study area, the visual range of fortlets is considerably denser. Fortlets control civilian settlements, the road network and water sources as well. However, most fortlets are not intervisible either.

Watchtowers exert the most comprehensive visual control over the Petraean hinterland. At least for the Nabataean period, the cumulative visibility analyses

1989 Such as the 2nd century AD temporary Roman fort at Tell Abara or the 4th century AD fort at Saddaqa.

1990 Such as Khirbet Ayl and ShamAyl Site No. 251.

1991 Small forts are Khirbet Dubayl, Khirbet al-Teen, Khirbet ar-Ruways, ShamAyl Site No. 236, Bir Madkhur, Mulgan and ShamAyl Site No. 190.

1992 See Khirbet Ayl, ShamAyl Site No. 251, Khirbet Dubayl, Khirbet al-Teen, Khirbet ar-Ruways and ShamAyl Site No. 190.

1993 With the exception of Tell Abara.

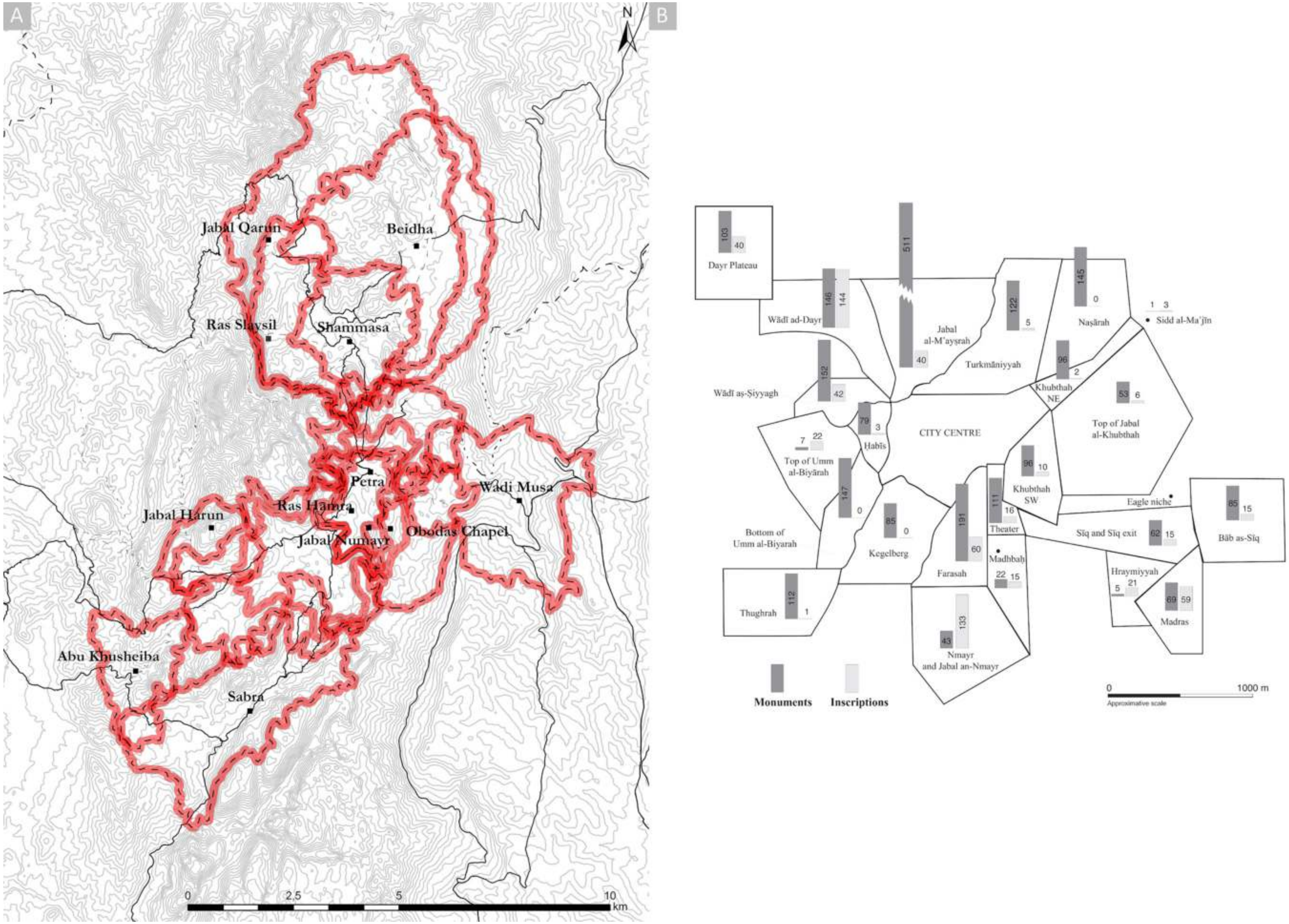


FIG. 364 Juxtaposition of possible districts of different social groups in the Petraean hinterland (A) with L. Nehmé's map of different social groups in urban Petra (B) (Nehmé 2013, 114, fig. 1).

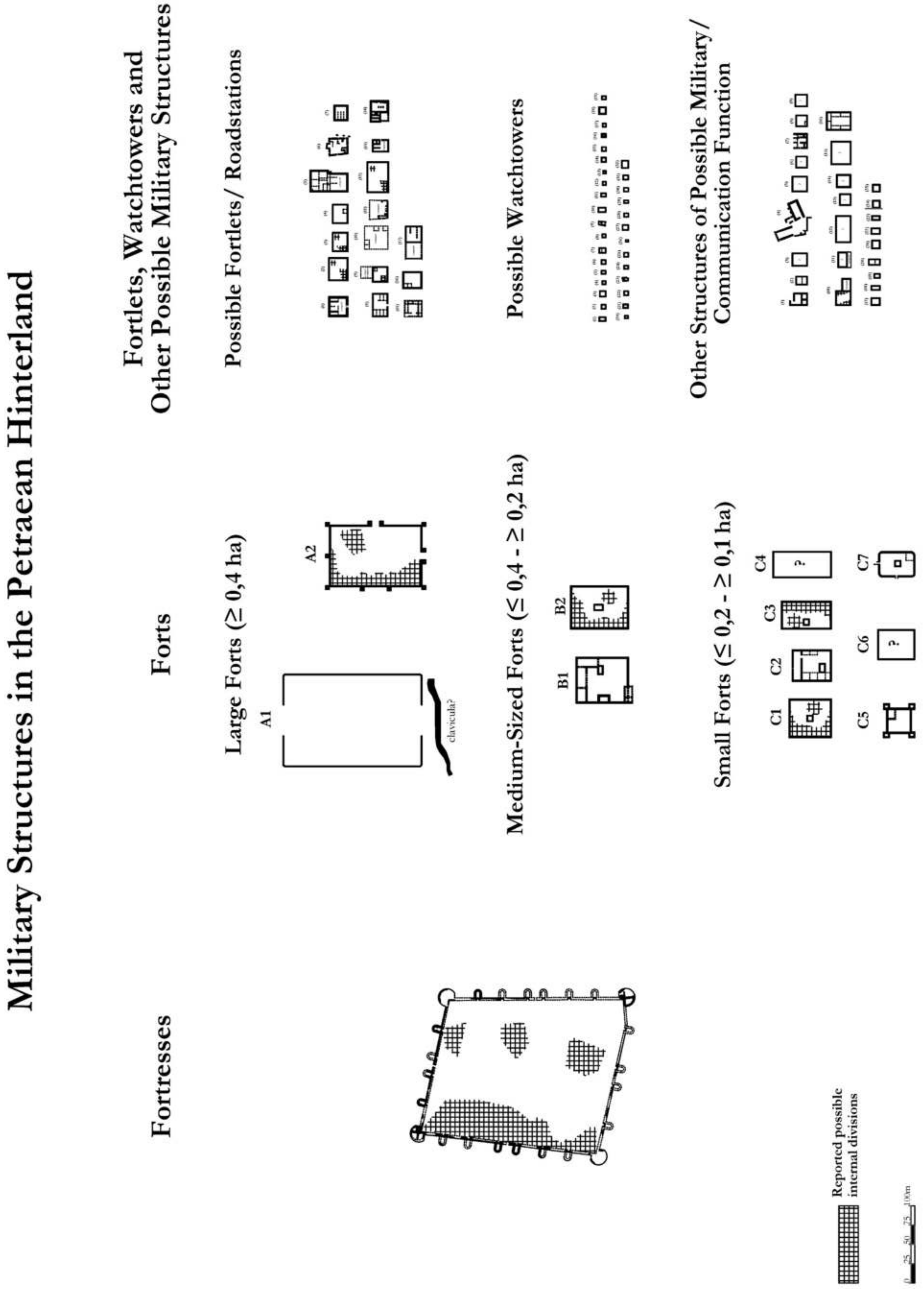


FIG. 365 Scaled sketch plans of all discussed military structures recorded in the Petraean hinterland.

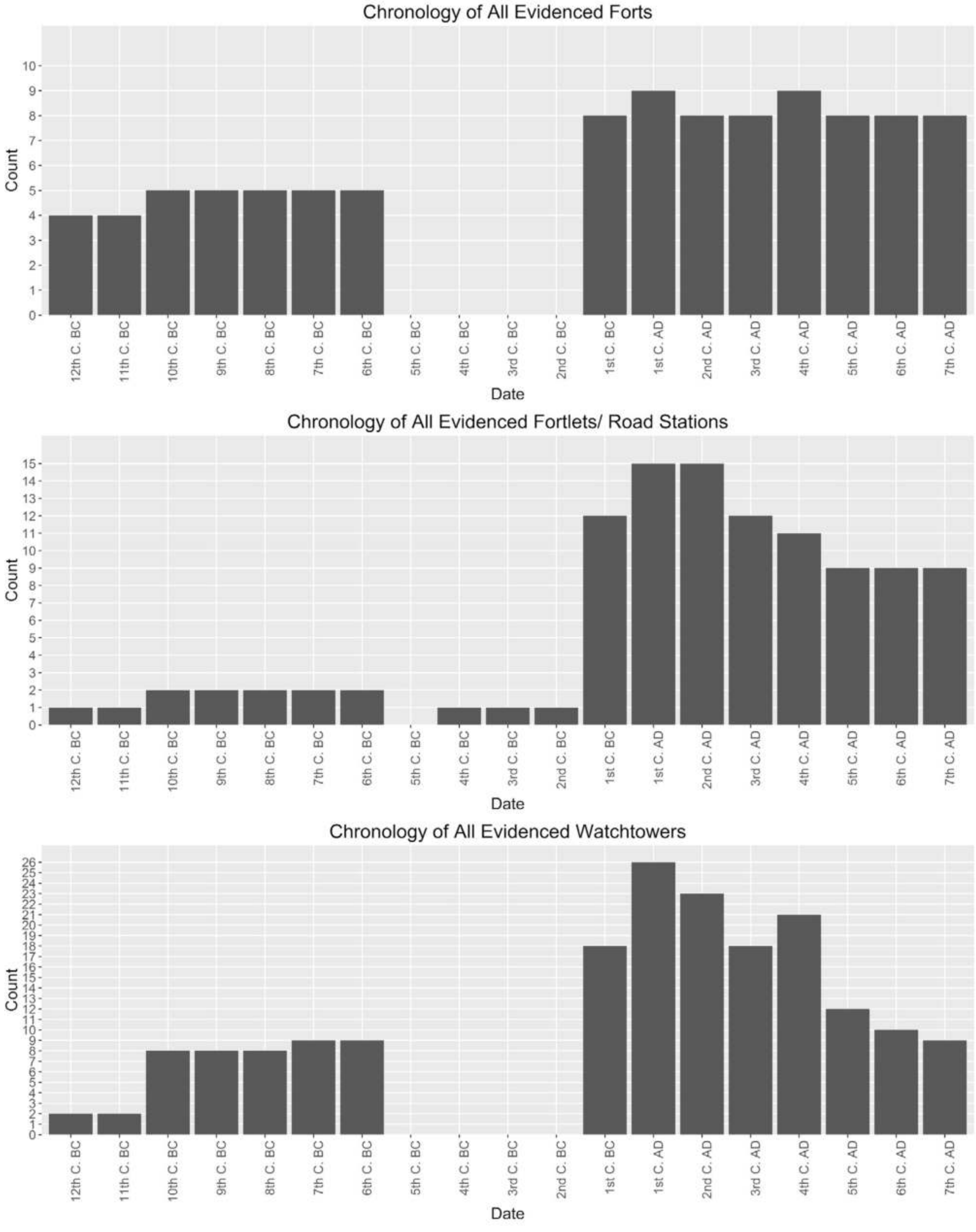


FIG. 366 The chronological development of forts, fortlets/road stations and watchtowers recorded in the Petraean hinterland.

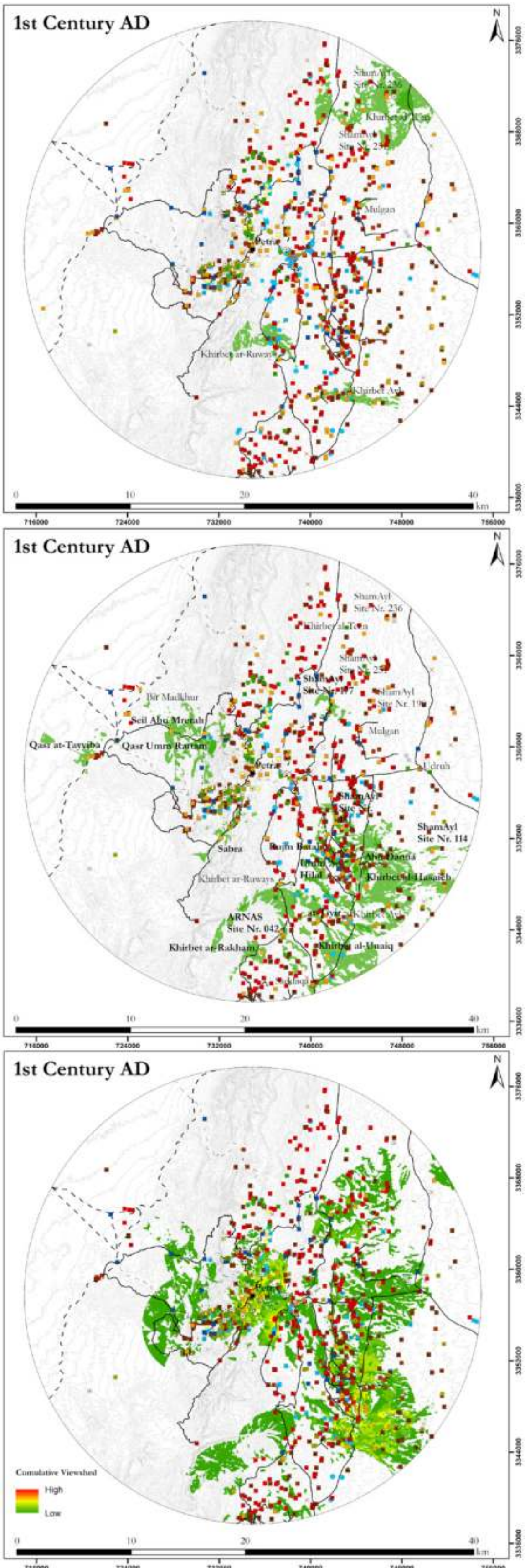


FIG. 367 The 'visual hierarchies' of the different military structures dating to the 1st century AD. Above: Visibility fields of all recorded forts. Center: Visibility fields of all recorded fortlets/road stations. Below: Visibility fields of all recorded watchtowers. Visibility radius of 4400 m.

have highlighted an intervisible network of watchtowers that particularly concentrates around urban Petra as well as the southern stretches of the Udruh-Basta road near Ayl and Basta. Arguably, this visibility map could be even more comprehensive if one accepts the proposal that the Nabataean σκοποί mentioned by Diodorus used the natural landscape – i. e. hilltops without any built structures – for strategic surveillance purposes in times of need. Even without considering this important aspect, the visibility analyses of watchtowers clearly suggest that they provided the missing visual link between larger military structures. Watchtowers were thus the key element for Nabataean military surveillance strategies in the Petraean hinterland.

Keeping these visual hierarchies in mind, cumulative visibility maps of *all* military sites are useful for investigating the general relationship between military structures and other archaeological sites in the study area (cf. FIGS. 71–77 and 368–375). While the Petraean hinterland was only under very little visual control by military structures during the Iron Age periods (cf. chapter 3), this changed significantly by the 1st century BC (cf. FIG. 368). The study area is now more comprehensively controlled (with areas visible from a maximum of ten military structures). This includes particularly the road network on the eastern high plateau and areas west of Petra as well (mostly along the routes leading from the Petra area to the Wadi Arabah). However, Petra is not yet under full surveillance. The most striking concentration of visibility fields is around Ayl and the Udruh-Saddaqa road. In contrast to the previous centuries, most archaeological sites within the cumulative visibility fields are civilian settlements, other structures and/or features as well as water structures. Only a comparatively small number of military sites are within the visibility fields.

The same observations can be made for the 1st century AD (cf. FIG. 369). During this period, the study area is under the best visual control of military structures. Visual areas include vast areas of the eastern high plateau and the western descent to the Wadi Arabah. Importantly, Petra and its immediate surroundings are now under complete surveillance although the area around Ayl still shows the most cumulative visibility fields (a maximum of 11 for the 1st century AD).

The analysis of the cumulative visibility analyses leads to a further important point: Apart from the 7th century AD, the number of *non-military* sites that are *not* within the cumulative visibility fields of contemporary military structures is always significantly higher than those that are within visual range of military sites.[1994] This is particularly the case for non-military sites that are not located in the immediate vicinity of roads and

1994 See the tables accompanying the visibility maps.

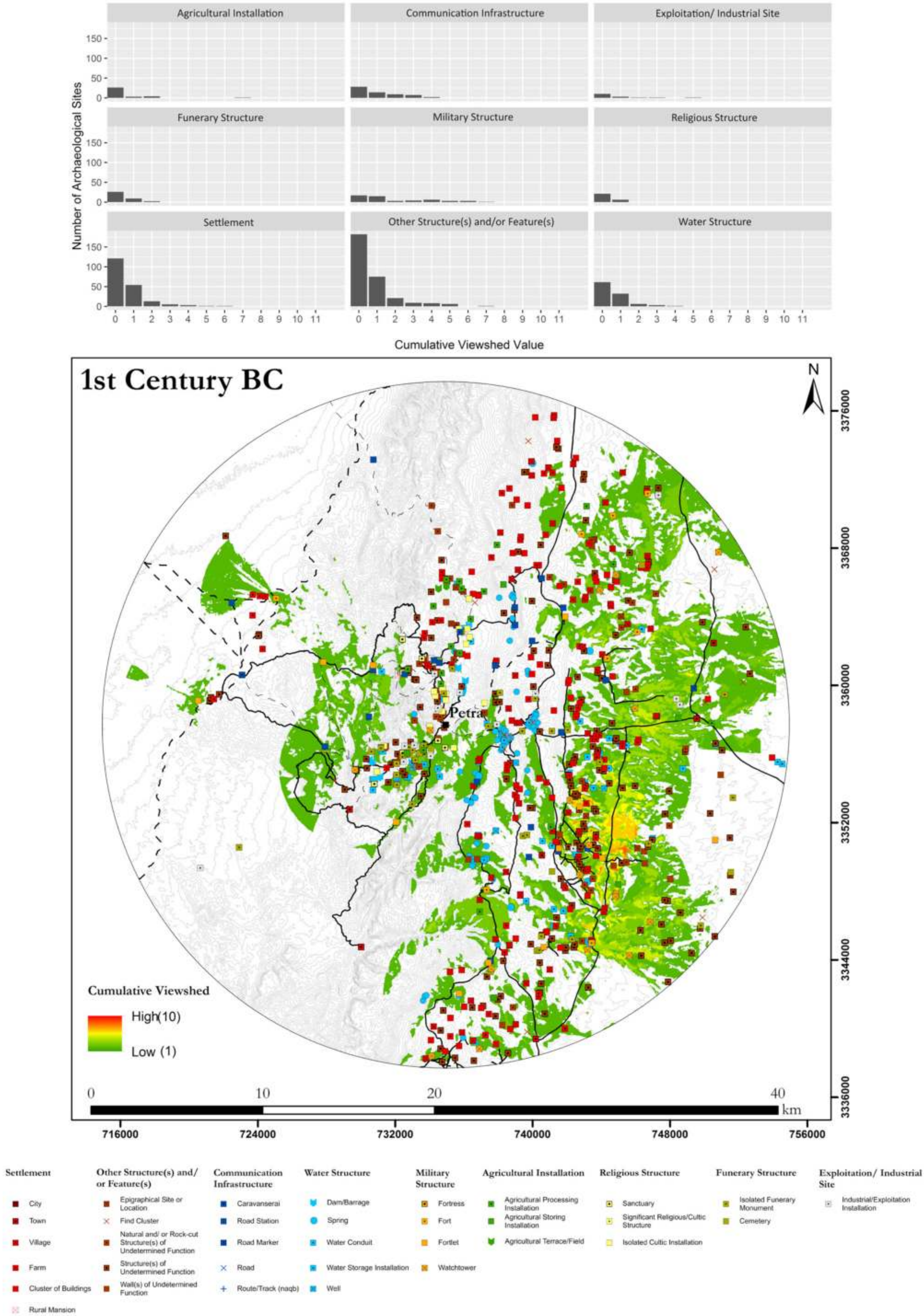


FIG. 368 Cumulative visibility analysis of all military sites dating to the 1st century BC with number of other contemporary sites within visibility fields.

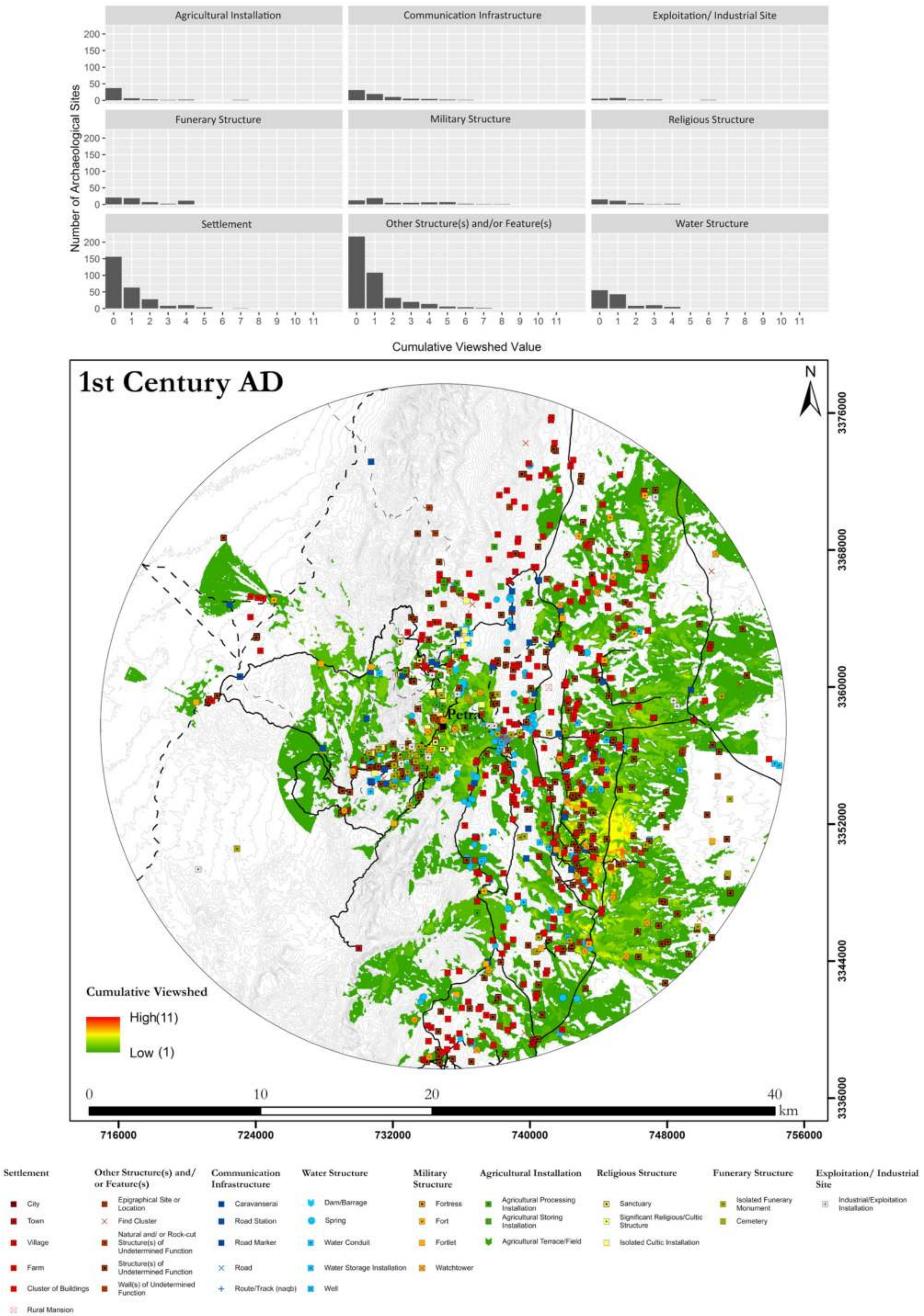


FIG. 369 Cumulative visibility analysis of all military sites dating to the 1st century AD with number of other contemporary sites within visibility fields.

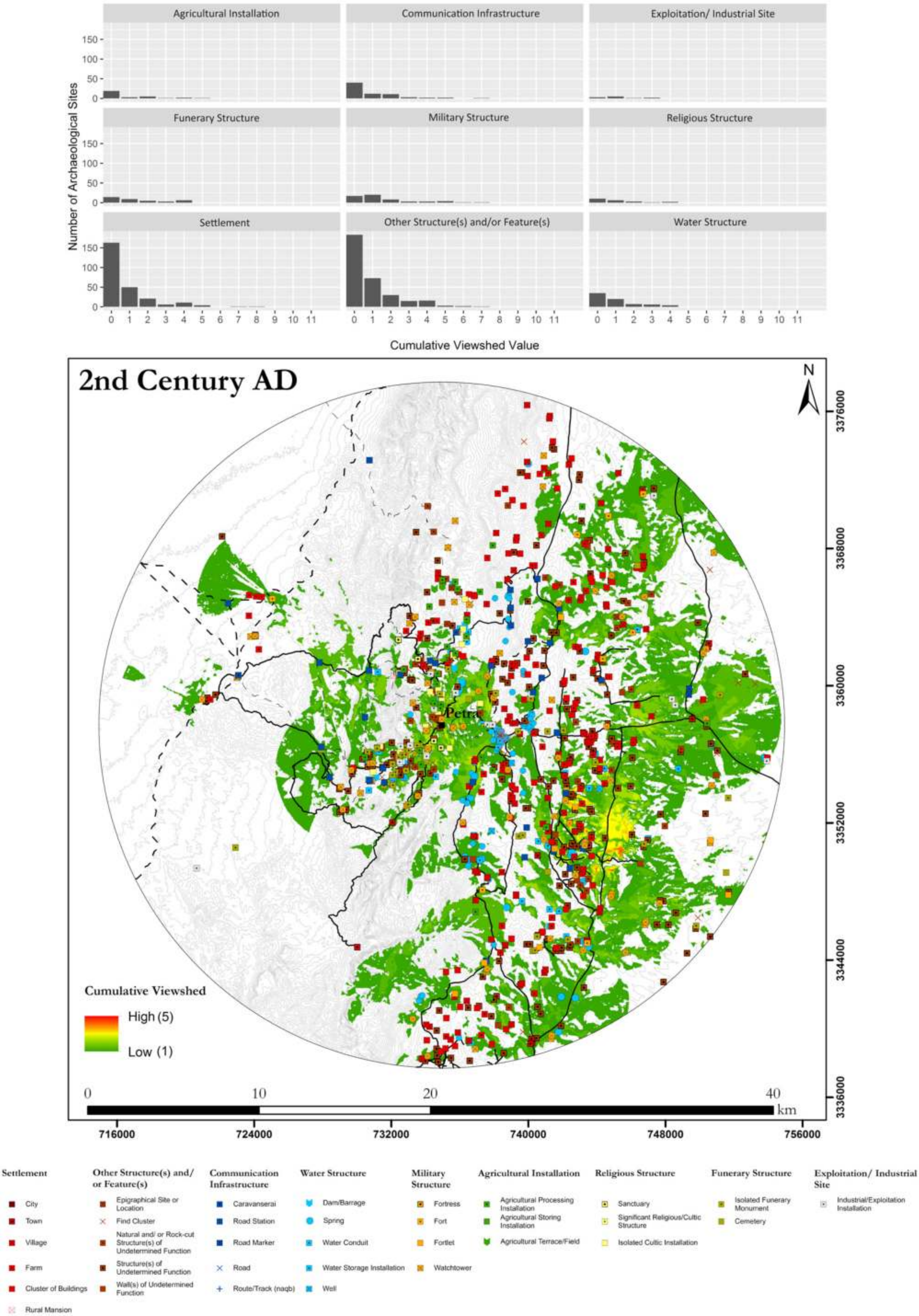


FIG. 370 Cumulative visibility analysis of all military sites dating to the 2nd century AD with number of other contemporary sites within visibility fields.

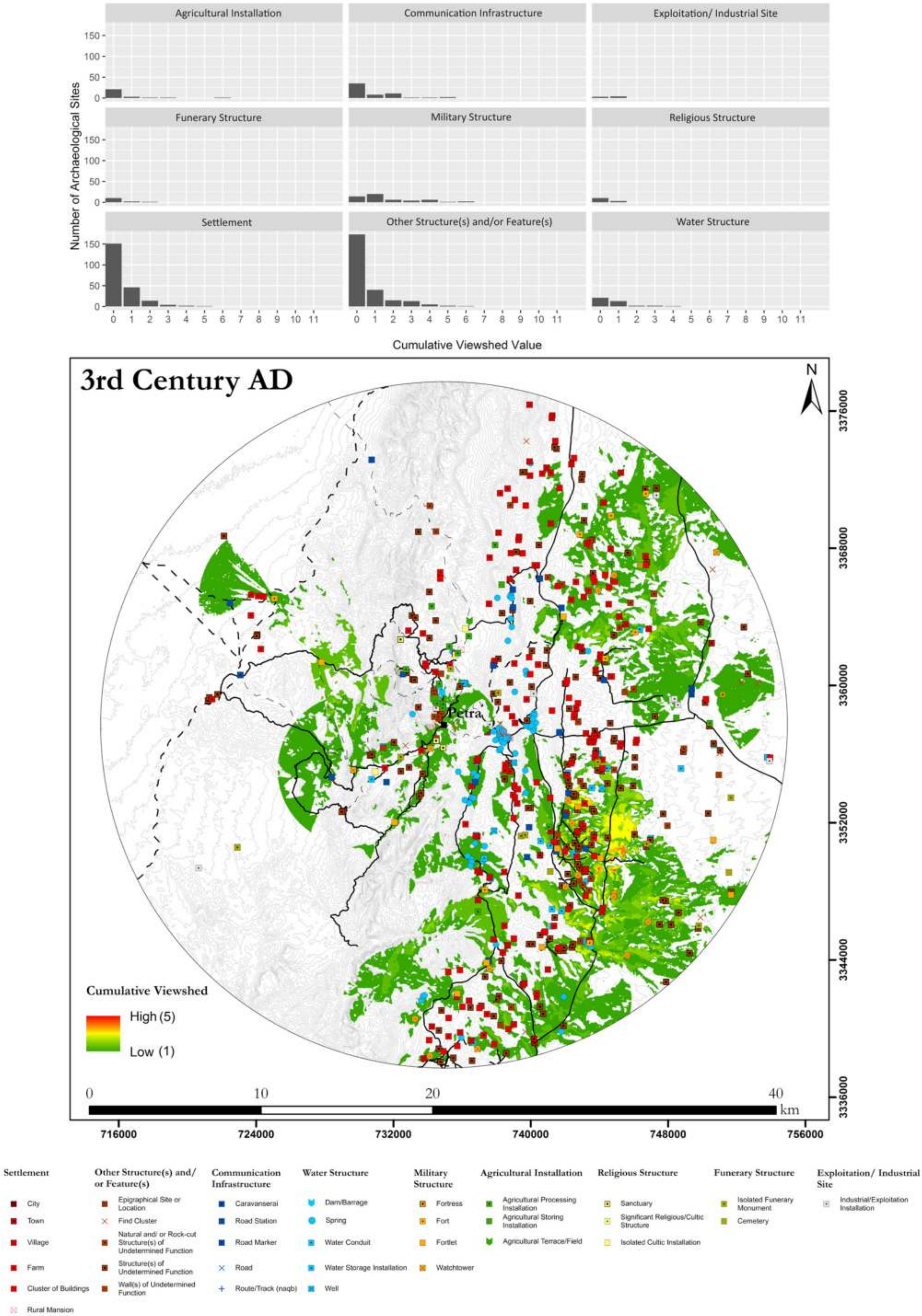


FIG. 371 Cumulative visibility analysis of all military sites dating to the 3rd century AD with number of other contemporary sites within visibility fields.

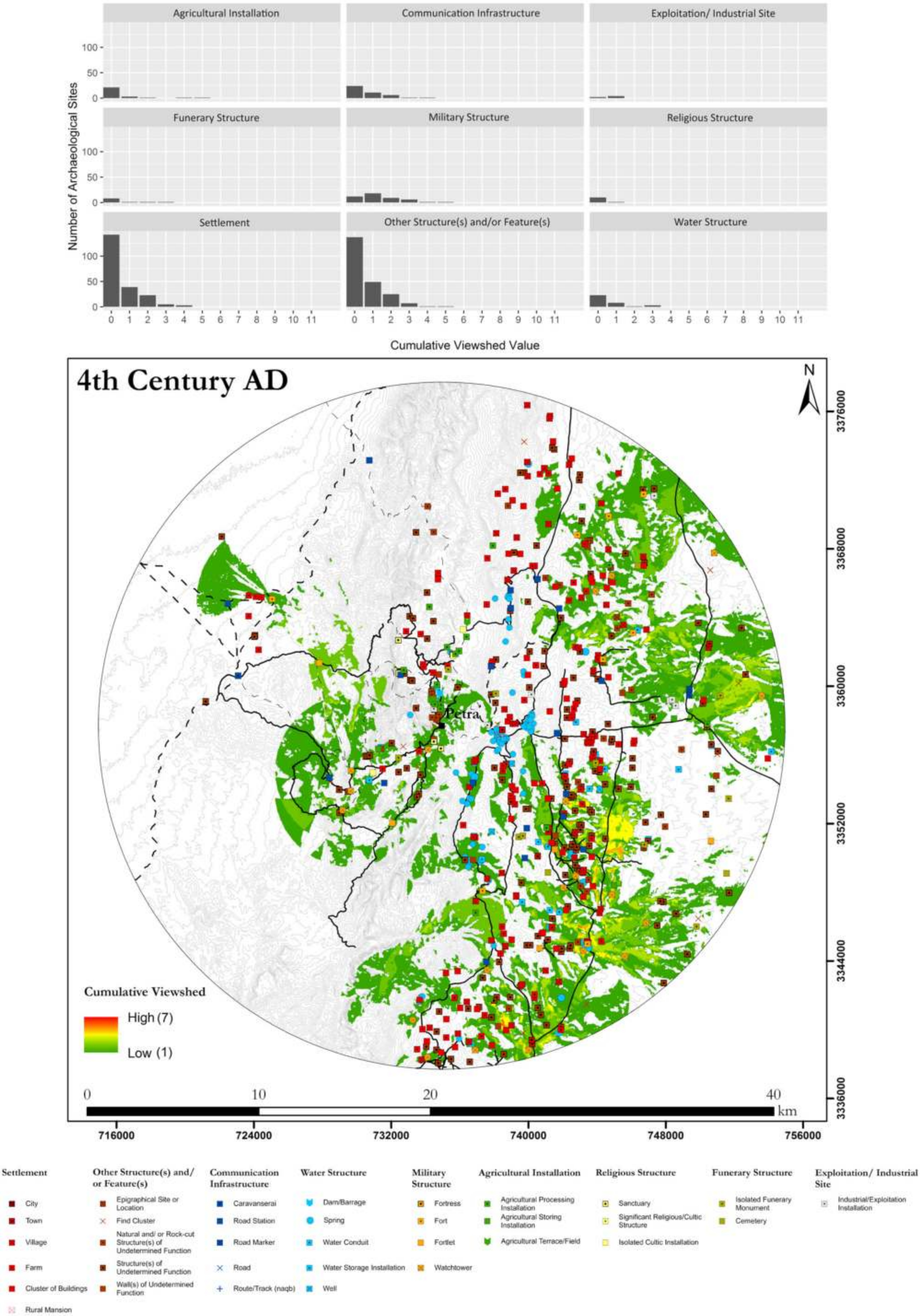


FIG. 372 Cumulative visibility analysis of all military sites dating to the 4th century AD with number of other contemporary sites within visibility fields.

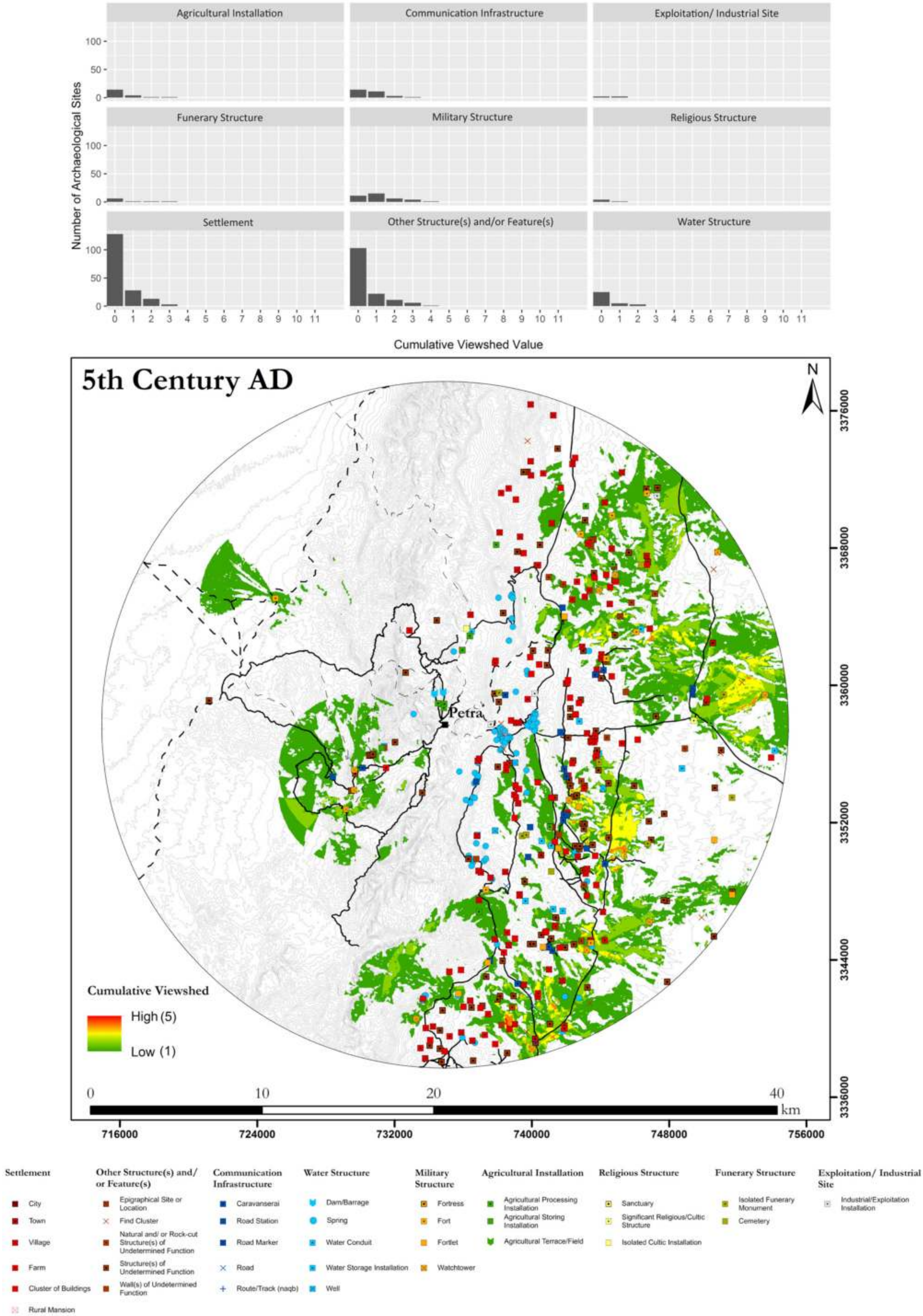


FIG. 373 Cumulative visibility analysis of all military sites dating to the 5th century AD with number of other contemporary sites within visibility fields.

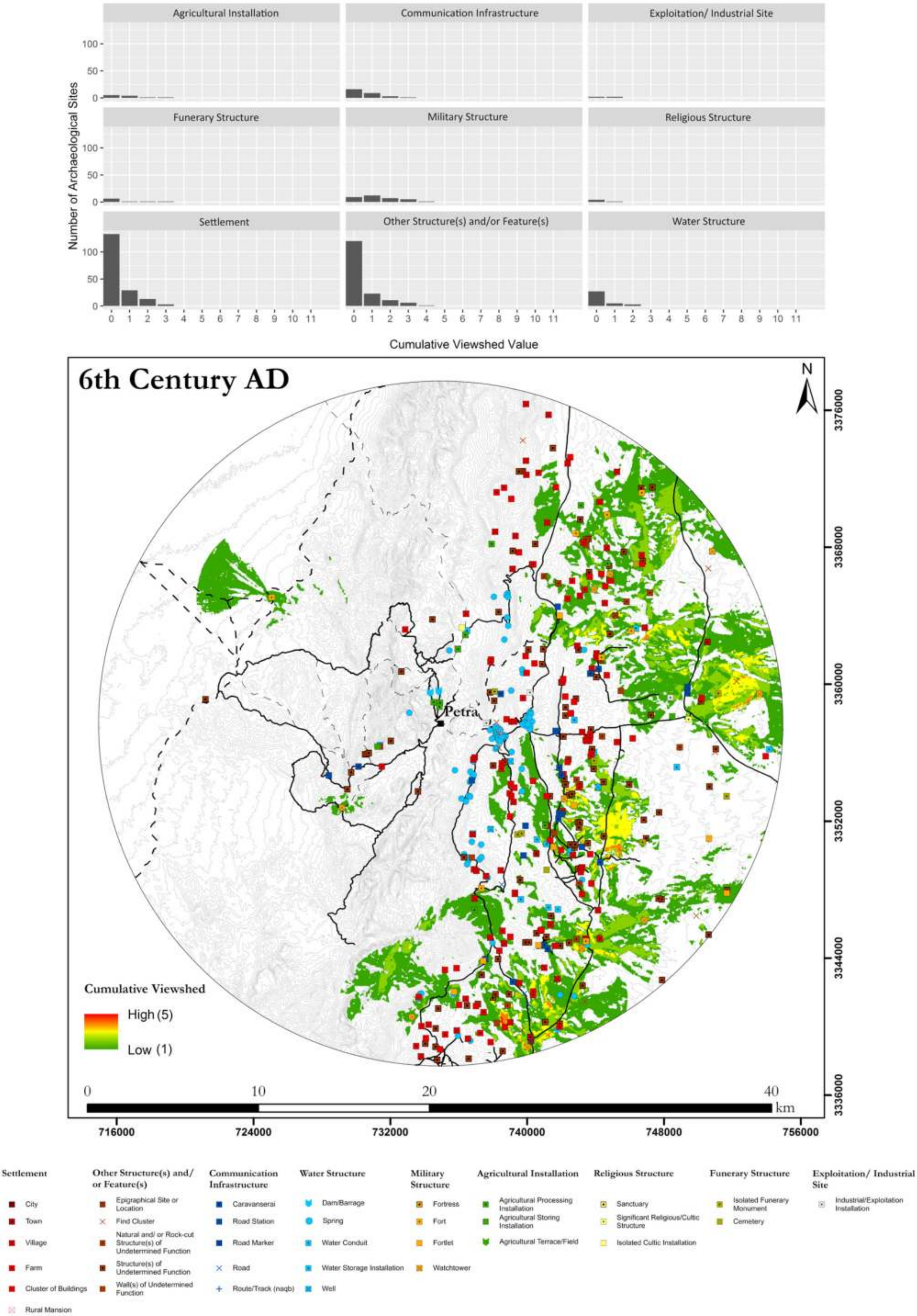


FIG. 374 Cumulative visibility analysis of all military sites dating to the 6th century AD with number of other contemporary sites within visibility fields.

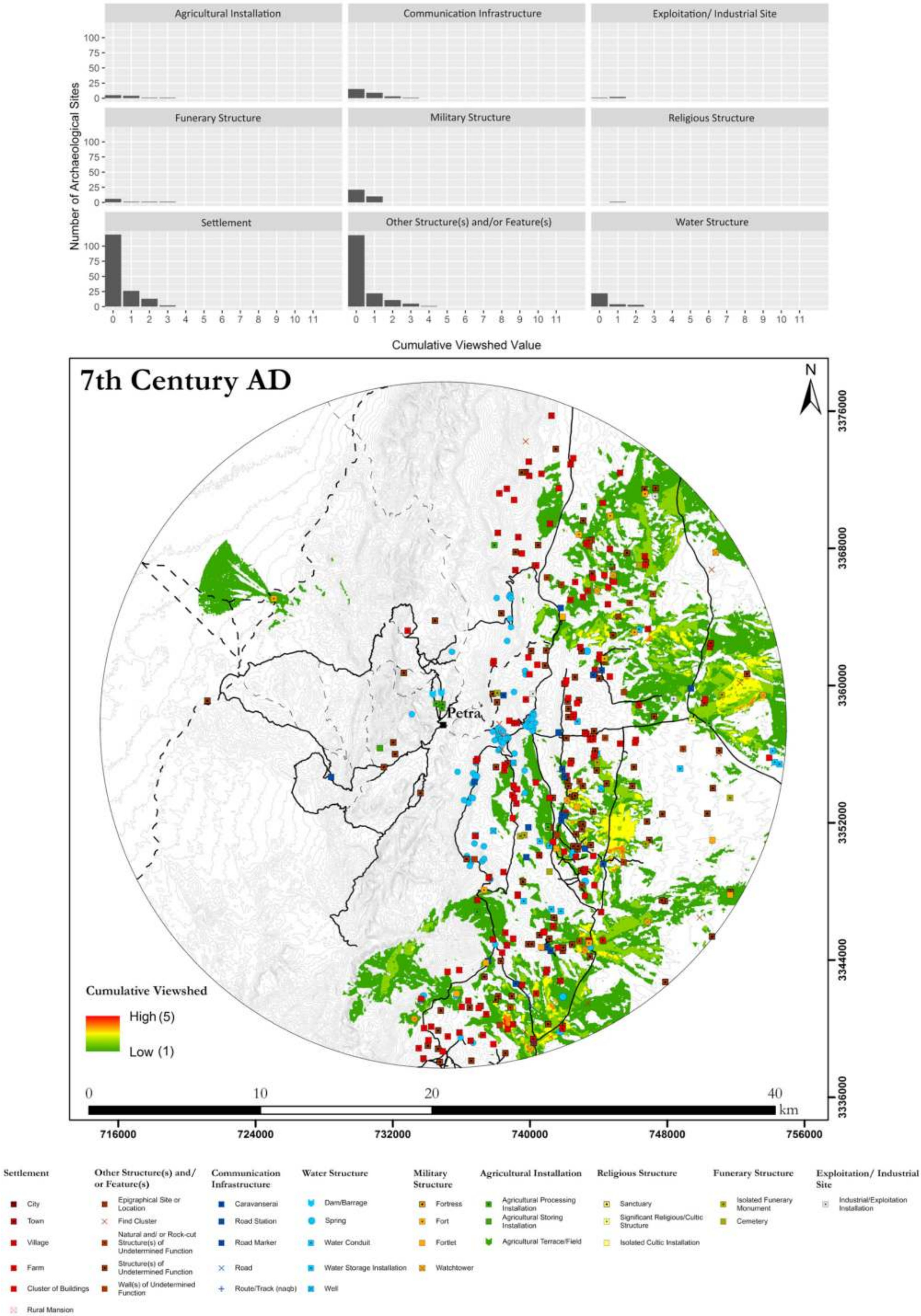


FIG. 375 Cumulative visibility analysis of all military sites dating to the 7th century AD with number of other contemporary sites within visibility fields

routes. Non-military sites situated closer to roads and/or routes are under better visual control by military structures. This is suggested by the consistently higher cumulative viewshed values at settlements such as Saddaqa, Ayl, Basta or Udruh, which are all located at important intersections of the road network. This points to an important relation between military sites and communication lines as already suggested by previous scholars.[1995] The analysis of the cumulative visibility analyses amends previous assumptions to the extent that, particularly during the Nabataean and Roman periods, military structures are closely associated with civilian settlements near roads and routes. The more distant settlements are from the road network, the less they are visually controlled by military structures. It can therefore be argued that the military structures in the Petraean hinterland served to monitor activities along important communication lines as well as at civilian settlements and water sources.

Describing the events of 312/311 BC when Antigonos Monophthalmos attempted to conquer Nabataean territories near Petra, Diodorus states that the Nabataeans successfully confronted the Antigonids with 8000 men. Diodorus also reports that the Macedonians suffered a defeat at the Dead Sea by 6000 Nabataeans.[1996] Although the numbers are exaggerated, these passages nevertheless account for the efficiency of Nabataean military forces at such an early stage of Nabataean history. This stands in contrast to the accounts of Strabo and Flavius Josephus who attest a weak and disorganized Nabataean army.[1997] This assessment is most likely due to the bias of Strabo, who was arguably angered by the supposed Nabataean deception of his friend Aelius Gallus and the failure of his campaign into South Arabia.[1998] However, Graf's seminal work on the Nabataean army emphasizes the efficiency and power of sizeable Nabataean military forces, which are documented particularly by Flavius Josephus when describing the conflicts between the Nabataeans and their Judaean neighbors.[1999] The impression is that by the 1st century BC, the Nabataeans could easily muster thousands of troops. At least in the earlier Nabataean period, the majority of these troops probably consisted of cavalry units.[2000] Instead of a having a large standing army, it seems that the Nabataean military was rather based on a

> [...] *small long-service royal army augmented by short-term levies provided by regional strategoi – civil and military officials – in times of war.*[2001]

Although there is only little historical and epigraphical evidence that gives further information on the Nabataean military structure, in addition to the mentioned *strategoi*, other titles of Nabataean military officials clearly employ Hellenistic (and to some extent also Roman) military terminologies.[2002] These Nabataean military officials include *chilliarches*, *hipparchoi* and a *centurion* or *hekatontarchos*.[2003] It is also assumed that an *epitropos* was, among other political responsibilities, the chief commander of the Nabataean military. This title was presumably taken over from the Ptolemies and appointed only to high-ranking officials under direct command of the king.[2004]

The political level beneath the *epitropos* were the mentioned *strategoi*, a title also well-known from both the Ptolemies and the Seleucids, who were appointed military and civil responsibilities on a regional level throughout the Nabataean realm and abroad.[2005] Nabataean *strategoi*, who often passed their titles and responsibilities to subsequent family or clan members as is evidenced in Hegra,[2006] exercised local military and political power and were important entities in the overall infrastructural organization of the Nabataean realm. This is exemplified by a passage from Flavius Josephus describing how a daughter of Aretas IV travelled from one *strategos* to the next when returning from Judaea to Petra after marital disputes with Herodes Antipas.[2007]

There is however, no evidence to suggest that a *strategos* oversaw territories in the Petraean hinterland. It is well possible that the king and/or the *epitropos* in Petra commanded military units in the immediate region. Although speculative, local leaders of specific so-

1995 E. g. Fiema 1995, 266–267 discussing particularly Roman period structures.

1996 Diod. Sic. 19, 95, 5. The most comprehensive work on the Nabataean military organization so far is Graf 1994b. Hackl et al. 2003, 66–69 as well as Kennedy 2004, 44–47, although largely based on Graf 1994b, give a good concise overview of the Nabataean army as well.

1997 Str. 16, 4, 23; Jos. Ant. Iud. 14, 31.

1998 Cf. Hackl et al. 2003, 69.

1999 Graf 1994b, 270–274. For example, see Jos. Ant. Iud. 13,15,1; 14,2,1; 14,2,3; 15, 5,4 as well as Jos. BI. 1, 4, 7; 1, 6, 2; 1, 19, 5; 3,4,2.

2000 Kennedy 2004, 45 mentioning the deployment of Nabataean cavalry by Malichos I in aid for Caesar at Alexandria in 47 BC.

2001 Kennedy 2004, 45.

2002 Graf 1994b, 274 also mentions two further titles that suggest a Semitic origin.

2003 Nehmé 2017, 142–143; Kennedy 2004, 45; Graf 1994b, 274–290.

2004 Hackl et al. 2003, 66–67 referring particularly to the notorious Syllaios. Cf. Teixidor 1995, 114 as well. Also note the *epitropos* Niros, mentioned in the 5th century AD Greek inscription at Siq Amm al-Alda (Zayadine 1992, 223–225; Musil 1907, 217).

2005 Nehmé 2015b; Hackl et al. 2003, 67; Teixidor 1995, 115–116; Graf 1994b, 275–279.

2006 Nehmé 2015b, 114–116; Hackl et al. 2003, 67 with further references.

2007 Jos. Ant. Iud. 18, 109.

cial groups – referred to in the Hawran as *ethnarchs* or *phylarchs* as epigraphical evidence from the Hellenistic and Roman periods suggest – could have controlled specific lands in Petra's rural environs.[2008] It is possible that these local leaders also held military responsibilities for their particular territories. Hypothetically, they could have acted as the 'chiefs of the camp,' known in Semitic as *RB MSRYT* and which may be equivalent to the Greek *stratopedarchoi* or the Roman *praefectus castrorum*.[2009] Possibly, these *stratopedarchoi* were responsible for rural Petra's forts, which certainly served as local garrisons and places where local control was exercised. It can probably be excluded that the forts were run by *chilliarches* ('commanders of thousand men') as they are far too small to have accommodated such a large number of troops.[2010] Instead, the archaeological evidence confirms previous assumptions that

> […] *the growing evidence of military presence at the capital of Petra and its surrounding districts reveals a more balanced distribution of the troops. The crack troops of the Nabataean royal army must have been concentrated at Petra and other strategic locations* […].[2011]

The presumed "balanced distribution of troops" is confirmed when considering the smaller military structures referred to here as possible fortlets and/or road stations. As noted above, most of these structures have forecourt and/or courtyard areas that, at least theoretically, could have accommodated transportation animals such as horses or camels. If these structures indeed served military purposes, it is therefore possible that small cavalry units were stationed there, perhaps commanded by a Nabataean *hipparchos*.[2012] While *hipparchoi* are usually the commanders of horsemen, camels were also used as riding animals within the Nabatean army.[2013] After the incorporation of the Nabatean realm into *Provincia Arabia*, δρομεδάριοι served in the imperial Roman army, who were most likely employed to police desert areas.[2014] The fortlets and/or road stations may therefore have also accommodated small camel- and/or horse-riding Nabataean cavalry units that policed the local lands. In contrast to a large, permanently stationed army, policing and controlling the Petraean hinterland was arguably one of the key functions of the Nabataean military in the study area. The military structures are comparatively small and provide only a minimum of infrastructure for smaller and more mobile units. They provided local security for civilian settlements (mostly those situated along communication lines), protected local water sources and monitored activities along important roads and routes to guarantee uninterrupted commercial traffic. They also fended off potential bandits.[2015]

During the Ptolemaic period, a major task for military units in rural Egypt was also that of policing. Greek sources mention Ptolemaic law enforcement titles such as the *phylakitai* and their superior officers, the *archiphylakitai*.[2016] Ptolemaic *phylakitai* served has village policemen and, either on the request of civilians or their superiors, arrested criminals, protected the transportation of trade goods and guarded buildings. In other Hellenistic communities, the protection and control of the countryside was of constant concern as well. For example, Xenophon mentions *peripoloi* who patrolled the countryside (particularly for the protection of natural resources) and Athenian inscriptions hail military commanders for protecting farmers and agricultural products.[2017] While the evidence for *peripoloi* is limited mainly to Hellenistic Attica, the known *paraphylakitai* in Asia Minor (particularly Pergamon) were mobile troops tasked with the surveillance and protection of the countryside.[2018]

Although the adoption of such hellenocentric examples should be considered critically, [2019] the fact

2008 For a critical assessment of *ethnachs, phylarchs* and *strategoi* mentioned in Greek and Safaitic inscriptions, see Macdonald 1993, 368–377 with further references.

2009 Hackl et al. 2003, 68; Graf 1994b, 274. A Nabataean inscription at Hegra dating between 6–8 AD also mentions a man who was a *centurion* (Greek *hekatontarchos*) (Graf 1994b, 289). As Hackl et al. 2003, 68 state, this is a particularly interesting find as it gives evidence to the adoption of a Roman military title one century before the annexation.

2010 Note that there are only two known references to a Nabataean *chilliarchos* (Hackl et al. 2003, 68; Graf 1994b, 279–282).

2011 Graf 1994b, 290.

2012 Hackl et al. 2003, 69; Graf 1994b, 282–289. The Greek *hipparchos* is only one transcription of the Nabataean HPRK, which may also be the Greek *eparchos* being the equivalent of the Latin *praefectus* commanding one *ala* unit (Graf 1994b, 282–283).

2013 Graf 2007. Cf. also chapter 6 in reference to Flavius Josephus' accounts on how Obodas I defeated Alexander Iannaios with the use of camels (Jos. Ant. Iud., 13, 374–375 and Jos. BI. 1, 90, 4; Hackl et al. 2003, 470, 538).

2014 Spaul 1994, 104–105.

2015 The term 'bandit' is not synonymous with pastoral nomadic social groups (cf. Macdonald 1993, 313–314 and 316). It rather refers to simple, non-political brigands, fugitives and outlaws that were inhabitants of the region. This is also assumed for the Trachonitis in southern Syria (Macdonald 1993, 313–314; Isaac 1990, 62–66 and 1984, 178–181).

2016 Cf. e.g. Bauschatz 2013, 49–98.

2017 Chaniotis 2008, 105–106.

2018 Chaniotis 2008, 131–138.

2019 The comparison to other Hellenistic rural military systems is nevertheless valid as the Nabataean army was largely based on Hellenistic models (Kennedy 2004, 45; Graf 1994b).

that contemporary military forces in other parts of the Hellenistic world were greatly tasked with the surveillance and protection of the countryside (i. e. civilian settlements, agricultural products and trade routes) is nevertheless significant. Similar models may therefore be assumed for the Petraean hinterland as well – at least in times of peace. As Diodorus and Flavius Josephus have shown, in times of war the Nabataeans were very able to provide a large and efficient army. However, while there is no literary or archaeological evidence to suggest a large standing Nabataean army, the reassessment of the military structures in the study area points to small local military units that patrolled and policed local territories, thus fulfilling similar responsibilities as Hellenistic *peripoloi* or (*para*)*phylakitai*.

Terra Petraea in the Roman Period

The following section continues the critical discussion of the Petraean hinterland from the 2nd until the 4th century AD. Although the nature of the Roman annexation process is still disputed, Petra and its surroundings most likely enjoyed continuing economic, military and political stability during the 2nd and early 3rd century AD. This is suggested by the various honorifics bestowed on Petra and the continuing urban development of the city. From the second half of the 3rd century AD, however, Petra and its hinterland are impacted by the empire's political and economic crisis. Although the Petra region was most likely largely unaffected by the Parthian Wars and the Palmyrene conquests of the Near East, the decline and shift of long-distance trade routes as well as the overall decreasing demand for Arabian commodities led to a noticeable economic decline. The crisis of the 3rd century AD eventually triggered several provincial reorganizations, beginning with Diocletian and continuing throughout the 4th century AD when Petra was designated the provincial capital of *Palestina Salutaris* (later Tertia).

Subsistence Strategies and Communication

As the general settlement pattern observed for the 1st century AD does not change in the 2nd century AD, the Roman annexation did not affect the settlement pattern. However, Kouki postulates that there was probably an increasing tendency towards landed property at the end of the century.[2020] This is also supported here.

The fact that most Nabataean rural mansions were apparently abandoned by the 2nd century AD may suggest that Roman authorities were deliberately undermining the Nabatean ruling class in and around Petra. There is evidence for destruction around the time of the annexation in urban Petra (cf. chapter 7) and cultic gathering places of elite social groups were abandoned and/or destroyed as well (cf. chapter 8). The abandonment of rural mansions may reflect this development. However, there is no evidence that would indicate an immediate change of the overall settlement pattern in the Petraean hinterland after the Roman annexation.

By the 3rd century AD, only one third of all settlements remained occupied and a particular decrease of small sites can be observed.[2021] This is particularly striking for the eastern and western peripheries of the Petraean hinterland. While the number of large sites decreases as well, the decline is not as dramatic as that of medium-sized and small sites. Small sites, such as single farms, decrease and clusters of buildings gradually begin to shift eastwards up the Jabal Shara escarpment and eastern high plateau.

During the 4th century AD, the Jabal Shara area remained similarly settled as during the 2nd century AD, but the western peripheries (particularly the major Nabataean settlements of Sabra, Abu Khusheiba and as-Sadeh) were gradually abandoned. By the 5th century AD, the western study area was almost completely deserted. In the eastern peripheries, a slow increase in settlements was observed and many small and medium-sized sites that were apparently not settled in the 3rd century AD were reoccupied in the 4th century AD. Kouki noted a significant level of continuity, specifically concerning the continued use of originally 1st century AD sites. This is explained by the

> […] *limited availability of water in the region, although the presence of easily available building material and preexisting agricultural installations may also have influenced the choice of location when abandoned settlements were reoccupied.*[2022]

Additionally, new villages were established and other, older sites reoccupied. Most notably, this was the case with the civilian use of the abandoned fortress at Udruh (Augustopolis) by the early 5th century AD.[2023] This development is completely contrary to areas west

2020 Kouki 2012, 132, 131. However, Wenner 2015, 86 correctly stresses the difficulty of differentiating between 1st century and 2nd century AD pottery material.

2021 Cf. Kouki 2012, 85–94 for a discussion on the settlement pattern between the 3rd and early 7th centuries AD. On the differing classifications of settlement types (particularly in terms of site size) defined by Kouki and this study, see the relevant section on 'subsistence strategies and communication' for the Nabataean period above.

2022 Kouki 2012, 94

2023 Kouki 2012, 90.

of the Jabal Shara escarpment where sites were increasingly abandoned. This suggests a relocation of the rural population as early as the 4th century AD and the contemporary growth of large sites indicates an increase of the population and/or nucleation of rural settlements. This stands in contrast to the hierarchical settlement pattern postulated for the 1st and 2nd centuries AD.[2024]

During the 4th century AD, the overall decrease of rural settlements continues, particularly for small sites such as farms. There is a clear eastern shift and continuous abandonment of all rural settlements west of the Jabal Shara escarpment.[2025] The kernel density estimations and Pearson correlation tests for the 4th and 5th centuries AD clearly suggest a growing nucleation particularly around villages, thus confirming Kouki's claim that the settlement hierarchy observed for the Nabataean period is no longer intact.

Arguably, if the rapid increase of rural settlements and the intensification of agriculture during the Nabataean period can be associated with the need to supply both the population of urban Petra and the bypassing caravans, the shift towards settlement nucleation by the late 3rd/early 4th centuries AD can be explained by the same factors. As long-distance trade declined by the 3rd century AD, this affected the economy of Petra and its hinterland as well. During the 4th century AD, the economic decline continued with a possible decrease of Petra's population. These urban trends seem to be mirrored by the decrease of smaller sites and the nucleation of larger settlements in Petra's hinterland. Kouki suggests that with the decline of long-distance trade, the need to provide caravans with agricultural goods decreased and the rural population turned to more mobile subsistence strategies.[2026] However, agricultural cultivation probably continued alongside pastoralism, particularly at the villages in the Jabal Shara area. This is supported here, although pastoralism arguably always played a vital role in the subsistence strategy of the Petraean hinterland.

The presumed decline of agricultural activities during the 3rd century AD is also confirmed by the development of agricultural installations (cf. chapter 4). From the 3rd century AD onwards, the number of agricultural processing installations decreases steadily. This is particularly the case with wine presses. The overall count of threshing floors, however, remained generally stable throughout the Late Roman and Byzantine periods. This inferred decline of viticulture is also mirrored by the archaeobotanical analyzes from ez-Zantur which indicate a clear decrease of grape remains (cf. FIG. 357). The analyses also suggest a distinct increase of olive remains in the 4th century AD, despite the fact that the archaeological evidence provided by the original survey reports seems to indicate further abandonment of processing installations. However, the olive presses at Khirbet an-Nawafla were still in use during the Islamic period indicating that at least olive cultivation continued well into Late Antiquity.

The overall development of the rural settlement pattern after the Roman annexation is also reflected by the industrial/exploitation installations. As ceramic goods continued to be produced at az-Zurraba until the Late Byzantine period and the presumed workshop at Khirbet al-Fiqai was supposedly established in the 2nd century AD, small-scale 'industries' were seemingly not impacted by the Roman annexation. This further supports the claim that the 2nd century AD was characterized by economic stability, if not even small growth.

However, corresponding to the overall economic decline in the 3rd century AD, several quarries are abandoned. Only the copper mine at Umm al-'Amad as well as the workshops at az-Zurraba and Khirbet al-Fiqai were active. As Umm al-'Amad as well as Khirbet al-Fiqai are abandoned in the 4th century AD, this confirms the continuing economic decline of the study area. This is also mirrored by the decrease of water structures from the 3rd century AD onwards, most notably rural water conduits (cf. chapter 4).[2027]

While the Nabataean road and route network of Petra's hinterland was generally not affected by the Roman annexation, the most important Roman contribution to the infrastructural network was undoubtedly the construction of the *via nova Traiana*. The significance of the *via nova Traiana* and its impact on an already existing communication network has been widely discussed.[2028] The main incentive for its construction was of commercial, military and administrative nature as the road connected the Transjordanian plateau with the northern Levant and therefore linked and facilitated communication between the different provinces of the Roman East.[2029] The relatively quick construction of the *via nova* immediately after the proclamation of *Provincia Arabia* not only shows that Petra remained an economically central place after the annexation, but also attests to the continuing importance of supraregional trade.[2030] How-

2024 Kouki 2012, 130.
2025 However, clusters of buildings already extended east of the Udruh area during the Nabataean period as well.
2026 Kouki 2012, 130.
2027 Petra's fresh water aqueducts were mainly damaged after the earthquake of 363 AD.
2028 See for example Ynnilä 2013, 253, 257; Borstad 2008; Fiema 2003, 49–50; Graf 1995a.
2029 Zayadine 1992, 229.
2030 Cf. Fiema 2003, 49.

ever, with the construction of the *via nova*, older roads such as the Darb ar-Rasif were not abandoned.[2031] The *via nova Traiana* was thus an infrastructural upgrade of the previous communication network. The fact that the new road was paved offered new economic opportunities with the possibility to use carts rather than pack animals, which was comparatively far more time-consuming.[2032] In addition, the construction of the road and the erection of *Latin* milestones very much signaled a sense of *romanitas* and belonging to the new province of Arabia.[2033]

While the *via nova* offered new economic possibilities for Petra and its hinterland, the various naqb connecting Petra with the Wadi Arabah and beyond were still in use. Caravan trade thus continued after the annexation.[2034] There is also evidence that suggests a re-use of at least Naqb ar-Ruba'i during the Late Roman and Byzantine periods.[2035] This may correspond to the general increase of military sites in Arabia during the Diocletianic period and the mid-4th century AD, as indicated by Ammianus Marcellinus when mentioning the dense Roman military presence and the construction of major forts and fortresses such as those at Udruh or Lejjun.[2036] A Late Roman revival of road-related sites along the Petra–Gaza road may be seen in this context as well. Major caravan activities therefore remained stable until the Late Roman period.[2037]

However, the FJHP argues that only the very most strategic sites in the as-Sto'e and al-Farasha regions were reoccupied in the later Roman phases and that previously domestic buildings and agricultural structures were re-used for security purposes.[2038] This stands in contrast to the evidence from the Negev, where a rise in agricultural production and a general flourishing of civilian settlements is observed together with an increase of military structures from the 4th century AD until the Late Byzantine period.[2039] As agricultural activities in the immediate Petra area concentrated almost entirely along the eastern high plateau during the Late Roman and Byzantine periods due to an increasing aridification of the region (cf. chapter 1), the FJHP's conclusions that agricultural structures were later reoccupied as potential observation posts may be a particular phenomenon limited to the western as-Sto'e and al-Farasha regions.[2040]

By the end of the 3rd century AD, long-distance trade decreased. This is best exemplified by the decline of the Petra–Gaza road and can be associated with the overall decreasing demand for Arabian luxury goods.[2041] This would explain the little evidence for continued use of road-/route-related structures and only a selective re-use of sites for strategic purposes in the Late Roman and Byzantine periods in the al-Farasha area. The presumed abandonment of Qasr Umm Rattam, Bir Madkhur or Gharandal confirms this as well.[2042]

2031 See also Zayadine 1992, 229.

2032 Ynnilä 2013, 259; Kloner 1996, 131–132.

2033 Recently argued by Speidel 2019, 58, 62–63.

2034 Fiema 2003. Based on the paved section and the significant width of Naqb ar-Ruba'i near the Snake Monument as well as the fact that surface finds from Abu Khusheiba supposedly do not date later than the annexation, Ben David suggests that Naqb ar-Ruba'i was rebuilt in the Roman period, possibly even by Diocletian for the *legio X Fretensis* (Ben David 2013, 273 and 2007, 106–108). He interprets Naqb ar-Ruba'i as a Roman military road connecting Petra with Aila (Ben David 2013, 273; 2012, 21 and 2007, 108). Stating that the original Nabataean Petra–Gaza road went through Abu Khusheiba and that Naqb ar-Ruba'i was a Late Roman addition heading south towards Aila, he contextualizes the construction of the route with the overall increased Roman military presence in the region during the later 3rd century AD (Ben David 2012, 21; 2007, 106). However, surface material from sites along Naqb ar-Ruba'i dates to the Nabataean period as well. Ynnilä follows Ben David and explains the supposed differing dates of the presumed Nabataean and Late Roman routes by assuming that they served travel in different directions. In the Nabataean period the main direction was to the west via Wadi Abu Khusheiba and mostly to the south in the Late Roman and Byzantine periods (Ynnilä 2013, 261). These views are in contrast to traditional assessments arguing for a direct and contemporary connection between Abu Khusheiba and Naqb ar-Ruba'i (Lindner 2003a, 70–71; Zayadine 1992, 229 and Jarvis 1940, 147). While the archaeological evidence as well as the favorable environmental conditions qualify Naqb ar-Ruba'i as the best and most direct way to reach Khirbet as-Faysif and the Mediterranean through the Negev, the evidence for suggesting differing dates for the Naqb ar-Ruba'i and Abu Khusheiba connections is not convincing. There is no evidence to suggest that both routes were not used in the Nabataean period (Ynnilä 2013, 262). Although Abu Khusheiba may not have been along the main course of the Petra–Gaza route, it was nevertheless "embedded in a spider's web of routes" and thus an important infrastructural focal point in Nabataean times (Lindner 2003a, 55–75). The proposition that the Diocletianic transferral of the *legio X Fretensis* from Jerusalem to Aila passed Naqb ar-Ruba'i does not seem logical. It is more realistic that the legion would have passed through the Arabah via Yotvota and Gharandal instead.

2035 Ynnilä 2013, 261–262. As an example for a Late Roman structure, see FJHP Site No. Ext075. For a structure yielding Byzantine material, see e. g. FJHP Site No. Ext071. Both are situated along Naqb ar-Ruba'i.

2036 Erickson-Gini 2007, 97; Parker 2006; Amm. 14, 8, 13.

2037 Fiema 2003, 49.

2038 Ynnilä 2013, 262.

2039 Erickson-Gini 2007, 97–98.

2040 Cf. e. g. Fiema 2003 and 2002a.

2041 Ynnilä 2013, 264; Erickson-Gini 2010, 51–64; Fiema 2003, 50.

2042 Ynnilä 2013, 264. For the abandonment of Qasr Umm Rattam, Bir Madkhur and Gharandal, see e. g. Smith 2010, 113; Lindner et al. 2007, 255. The FJHP argues that there is no positive archaeological evidence for a continued use of sites along the Petra–Gaza road after the annexation.

Fiema refers to another east-west connection between southern Jordan and Palestine that appears to have been more popular from the later 3rd century AD onwards.[2043] This road ran from Mampsis through the so-called 'Scorpion's Pass,' passed the fort at Haseva and further to at-Tilah. From there it presumably continued to at-Tafilah and Busayra where it joined with the *via nova Traiana*. One reason for this shift may be Petra's declining economic significance that is

> [...] *related to unstable political conditions, continuous wars, impoverishment of towns and regions, and a concomitant change in the pattern of main trade routes.*[2044]

The increasing importance of seaborne trade should also not be underestimated. This can be observed by the gradually growing importance of Aila during the 3rd century AD.[2045]

Society and Culture

Nabataean *heterotopiai* were either abandoned or significantly altered in the Petra area during the 2nd century AD. This has been related to the Roman annexation as it was argued that the new Roman authorities feared political uprisings could have been fostered by gatherings of indigenous social groups. This deserves further explanation as is attempted in the following discussion of the religious and funerary sites in the Petraean hinterland.

It was not the Nabataean religious belief system that was targeted by the Romans. Instead, they attempted to dissolve any form of the traditional, private cults and rituals where the various tribes, families or diverse social groups of Petra and its surroundings could convene and potentially organize against the new authorities. Roman suspicion towards social gatherings both in the Italian homelands and in the provinces is attested by a letter from Trajan – the emperor who annexed the Nabataean realm – to Pliny the Younger.[2046] As governor of Bithynia, Pliny asks the emperor for permission to establish an association of firemen to better control frequent fires in the province.[2047] Trajan's response clearly reflects his distinct fear of political conspiracies fostered by such associations:

> *You may very well have had the idea that it should be possible to form a company of firemen at Nicomedia on the model of those existing elsewhere, but we must remember that it is societies like these which have been responsible for the political disturbances in your province, particularly in its towns. If people assemble for a common purpose, whatever name we give them and for whatever reason, they soon turn into a political club.*[2048]

The Emperor's response falls well within the tradition of previous imperial policies as can be seen by the actions against Jewish associations by Aulus Avilius Flaccus in Alexandria during the reigns of Caligula and Tiberius:[2049]

> *The associations and clubs that continually feasted under the pretext of sacrifices, in which drunkenness turned into political intrigue, he* [Aulus Avilius Flaccus] *dissolved strictly, energetic and willfully.*[2050]

While without further excavations, the argument that Nabataean heterotopical religious structures ended because of the Roman annexation remains preliminary, the evidenced alterations of elite Petraean funerary monuments in the early 2nd century AD nevertheless strengthen this hypothesis (cf. chapter 8). For example, by the 2nd century AD access to the *triclinium* of the Roman Soldier Tomb Complex in the Wadi Farasa was greatly impeded and the upper *stibadium* of the complex was cut by several shaft tombs by the late 1st

Instead, they argue for a *re-use* of sites in the Late Roman and Byzantine periods. However, road-related sites along the Petra–Gaza road were in continuous use from the Nabataean to Late Roman periods. The FJHP may nevertheless be correct in assuming that the western trade routes of the Petra region were at least less frequented in the Late Roman period as during the Nabataean period.

2043 Fiema 2003, 50.

2044 Fiema 2003, 50. These roads shifted towards the north connecting the Persian Gulf with Mesopotamia, Northern Syria and Armenia as well as towards the south connecting southern Arabia with Ethiopia and the Red Sea.

2045 Fiema 2003, 50. While recognizing that seaborne trade constituted a real competition for Nabataean caravan trade, the gradual decline of Nabataean inland routes was not a direct result of the supposedly more advantageous sea trade. A good overview of this discussion and the refutation of the decline hypothesis is given by Fiema 2003, 40–41. The increasing importance of seaborne trade during the 3rd century was likely a result of the general economic and political turmoil of the Late Roman Empire.

2046 Tholbecq 2016, 1067, particularly n. 38 with reference to Venticinque 2015; Schmid 2013a, 259–260.

2047 Plin. Ep. 10, 33.

2048 Plin. Ep. 10, 34 (after Loeb Classical Library Edition 1969 with an English translation by B. Radice): "*Tibi quidem secundum exempla complurium in mentem venit posse collegium fabrorum apud Nicomedenses constitui. Sed meminerimus provinciam istam et praecipue eas civitates eius modi factionibus esse vexatas. Quodcumque nomen ex quacumque causa dederimus iis, qui in idem contracti fuerint, hetaeriae eaque brevi fient.*"

2049 Cf. Venticinque 2015 and most importantly in this context Schmid 2013a, 259 with reference to Bilde 2006 and Alston 1997 for a further historical contextualization of the passage.

2050 Philo, *In Flaccum*, 1, 4, 518 (translation after Schmid 2013a, 259, n. 13): "*Τὰς τε ἑταιρείας καὶ συνόδους, αἳ ἀεὶ ἐπὶ προσφάσει θυσιῶν εἱστιῶντο τοῖς πράγμασιν εμπαροινοῦσαι, διέλυε τοῖς ἀφηνιάζουσιν ἐμβριθῶς καὶ εὐτόντος προσφερόμενος.*"

century AD although there was still enough space in the original tomb. This has led Schmid to hypothesize that members of the elite Nabataean social group associated with the tomb complex were denied the right to bury their dead within the original complex.[2051] Although only 14 Nabataean tomb complexes in Petra are securely dated, the overall consensus is that they generally went out of use shortly after the annexation.[2052] The latest dated use of an older Nabataean tomb complex is that of Sextius Florentinus – one of the first Roman governors of the new province. The end of elite Nabataean tomb complexes in Petra therefore suggests that the Roman authorities deliberately undermined such cultic and social gatherings. Arguably, this was also the case for heterotopical religious structures in the city's hinterland.

However, there are indications that some religious structures in Petra's hinterland were not subject to this presumed Roman interventionism. Although there are some doubts concerning the structure's continuous use into the Roman period (cf. chapter 8), this particularly concerns the sanctuary at Jabal Harun.[2053] If the sanctuary truly continued into the Roman period, this requires further explanation.

Fiema argues that the Nabataean sanctuary on Jabal Harun continued to be used in Roman times due to the apparent supraregional significance of the sanctuary. He further argues that if the architectural reconstruction of the sanctuary is correct and the monument showed a high degree of Hellenistic-Roman architectural design, Roman authorities were perhaps more accepting of the sanctuary on Jabal Harun than those following different architectural traditions that were largely foreign to the Graeco-Roman world.[2054] Undermining Nabataean religious beliefs *per se* was not a Roman policy. On the contrary: *If* Isis was truly venerated on Jabal Harun and the cult was indeed connected to the Nabataean royal dynasty, it may be argued that Roman authorities deliberately allowed cult practices to be continued; only replacing the dynastic connection with a Roman one.[2055] The veneration of Isis would not have been problematic as the cult was widespread throughout the empire. However, if the Roman authorities would have allowed the particular 'dynastic' Isis cult at Jabal Harun to continue unaltered, this would certainly have carried possible political risks.[2056] Any reference to the suppressed Nabataean dynasty would have brought dangers and potentially fostered political uprisings. Such threats could have been averted by the forced end of cult practices on Jabal Harun, as Roman authorities appear to have carried out at smaller Nabataean heterotopical religious structures such as the Obodas Chapel. However, the forced abandonment of this supraregionally important sanctuary could have triggered unrest as well. This was avoided at Khirbet edh-Dharih and Khirbet et-Tannur: Both supraregional Nabataean sanctuaries were significantly refurbished after the annexation. They continued to serve the needs of religious pilgrims and were possibly still run by the local elite, who were compliant with the new political order.[2057] Tholbecq recently emphasized that the 2nd century façade of the sanctuary at Khirbet edh-Dharih cites typical Roman iconographical elements and shows close parallels to contemporary urban Roman decorative programs, particularly that of the temple of *Venus Genitrix* rededicated by Trajan in 113 AD.[2058]

Arguably, a similar commitment to such *romanitas* may have taken place at Jabal Harun (if the sanctuary indeed continued after the annexation and Isis was truly venerated). The active approval of continuing the cult of Isis by and perhaps *in the name of* the new Roman authorities could have appeased a potentially dangerous situation. Any association of the Isis cult with the Nabataean dynasty would have been claimed by the Romans. However, without distinct archaeological evidence, this remains speculative. Some parallels from urban Petra nevertheless point in a similar direction:

2051 Schmid 2013a, 258–259.
2052 Cf. e.g. Wadeson 2010, 54–55; McKenzie 1990, 33–59 in addition to Schmid 2013a.
2053 Possibly, the same applies to Ras Hamra, ad-Dahhune Slaysil and Jabal Qarun.
2054 Fiema 2016, 544 referring to the Nabataean sanctuaries at Khirbet edh-Dharih and Khirbet et-Tannur that were continuously used during the Roman period as well (cf. also Durand 2017, 93–95).
2055 However, note Tholbecq's serious doubts that Isis was venerated on Jabal Harun (Tholbecq et al. 2019, 24; 2017d, 693–694 and 2016, 1069). For the certainly debatable argument that Isis was connected with the Nabataean royal dynasty, particularly with Nabataean queens, see e.g. Wenning 2016, 519–524 with further references. Also consider Schwentzel 2014; Kropp 2013a, 242–243, 371–372 or Vaelske 2013, 357–359.
2056 Fiema 2016, 544 notes: "[…] *Isis was completely integrated into the social environment of Petra and she was probably even strongly connected with the royal dynasty. Thus, with the Roman suppression of the name of Nabataea, the royal family vanishing into obscurity, and no indication of the incorporation of Nabataean aristocracy into the Roman Senate, the association of the sanctuary with a deity strongly connected to the extinct dynasty might have carried potential dangers.*"
2057 Tholbecq 2017b, 46–50 with further references. See also Durand 2017, 98 for a similar argument concerning the continuity of the banquet installations at Khirbet edh-Dharih and et-Tannur after the annexation.
2058 Tholbecq 2017b, 51–52. Also note the incorporation of the iconography of Tyche at Khirbet et-Tannur and Petra (Tholbecq 2017b, 52–53).

The policy of associating Roman authoritative rule with major Nabataean cults is attested by the Roman addition of an *exedra* within the *temenos* of the Qasr al-Bint in Petra. While the temple's *symposia* complex ('Bâtiment B') was abandoned no later than the early 2nd century AD, the *exedra* was used for the Roman imperial cult (most likely non-existent in Petra before the annexation) as suggested by portraits of Marcus Aurelius and Lucius Verus.[2059] In Nabataean times, Petra's main temple most likely served the veneration of Dushara, who was often directly associated with Nabataean royalty. Moreover, the Qasr al-Bint uniquely displayed a dynastic gallery of the Nabataean kings, thus associating the entire *temenos* with the royal dynasty.[2060] While cult practices continued at the Qasr al-Bint after the annexation, the addition of the *exedra* may demonstrate how Roman authorities aimed at claiming major Nabataean religious structures with a dynastic connection and associating them with Roman rule. Any dynastic association between Dushara and the Nabataean kings would have been replaced with one of the Roman emperor.

The situation on Jabal Harun must have been slightly different, as the sanctuary shows no structural additions or alterations that can be associated with the Romans. Nevertheless, the phenomenon of Roman authorities claiming major Nabataean religious structures with a dynastic connection and associating them with Roman rule instead of Nabataean royalty is arguably similar. Although the evidence remains elusive, there are also indications that the presumed Nabataean temple at Bostra was later altered into a place for the Roman imperial cult. If so, this would fall into the line of argument that any cultic association with Nabataean royalty was replaced with the veneration of the Roman authorities.[2061] Based on a dedicatory inscription, the imperial cult at Bostra was also associated with Dushara.[2062] This link between the emperor and the god may suggest a Roman continuation of previous Nabataean traditions (particularly under Rabbel II) of associating the deity directly with the royal court. Particularly from Bostra, representations on the imperial coinage of Commodus, Caracalla, Elagabalus and Philippus the Arab show a strong resemblance between the depiction of the emperor on one side and that of Dushara (when in human form) on the other.[2063] This again indicates the Roman policy of erasing any association with the Nabataean dynasty and replacing it with Roman rule. Moreover, Philippus the Arab founded the long-lasting games at Bostra known as the *Actia Dusharia* in the mid-3rd century AD. This may further suggest a close association between Dushara and Roman rule.[2064]

Another argument that associations with Nabataean royalty were replaced by Roman imperial officials in Petra, is the fact that the last monumental tomb in the city was claimed by Sextius Florentinus, the Roman provincial governor who died in 130 AD.[2065] Based on architectural and decorative comparisons, Freyberger has convincingly demonstrated that the tomb was originally constructed in the Augustan era.[2066] Sextius Florentinus therefore reused an older Nabataean tomb. What is important in this context is not only the fact that a Roman governor chose Petra as his burial place, thus attesting to the continued importance of the city after the annexation, but that the tomb is situated along the Jabal al-Khubtah, which was arguably reserved for the burial of the Nabataean kings.[2067] It directly faces the presumed royal *basileia* as well.[2068] Not only is his funerary monument the last façade tomb in Petra, it may be assumed that Sextius Florentinus deliberately chose this location to equate Roman imperial governorship with (former) Nabataean royalty.[2069]

If cult activities at Jabal Harun continued after the annexation and Isis was truly venerated at the sanctuary, it may therefore be argued that Roman authorities

2059 On the 'Bâtiment B,' see e.g. recently Renel – Monchot 2017, 59, 69–70. On the Roman *exedra* and imperial cult, see Augé et al. 2016, 300–301; Tholbecq 2016, 1059; Augé et al. 2014, 54–75, particularly 69–70. A dedicatory inscription accompanied the portraits of the emperors.

2060 Wenning 2017, 120–122; Alpass 2013, 56–59; Wenning 2011, 290. Importantly, see Kropp 2013a, 288–290, 377–379 on the association of the *temenos* with Nabataean royalty.

2061 Alpass 2013, 187; Dentzer et al. 2002, 87.

2062 Alpass 2013, 187; IGLS XIII 9143.

2063 Acqua 2015, 390–394 arguing that hairstyle, dress code and even facial attributes of figural depictions of Dushara clearly resemble those of the emperor (particularly Philippus the Arab). There are also similar correlations between the depictions of empresses and goddesses, most importantly Tyche (Acqua 2015, 393–394). This further underlines the Roman policy of associating local rule with the emperor and his family.

2064 This is documented on Bostra's coinage. On the *Actia Dusharia*, see Hackl et al. 2003, 105; Millar 1993, 399–400; Bowersock 1990, 8–10. On Dushara as a 'civic deity' in the Roman period (including the *Actia Dusharia*), see Alpass 2015, 376–378 with further references. Based on her study of Roman imperial coinage from *Provincia Arabia*, C. M. Acqua also concludes that "[i]*t is thus likely that the imperial presence was (slowly?) integrated into the identity of the cities and was no longer thought of as an external power* […]. [T]*he emperor entered deservedly into the panthea of the cities and was considered and honoured together with, and as, the other local gods of the city*" (Acqua 2015, 395).

2065 Freyberger 1991, 1.

2066 Freyberger 1991.

2067 As suggested by some of Petra's most prominent façade tombs, such as the 'Unaishu tomb' or the 'Palace Tomb.'

2068 Cf. e.g. Schmid et al. 2012.

2069 For a similar argument concerning the transformation of the 'Great Temple' in Petra, see Schmid 2013a, 261–264.

deliberately allowed the sanctuary to continue. Its supraregional importance offered a good opportunity to set Roman authoritative rule in scene, by replacing any associations with the Nabataean royal dynasty with Roman rule (if accepting that Isis was connected to Nabataean royalty).[2070] However, as both the continuity of the sanctuary into the Roman period, as well as the identification of Isis as the venerated deity is disputed, this remains speculative.[2071]

Apart from the monumental *hypogea*, all monumental funerary structures of heterotopical character in Petra and its rural surroundings seemingly went out of use in the 2nd century AD. The question therefore arises why *hypogea* were in continuous use after the annexation. This is a particularly curious observation as monumental tombs elsewhere in Nabataea were not affected by the arrival of the Romans. For example, a monumental *hypogeum* discovered only a few kilometers northeast of Humeima close to the *via nova Traiana* is assumed to be the tomb of a certain Marcus Ulpius Su'aidu.[2072] The Humeima tomb is not only a further contemporary example of a monumental *hypogeum* in Nabataea, but the tomb owner's name suggests a strong sense of *romanitas* by a member of the local rural elite. Wadeson and Abudanh also list the monumental *hypogea* and other 'loculi tombs' of Umm al-Jimal as further parallels to the *hypogea* in the Petra area.[2073] These tombs date to the Nabataean, but also to the Roman periods and some were reused in Byzantine times as well. The monumental 'mausoleum' of the authorities of the sanctuary at Khirbet ad-Dharih was also constructed immediately after the annexation and was in continuous use until the mid-4th century AD.[2074]

The continued construction of monumental elite tombs during the Roman period is common in the Near East. For example, many of the monumental tower tombs, *hypogea* and 'temple- or house tombs' in Palmyra date between the 1st and 3rd centuries AD when Palmyra was already controlled by Rome.[2075] Specifically, the Palmyrene *hypogea* mostly date from the 2nd century AD onwards and feature elements of clearly Roman sepulchral architecture. This can be exemplified with the famous 'Tomb of the Three Brothers' where, in addition to burial *loculi*, large sarcophagi in form of *clinai* were arranged in the shape of a *triclinium*. The sarcophagi lids represent lying symposiarchs. Clearly, ritual banqueting formed an integral part of the Palmyrene elite funerary culture – a feature that is mirrored in the Nabataean funerary complexes at Petra. Other parallels between Nabataean funerary complexes and Palmyrene elite tombs can be drawn when considering the Palmyrene temple tombs, most notably Temple Tomb No. 36.[2076] While the burials of this monumental tomb are placed within simple *loculi*, they are arranged around a central courtyard and the architectural style of the temple tomb is paralleled by the complex classical façade tombs at Petra. This showcases the conceptual similarities between the Palmyrene and Petraean elite tombs. The funerary inscriptions from Palmyra also indicate that the tombs were owned by distinct families, clans or tribes – as is assumed for the Nabataean tomb complexes in Petra as well.[2077] The architectural and conceptual similarities between the Palmyrene and Petraean tombs as well as the shared importance of ritual banqueting, and their clearly distinctive use by different tribal social groups is apparent. The monumental Palmyrene tombs could therefore be considered as Palmyrene funerary *heterotopiai*, as is suggested for the Nabataean funerary complexes. However, the crucial difference is that the Palmyrene *heterotopiai* continued well into the Roman period while their Petraean counterparts did not.[2078]

One argument for the continued use of the monumental *hypogea* in Petra's hinterland could be the lack of archaeological evidence suggesting that regular ritual gatherings were held at these monuments. Unlike the tomb complexes in Petra, the *hypogea* in the city's hinterland would therefore not necessarily qualify as Nabataean *heterotopiai*. However, future investigations may reveal evidence of gatherings within the burial chambers or around the presumed superstructures of the tombs. A lack of *structural* indications of regular funerary rituals does not necessarily imply that they were not held. There are indications that banqueting installations were part of similar *hypogea* at Mampsis and Khirbet edh-Dharih, which would

2070 Also consider the sanctuary's more acceptable architectural appearance in Graeco-Roman design as claimed e.g. by Fiema 2016, 540–543 and Schmid 2016. Assuming that Ras Hamra also had a supraregional significance, a similar argument may apply here as well, as surface finds suggest a (limited) use in Roman times. However, there is no indication of the venerated deity and the later re-use of the sanctuary does not mean that it maintained its original function.

2071 Cf. particularly the criticism raised by Tholbecq et al. 2019, 24; 2017d, 693–694 and 2016, 1069.

2072 Oleson 2010, 29, 62 n.1 (also referred to in Wadeson – Abudanh 2016, 93).

2073 Wadeson – Abudanh 2016, 94–95. Also consider other parallels from Khirbet edh-Dharih, Mampsis and Dhat Ras all dating to the 1st/2nd century AD.

2074 Cf. Tholbecq 2017b, 46–47, 50 in reference to Lenoble et al. 2001, 100–108, particularly on the dating: 127–128.

2075 See e.g. al-As'ad – Schmidt-Colinet 2005 and Gawlikowski 2005.

2076 al-As'ad – Schmidt-Colinet 2005, 47.

2077 al-As'ad – Schmidt-Colinet 2005, 39.

2078 Cf. Tholbecq 2016, 1062 in reference to the Palmyrene model suggested by Yon 2002.

suggest that rituals were held at the *hypogea* in the Petraean hinterland as well. The shaft tombs along Petra's North Ridge feature flattened bedrock surfaces in front of the tombs as well, which the excavators claim could have been used for ritual activities.[2079] The *hypogea* may thus very well be considered as *heterotopiai* of a Nabataean rural elite. It therefore cannot be claimed that Roman authorities saw a threat in *all* Nabataean *heterotopiai per se* as might be the impression when following the argument for the end of Nabataean tomb complexes in Petra. This phenomenon seems to be limited to the tomb complexes and other heterotopical funerary structures of the Nabataean *elite* in *urban* Petra alone and is not necessarily mirrored by the funerary structures in Petra's hinterland. This suggests that Roman authorities had a conflicted relationship mostly with members of a *specific* Nabataean elite and not with Nabataean *heterotopiai* in general. The presumed Roman fear of political unrest fostered by Nabataean *heterotopiai* particularly concerned those of the social elite of urban Petra, but cannot be considered as a general Roman policy towards Nabataean funerary culture *per se*. There seems to have been an unusually harsh treatment of the Nabataean elite in urban Petra as there is no longer any reference to Nabataea as a political entity and any associations with the Nabataean royal dynasty are relinquished. There is also no indication that Nabataean elites were incorporated into the Roman Senate. Not only was the former Nabataean ruling class no longer included in the political decision-making process, they were deliberately suppressed by the Roman authorities.[2080] It is in this light that the end, or significant alteration of tomb complexes and other heterotopical structures of the Nabataean elite in Petra should be considered. While additional research of monumental tombs in Petra and its hinterland is necessary, this may offer a preliminary explanation as to why the *hypogea* seem to be the only monumental funerary monuments in the Petraean hinterland after the Roman annexation.

The Military Disposition

In the 2nd century AD, the number of occupied military sites generally remains the same as during the Nabataean period and most Nabataean structures are in continuous use in the immediate aftermath of the Roman annexation in 106 AD (cf. above). The GIS-based cumulative visibility analyses also suggested the same visual hierarchies of the different military structures throughout the entire Roman and Byzantine periods (apart from the 7th century AD) as for the Nabataean period. It was shown that Petra and its hinterland were under complete visual control during the 1st century AD and this remained unchanged in the 2nd century AD (cf. FIG. 370). By the 3rd century AD however, corresponding to the general decline of military sites, cumulatively visible areas decrease (cf. FIG. 371). The Petra valley, the Udruh-Petra road as well as the eastern areas between Udruh and Ayl are now less visually controlled. Only the area immediately north of Ayl remains under good surveillance. The same trend can be observed for the 4th century AD, although the areas around Udruh and Saddaqa show a high number of cumulative visibility fields (cf. FIG. 372). This may be related to the construction of the Late Roman fort at Saddaqa as well as the *castrum* at Udruh.

The formal spatial and statistical analysis has shown that the military disposition of the Petraean hinterland largely remained the same as during the Nabataean period. With the exception of Tell Abara (more below), no military structures were constructed in the Early Roman period. There is thus no evidence for a heightened Roman military presence. Instead, previous Nabataean military structures (forts, fortlets/road stations and watchtowers) are continued to be used after the annexation. This correlates with recent excavation results, for example from the Roman fort at Hegra, that confirm that the Romans immediately reused Nabataean military structures and seems to be in accord with one long-standing scholarly opinion that the annexation process occurred mostly without conflict.[2081]

This assumption is largely based on the fact that Trajan did not take over the honorific title of *Arabicus* and coinage issued immediately after the annexation (dating between 111 and 114 AD) reads *Arabia adquisita* instead of *capta*.[2082] Also, milestones along the newly established *via nova Traiana* between Bostra and Aila mention that the road stretches through regions that are *redacta in formam provinciae Arabiae*, thus seemingly in support of a more peaceful transition. There is also no contemporary literary source that mentions the annexation.

2079 Perry 2017, 105–106.
2080 Cf. Fiema et al. 2015, 375–376 with further references.
2081 Harvey 2018, 706–710. The Roman fort at Humeima was also constructed immediately after 106 AD, although the function of pre-existing Nabataean structures cannot be determined (e.g. Oleson 2019b, 397–398). Speidel 2019, 58–63 and 2016, 164 claims that the reason for the immediate reoccupation of major Nabataean military structures was the Roman military's primary function of controlling long-distance trade routes in the new *Provincia Arabia*.
2082 Bowersock 1983, 81; Spijkerman 1978, 32. For a general overview of the annexation process, see Parker 2009a; Kennedy 2004, 45–46; Fiema 2003, 43–47 as well as Freeman 1996.

The only literary references to the annexation process date more than a century later. Standing in conflict with the assumption of a peaceful annexation, Cassius Dio reports that the annexation process was commanded by then governor of Syria, Cornelius Palma, and Ammianus Marcellinus (4th century AD) refers to the use of force against the "arrogant" Nabataeans.[2083] Palma probably mobilized a substantial number of troops as is suggested by the epigraphically evidenced presence of the *legio VI ferrata* at Bostra and Gerasa as well as the deployment of the *legio III Cyrenaica* from Egypt to the Petra area directly after the annexation.[2084] Additionally, two Roman auxiliary units (*cohortes I Hispanorum and I Thebaeorum*) were stationed in Judaea immediately before the annexation in 105 AD and it is assumed that they were planned as military support for the expected annexation.[2085] As Parker pointed out "[a]*ll this suggests that the Romans were prepared for serious resistance to the annexation but obviously does not prove that there was in fact significant warfare.*"[2086]

Particularly from Petra, however, there is evidence that points to at least local conflicts at some point around the time of the annexation.[2087] This includes early 2nd century AD destruction levels at the Temple of the Winged Lions (a partially destroyed roof and a slim ash layer) as well as the complete destruction of the villa of ez-Zantur (evidenced by three coins of Rabbel II, Nabataean fine ware pottery of mainly Schmid phase 3b as well as Eastern Sigillata A dating around 100 AD).[2088] Another important find was made in the western *propylaeum* of Petra's 'Great Temple' where over 400 stone *ballistae* and other finds of potentially military nature (including over 160 arrow heads) were excavated.[2089] The majority of the *ballistae* (361) were discovered below the floor pavement of the *propylaeum* and the excavators convincingly suggest that they were used as a subfloor fill.[2090] In the same level, the excavators uncovered a coin dating to 39/40 AD, a fragment of an Herodian lamp dating between 50 and 70 AD as well as decorated Nabataean fine ware belonging to Schmid's Phase 3b (c. 70/80-c. 100 AD). This gives a *terminus post quem* of the last quarter of the 1st century AD. The excavators are certainly correct to assume that the *ballistae* and other finds of military nature point to local 'skirmishes,' which may be associated with the annexation.[2091]

In addition, this study also addressed the arguably deliberate destruction of heterotopical structures of the Nabataean elite that also occurred at the beginning of the 2nd century AD (cf. above). Furthermore, the *Petra North Ridge Project* (PNRP) has recently provided new dating evidence from the foundation levels of parts of Petra's northern city wall. Ceramic evidence suggests a construction date at some point during the early 2nd century AD.[2092] However, it remains unclear whether the wall was built immediately before, or just after the annexation. If one accepts that the wall served defensive purposes, the PNRP proposes two preliminary explanations.[2093] If built before 106 AD, the wall may have served as a final measure in fortifying Petra against the arriving Roman forces. If dated post-106 AD, the wall could have protected the Roman garrison (if stationed within Petra's urban limits) against potentially hostile locals. However, there is still no direct archaeological evidence for destruction or conflict associated with the wall and its defensive function can certainly be discussed. The

2083 Cass. Dio 68, 14, 5 and Amm. 14, 8, 13. There are also several 'Safaitic' texts that mention conflicts between Nabataeans and Romans. One mentions the "year the Nabataeans revolted against the people of Rome," but Graf 1989, 376, n. 141 raises serious doubts whether the text can be related to the annexation.

2084 Kennedy 2004, 47–48.

2085 Kennedy 2004, 49; Speidel 1977, 709.

2086 Parker 2009a, 1586–1587.

2087 See Parker 2009a, 1587–1589.

2088 For more on the evidence from the Temple of the Winged Lions, see Russel 1985 with further references, and more recently Horacek 2016, 71–92. On the destruction layers of ez-Zantur, see Schmid 1997, 414–415 who argues that the destruction is associated with the annexation. However, *contra* Schmid, Kolb 2002, 260–261 claims that the destruction was due to an unreported earthquake that occurred in the early 2nd century AD. For a more recent re-evaluation of the destruction of ez-Zantur, see Horacek 2016, 92–102.

2089 On the *ballistae* from the Great Temple, see most recently Joukowsky 2017, 369–382. The other finds of possible military nature include "[…] *a bronze scabbard tip, the left cheek plate of an helmet, a tear-drop-shaped bronze scale possibly from a suit of armor, fragments of 3 iron rings, a bronze hook, a bronze shafted spearhead, and a bronze loop of uncertain purpose*" (Joukowsky 2017, 372).

2090 Joukowsky 2017, 372–374.

2091 The excavators propose two explanations for the large number of *ballistae*: *"1. The ballista* [under the floor] *are Nabataean, were stockpiled against an anticipated attack from across Wadi Musa, but were never used (at least not these). 2. The ballista balls are Roman and represent the stored ammunition of the Roman garrison in the immediate wake of the occupation of Petra. The balls had been employed in action, and did cause damage to the Propylaeum, prompting the repairs undertaken in the subsequent years. At that point they were gathered up by the repairers and used as fill beneath floors*" (Joukowsky 2017, 381). However, as the *ballistae* were still in perfectly good condition, it seems rather doubtful that they were used in action. It is thus more plausible to assume that they were stored as an *unused* stockpile and later taken as material to level the floor fill of the *propylaeum*.

2092 Parker 2016, 592–593. For more on Petra's city wall, see Parr's excavation results in Parr 1990 and 1986.

2093 Parker 2016, 594.

wall may have also served more representative purposes and demarcated the urban limits of Petra. This seems supported by the fact that the Nabataean shaft tombs along the North Ridge were abandoned by the 2nd century AD and replaced by domestic structures, thus perhaps following "[…] *the imposition of Roman law by the new rulers, which normally forbade burial of the dead within the formal sacred boundaries (pomerium) of a city.*"[2094] Although its function remains debatable, the construction of the city wall points to heightened security concerns in Petra at the time of the Roman annexation.

Archaeological evidence at other sites in Nabataea also indicates local destruction levels dating to the early 2nd century AD.[2095] Some scholars associate these early 2nd century destruction levels with an unreported earthquake that apparently occurred in the region in 113/114 AD.[2096] However, there is no literary evidence for this earthquake and the disparate evidence from the presented sites is inconclusive whether an earthquake caused the reported destruction or not.[2097] The hypothesis that the destruction levels were caused by seismic events is rejected by Schmid, who argues that the scale of destruction varies in Petra and other sites in Nabataea. Some sites were not destroyed at all.[2098] If confirmed, this is a strong argument against the earthquake scenario. However, in addition to presenting more possible evidence for a 2nd century AD earthquake destruction from the Negev, Dafit and Aila, Parker recently reviewed the evidence discussed by Schmid.[2099] Parker argues that the possible early 2nd century AD earthquake destruction of Nabataean sites does not necessarily have to exclude the possibility of deliberate destructions caused during the Roman annexation.[2100] The evidence for both explanations is seemingly problematic and the debate remains unresolved. The *ballistae* from the Great Temple as well as the *ornamenta triumphalia* awarded to Cornelius Palma in 107 AD and the transfer of major Roman troops to the Petra region shortly before and after the annexation nevertheless point to local conflicts between Romans and Nabataeans.[2101] While it is unknown why Cornelius Palma was awarded the *ornamenta triumphalia*, it was definitely associated with some kind of military action in the region during the time of the annexation. The harsh treatment of the Nabataeans after the annexation can also be regarded as indirect evidence for conflict as there is no mention of the Nabataean royal dynasty or the name *Nabataea*, and nothing indicates that the Nabataean aristocracy was incorporated into the Roman senate.[2102]

At any rate, the opinion that the annexation process occurred mostly without conflict can be challenged.[2103] Although there is no unequivocal evidence for a military conflict around 106 AD, it is a likely possibility. Additionally, the presumed deliberate destruction – or at least discontinuity – of heterotopical structures at some point around the early 2nd century AD further indicates that the annexation did not occur without conflict.

There is also no archaeological evidence for conflict in Petra's hinterland. Although this is based on surface observations alone and excavations are needed to further clarify the issue, the only structure in the study area that could possibly be associated with the annexation is the temporary fort of Tell Abara, constructed at some point during the 2nd century AD. The fort is much larger than the presumed Nabataean forts in the Petraean hinterland and its structural layout resembles that of other temporary Roman military

2094 Parker 2016, 594. Cf. also Perry 2017, 103. On the argument for considering also the representative/symbolic meaning of fortification walls in antiquity, see Müth et al. 2016.

2095 Parker 2009a, 1588–1589 lists evidence from Nabataean sites in northern Jordan such as Khirbet edh-Dharih and Dhibon, in southern Jordan (Aqaba/Aila) as well as sites in the Negev along the Petra–Gaza Road (e.g. Oboda, Mampsis, En Rahel, En Ziq, Horvat Hazaza, Mezad Mahmal, Moyat 'Awad and Sha' ar Ramon). Also see Schmid 1997, 416–418 for a critical presentation of the evidence for destruction at these sites.

2096 Russel 1985, 40–41.

2097 As noted by Parker 2009, 1590, n. 6: Amiran et al. 1994, 289 lists the presumed earthquake of 113/114 AD as "Earthquake Reports of Doubtful Authenticity" due to inconclusive archaeological evidence and the lack of historical sources.

2098 Schmid 1997, 417–418.

2099 Parker does not follow Schmid's criticism of the 'unsatisfactory' archaeological evidence that would support the hypothesis for an earthquake destruction of the Nabataean site of Dhibon. However, he does not discuss Schmid's rejection of the evidence supposedly pointing to a 2nd century AD earthquake destruction at Mampsis and follows the traditional assumption that the site was partially destroyed by the presumed earthquake of 113/114 AD. For a most recent overview of the Nabataean sites in the Negev that were presumably destroyed by an earthquake during the early 2nd century AD, see Erickson-Gini 2010, 46–47.

2100 Parker 2009a, 1591.

2101 Cf. Parker 2009a, 1591.

2102 Graf 1989, 381–382 and most recently followed by Fiema et al. 2015.

2103 Also, note Fiema's claim that the presented evidence may be related to *internal* unrest. As the Nabataean royal dynasty was dissolved and the aristocracy disenfranchised, this could have led to political uprisings and turmoil – at least in Petra. It is therefore plausible that the evidence for destruction at Petra may be rather associated with internal uprisings, arson and other retaliatory strikes that were not necessarily directed at the Romans (Erickson-Gini – Tuttle 2017, 275–276; Fiema et al. 2015, 375 and Fiema 2012a, 300).

camps in the Near East. It may therefore be hypothesized that Tell Abara accommodated at least parts of the *legio III Cyrenaica* that were deployed from Egypt immediately after the annexation. The deployment of the legion is referred to in a letter found at Karanis (Egypt) that dates to the early months of 107 AD and was written by a certain Julius Apollinarius who addresses his father.[2104] Although the papyrus does not mention the legion directly, further papyrological evidence confirms that both Apollinarius and his father were members of the *legio III Cyrenaica*.[2105] It therefore seems safe to assume that Apollinarius was a member of the legion when he composed the letter. Importantly, Apollinarius mentions that he and his comrades (possibly two or more cohorts, one of which was about to leave for Bostra) were stationed at Petra. Whether this means that Apollinarius was within the city's *urban* limits is uncertain, but he refers to "stone cutting" performed by the stationed troops. Although he does not specify the exact reason, this was most likely related to building activities. Whether this was for road construction (such as the *via nova Traiana*) or for new military structures remains unknown. However, considering that Tell Abara is situated only 2 km southwest of Udruh near one of the supposedly largest limestone quarries in Jordan,[2106] Apollinarius' reference to stone cutting may be related to these quarries and thus associated with the construction of Tell Abara. While this remains entirely speculative, Tell Abara is the only 2nd century military structure in the Petraean hinterland. All Nabataean military sites seem to have been taken over and continuously used by the Romans. This suggests that the overall military disposition of the Petraean hinterland was unchanged. It is unknown what exactly happened with the Nabataean military in the first years of the annexation. There is also no way of knowing whether the military structures were occupied by military units or local civilians. The only evidence is a continuation of surface pottery. Nevertheless, it is at least possible that parts of "[…] *the Nabataean military corps was maintained for patrolling and defending the more difficult and extensive desert regions* […]" – including the Petraean hinterland.[2107] It is likely that Roman military units, particularly *auxilia*, which took part in the annexation and formed the initial garrison, soon recruited locals because of their good knowledge of the difficult natural landscape conditions and their experience with the rural population.[2108] Camel riders may have been particularly useful for cavalry *alae* such as those attested near Hegra.[2109]

It is therefore possible that local patrols continued to police the Petraean hinterland after the annexation, but now perhaps commanded by Roman officers. A further argument that local surveillance strategies were employed by the Romans is that most of the presented watchtowers were continuously used after the annexation. As these are placed on prominent hilltops that are hardly known to non-locals, it seems difficult to assume that these were manned by foreign watchmen. It is far more likely that the towers continued to be occupied by local σκοποί when required.

However, it is questionable whether these local recruits were previously part of the Nabataean army. By 111 AD, it was largely incorporated into the new *Cohortes I–VI Ulpiae Petraeorum*.[2110] The cohorts were mostly infantry but also consisted of large cavalry units, including mounted archers, who seem to have been deployed exclusively to the eastern provinces (most likely to serve as part of Trajan's campaign against the Parthians). There is no evidence to suggest that the cohorts remained within *Provincia Arabia*. This may have been a deliberate attempt to remove previously Nabataean military forces from their home territories as it fits into the generally harsh treatment of the Nabataeans by the new Roman authorities. During the early provincial era, recruits for *Provincia Arabia* were mostly employed from elsewhere (probably North Africa).[2111] It is nevertheless likely that local recruits were enrolled in the Roman army

2104 P. Mich. VIII, 466. For more on the letter, see Kennedy 2004, 47–48 and 175–176. Also cf. Erickson-Gini – Tuttle 2017, 278.

2105 P. Mich. VIII, 562 and 571.

2106 Cf. Killick 1983b, 127 and 1982, 415.

2107 Graf 1994b, 305.

2108 Cf. also Kennedy 2004, 51 and Hackl et al. 2003, 351.

2109 Two *alae* are known to have been stationed near Hegra: the *ala dromedariorum* and *ala Getulorum* (Gatier 2018). On the *alae*, see also Speidel 2019, 59–60, 62; Nehmé 2017, 143–148; Fiema et al. 2015, 377; Kennedy 2004, 48–49, 51; Hackl et al. 2003, 349–351; Bowersock 1988, 192–196; Speidel 1977, 703–704. Speidel mentions that the Syrian *ala I Ulipiae dromedariorum* was already part of the Roman army by the early 2nd century AD, which consisted mostly of local Arabian recruits as well. Also, consider the bilingual Greek and Nabataean inscription from the remote temple of the Roman imperial cult at Ruwafa in the northern Hijaz. It mentions that the temple was dedicated to Marcus Aurelius and Lucius Verus and constructed by members of the tribal social group of the 'Thamud' (e. g. cf. Fiema et al. 2015, 377). While it was initially assumed that the temple indicated possible attempts to mediate relations with remote tribal social groups (e. g. Bowersock 1988, 172, 178–180), recent interpretations claim that the 'Thamud' were individual recruits of a local Roman military unit (Macdonald 2009).

2110 On the *Cohortes Ulpiae Petraeorum*, see Kennedy 2004, 46–47; Freeman 1996, 107–108 and Graf 1994b, 297–305.

2111 Speidel 1977, 719 and Kennedy 2004, 51 referring to a draft of c. 700 men from the *legio III Augusta* to an unknown '*legio III*' in 127 AD.

early on.[2112] This may have been the case in the Petraean hinterland as well. The fact that the original Nabataean military structures were continuously occupied after the annexation indicates that maintaining internal security as well as policing and patrolling the Petraean hinterland remained the key function of the early Roman army in the study area.

There is also no archaeological evidence to suggest that the overall military disposition changed during the 3rd century AD. While surface pottery indicates a continued occupation of military structures, there again are no indications on who occupied these structures. From urban Petra, which was granted the status of a *metropolis* by Trajan and a *colonia* by Caracalla or Elagabalus, there is epigraphical evidence from the early 3rd century AD that names military commanders and army detachments, most notably a Roman *beneficiarius*.[2113] There is still no evidence from the hinterland that indicates great change in the military disposition. This is curious, as one would anticipate an affect from the increasing crisis of the 3rd century AD when economic instability and political turmoil – particularly the rising external threats posed by the Sassanids and the Palmyrenes – shook the Roman East. The archaeological evidence only reflects these political developments with the construction of the Late Roman forts at Saddaqa and Bir Madkhur as well as the completion of the legionary fortress at Udruh at the beginning of the 4th century AD.[2114]

Terra Petraea in the Byzantine Period

Following the economic and political instability of Late Roman Arabia as well as the rising military threats against the eastern frontier, the Byzantine period (4th – 7th century AD) is marked by contrasts. On the one hand, Christianity was successfully introduced to the Petra area. On the other hand, the old Nabataean cult of Dushara continued as well. While there are still literary sources from the 4th century AD that contextualize the region historically, after the 6th century AD Petra is no longer mentioned in any historical accounts. Because of the provincial reorganizations during the 4th century AD, Petra was designated the capital of the new province *Palestina Salutaris* (later Tertia) that included parts of southern Jordan, the Negev and probably also Sinai.[2115] Following the earthquake of 363 AD, a significant part of the urban center was destroyed and major sites such as the Temple of the Winged Lions, the Qasr al-Bint and the 'Great Temple' were abandoned. The luxury villa of ez-Zantur was also destroyed by a presumed subsequent earthquake in the early 5th century AD and shops along the Roman street in Petra's center were gradually abandoned. Although Petra clearly enjoyed ecclesiastical significance during the 5th and early 6th centuries AD and the city's honorific titles are still mentioned in 6th century AD sources, they merely refer to the city's once glorious past and do not reflect the historical reality. The archaeological evidence clearly indicates Petra's continuing economic and political decline. Following the Muslim conquest of the Petra area in 630 AD, the city eventually ceased to exist as an urban center entirely.

Subsistence Strategies and Communication

The economic decline of the 3rd century continued in the 4th century AD. This is reflected by the significant decrease of smaller settlements and the increasing nucleation around larger, village-sized settlements. The need for supplying caravans with agricultural products diminished and Petra's rural population increasingly followed pastoral subsistence strategies. Apart from the continued activities at the workshop of az-Zurraba until the 7th century AD, all small-scale 'industries' in the Petraean hinterland were abandoned as well.

This trend continued in the 5th century AD when landed properties were owned by fewer landholders and ownership was claimed through inheritance, marriages and land purchases. While this was most likely the case in earlier periods as well, the 6th century AD Petra Papyri now offer explicit textual evidence for this in Late Antiquity.[2116]

2112 Cf. recently discovered Nabataean inscriptions mentioning a *centurio* and "cavalry men" (*prš*) at Dumat al-Jandal, possibly dating to 114/115 AD and 135/136 respectively (Nehmé 2017, 142–144).

2113 Fiema et al. 2015, 378 and Fiema 2003, 46. The *beneficiarius* is inscribed on an altar carved into Petra's Siq entrance (Zayadine – Fiema 1986, 203–205). On the *beneficiarii*, see Kennedy 2004, 51 as well. For the presence of the military commanders and detachments in Petra, see Fiema 2003, 46 with further references.

2114 On the Late Roman and Byzantine army in the East, see Kennedy 1996 and Kennedy 2006. The Tetrachic period is generally characterized by the extensive construction of new military structures as well as infrastructural improvements along the eastern frontier as evidenced, for example, by the *strata diocletiana*.

2115 On the late Roman provincial rearrangements in Arabia, see Sipilä 2009 and 2004. For a general historical overview of Late Roman/Byzantine Arabia, see Fiema et al. 2015, 385–390, 394–395; Fiema 2015, 361; 2003, 52–53 and 2002a, 192–195.

2116 Kouki 2012, 123–128.

During the 6th and 7th centuries AD, the nucleation of large sites continued. By the late 7th century AD, the settlement pattern grew more concentrated around large villages and towns between Udruh and Ma'an at the fringes of the eastern desert. However, the site distributions show that there are only a few settlements east of Udruh. The only exception are clusters of buildings, although these were distributed along the eastern peripheries during the Nabataean period as well.

Although most Byzantine settlements remained west of Udruh, the overall eastern shift of settlements culminated in the Byzantine period. This is archaeologically further evidenced by extensive run-off cultivation systems associated with large settlements. This eastern shift may be partially explained by new economic incentives along north-south running trade routes that connected with Syria and the northern Hijaz.[2117]

Despite the abandonment of settlements west of Petra and the overall decrease of settlements during the 5th – 7th centuries AD, both the archaeological evidence and the Petra Papyri do not suggest a decline of the Late Byzantine rural population. Kouki suggests that the nucleation of larger, village-sized sites

> [...] *is the result of the increased importance of agricultural pursuits for the local economy, the concentration of landownership and the relocation of the rural population associated with these economic and social changes.*[2118]

This is supported by the findings of this study as well.

The importance of these "agricultural pursuits" is also indicated by the identified agricultural installations. As olive presses were still used in the Islamic period at Khirbet an-Nawafla, olive cultivation most likely continued in the Byzantine periods. The Petra Papyri mention irrigated orchards and *xerokēpia* (dry gardens).[2119] These *xerokēpia* were supposedly located near houses both at Petra as well as in its hinterland. It is also assumed that they included olive trees and other drought-tolerant plants such as barley as the climate arguably grew more arid. This would explain the generally stable count of the recorded threshing floors in the Late Roman and Byzantine periods, which are now situated exclusively along the eastern high plateau in accordance with the general eastern shift of the overall rural settlement pattern. Seemingly, cultivation practices in the Petraean hinterland focused more on growing cereals for local use in the Byzantine period (e.g. as evidenced by the extensive field systems in the Udruh area). This is also corroborated by the archaeobotanical evidence from ez-Zantur (cf. FIG. 357). Moreover, macrofossil samples from the Jabal Harun area have shown that, in the Byzantine period, 52,6 % of all analyzed plant remains were grains. In the Islamic period, these constituted only 22,7 %. This suggests that the consumption and therefore the cultivation of grains declined towards the end of the Byzantine period.[2120] The increasingly arid climate and thus less suitable lands for cereal cultivation would explain this decline.

Although water storage installations remain the largest category of all recorded water structures until Late Antiquity, the overall count of water structures decreases significantly as well. Whether this development also reflects the general decline of rainfall and an increasing aridification of the Petra area by the 4th/5th century AD is debatable. Further research in this respect is required. It may be postulated, however, that the deteriorating climatic conditions and thus the decreasing availability of run-off water, partially influenced the construction of the Byzantine *qanat* system and overall eastern shift of rural settlements towards the Udruh area where ground water was presumably tapped for both drinking and service water for irrigating local agricultural fields.

The macrofossil analyzes conducted by the FJHP suggest increasing slope erosion as well. This indicates significant deforestation in the later Byzantine and Early Islamic periods.[2121] While acknowledging the longevity of run-off cultivation systems, agricultural activities became less intensive in the Petra area. This suggests a shift to a more extensive cultivation mode and a generally more diversified subsistence strategy.[2122] This correlates with the increasingly nucleated settlement pattern described above.

Society and Culture

Although the early 4th century AD accounts of Eusebius suggest that the veneration of the old Nabataean supreme deity Dushara continued in the Byzantine period, the major socio-religious change was undoubtedly the introduction of Christianity. The fact that this first occurred only gradually is attested by the late 4th

2117 There is no evidence to suggest that the routes in Petra's western hinterland (including the Petra–Gaza road) were frequently used after the mid-3rd century AD. Cf. also Erickson-Gini – Israel 2013, 41.

2118 Kouki 2012, 132.

2119 Cf. Bouchaud et al. 2017, 239 with further references.

2120 Lavento et al. 2013b, 225.

2121 Tenhunen 2016; Tenhunen – Kouki 2013 and Tenhunen 2013.

2122 This is argued particularly by the FJHP on the basis of surface pottery from the Jabal Harun area (Lavento et al. 2013b, 225; Ynnilä 2013, 266 and Kouki 2012, 107–108 with further references).

century AD accounts of Epiphanius and Sozomen describing the mixed practice of pagan cults alongside Christianity. There are also indications that pagan cults continued into the early 5th century AD.[2123] It is likely that the coexistence of pagan cults and Christian practices (partly of differing theological convictions) may have ignited local unrest and conflict.[2124] Nevertheless, Petra was an episcopal seat since the mid-4th century AD and by the 5th century AD, claimed major ecclesiastical significance as the city received the status of the Metropolitan See of the Patriarchate of Jerusalem with Johannes as the first metropolitan bishop of Petra in 451 AD.[2125] Archaeologically, this elevated ecclesiastical status of Petra is reflected by the construction of four major churches in the city center from the mid-5th until the 6th century AD while other major buildings continued to be abandoned. These churches include the conversion of the former Nabataean 'Urn Tomb' into a church in 446 AD, the construction of the 'Ridge Church' and 'Blue Chapel' during the 5th – 6th centuries AD as well as the large 'Petra Church' (Church of the Virgin Mary) in the late 5th century AD.[2126] Simultaneously, Anastasius and Justin I declared Petra as a place of exile for opposing ecclesiastics and criminals in the late 5th/early 6th century AD. Petra was thus either considered a loyal and safe city of the Byzantine Empire or, contrarily, so far out of reach that it was no longer of interest to Constantinople.[2127]

In Petra's hinterland, churches were constructed at Udruh (Augustopolis) during the early 4th century AD and, although not yet confirmed by archaeological excavation, at other major towns such as Saddaqa as well.[2128] Udruh is known as an episcopal seat at least since the mid-5th century as a certain Bishop John of Augustopolis participated at the Council of Ephesus in 431 AD. Another bishop from Udruh was part of the Council of Jerusalem in 536 AD.[2129]

It is also hypothesized that the Byzantine settlement of Pentakomia could be associated with Basta, although no churches are known there so far.[2130] A church was constructed at Beidha as well.[2131] The only other religious structure in Petra's hinterland where survey material indicates a use during the Byzantine period is Ras Hamra. Surface pottery supposedly dates as late as the 6th century AD.[2132] However, as the site underwent substantial structural changes, it remains unknown whether Ras Hamra still served religious functions during these later periods.

The construction of churches attest to the spread of Christianity throughout Petra's surroundings, but they were arguably only of local importance and certainly did not carry any supraregional religious significance such as the monastery on Jabal Harun. It was constructed in the late 5th century AD following only occasional occupation of the mountaintop after the presumed destruction of the Nabataean sanctuary during the earthquake in 363 AD.[2133] While the Synod of Jerusalem (536 AD) attests to a prior Johannes of a monastery of Theodorus at Petra (location yet unknown), the monastic complex on Jabal Harun was undoubtedly the most important religious structure outside Petra during the Byzantine period. Already in the 4th century AD, Eusebius attests to the mountain's significance as a place of pilgrimage.[2134] While Petra itself remained the major religious focus point in the region during the Roman and Byzantine periods, Jabal Harun's significance as a pilgrimage center is further attested by Greek commemorative inscriptions documented along the *Darb an-Nabi Harun*.

There are only few and vague references to funerary structures in Petra's hinterland that potentially date to the Byzantine period. These include the cemetery at Bir Madkhur and the three 'monumental' tombs documented by ShamAyl along the eastern high plateau where surface material suggests a very coarse date from the 1st century BC to the 7th century AD.[2135] Although the limited archaeological information provided for these tombs does not allow to determine their exact nature, it is possible that they are monumental *hypogea*. Sachet's excavation of shaft tombs near the Snake Monument in Petra's southwestern outskirts revealed 4th century AD material as well.[2136]

Discovered during excavations of the Petra Church, the Petra Papyri (dating between c. 537–592 and 593 AD) provide further information on the social structure and administration of the Petraean hinterland in Byzantine times.[2137] As the papyri do not mention a Petraean city council (*boulé*), governmental

2123 Fiema 2015, 364–365; Fiema et al. 2015, 389: Epiph. Panar. 2, 51, 22, 11 and Sozom. Hist. eccl.7, 15.
2124 Cf. Erickson-Gini – Tuttle 2017, 280–281.
2125 Cf. Fiema 2015, 366–367 for an overview of Petraean bishops and monks.
2126 Fiema 2015, 374.
2127 Cf. Fiema 2015, 365.
2128 Abudanh 2006, 425–426; Fiema 2002a, 209–212; Graf 1995a, 250; Killick 1986b.
2129 Erickson-Gini – Tuttle 2017, 282–283 and 2015, 370.
2130 Graf 1995a, 251.
2131 Bikai et al. 2008, 466.
2132 Parcak – Tuttle 2016, 42; Hübner 2002, 173.
2133 Fiema 2012b, 31.
2134 Euseb. On. 176, 7.
2135 MacDonald et al. 2016, 227, 249, 261; Perry 2007, 88–89.
2136 Sachet 2009, 100. There are also Christian tomb stones marked by simple crosses without inscriptions (Fiema 2015, 374).
2137 Cf. e.g. Fiema 2012c, 310. Generally on the Petra Papyri, see e.g. Koenen 2003 and Frösén et al. 2002.

responsibilities were most likely bestowed mainly on local elites, the bishop (or generally the clergy), estate owners as well as previous members of the former city council (*politeuomenoi*) and their descendants. These influential families were responsible for tax collection for both the city and the imperial government. Udruh and Saddaqa are reported to be within the jurisdiction of Petra as the administrative center of the region.[2138] Further administrative posts mentioned in the papyri include an *exactor* (a senior official, in charge of tax matters within the city and responsible for the property and tax register), *hypodektai* (tax collectors and officials responsible for the amount of individual tax payments), an *epitropos* (possibly an official or manager of rural property) as well as a *defensor civitatis* and a *comes magnificus sacri consistorii*.[2139] Legal matters were often resolved by respected clergymen or private individuals and were mostly confirmed by sacred oaths taken in Petra's churches.

While the Petra Papyri highlight mainly singular aspects of urban life from the perspective of landholding elite families, they nevertheless suggest that Petra and its hinterland was still administered by local governmental officials until the end of the 6th century AD. They also attest to the ethnical and lingual spectrum of the Petra region during the Byzantine period. As the individuals mentioned in the Petra Papyri have Greek and Roman, typical Christian as well as Nabataean names such as "Dusarios" or "Obodianos," it is apparent that 400 years after the Roman annexation of Nabataea, old Nabataean customs and traditions survived.[2140] While Greek names are often used equally next to local Arabic names, others often used titles such as "Flavius" or "Ulpius" as status symbols, thus undoubtedly referring to the region's Roman past. Many toponyms are also referred to by their Semitic (mainly Arabic) names while individual estates are listed in Greek. This indicates that the population of the Petra region spoke or at least understood a pre-Islamic, early Arabic dialect while Greek substituted the Nabataean-Aramaic script as the official language.

The Military Disposition

Corresponding to the gradual decrease of military sites from the 3rd century AD onwards, the GIS-based cumulative visibility analyses have shown that the Petra region grew increasingly less visually controlled in later periods. Only areas immediately north of Ayl as well as around Udruh and Saddaqa showed a high number of cumulative visibility fields during the 4th century AD. This may be related to the construction of the Late Roman fort at Saddaqa and the fortress at Udruh. The continuing decrease of military sites during the 5th to 7th centuries AD clearly results in a far less visually controlled Petraean hinterland (cf. FIGS. 373–375). This can be particularly observed for areas west of Petra. In the 7th century AD, the number of military sites *not* within the cumulative visibility fields (i. e. cumulative viewshed values of 0) is higher than those within the visibility fields for the first time. While this again reflects the overall decreasing number of military sites, it also suggests that visual communication between military sites became less important in the 7th century AD.

Despite the fact that the Petraean hinterland grew increasingly less visually controlled by fewer military sites from the 3rd century AD onwards, the region experienced a structural 'upgrade' with the construction of the Late Roman fort at Bir Madkhur and the *castrum* at Udruh in the 4th century AD. Similar developments can be observed elsewhere in Arabia during the Tetrachic period as well.[2141] Major garrisons were reportedly stationed in al-Hamman (ancient Admatha), 'Ain Gharandal (Arieldela), possibly Khirbet Ruwath (Robatha), Saddaqa and Humeima during the 4th century.[2142] The Petra area was thus under good military control. In addition to the economic crisis and political turmoil of the 3rd century AD, this development is certainly a reflection of the increasing military threats in the Near East posed by the Sassanids and Palmyrenes in the mid-3rd century AD. The history of the new province *Palestina Salutaris/Tertia* is also characterized by heightened activities of nomadic tribes who were considered as external and internal military threats, but as valuable military allies as well.[2143]

In order to meet these new threats, the general military disposition grew increasingly localized and heavily reliant on smaller, mobile troops as evidenced by the *Notitia Dignitatum* that lists largely cavalry units.[2144] From the 5th century AD onwards, literary evidence suggests the increased deployment of *limitanei* or mobile *comitatenses* responsible for policing and patrolling the frontier zones.[2145] These troops could have

2138 Cf. e. g. Kouki 2012, 17.
2139 Fiema 2015, 372.
2140 Cf. Fiema 2015, 372–373.
2141 Cf. e. g. Kennedy 2006; 1996.
2142 Fiema 2002b, 131.
2143 The level of threat posed by the nomadic tribes, commonly referred to as 'Saracens,' is still heavily disputed. See e. g. Brüggemann 2007; Lewin 1996; Macdonald 1993; Graf 1989; Parker 1986.
2144 Kennedy 2004, 41–42; Graf 1989; Parker 1986.
2145 Evidenced by Just. Nov. 102 and 103 from 536 AD (cf. Fiema 2007, 314).

been aided by local Arab *foederati* now forming an important part of the Late Roman/Byzantine army.[2146] For example, a possible military alliance with locals in the Petraean hinterland is recorded by a 4th – 5th century AD inscription near Ras Slaysil along Naqb Namala. It mentions a local *ex-magister hopliton* who most likely served as a leader of a local militia monitoring activities along Naqb Namala.[2147] The decrease of smaller military structures such as fortlets/road stations in the 4th century AD can therefore not necessarily be seen as a gradual military weakening of the Petraean hinterland. Instead, such abandonments "[…] *may represent a new policy of minimizing the investment in the areas of less importance to the empire, and are also related to changes in tactics*."[2148] While cavalry units of the *limitanei*-type were apparently stationed at larger military structures at intersections of important roads (such as the forts at Saddaqa and perhaps Bir Madkhur), larger rural areas of Petra's hinterland may have been mostly monitored by mobile groups or possible local *foederati* who presumably had extensive experience in policing remote rural areas.

The purely military nature of Late Roman military structures in Petra's hinterland should generally be reconsidered. For example, the *legio VI Ferrata* was most likely stationed at Udruh for c. 20 years only and the site then quickly regained its civilian status. It is questionable whether Udruh was of great military significance for long. It is also uncertain whether the Late Roman fort at Saddaqa should be regarded as a purely defensive structure as well. The Late Roman Greek graffiti in the Wadi Haggag in Sinai mention troops stationed at the *κάστρον* of Saddaqa, but by the 6th century AD the term *κάστρον* designated a fortified *settlement*, and the term *polis* and *κάστρον* were used interchangeably.[2149] Although the Petra Papyri state that a regular military unit was still stationed at Saddaqa in the late 6th century AD, it is unknown whether this was the same cavalry unit listed in the *Notitia Dignitatum*. The mentioned unit included non-commissioned officers (*prior* and *ordinarius*) and consisted of regular soldiers and local recruits serving their hometown and who owned property there.[2150] At some point between the 4th and 6th century AD, the *castrum* at Saddaqa is thus perhaps better characterized as a fortified civilian settlement as can be assumed for Udruh already since the second quarter of the 4th century AD. This renders any assumption of severe security problems that would require large numbers of troops doubtful. The construction of the Late Roman fort at Saddaqa and the fortress at Udruh can rather be considered as a reaction to the general eastern shift and concentration of civilian settlements along roads on the eastern high plateau.

Instead of concentrating on large fortifications, the Petraean hinterland arguably relied more on small mobile troops such as possible Arab *foederati* to provide security during the 5th and particularly the 6th century AD.[2151] As literary sources suggest, the greatest security threat to rural areas were not external armies, but mostly small-scale, local disturbances and banditry.[2152] Political alliances with large Arab tribal confederations such as with the Ghassanids in the 6th century AD became increasingly important. One example is Justinian's grant of a *phylarchy* over *Palestina* to the Ghassanid leader Abu Karib (Abochorabos) in 529 AD, which included the Petra area.[2153] Justinian also dismissed the *limitanei* as border troops and payed the Ghassanid *phylarch* to secure the frontier areas instead. However, the *phylarch* remained under the command of the provincial *dux* until the Islamic conquest.[2154] Although the literary sources do not directly mention Arab *foederati* in the Petra area, the Petra Paypri (probably dated to 544 AD) describe the Ghassanid *phylarch* Abu Karib as a mediator of a civil dispute over property rights at *Zadacathon* (Saddaqa).[2155] The *phylarch* was seemingly of good repute and respected in the area, as he understood local customs and traditions. He thus served the Byzantine Empire as an important diplomatic asset for solving local conflicts and preventing possible disturbances. Although the phylarchy was already dissolved by 581 AD, the employment of local Arab leaders in charge of *foederati* arguably remained a key aspect for subduing small-scale disturbances and banditry in the study area, as these were the main security concerns in the Late Byzantine period before the Islamic conquest of the East in the early 7th century AD.[2156]

2146 Fiema 1995, 267; Fiema 2002a, 213; 2002b, 132; Graf 1989; Isaac 1984; Shahid 1984; Bowersock 1983, 184–185.
2147 Fiema 2002a, 195; Zayadine 1992, 218–22.
2148 Fiema 1995, 267.
2149 Fiema 2002a, 211; 2007, 316.
2150 Fiema 2015, 362 and 2007, 317. Similar units are presumed at Kastron Ammatha (al-Hamman) as well.
2151 Cf. e. g. Fiema 2015, 362.
2152 Cf. Graf 1989 and Isaac 1984, 193–198.
2153 Erickson-Gini – Tuttle 2017, 282 and 2015, 363; Procop. Pers. 1, 19, 8–13.
2154 Fiema 2015, 363; 2002b, 132–133 and 1996, 314.
2155 Fiema 2002b, 133–134 and 1996, 316.
2156 Cf. Fiema 2007, 317.

Chapter 10
Conclusion

This landscape archaeological characterization of the Petraean hinterland provides an extensive assessment of *Terra Petraea* through time, researching overall strategies of spatial organization in Petra's rural environs. While the main chronological focus is clearly set on the Nabataean (1^{st} centuries BC and AD) and Roman periods (2^{nd} and 3^{rd} centuries AD), this study discussed the Petraean hinterland from a wide-ranging diachronic perspective. As a chronological 'preview,' the scope of this study already began in the Iron Age periods (12^{th} – 5^{th} centuries BC). The Hellenistic period (4^{th} – 2^{nd} centuries BC) was also assessed. As a chronological 'outlook,' the Byzantine period was evaluated as well.

The main archaeological dataset was derived from 14 different surveys conducted in the Petraean hinterland following varying intensities and different methodologies. The over 1700 archaeological sites recorded by these surveys within the study area, which was defined as a 20 km radius around Petra, was critically reevaluated and fitted into a coherent site classification system. In order to conduct a valid diachronic investigation of the archaeological sites, the varying definitions of chronological periods and other chronological uncertainties inherent to the original survey data was corrected by means of complex statistical calculation (chapter 2).

On this basis, it was possible to critically assess a wide array of archaeological site types recorded in the Petraean hinterland. These include rural settlements, agricultural installations, water structures, road and route related sites as well as the communication network itself, funerary and religious structures, military and industrial sites as well as 'other structures and/or features' that could not be fitted into any superordinate archaeological categories.

In addition to providing a detailed presentation of the archaeological evidence, the different site types were further analyzed by means of state-of-the-art landscape archaeological methodologies including the spatial statistical method of point pattern analysis, GIS-based analyses such as the calculation of least-cost paths and site-catchments, as well as visibility analyses.

While the methodological chapter 2 may seem somewhat lengthy, it was important to make the various advantages and pitfalls of the applied landscape archaeological approach transparent. Defined as the study of past cultural landscape changes based on the material remains of past cultures, landscape archaeology offers a unique set of methodologies to further research various aspects on the relationship between the natural environment and cultural landscapes. However, the different multi- and interdisciplinary approaches followed within landscape archaeology often carry particular risks. These are only rarely discussed in landscape archaeological studies. On the one hand, some landscape archaeological approaches focus too strongly on the development and application of the different analytical methods. This 'methodological trap' often leads to the neglect of more in-depth archaeological and culture-historical discussions. Other studies simply follow the 'push-the-button principle' without critically assessing (or understanding) the methodological shortcomings of the applied analyses. It was therefore crucial to critically discuss the technical particularities of the landscape archaeological methods applied in this study at length, and to reveal their inherent strengths, weaknesses and methodological premises. Only by acknowledging these advantages and pitfalls is it possible to fully assess the value of landscape archaeological analyses, which should be regarded as nothing else than useful additional methodological toolsets for farther-reaching archaeological and culture-historical discussions. With this in mind, it was possible to gain new insights into the subsistence strategies and communication network, the socio-cultural history as well as the military disposition of *Terra Petraea* from the Iron Age to the Byzantine periods.

In terms of Iron Age subsistence strategies, the rural agricultural settlement pattern of the Petra region during the 12^{th} and 11^{th} centuries BC is characterized by comparatively few settlements in areas with high rainfall and good soil properties for agricultural cultivation. This suggests that limited agricultural cultivation was practiced as early as the 12^{th} century BC. The few agricultural installations and possible pastoralists' camp sites and corrals corroborate this. During the Iron Age periods, the population of the Petraean hinterland therefore most likely followed pastoral subsistence strategies. Agricultural practices were carried out on a small and local scale only. There are no indications for run-off cultivation and the water management system was largely based on the collection of water in cisterns.

While an overall increase of rural settlements was observed from the 10th century BC onwards, all settlements were abandoned by the 5th century BC (with only singular exceptions). This is most likely associated with the collapse of the Edomite kingdom.

Industrial activities were only small-scale and limited to the exploitation of the copper mines of Umm al-'Amad in the Early Iron Age (12th – 9th century BC). These copper mining activities were not extensive and therefore no competition to the much larger contemporary mines at Timnah or Faynan.

The domestication of the dromedary in the late 2nd millennium BC offered new trade-related economic opportunities. In the Petra area, the *Darb ar-Rasif* ('King's Highway') was undoubtedly the major economic artery of the Edomite kingdom as it gave access to transregional caravan trade with South Arabia and Mesopotamia. Additionally, the 'Incense Road' connected the Petra region with Mediterranean trade as early as the Iron Age.

The military disposition during the Early Iron Age was limited to a small number of military structures. Although a slight increase was observed during the 10th – 6th centuries BC, all military structures were abandoned by the 5th century BC. The GIS-based visibility analyses have shown that the Petraean hinterland was only under very little visual control by military structures.

Additionally, this study reinterpreted several structures that previous scholars identified as simple 'watchtowers.' They are situated on dominant hilltops along important roads on the eastern high plateau, but are much larger and structurally more complex than the other structures discussed as watchtowers. This suggests a clear defensive character. It was therefore tentatively proposed to refer to these structures as Iron Age 'hilltop refuges.' While further research is required, they may be considered as possible pre-Nabataean military structures.

After the dramatic abandonment of all rural settlements in the 5th century BC, there is a slight increase of rural agricultural settlements during the Hellenistic period. However, as only singular sites are recorded for the 4th – 2nd centuries BC, the Petraean hinterland is still largely void of rural settlements. This clearly reflects the political vacuum and overall instability of the Petra area after the collapse of the Edomite kingdom. As there is no meaningful evidence for agricultural activities, the rural population most likely relied mainly on pastoral subsistence strategies. This confirms the accounts of historical sources that describe the nomadic lifestyle of the early Nabataeans. However, as early Aramaic *ostraca* (4th – 3rd century BC) from Palestine and Idumaea document the involvement of regional Arabs in trade activities with agricultural goods, Petra's rural population may have been more engaged in agricultural practices than previously assumed for the Hellenistic period. While the few recorded settlements are tentative archaeological indications that limited agriculture was practiced, the overall absence of sites still suggests a large-scale abandonment of agricultural subsistence strategies. This indicates that the early Nabataeans followed a largely pastoral nomadic lifestyle. Dating as early as the late 2nd century BC, the tribal sanctuary of the 'Obodas Chapel' attests to the strong tribal-based social structure of the Petra region during the Hellenistic period. This reflects the nomadic background of the early Nabataeans as well.

Although there is no evidence to suggest that the highly developed road and route system of the Petra area was established before the 1st century BC, the early Nabataeans were undoubtedly involved in long-distance trade during the Hellenistic period. This is clearly indicated by Hellenistic ceramic assemblages and numismatic evidence recently excavated in Petra as well as additional evidence from Moyat 'Awad and Horvat Ma' agurah along the Petra-Gaza road. As small domestic structures were uncovered in Petra, gradual settlement activities most likely began in the Hellenistic period as well. The few Hellenistic sites in Petra's hinterland may support this.

There is only one possible military site in the Petraean hinterland that possibly dates to the 4th – 2nd centuries BC. There is thus no information on the military disposition of the Petraean hinterland for the Hellenistic period.

The 1st century BC is characterized by an explosive increase of all rural settlement types. This is clearly associated with the Nabataean sedentarization process and increasing need for agricultural goods to meet the demands of Petra's rising urban population as well as heightened trade activities along the long-distance caravan routes. This development continued in the 1st century AD and culminated in the 2nd century AD. The rapid expansion of rural agricultural settlements is thus a direct reflection of the economic and political peak of the Nabataean realm during the 1st century AD.

Nabataean rural settlements concentrate mainly along the Jabal Shara escarpment and eastern high plateau. These areas receive the highest rainfall rates and thus offer the best environmental conditions for crop cultivation. P. Kouki's three-tiered settlement hierarchy, characterized mainly by small sites (single farms), followed by a smaller number of medium-sized sites and only singular large sites, is fully supported by the findings of this study. However, the additional archaeological data evaluated here clearly suggests that the observed settlement hierarchy already developed during the 1st century BC – thus one century earlier than previously assumed.

As major Nabataean settlements (e. g. Sabra, Abu Khusheiba, Udruh or Saddaqa) did not attract large concentrations of rural sites, their development is best explained by their location along important trade routes. They most likely functioned as transshipment centers for trade goods and were administered by members of the local elite. However, the economic and agricultural backbone of the Petra area during the Nabataean period was clearly formed by smaller settlements. The point pattern analyses have further shown that the mean center of the rural settlement distribution during the 1st century BC was Wadi Musa. This highlights the often underestimated importance of the town, which remained the mean center of rural settlements until the 3rd century AD. Petra itself was never the focus of its surrounding settlement pattern. This is most probably due to the advantageous position of Wadi Musa along the Darb ar-Rasif and later the *via nova Traiana*. Wadi Musa was arguably the most important trade-related transshipment center east of Petra.

Agricultural installations offer additional archaeological evidence that rural Petra's economy was mainly based on agriculture. Clear clusters of agricultural terraces and barrages were identified in the extended Jabal Harun and Beidha areas as well as in the ad-Thankia region north of Baja where run-off cultivation was practiced. The distribution of agricultural processing installations and terraces/barrages furthermore allowed the rough mapping of different cultivation zones for the Petraean hinterland. While the eastern high plateau was mainly used for cereal cultivation, olives were most likely cultivated along the western slopes of the Jabal Shara escarpment. These were probably grown mainly for local use and/or as components of processed products. The extended ad-Thankia and Beidha areas were predominantly used for viticulture. The Jabal Harun area was mainly used for cereal production by means of run-off cultivation. Archaeobotanical evidence from the luxurious suburban mansion of ez-Zantur and the Jabal Harun area confirm these cultivation practices. The shift to a more agriculture-based society in the Nabataean period is further corroborated by the fact that technologically highly developed aqueducts supplied not only Petra, but also other rural Nabataean sites such as Qasr Umm Rattam, Sabra and as-Sadeh with fresh water. High-quality drinking water was directly tapped from the numerous springs distributed along the Jabal Shara escarpment. This highly advanced water management system in urban and rural Petra not only attests to Nabataean hydrological engineering skills, but also to a largely sedentary, agriculture-based rural society.

In addition to clear archaeological evidence that agriculture formed the primary economic basis of the study area, a significant number of archaeological sites were identified that may be interpreted as material evidence for alternative pastoral subsistence strategies practiced in the Petraean hinterland in addition to farming. These camp sites and corrals clearly indicate that a pastorally organized rural population constituted a significant part of the Petraean hinterland through all discussed periods. This does not only have major economic implications, but it is also socially significant as no clear division between a strictly sedentary and non-sedentary population can be established.

The Khatt Shebib wall was most likely a demarcation line between a more settled community to the west and predominantly pastoral nomadic peoples in the vast desert areas east of Udruh. The Khatt Shebib served to regulate and monitor activities of these peoples and the 6 km long opening of the wall in the Udruh area was interpreted to have directed their movement to specific meeting areas to trade livestock with agricultural and other commercial goods produced in the more settled areas in the west. Two large stone circles (both c. 400 m in diameter) were situated at both ends of the Khatt Shebib's opening near Udruh and Khirbet Jarba. Arguably, this was not coincidental. They were tentatively considered as possible 'open market areas' where livestock and agricultural goods could have been exchanged between communities west of the Khatt Shebib and people living east of the wall. If so, this would indicate a mutually beneficial relationship between sedentaries and non-sedentaries in the Petraean hinterland through time. The fact that there is no spatial separation between rural settlements and pastoral camp sites or other archaeological sites pertaining to a more mobile, pastoral lifestyle in the study area further supports this conclusion.

Small-scale industries flourished in the Petraean hinterland during the Nabataean period. The ceramic workshop at az-Zurraba in Wadi Musa is well known and an additional Nabataean pottery workshop was excavated at Udruh. Another workshop may possibly be located at Khirbet al-Fiqai. Whether these workshops produced commodities for local needs only or contributed to regional trade as well, cannot be determined. The copper mines of the Umm al-'Amad area continued to be exploited during the Nabataean period as well. This indicates that the Nabataeans attempted to fully exploit the region's economic opportunities.

This study has provided an exhaustive account on the road and route network of the Petraean hinterland. This particularly concerns the various *naqb* connecting Petra with its extended hinterland to the west. It was shown that routes for larger camel caravans avoided steep slopes and circumvented difficult volcanic formations where possible, as it cuts the camel's soft feet. Some of these routes were further stabilized by curbstones and avoided wadi bottoms as they often flooded during rainfall. Such camel routes were classified as *Class A routes*. Other routes crossed more difficult terrain and passed through volcanic formations more frequently. These routes allowed only pedestrian, donkey and/or mule travel. These were defined as *Class B routes*.

The different environmental characteristics of Class A and B routes affected the mode of travel and the selection of the appropriate beast of burden (if any). Environmental constraints therefore greatly impacted the infrastructural development of Petra's western hinterland and the overall organization of caravan trade in the region.

The qualitative and quantitative assessment of routes intersecting at specific route stations furthermore highlighted particular infrastructural hubs. Khirbet as-Faysif was the primary destination in the Wadi Arabah along the main course of the Petra–Gaza road via the Class A routes of Naqb ar-Ruba'i and Wadi Jawf Ahmar.

The site of Qasr Umm Rattam served as a control and/or resting post along the Wadi Musa, an important camel route leading from the Arabah up to the central plateau with good access to the Petra valley.

East from Qasr Umm Rattam, the site of Dawrum Dey was identified as a major transfer point for animals and goods. While there are no structural features that could have accommodated caravans apart from the availability of water, the site lies at the intersection of three Class A routes and two Class B routes.

The infrastructural importance of Sabra was further attested by showing that four Class A routes not only connected the site with the Jabal Harun area (and by extension with Petra), but with the major roads in the Arabah. Sabra's infrastructural connectivity predestined the site for major trade activities. With good access to Sabra and major roads in the Wadi Arabah, Abu Khusheiba is also similarly well connected.

In addition to the detailed analysis of Petra's western communication network, the region's eastern access routes were discussed as well. As the major communication line for caravans coming from South Arabia is from the southeast continuing northward from ancient Hawara (Humeima) via the Darb ar-Rasif and later the *via nova Traiana*, caravans undoubtedly passed Wadi Musa. This further highlights the site's infrastructural and economic importance. While previous research identified Beidha as a major caravan stop, the natural landscape conditions of Naqb Namala did not favor large-scale caravan traffic from the north, the main direction from where Beidha could be reached. While only small-scale caravan traffic reached Beidha from the north, major caravans from the southeast had to halt at Wadi Musa first. Although the wide and flat plains of the Beidha area offered better watering opportunities and pasturage for larger groups of animals, caravans most likely unloaded their goods at Wadi Musa before continuing to Petra and subsequently Beidha where both animals and caravan drivers found adequate space and infrastructure to rest.

As there are no historical records on the management and logistical organization of ancient caravan trade in the Petra region, modern ethnographical studies were consulted to gain further insights on possible practical details of regional caravan trade. Modern examples have shown that a general caravan leader with good knowledge of the regional landscape was responsible for the success or failure of the journey. It can only be assumed that a similar leader well acquainted with Petra's difficult terrain led caravans in antiquity as well. Assyrian sources mention that caravans traveled in smaller groups with riders conveying messages between them, thus emphasizing the well-structured organization of ancient caravan travel. As the difficult landscape conditions prevented a meaningful management of large caravan groups, it is possible that only smaller groups travelled along Class B routes in the Petra area. Similar messengers could have aided the caravans in the Petra area as well.

Road/route stations were positioned no more than 10 km apart. Larger route stations or caravanserais are not known in the Petra area. However, if only smaller caravan groups traveled along the routes successively, large-scale structural accommodations were not required.

The funerary landscape of the Petraean hinterland was also discussed. Various funerary structures, including Nabataean façade and shaft tombs, rock-cut pit graves, cemeteries, burial cairns as well as monumental *hypogea* were identified. Natural landscape features undoubtedly impacted the location and nature of rural Petra's funerary monuments and many are situated near routes. This offered additional visibility and exposure to by-passers.

Particularly funerary monuments on prominent landmarks (e.g. ridges, ledges or slopes) with good visibility over their immediate surroundings may have demarcated specific territories or districts. Such monuments include the monumental *hypogea*, isolated burial cairns and façade tombs. The *hypogea* and façade tombs probably marked the burial places of wealthy families, clans or tribes. Although speculative, the tomb owners may have belonged to the Nabataean rural elite who might have held specific lands as their burials were surrounded by agricultural fields and other agricultural installations.

Isolated burial cairns located along routes and placed on hilltops or prominent ridges with good visibility across the landscape may indicate persisting tribal traditions in the Petra region. Burial cairns and other funerary monuments were defined by the Foucauldian term *heterotopia* as they were specific places reserved only for distinct social groups. Particularly Nabataean tomb complexes incorporate ritual banqueting installations for regular gatherings. This highlights the distinct Nabataean social structure of the Petra region that was deeply rooted in tribal traditions.

Rural religious structures (sanctuaries and isolated cultic installations) date to the 1st century BC and are contemporary with those of urban Petra. The Petraean hinterland was also a sacred landscape that probably attracted local and regional tribes. This underlines not only urban Petra's increasing supraregional religious significance, but that of its hinterland as well.

Sanctuaries accessible to a larger public are situated along Class A and B routes. More 'private' sanctuaries (e.g. the Obodas Chapel or the Isis sanctuary in the Wadi as-Siyyagh) are not as easily accessible. Good accessibility to 'public' religious structures along Class A routes was a key aspect in the Petraean hinterland as they were probably visited during religious pilgrimages.

Specific funerary monuments and religious structures with evidence for ritual gatherings (e.g. cultic fraternal societies) were also considered as Nabataean *heterotopiai*. In addition to their cultic significance, heterotopical funerary and religious structures were important *social* gatherings where Nabataen tribes, families or other social groups regularly convened. The specific social significance of heterotopical funerary and religious structures mirrors the fundamental family- or tribal-based social structure of Nabataean Petra and its hinterland.

Rural sanctuaries vary in their architectural design. This may reflect varying local traditions that do not follow any predefined architectural norms. As they are situated on easily accessible hilltops and overlook their immediate landscapes, they may have demarcated specific territories.

Larger Nabataean sanctuaries such as Jabal Harun may have been involved in economic activities, particularly in the production of agricultural goods, therefore acting as landowners. As major Nabataean settlements such as Wadi Musa, Sabra, Abu Khusheiba and as-Sadeh had their own temples, these sites may have been inhabited by distinct social groups. Together with the heterotopical funerary structures, specific religious structures reflect a highly diverse, possibly tribal-based, social structure of Petra's rural surroundings. Consequently, Nabataean rural mansions in the Petraean hinterland may have demarcated specific 'districts' of particular social groups as well.

Similar to urban Petra, where different social groups were identified that collectively commemorated a specific deity within spatially defined districts, it is likely that the Petraean hinterland was spatially divided into socially distinct territories as well.

As the majority of the identified groups in Petra were associated with ritual banqueting installations, these distinct social spaces can be considered as further examples of Nabataean *heterotopiai*. This supports the hypothesis that rural Nabataean *heterotopiai* and other sites in the Petraean hinterland demarcated particular social landscapes. Such structures include specific religious structures and funerary monuments, significant settlements as well as rural mansions. The complex social structure of Petra's hinterland is therefore best characterized as an intricate patchwork of different social groups.

This study also gained insights into the military disposition of the Petraean hinterland. This is mainly the result of a critical structural and locational re-assessment of the recorded military structures and setting them in their spatial and archaeological context. This approach thus avoided the 'interpretative trap' of employing undifferentiated military terminologies for describing archaeological sites although the evidence was often problematic and ambiguous. Despite these efforts to correct these shortcomings and to provide as much archaeological and historical context as possible, systematic and comprehensive archaeological research of the discussed military sites is still required.

It nevertheless became apparent that a clear differentiation in terms of site size is possible. This corresponds to the various functions of the discussed military structures, and not their chronology. In addition to the Late Roman fortress at Udruh, this study has identified large forts (structures greater than 0,4 ha), medium-sized forts (structures between 0,4 and 0,2 ha) and small forts (structures between 0,2 and 0,1 ha). Although pre-Roman forts vary in their structural layout depending on their environmental settings, the majority were described as rectangular structures with internal divisions and a single tower enclosed by exterior walls. However, without a more detailed archaeological assessment, it remains elusive whether these structures represent a local type of military architecture.

Securely assigning a military function for structures measuring 0,1 ha or smaller is difficult. Such 'fortlets and/or road stations' are predominantly located on hilltops or slopes in close vicinity to roads. They are further characterized by thick exterior walls with possible internal divisions and courtyard or forecourt areas.

The most common type of military sites in the Petraean hinterland are isolated rectangular or square structures smaller than c. 90 m² positioned on hilltops or slopes. These were identified as possible watchtowers.

The majority of all military sites were constructed in the 1st centuries BC and AD. They are mostly associated with the road network, civilian settlements and water sources. GIS-based visibility analyses have highlighted a 'visual hierarchy' of military sites: Visual control from forts encompasses comparatively small areas, and mostly include civilian settlements as well as the road network. Forts are not intervisible. The same was observed for fortlets, although their visual range is slightly more extensive than that of forts. The identified watchtowers exert the most comprehensive visual control over the Petraean hinterland. The cumulative visibility analyses revealed an intervisible network of watchtowers during the Nabatean period (particularly the 1st century AD). The watchtowers enabled visual communication with larger military structures and were therefore the key element for Nabataean surveillance strategies in the Petraean hinterland. It was also proposed to consider that Nabataean σκοποί (watchmen) used the *natural* landscape (i.e. natural hilltops etc.) for surveillance purposes in times of need.

Previous claims that the Nabataean military did not consist of a large standing army are supported here. Short-term troops were probably levied only in times of war by *strategoi*, the civil and military officials. The Nabataean army generally followed Hellenistic models. Importantly, it was mainly tasked with policing and controlling the Petraean hinterland as the identified military structures are small and provide only a minimum of infrastructure. Similar to other examples from the Hellenistic world, it is likely that these accommodated only smaller and more mobile military units. This supports the argument that the Nabataean military mainly provided for the security of local civilian settlements, protected local water sources and monitored activities along important roads and routes.

The Roman annexation of Nabataea did not affect the settlement pattern of the Petraean hinterland. With the construction of the *via nova Traiana*, the Romans provided a major infrastructural upgrade to the previous communication network along Petra's eastern uplands without abandoning older roads such as the Darb ar-Rasif. The main incentive of its construction was of a commercial and administrative nature and aimed at connecting the Transjordanian plateau with the northern Levant, thus facilitating communication between the eastern provinces. As the various naqb that connected Petra with its western hinterland were still in use, supraregional caravan trade remained the most important economic avenue in the region.

By the 3rd century AD, a significant decrease of rural settlements signaled the beginning economic decline. From the 4th century AD onward, the western peripheries (particularly the major Nabataean settlements of Sabra, Abu Khusheiba and as-Sadeh) were gradually abandoned, while smaller settlements continued to shift farther east. Across the eastern high plateau new, village-sized settlements were founded and older sites reoccupied by the early 5th century AD. This different development of the eastern and western peripheries of the Petraean hinterland indicates that the rural population relocated as early as the 4th century AD. The contemporary growth of large sites in the east suggests both an increase of rural Petra's population and/or nucleation of rural settlements. This stands in contrast to the hierarchical settlement pattern observed for the 1st and 2nd centuries AD. This shift towards settlement nucleation by the late 3rd/early 4th centuries AD can be explained by the decline of long-distance trade during the 3rd century AD and the generally decreasing demand for Arabian trade goods. The 4th century AD is marked by continuing economic decline. This is reflected by the decrease of smaller sites and nucleation of larger settlements. Following the decline of long-distance trade, the need for providing agricultural goods most likely decreased as well. The rural population therefore probably turned to more mobile subsistence strategies in addition to (more limited) farming.

As the agricultural processing installations (particularly wine presses) went out of use during the 3rd century AD as well, viticulture was probably no longer practiced either. The general economic decline of the Late Roman period is further attested by the abandonment of the copper mines at Umm al-'Amad as well as the possible ceramic workshop at Khirbet al-Fiqai during the 4th century AD.

As there is convincing archaeological evidence to suggest a re-use of at least Naqb ar-Ruba'i during the Late Roman and Byzantine period and important sites along the Petra–Gaza road were reoccupied in the early 3rd century AD, caravan trade remained temporarily stable. However, by the end of the 3rd century AD long-distance land travel, particularly along the Petra–Gaza road, was eventually abandoned as well.

The Roman period is also characterized by the abandonment of all Nabataean *heterotopiai* by the 2nd century AD. Arguably, this corresponds directly with the Roman annexation, as the new Roman authorities feared political uprisings could have been fostered by gatherings of indigenous social groups.

However, there are also religious structures that were (possibly) not abandoned after the annexation, most notably the Nabataean sanctuary on Jabal Harun. This was explained with the sanctuary's supraregional significance as well as its unusually high degree of Hellenistic-Roman architectural design. Additionally, assuming that Isis was venerated on Jabal Harun and accepting the argument that the goddess was associated with the former Nabataean dynasty, it is possible that the Roman authorities deliberately allowed cult practices to be continued, however only with replacing the connection to the Nabataean dynasty with that of Roman rule. This falls in line with a larger argument that the Romans claimed major Nabataean religious structures and associated previous connections to Nabataean royalty with the empire. However, the continuity of the sanctuary on Jabal Harun into the Roman period as well as the identification of Isis as the venerated deity (and her association with the Nabataean dynasty) remains disputed.

While all other monumental funerary structures of heterotopical character in Petra and its hinterland were abandoned in the 2nd century AD, the only tombs where surface material suggests a continuous use after the annexation are the monumental *hypogea*. Nabataean *heterotopiai per se* therefore did not pose a threat to the Roman authorities. Possibly, this phenomenon was only limited to a specific class of the Nabataean elite (predominantly in urban Petra as suggested by the end of Nabataean tomb complexes).

The military disposition of the Petraean hinterland remained unchanged during the 2nd century AD. Most previous Nabataean structures were continuously occupied after the Roman annexation and, apart from the temporary fort at Tell Abara, no new military structures were constructed. The same visual hierarchies of military structures observed for the Nabataean period were noted throughout the Roman and Byzantine periods. The military disposition of the Petra area was not affected by the annexation. The military most likely continued to be tasked with policing and monitoring Petra's rural areas and concentrated on surveilling activities at rural civilian settlements, water sources and the road network. The evidence from Petra's hinterland does not suggest large-scale military conflicts that could be associated with the annexation. While the archaeological and historical evidence from urban Petra suggests at least local skirmishes, the evidence from the hinterland does not point to any armed conflict. Instead, it is likely that Roman military units recruited locals because of their knowledge of the regional landscape and their good relations with the rural population.

Despite the gradual decline of military sites from the 3rd century AD onward, the overall military disposition did not change significantly. The evidence only mirrors the economic instability and political turmoil of the Late Roman Empire with the construction of the Late Roman forts at Saddaqa and Bir Madkhur as well as the completion of the legionary fortress at Udruh at the beginning of the 4th century AD. However, the Petra area seems largely unaffected by the events that shook the Late Roman Near East.

Following the overall economic decline of the Late Roman period, landed properties were owned by fewer landholders and ownership was increasingly claimed through inheritance, marriage and land purchase in the Byzantine period. Although most Byzantine settlements remained west of Udruh, the overall eastern shift of settlements culminated in the Byzantine period. This is archaeologically further evidenced by extensive run-off cultivation systems associated with large settlements. The eastern shift of rural settlements can at least partially be explained by new economic opportunities along alternative routes that connected with Syria and the northern Hijaz. There is no reason to assume that Petra's rural population declined during the Late Byzantine period. Instead, agriculture grew increasingly important along the eastern peripheries of the Petraean hinterland. The evidence for continuing olive cultivation and the irrigated orchards as well as *xerokēpia* (dry gardens) mentioned in the Petra Papyri further corroborate this. Grain cultivation only declined as the climate grew increasingly more arid and thus less suitable for cereal cultivation towards the Late Byzantine period. The deteriorating climatic conditions possibly led to the decreasing availability of run-off water, which may have instigated the construction of the Byzantine *qanat* system and the eastern shift of rural settlements towards the Udruh area where ground water was available.

The important socio-religious change in the Byzantine period was the introduction of Christianity. By the early 5th century AD, urban Petra enjoyed major ecclesiastical significance and this elevated status is reflected by the construction of four major churches in the city center from the mid-5th until the 6th century AD. However, other major buildings in the city continued to be abandoned. In the 4th century AD, churches are also constructed at Udruh, Wadi Musa and possibly Saddaqa and Beidha as well. The most important religious structure in the Petraean hinterland during the Byzantine period was undoubtedly the monastic complex of Jabal Harun, built in the late 5th century AD. While urban Petra remained the major religious focus point of the region, Jabal Harun was particularly important as a pilgrimage center.

The Petra Papyri provide further information on the social structure and administration of the Petraean hinterland in Byzantine times. Administrative responsibilities were most likely bestowed on local elites, the church, estate owners as well as previous members of the old city council and their descendants. These officials were responsible for tax collection for both Petra and the imperial government until the end of the 6th century AD. The Petra Papyri also list individuals carrying Greek and Roman, typical Christian as well as Nabataean names indicating that long after the Roman annexation, old Nabataean customs and traditions persisted.

The Byzantine period marks an overall decrease of military sites in the Petra area. The construction of the Late Roman fort at Bir Madkhur as well as the *castrum* at Udruh in the 4th century AD, probably reflects increasing military threats in the Near East from the mid-3rd century AD, including heightened activities of nomadic tribes. These were both external and internal military threats, but served as valuable military allies as well.

The general military disposition grew increasingly localized and relied on smaller, more mobile troops of the *limitanei*-type. These were stationed at larger military structures such as the forts at Saddaqa and perhaps Bir Madkhur. At some point between the 4th and 6th century AD, however, the fort at Saddaqa was probably more a fortified civilian settlement than a purely defensive structure. Similar assumptions can be made for Udruh already in the early 4th century AD.

The *limitanei* were probably aided by local Arabs. Local allies with experience in surveilling remote rural desert areas presumably policed the larger rural areas of Petra's hinterland. There are no indications of severe threats that would have required large numbers of troops. Arguably, the greatest security problem faced by the Late Roman and Byzantine army were primarily small-scale, local disturbances and banditry.

The Byzantine period is also characterized by political alliances with Arab tribal confederations such as the Ghassanids. These alliances grew increasingly important as demonstrated by Justinian's grant of a *phylarchy* over *Palestina* (including the Petra area) to the Ghassanid leader Abu Karib (Abochorabos) in the first quarter of the 6th century AD. The Ghassanid *phylarch* served the Byzantine emperor as an important diplomatic asset for solving local conflicts and preventing possible disturbances. The employment of local Arab leaders as *foedi* probably remained an important strategy for subduing disturbances and banditry in the Petraean hinterland, although the phylarchy was already dissolved in the last quarter of the 6th century AD. There are no indications for major security concerns in the Late Byzantine period before the Islamic conquest in the early 7th century AD.

Appendices

Appendix I

Due to practical reasons, this study's site catalogue is only provided digitally, open-access in tabular form. It is available at https://doi.org/10.5281/zenodo.4892661. The reader will find an Excel file entitled 'Appendix I_Terra Petraea_Site Catalogue.' This file lists all archaeological sites recorded by the various surveys (cf. chapter 2) within the study area. The Excel file has numerous columns with relevant spatial and archaeological information. The column 'Object_ID' is only relevant for sorting the data in a GIS. 'Site_Name' gives the abbreviation of the original survey with original survey numbers. 'Site_Name_Other' gives the local site name, if provided.

These are then followed by coordinate information in a UTM 36N system. The quality of the spatial information ('Localization') is assessed. The term 'precise' states that the coordinate information has an accuracy of c. 3 m or better. The column 'Original_Site_Type' lists the original designation of the relevant site by the original survey. This is then followed by the categorization of each site according to this study's site classification system ('Type of Archaeological Evidence' and 'Type of Archaeological Evidence_Subcategory').

The following columns give the dating values '0,' '0,5' and '1' (cf. chapter 2) of each recorded site by cultural periods as well as on a century basis.[2157]

The dating quality is assessed in the column 'Dating_Quality.' Basic bibliographical references to each site is given in the column 'Literature.' Finally, some comments may be given for individual sites.

Appendix II

Appendix II is a PDF version of the R-script written by the author for conducting the point pattern analyses (cf. chapter 2). As this script is over 360 pages long, it is only provided digitally, open-access at https://doi.org/10.5281/zenodo.4892736.[2158] The file is entitled 'Appendix II_Terra Petraea_Point Pattern Analysis_Rscript.'

Appendix III

Appendix III is a PDF version of an exemplary R-script written by the author for conducting the visibility analyses (cf. chapter 2). The file is only available digitally, open-access at https://doi.org/10.5281/zenodo.4892746. It is entitled 'Appendix III_Terra Petraea_Viewshed_Rscript.'

Appendix IV

Appendix IV is a PDF version of an exemplary R-script written by the author for evaluating the chronological inconsistencies inherent to the original survey data (cf. chapter 2). The file is only available digitally, open-access at https://doi.org/10.5281/zenodo.4892756. It is entitled 'Appendix IV_Terra Petraea_Chronological Inconsistencies_Rscript.'

2157 IA= Iron Age; IA1 = Iron Age 1; IA2= Iron Age 2; IA2a= Iron Age 2a; IA2b = Iron Age 2b; IA2c = Iron Age 2c; H = Hellenistic; N= Nabataean; EN= Early Nabataean; MN= Middle Nabataean; LN = Late Nabataean; R = Roman; ER = Early Roman; MR = Middle Roman; LR = Late Roman; B = Byzantine; EB = Early Byzantine; MB = Middle Byzantine; LB = Late Byzantine. -1200 = 12th century BC, -1100 = 11th century BC, -1000 = 10th century BC, -900 = 9th century BC, -800 = 8th century BC, -700 = 7th century BC, -600 = 6th century BC, -500 = 5th century BC, -400= 4th century BC, -300 = 3rd century BC, -200 = 2nd century BC, -100 = 1st century BC, 100 =1st century AD, 200 = 2nd century AD, 300 = 3rd century AD, 400 = 4th century AD, 500 = 5th century AD, 600 = 6th century AD, 700 = 7th century AD.

2158 The author would like to thank D. Knitter for assisting in writing the script.

Tables

TAB. 1 List of archaeological surveys conducted in the Petra area since A. Musil in chronological order. With relevant abbreviations followed in this study.

Survey	Abbreviation	Date	Total Amount of Sites Surveyed	Selected Literature
Petra and environs (conducted by A. Musil)	-	1896–98, 1900–1902	?	Musil 1907
Petra and environs, Beidha, Udruh, Saddaqa, Ma'an (conducted by R. Brünnow, A. von Domaszewski)	-	1897–98	?	Brünnow – von Domaszewski 1905; Brünnow – von Domaszewski 1904
Petra and environs (conducted by G. Dalman)	.	Early 20th century	?	Dalman 1908 and 1912
Petra urban center, Jabal Harun area (conducted by T. Wiegand and the Deutsch-Türkisches Denkmalschutz-Kommando)	-	1914–1918	?	Bachmann et al. 1921
Petra region (conducted by N. Glueck)	-	1930s	?	Glueck 1934; 1935; 1939; 1945; 1959
Petra region including Sabra, Abu Khusheiba, Umm Rattam, as-Sadeh etc. (conducted by M. Lindner)	-	Since the 1970s	?	Lindner 1987; Lindner 1992a; Lindner 1992b; Lindner – Zeitler 1997; Lindner et al. 2000; Lindner 2003a
Edom Survey (conducted by S Hart)	ES	1984–1985	115	Hart 1987a; Hart – Faulkner 1985
Udruh Region (conducted by A. Killick)	-	1980s	200	Killick 1987; Killick 1983a; Killick 1983b
'Aqaba – Ma'an Survey (conducted by W. J. Jobling)	-	since 1980	?	Jobling 1985; 1984; 1983 and 1982
Beidha Ethnoarchaeological Survey (E. B. Banning and Ilse Köhler-Rollefson)	BS	1983	63	Banning – Köhler-Rollefson 1983; Ullah 2003
Hisma, Ras an-Naqb, 'Aqaba (conducted by D. Graf)	-	1978	?	Graf 1979
Via nova Traiana between Petra and 'Aqaba (conducted by David Graf)	-	1986–89	?	Graf 1995a
Southeast Araba Archaeological Survey (conducted by A. M. Smith II)	SAAS	1994, 1996, 1998	330	Smith 2010; Smith 2007; Smith 2005; Smith 1997
Dana Archaeological Survey (conducted G. M. Findlater)	DAS	1994–1996	400	Findlater 2003
Jabal Shara Survey (JSS) (conducted by L.Tholbecq)	JSS	1996–97	160	Tholbecq 2013a; Tholbecq 2001
Archaeological Survey of the Wadi Musa Water Supply and Wastewater Project (conducted by K. 'Amr et al.)	WMWS	1996, 1998–2000	132	'Amr – al-Momani 2001; 'Amr et al. 1998
Bir Madkhur Project (conducted by A. M. Smith II)	BMP	since 1997	25	Smith 2018; Ramsay – Smith 2013; Smith 2010; Smith 2007
Udruh Region (conducted by F. Abudanh)	Abudanh Survey	2003–2004	336	Abudanh 2006
Finnish Jabal Harun Project (conducted by J. Frösén/M. Lavento)	FJHP	1998–2005	189 (Intensive Area = FJHP Site No. Sxxx); 172 (Extended Area = FJHP Site No. Extxxx)	Kouki – Lavento 2013
Ayl to Ras an-Naqab Archaeological Survey (conducted by B. MacDonald)	ARNAS	2005–2007	389	MacDonald et al. 2012
Showbak-Dana L2HE Survey (conducted by N. G. Smith)	L2HE	2009	48	Smith 2009
Shammakh to Ayl Archaeological Survey (conducted by B. Macdonald)	ShamAyl	2010–2011	366	MacDonald et al. 2016; 2011 and 2010
Udruh Archaeological Project (conducted by M. Driessen and F. Abudanh)	UAP	2011–2014	?	Driessen – Abudanh 2018; 2015 and 2013
Petra Area and Wadi Slaysil Survey (conducted by S. E. Alcock and A. R. Knodell) and Petra Routes Project (conducted by M. Berenfeld and F. Rojas)	PAWS and PRP	2010–2012	1036 'Features'	Knodell et al. 2017; Alcock – Knodell 2012 and Knodell – Alcock 2011; Berenfeld et al. 2016 and Rojas – Berenfeld 2012
Petra Hinterland Tombs Project (conducted by L. Wadeson and F. Abudanh)	PHTP	2012	12	Wadeson – Abudanh 2016
Petra Hinterland Survey Project (conducted by W. M. Kennedy and S. G. Schmid)	PHSP	2016	165	Present study

TAB. 2 Categorization of the original data into different survey classes A–C.

Survey Classes	Definition of Survey Classes	Surveys
Survey Class A	Survey data giving coordinate information[1], pre-defined time spans of archaeological (cultural) periods with start and end point as well as the respective periods per archaeological site.	F. Abudanh's survey of the Udruh region The Ayl to Ras-en Naqb Archaeological Survey The Shammak to Ayl Archaeological Survey The Finnish Jabal Harun Project. The Edom Survey (partly)
Survey Class B	Survey data giving coordinate information, but mentioning cultural periods per archaeological site only (without pre-defined time spans).[2]	The Jabal Shara Survey The Archaeological Survey of the Wadi Musa 1996 and 1998, The Beidha Ethnoarchaeological Survey, The Dana-Showbak-LH2KE Survey, The Southeast Araba Archaeological Survey The Bir Madkhur Project The Edom Survey (mostly)
Survey Class C	Survey data without coordinate information and mentioning cultural periods per archaeological site only.	Survey activities by M. Lindner A. Killick's survey of the Udruh region The Udruh Archaeological Project (mostly) The Petra Area and Wadi Slaysil Survey or Brown Universtiy Archaeological Project

1 This study conducts all spatial analyses in an UTM 36N environment.
2 In several cases, survey data of Class B offer more precise information on the time spans of the respective cultural periods. In such cases, these sites were counted to Survey Class A.

TAB. 3 Exemplary table of how to define the fuzzy and Boolean dating values to Class A survey sites according to cultural periods and their respective centuries (only showing from the 1st century BC to 2nd century AD). N= Nabataean; R= Roman; B= Byzantine.

Survey Specifics			Cultural Phases			Respective Time Spans of Cultural Phases (century-based)			
Survey	**Site No.**	**Site Type**	**N**	**R**	**B**	**1st century BC**	**1st century AD**	**2nd century AD**	**…**
[Class A Survey]	[Class A Survey]_ No. 001	[Site Type A]	0	1	0	0	1	1	…
[Class A Survey]	[Class A Survey]_ No. 002	[Site Type B]	1	0	0	1	1	0	…
[Class A Survey]	[Class A Survey]_ No. 003	[Site Type C]	0	0	1	0	0	0	…
[Class A Survey]	[Class A Survey]_ No. 004	[Site Type C]	0,5	0	0	0,5	0,5	0,5	…
[Class A Survey]	[Class A Survey]_ No. 005	[Site Type A]	1	1	1	1	1	1	…
[Class A Survey]	[Class A Survey]_ No. 006	[Site Type B]	1	0	0,5	1	1	0	…
…	…	…	…	…	…	…	…	…	…

TAB. 4 Simplified example for calculating the summed fuzzy and Boolean dating values for the Nabataean period based on Class A Survey data.

Survey	**Site No.**	**N**	**100 BC**	**90 BC**	**80 BC**	**70 BC**	**…**	**0**	**10 AD**	**20 AD**	**30 AD**	**…**	**320 AD**
Abudanh 2006	Abudanh 2006 003	1	1	1	1	0	…	1	…	…	…	…	0
…	…	…	…	…	…	…	…	…	…	…	…	…	…
FJHP (Exterior Area)	FJHP Ext 003	1	1	1	1	0	…	1	1	1	1		0
…	…	…	…	…	…	…	…	…	…	…	…	…	…
FJHP (Core Area)	FJHP S004	1	1	1	1	0	…	1	1	1	1	…	0
…	…	…	…	…	…	…	…	…	…	…	…	…	…
ARNAS	ARNAS 001	1	0	0	0	1		1	1	1	1	…	1
…	…	…	…	…	…	…	…	…	…	…	…	…	…
ShamAyl	ShamAyl 001	1	0	0	0	1		1	1	1	1		0
…	…	…	…	…	…	…	…	…	…	…	…	…	…
	$SumDV_{tb}$:		**202, 5**	**202,5**	**202,5**	**479,5**	**…**	**555**	**554**	**555**	**555**	**…**	**277**

TAB. 5 General distribution characteristics for 1st century AD settlements in the Petraean hinterland (standard distances and GIV).

	Standard Distance Between Points (m)	**Global Intensity Value (per km²) (GIV)**
Settlements	10146,59	0,168
Cities	-	0,0006
Clusters of Buildings	10467,40	0,045
Farms	9430,15	0,063
Towns	10647,82	0,006
Rural Mansions	3211,44	0,008
Villages	10935,50	0,047

TAB. 6 List of Pearson correlation coefficients between settlements and other 1st century AD sites.

First-Order Properties of Settlements – Pearson Correlation Coefficients														
	Settlements		**Cities**		**Clusters of Buildings**		**Farms**		**Towns**		**Rural Mansions**		**Villages**	
	With 500 Sample Points	Without Sample Points	With 500 Sample Points	Without Sample Points	With 500 Sample Points	Without Sample Points	With 500 Sample Points	Without Sample Points	With 500 Sample Points	Without Sample Points	With 500 Sample Points	Without Sample Points	With 500 Sample Points	Without Sample Points
Agricultural Installations	0,3367296	0,3003636	-	-	-	-	-	-	-	-	-	-	-	-
Agricultural Processing Installations	-	0,326483	-	-	0,1797616	0,2144303	0,3687673	0,4138614	-0,03802	-0,036408	0,3619826	0,3670817	0,0119119	0,05498207
Agricultural Storing Installations	-	0,3064319	-	-	0,4290127	0,3439455	0,2587742	0,2021151	0,5934338	0,5831909	0,0710477	0,0860459	0,4099655	0,3626313
Agricultural Terraces/ Fields	-	0,2111652	-	-	0,1387124	0,1268457	0,1885053	0,2411282	-0,024988	-0,011111	0,5292424	0,4470978	-0,020187	-0,0073985
Communication Infrastructures	0,5006559	0,3134703	-	-	-	-	-	-	-	-	-	-	-	-
Caravanserais	-	-0,02805524	-	-	-0,1285268	-0,07785676	0,02171079	0,07226528	-0,21840	-0,229241	-0,009680	0,0167325	-0,161508	-0,1395592
Road Marker	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Road Stations	-	0,3208095	-	-	0,3208453	0,3222438	0,3473034	0,3408906	-0,044236	0,00903642	0,1267388	0,1942491	0,2312914	0,1838597
Roads	-	0,2259105	-	-	0,1642097	0,1191216	0,4560658	0,2581262	0,0392582	0,05210417	0,0358449	0,03519885	0,2371993	0,203066
Routes/Tracks (naqb)	-	0,3267308	-	-	0,3995284	0,3316456	0,3569268	0,2963978	0,1189314	0,2118646	0,0796812	0,08334686	0,3126108	0,3081762
Exploitation/ Industrial Sites	0,2610794	0,2161435	-	-	-	-	-	-	-	-	-	-	-	-
Industrial/Exploitation Installations	-	0,2161435	-	-	0,07595649	0,03996103	0,1910988	0,2428741	0,0802669	0,1030413	0,6195865	0,5115939	0,0697483	0,04960751
Funerary Structures	0,3125015	0,1674556	-	-	-	0,05164114	-	-	-	-	-	-	-	-
Cemeteries	-	0,2331026	-	-	0,1323011	0,07391242	0,2090601	0,2270687	0,131267	0,1949845	0,5837269	0,460817	0,1433927	0,1340374
Isolated Funerary Monuments	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Military Structures	0,396376	0,3489012	-	-	-	-	-	-	-	-	-	-	-	-
Forts	-	0,3149786	-	-	0,3306224	0,3544119	0,2308491	0,2086606	0,3267213	0,3415825	0,0405259	0,08530689	0,4181823	0,3626157
Fortlets	-	0,4329647	-	-	0,5629406	0,496258	0,4189942	0,3633659	0,1442447	0,1087455	0,1109349	0,1533411	0,3826022	0,4094147
Fortresses	-	0,1113849	-	-	0,1674323	0,1299133	0,1211511	0,06181816	0,4091867	0,4589346	-0,031527	-0,0339199	0,1645846	0,157396
Watchtower	-	0,2653296	-	-	0,1994202	0,1468474	0,2673616	0,3157022	0,1866374	0,1553256	0,3198893	0,2057875	0,154813	0,08398464
Religious Structures	0,2045714	0,1008424	-	-	-	-0,01669585	-	-	-	-	-	-	-	-
Isolated Cultic Installations	-	0,09689484	-	-	-0,01833607	-0,00016115	0,08813467	0,1477164	0,0209733	0,04384126	0,442933	0,2632433	-0,046296	-0,0460861
Sanctuaries	-	0,1046496	-	-	-0,06784551	-0,06832812	0,208709	0,1916772	0,00790896	0,04383229	0,5126986	0,2664137	-0,060456	-0,0509494
Significant Religious/ Cultic Structures	-	-	-	-	-	-	-	-	-	-	-	-	-	-

	Settlements		Cities		Clusters of Buildings		Farms		Towns		Rural Mansions		Villages	
	With 500 Sample Points	Without Sample Points	With 500 Sample Points	Without Sample Points	With 500 Sample Points	Without Sample Points	With 500 Sample Points	Without Sample Points	With 500 Sample Points	Without Sample Points	With 500 Sample Points	Without Sample Points	With 500 Sample Points	Without Sample Points
Settlements	1	1	-	-	-	-	-	-	-	-	-	-	-	-
Cities	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Clusters of Buildings	-	0,6671892	-	-	1	1	0,434636	0,3993247	0,3136361	0,1820753	0,0360827	0,1381023	0,5870098	0,4656347
Farms	-	0,7267726	-	-	0,434636	0,3993247	1	1	0,1024617	0,07066847	0,0568439	0,1164056	0,2782687	0,2400671
Towns	-	0,1905483	-	-	0,3136361	0,1820753	0,1024617	0,07066847	1	1	0,0441173	0,05331271	0,2588951	0,2352406
Rural Mansions	-	0,347476	-	-	0,03608267	0,1381023	0,05684389	0,1164056	0,04411731	0,05331271	1	1	0,099036	0,1560045
Villages	-	0,6148561	-	-	0,5870098	0,4656347	0,2782687	0,2400671	0,2588951	0,2352406	0,099036	0,1560045	1	1
Other Structure(s) and/or Feature(s)	0,5918882	0,3768442	-	-	-	-	-	-	-	-	-	-	-	-
Epigraphical Sites or Locations	-	0,2151582	-	-	0,147812	0,1394563	0,271011	0,285665	-0,0179585	0,009363551	0,3825667	0,3146303	0,0222639	0,00219877
Find Clusters	-	0,1012564	-	-	0,05772394	-0,02064102	0,06981415	0,09967441	0,3201125	0,2993207	0,4543972	0,3008066	0,0143463	0,00600382
Natural and/or Rock-cut Structures of Undetermined Function	-	0,2615105	-	-	0,1891277	0,1466983	0,3030018	0,3254416	-0,0065443	0,02793103	0,4187832	0,3233018	0,1118247	0,06256272
Structures of Undetermined Function	-	0,39902	-	-	0,3875474	0,2547346	0,5918586	0,4607157	0,1260101	0,1310594	0,1257167	0,1651166	0,2987346	0,1602953
Walls of Undetermined Function	-	0,3164266	-	-	0,3237132	0,2098412	0,272937	0,2781735	0,2684441	0,2481459	0,3629301	0,3357485	0,3315642	0,2835433
Water Structures	0,4086233	0,2409698	-	-	-	-	-	-	-	-	-	-	-	-
Dams/Barrages	-	0,03764638	-	-	0,007961163	-0,01449041	0,05796403	0,1210087	0,0164128	0,06347131	0,0326359	0,06554683	-0,040613	-0,0524566
Springs	-	0,2837652	-	-	0,3922408	0,2944148	0,1896001	0,1453627	0,539231	0,5047798	0,00432619	0,00784647	0,4718546	0,435045
Water Conduits	-	0,09475781	-	-	0,05248939	0,002574292	0,1057667	0,1110757	0,0435472	0,1233658	0,2965709	0,208476	0,0476493	0,04850506
Water Storage Installations	-	0,3480259	-	-	0,3356228	0,2179736	0,6483402	0,4416063	0,09241764	0,1677585	0,2499893	0,2277555	0,2192965	0,1276647
Wells	-	0,3669347	-	-	0,4145059	0,2722967	0,5498941	0,4289484	0,1234731	0,1543336	0,0966829	0,1428801	0,2484513	0,2811209

TAB. 7 List of qualitative description of Pearson correlation coefficients (based on Evans 1996).

Pearson Correlation Coefficient	**Qualitative Description**
0	No spatial correlation
0 – +/- 0,1	Very Little
+/- 0,1 – +/- 0,2	Little
+/- 0,2 – +/- 0,4	Moderate
+/- 0,4 – +/- 0,6	Good
+/- 0,6 – +/- 0,8	Strong
+/- 0,8 – +/- 0,9	Excellent
+/- 0,9 – +/- 1	Nearly complete
+/- 1	Complete spatial correlation

TAB. 8 Qualified list of Pearson correlation coefficients between settlements and other 1st century AD sites.

First-Order Properties of Settlements – Pearson Correlation Coefficients														
	Settlements		Cities		Clusters of Buildings		Farms		Towns		Rural Mansions		Villages	
	With 500 Sample Points	Without Sample Points	With 500 Sample Points	Without Sample Points	With 500 Sample Points	Without Sample Points	With 500 Sample Points	Without Sample Points	With 500 Sample Points	Without Sample Points	With 500 Sample Points	Without Sample Points	With 500 Sample Points	Without Sample Points
Agricultural Installations	Moderate	Moderate	-	-	-	-	-	-	-	-	-	-	-	-
Agricultural Processing Installations	-	Moderate	-	-	Little	Moderate	Moderate	Good	Very Little	Very Little	Moderate	Moderate	Very Little	Very Little
Agricultural Storing Installations	-	Moderate	-	-	Good	Moderate	Moderate	Moderate	Good	Good	Very Little	Very Little	Good	Moderate
Agricultural Terraces/ Fields	-	Moderate	-	-	Little	Little	Little	Moderate	Very Little	Very Little	Good	Good	Very Little	Very Little
Communication Infrastructures	Good	Moderate	-	-	-	-	-	-	-	-	-	-	-	-
Caravanserais	-	Very Little	-	-	Little	Very Little	Very Little	Very Little	Moderate	Moderate	Very Little	Very Little	Very Little	Little
Road Marker	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Road Stations	-	Moderate	-	-	Moderate	Moderate	Moderate	Moderate	Very Little	Very Little	Little	Little	Moderate	Little
Roads	-	Moderate	-	-	Little	Little	Good	Moderate	Very Little	Very Little	Very Little	Very Little	Moderate	Moderate
Routes/Tracks (naqb)	-	Moderate	-	-	Moderate	Moderate	Moderate	Moderate	Little	Moderate	Very Little	Very Little	Moderate	Moderate
Exploitation/ Industrial Sites	Moderate	Moderate	-	-	-	-	-	-	-	-	-	-	-	-
Industrial/Exploitation Installations	-	Moderate	-	-	Very Little	Very Little	Little	Moderate	Very Little	Little	Strong	Good	Very Little	Very Little
Funerary Structures	Moderate	Little	-	-	-	Very Little	-	-	-	-	-	-	-	-
Cemeteries	-	Moderate	-	-	Little	Very Little	Moderate	Moderate	Little	Little	Good	Good	Little	Little
Isolated Funerary Monuments	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Military Structures	Moderate	Moderate	-	-	-	-	-	-	-	-	-	-	-	-
Forts	-	Moderate	-	-	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Very Little	Very Little	Good	Moderate
Fortlets	-	Good	-	-	Good	Good	Good	Moderate	Little	Little	Little	Little	Moderate	Good
Fortresses	-	Little	-	-	Little	Little	Little	Very Little	Good	Good	Very Little	Very Little	Little	Little
Watchtower	-	Moderate	-	-	Little	Little	Moderate	Moderate	Little	Little	Moderate	Moderate	Little	Very Little
Religious Structures	Moderate	Very Little	-	-	-	Very Little	-	-	-	-	-	-	-	-
Isolated Cultic Installations	-	Very Little	-	-	Very Little	Very Little	Very Little	Little	Very Little	Very Little	Good	Moderate	Very Little	Very Little

	Settlements		Cities		Clusters of Buildings		Farms		Towns		Rural Mansions		Villages	
	With 500 Sample Points	Without Sample Points	With 500 Sample Points	Without Sample Points	With 500 Sample Points	Without Sample Points	With 500 Sample Points	Without Sample Points	With 500 Sample Points	Without Sample Points	With 500 Sample Points	Without Sample Points	With 500 Sample Points	Without Sample Points
Sanctuaries	-	Little	-	-	Very Little	Very Little	Moderate	Little	Very Little	Very Little	Good	Moderate	Very Little	Very Little
Significant Religious/ Cultic Structures	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Settlements	Complete	Complete	-	-	-	-	-	-	-	-	-	-	-	-
Cities	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Clusters of Buildings	-	Strong	-	-	Complete	Complete	Good	Moderate	Moderate	Little	Very Little	Little	Good	Good
Farms	-	Strong	-	-	Good	Good	Complete	Complete	Little	Very Little	Very Little	Little	Moderate	Moderate
Towns	-	Little	-	-	Moderate	Moderate	Little	Very Little	Complete	Complete	Very Little	Very Little	Moderate	Moderate
Rural Mansions	-	Moderate	-	-	Very Little	Moderate	Very Little	Little	Very Little	Very Little	Complete	Complete	Very Little	Little
Villages	-	Strong	-	-	Good	Good	Moderate	Moderate	Moderate	Moderate	Very Little	Little	Complete	Complete
Other Structure(s) and/or Feature(s)	Good	Moderate	-	-	-	-	-	-	-	-	-	-	-	-
Epigraphical Sites or Locations	-	Moderate	-	-	Little	Little	Moderate	Moderate	Very Little	Very Little	Moderate	Moderate	Very Little	Very Little
Find Clusters	-	Little	-	-	Very Little	Very Little	Very Little	Very Little	Moderate	Moderate	Good	Moderate	Very Little	Very Little
Natural and/or Rock-cut Structures of Undetermined Function	-	Moderate	-	-	Little	Little	Moderate	Moderate	Very Little	Very Little	Good	Moderate	Little	Very Little
Structures of Undetermined Function	-	Moderate	-	-	Moderate	Moderate	Good	Good	Little	Little	Little	Little	Moderate	Little
Walls of Undetermined Function	-	Moderate	-	-	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate
Water Structures	Good	Moderate	-	-	-	-	-	-	-	-	-	-	-	-
Dams/Barrages	-	Very Little	-	-	Very Little	Very Little	Very Little	Little	Very Little	Very Little	Very Little	Very Little	Very Little	Very Little
Springs	-	Moderate	-	-	Moderate	Moderate	Little	Little	Good	Good	Very Little	Very Little	Good	Good
Water Conduits	-	Very Little	-	-	Very Little	Very Little	Little	Little	Very Little	Little	Moderate	Moderate	Very Little	Very Little
Water Storage Installations	-	Moderate	-	-	Moderate	Moderate	Strong	Good	Little	Little	Moderate	Moderate	Moderate	Little
Wells	-	Moderate	-	-	Good	Moderate	Good	Good	Little	Little	Little	Little	Moderate	Moderate

TAB. 9 Environmental characteristics of 1st century AD settlements in the Petraean hinterland.

	Slope Values (%)			Slope Direction (%)	Elevation Values (m)			Distance to Streams (m)			Geological Zones covered (%)*												
	Min.	Max.	Avg.		Min.	Max.	Avg.	Min.	Max.	Avg.	L	U	LSl	S	F	V	G	Q	C	A	LS	AF	FG
Settlements	0,67	74,92	16,21	E(12,2); N(12,64); NE(12,64); NW(8,92); S(13,38); SE(10,04); SW(15,24); W(14,87)	224,04	1712,85	1388,27	0	3788,18	694,14	58,36	6,69	3,35	13,38	1,49	1,12	-	-	-	13,79	-	-	-
Cities	17,84	17,84	17,84	N (100)	885,74	885,74	885,74	55,78	55,78	55,78	-	-	-	100	-	-	-	-	-	-	-	-	-
Clusters of Buildings	2,46	43,73	16,03	E(9,72); N(11,11); NE(11,11); NW(9,72); S(12,5); SE(9,72); SW(23,61); W(12,5)	1052,62	1702,40	1481,31	0	1735,85	878,87	65,28	4,17	1,39	11,11	-	-	-	-	-	-	-	-	-
Farms	2,41	44,14	13,41	E(10); N(11); NE(17); NW(8); S(18); SE(13); SW(9); W(14)	224,04	1709,31	1310,69	0	3788,18	655,95	58	7	-	21	2	1	-	-	-	4	-	-	-
Towns	0,67	71,92	20,53	N(40); NE(10); SE(10); SW(10);W(20)	689,86	1636,59	1212,45	0	669,33	171,03	20	-	10	-	30	10	-	-	-	-	-	-	-
Rural Mansions	10,05	74,92	27,83	E(30,77); N(23,08); SW(30,77); W(15,38)	617,72	1479,82	1120,21	0	1014,03	222,70	15,38	-	38,46	38,46	-	7,69	-	-	-	-	-	-	-
Villages	0,80	45,96	17,48	E(16); N(9,33); NE(10,67); NW(10,67); S(12); SW(9,33); W(17,33)	1093,70	1712,85	1486,66	0	3264,32	725,77	64	10,67	2,67	1,33	-	-	-	-	-	-	-	-	-

*: **L**= Limestone; **U**= Undifferentiated; **LSl**= Landslip; **S**= Sandstone; **F**= Fluviatile; **V**= Volcanic; **G**= Gravel; **Q**= Quartz; **C**= Conglomerate; **A**= Alluvium; **LS**= Lake Sediments; **AF**= Alluvial Fan; **FG**= Fluviatile Gravel

TAB. 10 Standard Euclidean distance values to other archaeological sites from 1st century AD settlements in the Petra area.

Second Order Properties of Settlements – Distance Values to Archaeological Sites (m)

	Settlements			Cities			Clusters of Buildings			Farms			Towns			Rural Mansions			Villages		
	Min.	Max.	Mean	Min.	Max.	Mean	Min.	Max.	Mean	Min.	Max.	Mean	Min.	Max.	Mean	Min.	Max.	Mean	Min.	Max.	Mean
Agricultural Installations	17,20	34100,47	11654,11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Agricultural Processing Installations	-	-	-	953,67	15436,77	6309,14	169,39	32812,41	12097,23	17,20	31892,89	10517,04	907,74	31442,37	15769,70	48,33	18471,15	6721,85	138,28	33506,61	13056,08
Agricultural Storing Instal-lations	-	-	-	2851,58	16170,43	10993,59	963,01	32637,45	13034,07	946,51	30780,91	12992,41	1077,44	26795,15	13838,62	2070,48	21301,75	11079,58	575,55	34100,47	13215,31
Agricultural Terraces/ Fields	-	-	-	1564,85	8024,18	4412,11	526,74	27089,10	11826,97	866,01	26675,76	9908,28	1086,06	27114,64	15327,06	812,48	9693,78	5383,74	361,20	27525,13	12860,22
Communi-cation Infra-structures	18,97	35283,36	11940,04	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Caravanserais	-	-	-	5426,05	12248,41	10882,59	1304,36	31235,51	1303,97	27897,19	15611,49	1303,97	6256,18	27516,21	20271,29	280,02	18026,29	12419,47	1198,07	27458,96	19348,30
Road Marker	-	-	-	14540,26	14540,26	14540,26	1045,90	25630,83	3184,23	27938,26	13313,11	3184,23	1781,09	24538,95	16139,09	8283,08	17226,91	12534,48	2655,50	26614,51	13652,53
Road Stations	-	-	-	3602,14	15988,52	8229,30	286,02	34793,64	18,97	34980,62	11634,31	18,97	763,12	35283,36	15478,95	383,88	19227,32	8498,75	178,77	35018,77	13571,62
Roads*	-	-	-	1159,35	15916,57	9076,17	916,26	29896,37	282,60	28900,91	10932,13	282,60	1077,44	24086,87	12647,34	1031,48	20130,14	8506,16	205,76	31396,83	11418,47
Routes/Tracks (naqb)*	-	-	-	1188,04	14591,06	8985,29	399,01	31488,69	123,91	31122,14	11482,55	123,91	1968,10	30891,96	12880,55	1197,73	19208,38	9065,72	193,07	31192,04	12042,66
Exploitation/ Industrial Sites	185,21	35500,46	12194,19	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Industrial/ Exploitation Installations	-	-	-	1071,56	18169,67	7164,15	426,24	34703,05	12725,41	185,21	33998,26	11470,24	618,68	32743,51	15080,65	635,74	23038,55	7820,79	556,14	35500,46	13309,66
Funerary Structures	95,29	32626,79	11735,38	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cemeteries	-	-	-	1690,62	18667,70	5859,42	348,14	30558,40	12085,06	151,18	32193,08	11017,01	1126,25	28556,21	13497,70	1243,90	22524,06	7212,25	624,79	31373,41	12418,36
Isolated Funerary Monuments	-	-	-	1789,61	18885,26	6470,46	356,74	31468,83	12362,01	95,29	32430,99	11282,89	420,12	30082,13	12992,82	185,41	22876,33	7659,12	191,70	32626,79	12622,17
Military Structures	15,65	37997,14	13093,93	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Forts	-	-	-	3363,21	19094,37	12384,44	268,92	37462,51	14360,98	436,52	35392,91	14303,77	1093,19	35341,34	14240,58	1410,55	25582,04	12538,27	101,83	35237,28	14319,51
Fortlets	-	-	-	1642,87	19409,73	11335,98	15,65	34572,96	12836,66	125,10	33651,01	12515,09	1074,45	32703,56	15839,31	632,37	23317,98	10518,58	307,06	35820,97	13369,86
Fortresses	-	-	-	9931,41	14547,40	13001,28	1167,94	26472,99	12747,33	2378,46	28097,17	13145,43	58,19	23718,69	13613,29	8606,44	17521,41	12092,97	705,07	27920,97	12790,39
Watchtower	-	-	-	302,16	19381,24	8834,40	131,49	36569,27	13470,46	85,02	35175,14	12413,91	179,80	34284,74	15059,14	54,60	24709,26	9463,26	162,94	37997,14	13911,99
Religious Structures	123,19	26892,39	11066,40	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

	Settlements			Cities			Clusters of Buildings			Farms			Towns			Rural Mansions			Villages		
	Min.	Max.	Mean	Min.	Max.	Mean	Min.	Max.	Mean	Min.	Max.	Mean	Min.	Max.	Mean	Min.	Max.	Mean	Min.	Max.	Mean
Isolated Cultic Installations	-	-	-	782,26	7416,20	3236,23	275,09	26401,25	178,47	25660,17	9897,51	178,47	1974,65	26180,52	14042,36	123,19	11326,34	5078,67	848,25	26892,39	12652,73
Sanctuaries	-	-	-	1080,59	5578,21	2845,46	2363,26	24213,85	150,08	24588,69	10021,45	150,08	3738,22	24777,75	13864,44	321,76	10549,15	5158,35	2105,23	24462,39	12782,34
Significant Religious/Cultic Structures	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Settlements	9,85	38297,76	12471,67	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cities	-	-	-	0,00	0,00	0,00	0,00	36155,38	12589,48	2042,93	19036,11	9139,65	3494,56	19294,85	12922,23	515,96	6500,47	3539,36	2803,87	19511,96	11610,88
Clusters of Buildings	-	-	-	3811,51	19064,97	11018,95	0,00	-	-	9,22	35243,40	12505,13	583,83	35121,29	14809,50	248,20	24392,37	10419,85	3,00	37592,14	13026,46
Farms	-	-	-	2042,93	19036,11	9139,65	9,22	35243,40	12505,13	9,22	35243,40	12505,13	1535,77	33271,20	15147,85	455,89	23772,96	8934,13	131,48	36681,85	13105,66
Towns	-	-	-	3494,56	19294,85	12922,23	583,83	35121,29	14809,50	0,00	33726,64	11582,88	0,00	27105,20	12856,84	174,89	24245,41	13413,77	229,07	36605,32	14537,36
Rural Mansions	-	-	-	515,96	6500,47	3539,36	248,20	24392,37	10419,85	1535,77	33271,20	15147,85	174,89	24245,41	13413,77	0,00	8950,13	3874,08	737,41	24878,95	11248,64
Villages	-	-	-	2803,87	19511,96	11610,88	3,00	37592,14	13026,46	455,89	23772,96	8934,13	229,07	36605,32	14537,36	737,41	24878,95	11248,64	0,00	38200,49	13131,45
Other Structure(s) and/or Feature(s)	17,20	35910,91	11610,43	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Epigraphical Sites or Locations	-	-	-	1010,36	13251,13	5848,22	330,87	27334,36	11851,33	626,77	26822,29	10373,77	3443,15	26959,85	14744,30	422,25	17195,46	6586,84	589,75	28151,05	12652,11
Find Clusters	-	-	-	2537,47	18676,73	7103,55	246,56	35887,47	13136,61	141,39	34982,85	11892,64	378,26	35096,00	14030,55	145,73	23503,42	8267,84	745,47	36461,08	13470,47
Natural and/ or Rock-cut Structures of Undetermined Function	-	-	-	479,27	16949,98	7874,03	273,72	33101,23	12399,30	133,00	31446,50	11344,17	1589,02	31898,14	15251,47	348,88	21984,32	8254,72	81,02	34574,98	13055,62
Structures of Undetermined Function	-	-	-	241,34	19916,99	9320,61	19,92	36870,89	12901,06	9,85	35485,53	12216,27	277,79	34770,73	14296,41	367,54	25010,81	9595,99	21,84	38297,76	13243,27
Walls of Undetermined Function	-	-	-	964,22	17841,52	8724,04	470,22	34191,70	12236,34	229,44	32332,85	11829,61	420,12	29180,63	13141,81	292,33	22949,54	9208,19	61,47	35660,77	12372,20
Water Structures	0	33584,74	11205,28	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Dams/ Barrages	-	-	-	1860,37	5894,65	3931,80	821,91	24849,96	12535,22	425,64	24143,94	10518,00	2238,95	24643,03	13845,37	513,88	11658,74	5922,82	638,55	25346,38	13143,07
Springs	-	-	-	3560,31	19161,81	13055,55	559,95	34642,75	13501,10	199,82	33736,07	14185,17	1647,64	33803,28	12869,91	2683,24	23916,54	13008,65	121,43	35910,91	13110,58
Water Conduits	-	-	-	1838,10	19404,21	6448,46	412,48	29363,60	12261,40	99,80	33024,55	11217,57	682,91	26538,68	13238,93	141,77	22672,09	7559,85	197,57	30863,24	12580,89
Water Storage Installations	-	-	-	1494,49	19689,51	7048,63	106,30	28868,99	11702,33	17,20	33309,52	10844,38	813,15	27527,85	12906,21	290,66	22965,51	7700,10	59,93	30364,66	12001,66
Wells	-	-	-	4613,41	9902,80	7812,35	1015,50	22983,95	10187,50	422,17	23357,97	9897,27	2040,25	16892,69	11311,80	1451,02	13686,01	7416,19	1099,04	24432,33	10271,97

*: Note that the distance values given for roads and routes/track (naqb) are based on (point) data provided by the various surveys and not the roads and routes themselves.

TAB. 11 Defined cost classes according to the reclassified slope values.

Slope Classification		
Slope (%)	**Description**	**Cost Class**
< 5	plateau	1
< 10	gentle slope	2
≥ 10 < 25	moderate slope	3
≥ 25 < 45	severe slope	4
≥ 45	very severe slope	5

TAB. 12 Defined cost classes of the geological formations.

Geology Classification	
Geological Formation	**Cost Class**
Undifferentiated	1
Landslip	1
Sandstone	2
Soil	2
Limestone	3
Porphyry	3
Phosphorite	3
Conglomerate	4
Fluviatile	5
Alluvium	6
Quartzite	7
Marl	8
Aeolian Sand	8
Granite	9
Shale	9
Gravel	9
Basalt	10
Diorite	10
Gabbro	10
Volcanic	10

TAB. 13 Qualified list of Pearson correlation coefficients between settlements and other archaeological sites dating to the 12th century BC.

First-Order Properties of 12th century BC Settlements – Pearson Correlation Coefficients

	Settlements	Cluster of Buildings	Farms	Towns	Rural Mansions	Villages
Agricultural Installations	Weak	-	-	-	-	-
Agricultural Processing Installations	-	Weak	Very Weak	Moderate	Weak	Moderate
Agricultural Storing Installations	-	Moderate	Very Strong	Strong	Weak	Weak
Agricultural Terraces/Fields	-	Very Weak	Very Weak	Very Weak	Weak	Very Weak
Communication Infrastructures	Weak	-	-	-	-	-
Caravanserais	-	Very Weak	Weak	Weak	Weak	Very Weak
Road Marker	-	-	-	-	-	-
Road Stations	-	Very Weak	Weak	Weak	Weak	Very Weak
Roads	-	Weak	Very Weak	Very Weak	Weak	Very Weak
Routes/Tracks (naqb)	-	Moderate	Weak	Very Weak	Weak	Weak
Exploitation/Industrial Sites	Very Weak	-	-	-	-	-
Industrial/Exploitation Installations	-	Weak	Very Weak	Very Weak	Weak	Very Weak
Funerary Structures	-	-	-	-	-	-
Cemeteries	-	-	-	-	-	-
Isolated Funerary Monuments	-	-	-	-	-	-
Military Structures	Weak	-	-	-	-	-
Forts	-	Weak	Strong	Strong	Weak	Very Weak
Fortlets	-	Moderate	Weak	Weak	Weak	Strong
Fortresses	-	-	-	-	-	-
Watchtower	-	Weak	Strong	Moderate	Weak	Weak
Religious Structures	-	-	-	-	-	-
Isolated Cultic Installations	-	-	-	-	-	-
Sanctuaries	-	-	-	-	-	-
Significant Religious/Cultic Structures	-	-	-	-	-	-
Settlements	-	-	-	-	-	-
Clusters of Buildings	-	-	Strong	Very Weak	Weak	Strong
Farms	-	Strong	-	Strong	Weak	Moderate
Towns	-	Very Weak	Strong	-	Weak	Very Weak
Rural Mansions	-	Very Weak	Strong	Very Weak	-	Very Weak
Villages	-	Strong	Moderate	Very Weak	Weak	-
Other Structure(s) and/or Feature(s)	Strong	-	-	-	-	-
Epigraphical Sites or Locations	-	-	-	-	-	-
Find Clusters	-	Weak	Weak	Moderate	Weak	Moderate
Natural and/or Rock-cut Structures of Undetermined Function	-	Weak	Very Weak	Very Weak	Weak	Very Weak
Structures of Undetermined Function	-	Moderate	Moderate	Very Weak	Weak	Very Strong
Walls of Undetermined Function	-	Moderate	Moderate	Very Weak	Weak	Very Weak
Water Structures	Very Weak	-	-	-	-	-
Dams/Barrages	-	Very Weak	Very Weak	Very Weak	Weak	Very Weak
Springs	-	Very Weak	Very Weak	Very Weak	Weak	Very Weak
Water Conduits	-	Very Weak	Very Weak	Very Weak	Weak	Very Weak
Water Storage Installations	-	Very Weak	Very Weak	Very Weak	Weak	Very Weak
Wells	-	Strong	Weak	Weak	Weak	Very Weak

TAB. 14 Qualified list of Pearson correlation coefficients between settlements and other archaeological sites dating to the 11th century BC.

First-Order Properties of 11th century BC Settlements – Pearson Correlation Coefficients						
	Settlements	**Cluster of Buildings**	**Farms**	**Towns**	**Rural Mansions**	**Villages**
Agricultural Installations	Weak	-	-	-	-	-
Agricultural Processing Installations	-	Weak	Very Weak	Moderate	Weak	Moderate
Agricultural Storing Installations	-	Weak	Very Strong	Very Strong	Weak	Weak
Agricultural Terraces/Fields	-	Weak	Very Weak	Very Weak	Weak	Very Weak
Communication Infrastructures	Weak	-	-	-	-	-
Caravanserais	-	Weak	Weak	Weak	Weak	Very Weak
Road Marker	-	-	-	-	-	-
Road Stations	-	Weak	Weak	Weak	Weak	Very Weak
Roads	-	Weak	Very Weak	Very Weak	Weak	Very Weak
Routes/Tracks (naqb)	-	Weak	Weak	Very Weak	Weak	Weak
Exploitation/Industrial Sites	Weak	-	-	-	-	-
Industrial/Exploitation Installations	-	Weak	Very Weak	Very Weak	Weak	Very Weak
Funerary Structures	-	-	-	-	-	-
Cemeteries	-	-	-	-	-	-
Isolated Funerary Monuments	-	-	-	-	-	-
Military Structures	Weak	-	-	-	-	-
Forts	-	Weak	Strong	Very Strong	Weak	Very Weak
Fortlets	-	Moderate	Weak	Weak	Weak	Strong
Fortresses	-	-	-	-	-	-
Watchtower	-	Weak	Strong	Moderate	Weak	Weak
Religious Structures	-	-	-	-	-	-
Isolated Cultic Installations	-	-	-	-	-	-
Sanctuaries	-	-	-	-	-	-
Significant Religious/Cultic Structures	-	-	-	-	-	-
Settlements	-	-	-	-	-	-
Clusters of Buildings	-	-	Strong	Very Weak	Weak	Strong
Farms	-	Strong	-	Strong	Weak	Moderate
Towns	-	Very Weak	Strong	-	Weak	Very Weak
Rural Mansions	-	Very Weak	Strong	Very Weak	-	Very Weak
Villages	-	Strong	Moderate	Very Weak	Weak	-
Other Structure(s) and/or Feature(s)	Strong	-	-	-	-	-
Epigraphical Sites or Locations	-	-	-	-	-	-
Find Clusters	-	Weak	Weak	Moderate	Weak	Moderate
Natural and/or Rock-cut Structures of Undetermined Function	-	Weak	Very Weak	Very Weak	Weak	Very Weak
Structures of Undetermined Function	-	Moderate	Moderate	Very Weak	Weak	Strong
Walls of Undetermined Function	-	Moderate	Moderate	Very Weak	Weak	Very Weak
Water Structures	Very Weak	-	-	-	-	-
Dams/Barrages	-	Weak	Very Weak	Very Weak	Weak	Very Weak
Springs	-	Weak	Very Weak	Very Weak	Weak	Very Weak
Water Conduits	-	Very Weak	Very Weak	Very Weak	Weak	Very Weak
Water Storage Installations	-	Weak	Weak	Very Weak	Weak	Very Weak
Wells	-	Weak	Weak	Weak	Weak	Very Weak

TAB. 15 Qualified list of Pearson correlation coefficients between settlements and other archaeological sites dating to the 10th century BC.

First-Order Properties of 10th century BC Settlements – Pearson Correlation Coefficients						
	Settlements	**Cluster of Buildings**	**Farms**	**Towns**	**Rural Mansions**	**Villages**
Agricultural Installations	Weak	-	-	-	-	-
Agricultural Processing Installations	-	Very Weak	Weak	Very Weak	Very Weak	Weak
Agricultural Storing Installations	-	Very Weak	Weak	Very Weak	Very Weak	Weak
Agricultural Terraces/Fields	-	Very Weak	Weak	Very Weak	Very Weak	Weak
Communication Infrastructures	Weak	-	-	-	-	-
Caravanserais	-	Very Weak	Weak	Very Weak	Very Weak	Weak
Road Marker	-	-	-	-	-	-
Road Stations	-	Very Weak	Weak	Very Weak	Very Weak	Weak
Roads	-	Very Weak	Weak	Very Weak	Very Weak	Weak
Routes/Tracks (naqb)	-	Very Weak	Weak	Very Weak	Very Weak	Weak
Exploitation/Industrial Sites	Weak	-	-	-	-	-
Industrial/Exploitation Installations	-	Weak	Weak	Very Weak	Very Weak	Weak
Funerary Structures	-	-	-	-	-	-
Cemeteries	-	-	-	-	-	-
Isolated Funerary Monuments	-	-	-	-	-	-
Military Structures	Moderate	-	-	-	-	-
Forts	-	Moderate	Moderate	Strong	Very Weak	Moderate
Fortlets	-	Moderate	Moderate	Very Weak	Very Weak	Weak
Fortresses	-	-	-	-	-	-
Watchtower	-	Moderate	Weak	Strong	Very Weak	Moderate
Religious Structures	-	-	-	-	-	-
Isolated Cultic Installations	-	-	-	-	-	-
Sanctuaries	-	-	-	-	-	-
Significant Religious/Cultic Structures	-	-	-	-	-	-
Settlements	-	-	-	-	-	-
Clusters of Buildings	-	-	Strong	Moderate	Very Weak	Strong
Farms	-	Strong	-	Weak	Very Weak	Strong
Towns	-	Moderate	Weak	-	Very Weak	Weak
Rural Mansions	-	Moderate	Weak	Very Weak	-	Very Weak
Villages	-	Strong	Strong	Weak	Very Weak	-
Other Structure(s) and/or Feature(s)	Moderate	-	-	-	-	-
Epigraphical Sites or Locations	-	-	-	-	-	-
Find Clusters	-	Moderate	Weak	Weak	Very Weak	Weak
Natural and/or Rock-cut Structures of Undetermined Function	-	Weak	Weak	Very Weak	Very Weak	Weak
Structures of Undetermined Function	-	Strong	Strong	Moderate	Very Weak	Strong
Walls of Undetermined Function	-	Weak	Weak	Very Weak	Very Weak	Weak
Water Structures	Very Weak	-	-	-	-	-
Dams/Barrages	-	Very Weak	Weak	Very Weak	Very Weak	Weak
Springs	-	Weak	Weak	Very Weak	Very Weak	Weak
Water Conduits	-	Very Weak	Very Weak	Very Weak	Very Weak	Very Weak
Water Storage Installations	-	Weak	Weak	Strong	Very Weak	Weak
Wells	-	Very Weak	Weak	Weak	Very Weak	Weak

TAB. 16 Qualified list of Pearson correlation coefficients between settlements and other archaeological sites dating to the 9th century BC.

First-Order Properties of 9th century BC Settlements – Pearson Correlation Coefficients						
	Settlements	**Cluster of Buildings**	**Farms**	**Towns**	**Rural Mansions**	**Villages**
Agricultural Installations	Weak	-	-	-	-	-
Agricultural Processing Installations	-	Very Weak	Weak	Very Weak	Moderate	Weak
Agricultural Storing Installations	-	Very Weak	Weak	Very Weak	Moderate	Weak
Agricultural Terraces/Fields	-	Very Weak	Very Weak	Very Weak	Moderate	Moderate
Communication Infrastructures	Weak	-	-	-	-	-
Caravanserais	-	Very Weak	Weak	Very Weak	Moderate	Weak
Road Marker	-	-	-	-	-	-
Road Stations	-	Very Weak	Weak	Very Weak	Moderate	Weak
Roads	-	Very Weak	Weak	Very Weak	Moderate	Weak
Routes/Tracks (naqb)	-	Very Weak	Weak	Very Weak	Moderate	Weak
Exploitation/Industrial Sites	Weak	-	-	-	-	-
Industrial/Exploitation Installations	-	Weak	Weak	Very Weak	Moderate	Weak
Funerary Structures	-	-	-	-	-	-
Cemeteries	-	-	-	-	-	-
Isolated Funerary Monuments	-	-	-	-	-	-
Military Structures	Moderate	-	-	-	-	-
Forts	-	Weak	Moderate	Very Strong	Moderate	Weak
Fortlets	-	Moderate	Moderate	Very Weak	Moderate	Moderate
Fortresses	-	-	-	-	-	-
Watchtower	-	Weak	Very Weak	Moderate	Moderate	Weak
Religious Structures	-	-	-	-	-	-
Isolated Cultic Installations	-	-	-	-	-	-
Sanctuaries	-	-	-	-	-	-
Significant Religious/Cultic Structures	-	-	-	-	-	-
Settlements	-	-	-	-	-	-
Clusters of Buildings	-	-	Moderate	Weak	Moderate	Strong
Farms	-	Moderate	-	Weak	Moderate	Strong
Towns	-	Weak	Weak	-	Moderate	Moderate
Rural Mansions	-	Weak	Weak	Very Weak	-	Weak
Villages	-	Strong	Moderate	Weak	Moderate	-
Other Structure(s) and/or Feature(s)	Moderate	-	-	-	-	-
Epigraphical Sites or Locations	-	-	-	-	-	-
Find Clusters	-	Weak	Weak	Weak	Moderate	Weak
Natural and/or Rock-cut Structures of Undetermined Function	-	Weak	Weak	Weak	Moderate	Weak
Structures of Undetermined Function	-	Strong	Moderate	Moderate	Moderate	Moderate
Walls of Undetermined Function	-	Weak	Weak	Very Weak	Moderate	Weak
Water Structures	Weak	-	-	-	-	-
Dams/Barrages	-	Weak	Very Weak	Very Weak	Moderate	Weak
Springs	-	Weak	Weak	Weak	Moderate	Moderate
Water Conduits	-	Very Weak	Very Weak	Weak	Moderate	Very Weak
Water Storage Installations	-	Very Weak	Very Weak	Moderate	Moderate	Very Weak
Wells	-	Very Weak	Very Weak	Moderate	Moderate	Very Weak

TAB. 17 Qualified list of Pearson correlation coefficients between settlements and other archaeological sites dating to the 8th century BC.

First-Order Properties of 8th century BC Settlements – Pearson Correlation Coefficients						
	Settlements	**Cluster of Buildings**	**Farms**	**Towns**	**Rural Mansions**	**Villages**
Agricultural Installations	Very Weak	-	-	-	-	-
Agricultural Processing Installations	-	Very Weak	Weak	Very Weak	Very Weak	Weak
Agricultural Storing Installations	-	Very Weak	Weak	Very Weak	Very Weak	Weak
Agricultural Terraces/Fields	-	Very Weak	Weak	Very Weak	Very Weak	Weak
Communication Infrastructures	Very Weak	-	-	-	-	-
Caravanserais	-	Very Weak	Weak	Very Weak	Very Weak	Weak
Road Marker	-	-	-	-	-	-
Road Stations	-	Very Weak	Weak	Very Weak	Very Weak	Weak
Roads	-	Very Weak	Weak	Very Weak	Very Weak	Weak
Routes/Tracks (naqb)	-	Very Weak	Weak	Very Weak	Very Weak	Weak
Exploitation/Industrial Sites	Very Weak	-	-	-	-	-
Industrial/Exploitation Installations	-	Weak	Weak	Very Weak	Very Weak	Weak
Funerary Structures	-	-	-	-	-	-
Cemeteries	-	-	-	-	-	-
Isolated Funerary Monuments	-	-	-	-	-	-
Military Structures	Moderate	-	-	-	-	-
Forts	-	Moderate	Moderate	Very Strong	Very Weak	Moderate
Fortlets	-	Moderate	Moderate	Very Weak	Very Weak	Weak
Fortresses	-	-	-	-	-	-
Watchtower	-	Weak	Very Weak	Moderate	Very Weak	Weak
Religious Structures	-	-	-	-	-	-
Isolated Cultic Installations	-	-	-	-	-	-
Sanctuaries	-	-	-	-	-	-
Significant Religious/Cultic Structures	-	-	-	-	-	-
Settlements	-	-	-	-	-	-
Clusters of Buildings	-	-	Strong	Weak	Very Weak	Strong
Farms	-	Strong	-	Weak	Very Weak	Moderate
Towns	-	Weak	Weak	-	Very Weak	Weak
Rural Mansions	-	Weak	Weak	Very Weak	-	Weak
Villages	-	Strong	Moderate	Weak	Very Weak	-
Other Structure(s) and/or Feature(s)	Moderate	-	-	-	-	-
Epigraphical Sites or Locations	-	-	-	-	-	-
Find Clusters	-	Moderate	Weak	Moderate	Very Weak	Weak
Natural and/or Rock-cut Structures of Undetermined Function	-	Weak	Weak	Very Weak	Very Weak	Weak
Structures of Undetermined Function	-	Strong	Moderate	Moderate	Very Weak	Strong
Walls of Undetermined Function	-	Moderate	Weak	Very Weak	Very Weak	Weak
Water Structures	Very Weak	-	-	-	-	-
Dams/Barrages	-	Very Weak	Weak	Very Weak	Very Weak	Weak
Springs	-	Weak	Weak	Very Weak	Very Weak	Weak
Water Conduits	-	Weak	Very Weak	Very Weak	Very Weak	Very Weak
Water Storage Installations	-	Weak	Very Weak	Strong	Very Weak	Weak
Wells	-	Very Weak	Weak	Very Weak	Very Weak	Weak

TAB. 18 Qualified list of Pearson correlation coefficients between settlements and other archaeological sites dating to the 7th century BC.

First-Order Properties of 7th century BC Settlements – Pearson Correlation Coefficients

	Settlements	Cluster of Buildings	Farms	Towns	Rural Mansions	Villages
Agricultural Installations	Weak	-	-	-	-	-
Agricultural Processing Installations	-	Very Weak	Weak	Very Weak	Moderate	Weak
Agricultural Storing Installations	-	Very Weak	Weak	Very Weak	Moderate	Weak
Agricultural Terraces/Fields	-	Very Weak	Weak	Very Weak	Moderate	Moderate
Communication Infrastructures	Very Weak	-	-	-	-	-
Caravanserais	-	Very Weak	Weak	Very Weak	Moderate	Weak
Road Marker	-	-	-	-	-	-
Road Stations	-	Very Weak	Weak	Very Weak	Moderate	Weak
Roads	-	Very Weak	Weak	Very Weak	Moderate	Weak
Routes/Tracks (naqb)	-	Very Weak	Weak	Very Weak	Moderate	Weak
Exploitation/Industrial Sites	Weak	-	-	-	-	-
Industrial/Exploitation Installations	-	Weak	Weak	Very Weak	Moderate	Weak
Funerary Structures	-	-	-	-	-	-
Cemeteries	-	-	-	-	-	-
Isolated Funerary Monuments	-	-	-	-	-	-
Military Structures	Moderate	-	-	-	-	-
Forts	-	Moderate	Moderate	Very Strong	Moderate	Moderate
Fortlets	-	Moderate	Moderate	Very Weak	Moderate	Moderate
Fortresses	-	-	-	-	-	-
Watchtower	-	Moderate	Weak	Moderate	Moderate	Moderate
Religious Structures	-	-	-	-	-	-
Isolated Cultic Installations	-	-	-	-	-	-
Sanctuaries	-	-	-	-	-	-
Significant Religious/Cultic Structures	-	-	-	-	-	-
Settlements	-	-	-	-	-	-
Clusters of Buildings	-	-	Strong	Moderate	Moderate	Strong
Farms	-	Strong	-	Weak	Moderate	Strong
Towns	-	Moderate	Weak	-	Moderate	Moderate
Rural Mansions	-	Moderate	Weak	Very Weak	-	Moderate
Villages	-	Strong	Strong	Weak	Moderate	-
Other Structure(s) and/or Feature(s)	Moderate	-	-	-	-	-
Epigraphical Sites or Locations	-	-	-	-	-	-
Find Clusters	-	Moderate	Weak	Moderate	Moderate	Moderate
Natural and/or Rock-cut Structures of Undetermined Function	-	Weak	Weak	Very Weak	Moderate	Weak
Structures of Undetermined Function	-	Strong	Moderate	Moderate	Moderate	Strong
Walls of Undetermined Function	-	Moderate	Weak	Very Weak	Moderate	Weak
Water Structures	Very Weak	-	-	-	-	-
Dams/Barrages	-	Weak	Very Weak	Very Weak	Moderate	Weak
Springs	-	Weak	Weak	Very Weak	Moderate	Moderate
Water Conduits	-	Very Weak	Very Weak	Very Weak	Moderate	Very Weak
Water Storage Installations	-	Weak	Very Weak	Moderate	Moderate	Very Weak
Wells	-	Weak	Very Weak	Moderate	Moderate	Very Weak

TAB. 19 Qualified list of Pearson correlation coefficients between settlements and other archaeological sites dating to the 6th century BC.

First-Order Properties of 6th century BC Settlements – Pearson Correlation Coefficients

	Settlements	Cluster of Buildings	Farms	Towns	Rural Mansions	Villages
Agricultural Installations	Very Weak	-	-	-	-	-
Agricultural Processing Installations	-	Very Weak	Weak	Very Weak	Moderate	Weak
Agricultural Storing Installations	-	Very Weak	Weak	Very Weak	Moderate	Weak
Agricultural Terraces/Fields	-	Weak	Weak	Weak	Moderate	Moderate
Communication Infrastructures	Very Weak	-	-	-	-	-
Caravanserais	-	Very Weak	Weak	Very Weak	Moderate	Weak
Road Marker	-	-	-	-	-	-
Road Stations	-	Very Weak	Weak	Very Weak	Moderate	Weak
Roads	-	Very Weak	Weak	Very Weak	Moderate	Weak
Routes/Tracks (naqb)	-	Very Weak	Weak	Very Weak	Moderate	Weak
Exploitation/Industrial Sites	Very Weak	-	-	-	-	-
Industrial/Exploitation Installations	-	Weak	Weak	Very Weak	Moderate	Weak
Funerary Structures	-	-	-	-	-	-
Cemeteries	-	-	-	-	-	-
Isolated Funerary Monuments	-	-	-	-	-	-
Military Structures	Moderate	-	-	-	-	-
Forts	-	Moderate	Moderate	Strong	Moderate	Moderate
Fortlets	-	Moderate	Moderate	Very Weak	Moderate	Moderate
Fortresses	-	-	-	-	-	-
Watchtower	-	Moderate	Weak	Strong	Moderate	Weak
Religious Structures	-	-	-	-	-	-
Isolated Cultic Installations	-	-	-	-	-	-
Sanctuaries	-	-	-	-	-	-
Significant Religious/Cultic Structures	-	-	-	-	-	-
Settlements	-	-	-	-	-	-
Clusters of Buildings	-	-	Strong	Moderate	Moderate	Strong
Farms	-	Strong	-	Weak	Moderate	Strong
Towns	-	Moderate	Weak	-	Moderate	Weak
Rural Mansions	-	Moderate	Weak	Very Weak	-	Weak
Villages	-	Strong	Strong	Weak	Moderate	-
Other Structure(s) and/or Feature(s)	Moderate	-	-	-	-	-
Epigraphical Sites or Locations	-	-	-	-	-	-
Find Clusters	-	Moderate	Weak	Moderate	Moderate	Moderate
Natural and/or Rock-cut Structures of Undetermined Function	-	Weak	Weak	Very Weak	Moderate	Weak
Structures of Undetermined Function	-	Strong	Strong	Moderate	Moderate	Strong
Walls of Undetermined Function	-	Weak	Moderate	Very Weak	Moderate	Weak
Water Structures	Very Weak	-	-	-	-	-
Dams/Barrages	-	Weak	Weak	Very Weak	Moderate	Moderate
Springs	-	Weak	Weak	Very Weak	Moderate	Weak
Water Conduits	-	Very Weak	Very Weak	Very Weak	Moderate	Very Weak
Water Storage Installations	-	Weak	Weak	Moderate	Moderate	Weak
Wells	-	Weak	Weak	Moderate	Moderate	Very Weak

TAB. 20 Mean slope and elevation values for agricultural terraces/fields and dams/barrages.

Century	Mean Slope Value (%)	Mean Elevation Value (m)
1st century BC	9,30	1036,82
1st century AD	16,20	1038,60
2nd century AD	16,15	1042,39
3rd century AD	25,96	1019,26

TAB. 21 Pottery forms and decor phases after Schmid 2000 collected on the plateau east of at-Tayyiba (preliminary pottery analysis).

Fine Ware Pottery (Painted and Unpainted Body Sherds, Bases, Handles)			
Form	**Number**	**Decor/Phase**	**Remarks**
Body Open Form	1	3b	-
Body Open Form	25	Unknown	-
Base Open Form	1	Unknown	-
Body Closed Form	8	Unknown	-

Fine Ware Pottery (Unpainted Rim Sherds)			
Form	**Number**	**Decor/Phase**	**Remarks**
E1c8	1	3	
E1c7	1	3	Fragmented
F10b270 (?)	1	?	Unclear
Unknown Open Rim Form	1	?	-

Other Pottery			
Form	**Number**	**Decor/Phase**	**Remarks**
Body Open Form	10	Nabataean-Roman (?)	Coarse Ware
Body Closed Form	26	Nabataean-Roman (?)	Coarse Ware
Rim	1	Nabataean-Roman (?)	Coarse Ware
Handle	2	Nabataean-Roman (?)	Coarse Ware
Handle with Rim	1	Nabataean-Roman (?)	Coarse Ware
Lamp	1	Nabataean-Roman (?)	Fragmented

TAB. 22 Qualified list of Pearson correlation coefficients between settlements and other archaeological sites dating to the 1st century BC.

First-Order Properties of 1st century BC Settlements – Pearson Correlation Coefficients						
	Settlements	**Cluster of Buildings**	**Farms**	**Towns**	**Rural Mansions**	**Villages**
Agricultural Installations	Weak	-	-	-	-	-
Agricultural Processing Installations	-	Weak	Moderate	Very Weak	Strong	Very Weak
Agricultural Storing Installations	-	Weak	Weak	Strong	Very Weak	Weak
Agricultural Terraces/Fields	-	Very Weak	Very Weak	Very Weak	Very Weak	Very Weak
Communication Infrastructures	Moderate	-	-	-	-	-
Caravanserais	-	Very Weak	Very Weak	Weak	Very Weak	Very Weak
Road Marker	-	-	-	-	-	-
Road Stations	-	Weak	Weak	Very Weak	Strong	Very Weak
Roads	-	Very Weak	Weak	Very Weak	Very Weak	Very Weak
Routes/Tracks (naqb)	-	Weak	Weak	Very Weak	Weak	Very Weak
Exploitation/Industrial Sites	Very Weak	-	-	-	-	-
Industrial/Exploitation Installations	-	Very Weak	Weak	Very Weak	Strong	Very Weak
Funerary Structures	Very Weak	-	-	-	-	-
Cemeteries	-	Very Weak	Weak	Weak	Strong	Very Weak
Isolated Funerary Monuments	-	Very Weak	Weak	Weak	Moderate	Very Weak
Military Structures	Weak	-	-	-	-	-
Forts	-	Weak	Weak	Very Weak	Very Weak	Weak
Fortlets	-	Moderate	Weak	Very Weak	Weak	Moderate
Fortresses	-	-	-	-	-	-
Watchtower	-	Very Weak	Weak	Very Weak	Moderate	Very Weak
Religious Structures	Very Weak	-	-	-	-	-
Isolated Cultic Installations	-	Very Weak	Very Weak	Very Weak	Weak	Very Weak
Sanctuaries	-	Very Weak	Very Weak	Very Weak	Moderate	Very Weak
Significant Religious/Cultic Structures	-	-	-	-	-	-
Settlements	-	-	-	-	-	-
Clusters of Buildings	-	-	Moderate	Very Weak	Weak	Moderate
Farms	-	Moderate	-	Very Weak	Moderate	Weak
Towns	-	Very Weak	Very Weak	-	Very Weak	Very Weak
Rural Mansions	-	Weak	Moderate	Very Weak	-	Very Weak
Villages	-	Weak	Weak	Very Weak	Very Weak	-
Other Structure(s) and/or Feature(s)	Weak	-	-	-	-	-
Epigraphical Sites or Locations	-	Weak	Weak	Very Weak	Strong	Very Weak
Find Clusters	-	Very Weak	Very Weak	Weak	Strong	Very Weak
Natural and/or Rock-cut Structures of Undetermined Function	-	Weak	Moderate	Very Weak	Strong	Very Weak
Structures of Undetermined Function	-	Very Weak	Moderate	Very Weak	Weak	Very Weak
Walls of Undetermined Function	-	Weak	Weak	Weak	Moderate	Weak
Water Structures	Weak	-	-	-	-	-
Dams/Barrages	-	Very Weak	Very Weak	Very Weak	Weak	Very Weak
Springs	-	Weak	Weak	Weak	Very Weak	Moderate
Water Conduits	-	Very Weak	Very Weak	Very Weak	Weak	Very Weak
Water Storage Installations	-	Weak	Moderate	Very Weak	Moderate	Very Weak
Wells	-	Weak	Weak	Weak	Moderate	Weak

TAB. 23 Qualified list of Pearson correlation coefficients between settlements and other archaeological sites dating to the 1st century AD.

First-Order Properties of 1st century AD Settlements – Pearson Correlation Coefficients						
	Settlements	**Cluster of Buildings**	**Farms**	**Towns**	**Rural Mansions**	**Villages**
Agricultural Installations	Weak	-	-	-	-	-
Agricultural Processing Installations	-	Very weak	Weak	Very weak	Weak	Very weak
Agricultural Storing Installations	-	Moderate	Weak	Moderate	Very weak	Moderate
Agricultural Terraces/Fields	-	Very weak	Very weak	Very weak	Moderate	Very weak
Communication Infrastructures	Moderate	-	-	-	-	-
Caravanserais	-	Very weak	Very weak	Weak	Very weak	Very weak
Road Marker	-	-	-	-	-	-
Road Stations	-	Weak	Weak	Very weak	Very weak	Weak
Roads	-	Very weak	Moderate	Very weak	Very weak	Weak
Routes/Tracks (naqb)	-	Moderate	Weak	Very weak	Very weak	Weak
Exploitation/Industrial Sites	Weak	-	-	-	-	-
Industrial/Exploitation Installations	-	Very weak	Very weak	Very weak	Strong	Very weak
Funerary Structures	Weak	-	-	-	-	-
Cemeteries	-	Very weak	Weak	Very weak	Moderate	Very weak
Isolated Funerary Monuments	-	Very weak	Weak	Very weak	Moderate	Very weak
Military Structures	Moderate	-	-	-	-	-
Forts	-	Weak	Weak	Weak	Very weak	Moderate
Fortlets	-	Moderate	Moderate	Very weak	Very weak	Weak
Fortresses	-	Very weak	Very weak	Moderate	Very weak	Very weak
Watchtower	-	Weak	Weak	Very weak	Weak	Very weak
Religious Structures	Weak	-	-	-	-	-
Isolated Cultic Installations	-	Very weak	Very weak	Very weak	Moderate	Very weak
Sanctuaries	-	Very weak	Weak	Very weak	Moderate	Very weak
Significant Religious/Cultic Structures	-	-	-	-	-	-
Settlements	-	-	-	-	-	-
Clusters of Buildings	-	-	Moderate	Weak	Very weak	Moderate
Farms	-	Moderate	-	Very weak	Very weak	Weak
Towns	-	Weak	Very weak	-	Very weak	Weak
Rural Mansions	-	Very weak	Very weak	Very weak	-	Very weak
Villages	-	Moderate	Weak	Weak	Very weak	-
Other Structure(s) and/or Feature(s)	Moderate	-	-	-	-	-
Epigraphical Sites or Locations	-	Very weak	Weak	Very weak	Weak	Very weak
Find Clusters	-	Very weak	Very weak	Weak	Moderate	Very weak
Natural and/or Rock-cut Structures of Undetermined Function	-	Very weak	Weak	Very weak	Moderate	Very weak
Structures of Undetermined Function	-	Weak	Moderate	Very weak	Very weak	Weak
Walls of Undetermined Function	-	Weak	Weak	Weak	Weak	Weak
Water Structures	Moderate	-	-	-	-	-
Dams/Barrages	-	Very weak	Very weak	Very weak	Very weak	Very weak
Springs	-	Weak	Very weak	Moderate	-	Moderate
Water Conduits	-	Very weak	Very weak	Very weak	Weak	Very weak
Water Storage Installations	-	Weak	Strong	Very weak	Weak	Weak
Wells	-	Moderate	Moderate	Very weak	Very weak	Weak

TAB. 24 Qualified list of Pearson correlation coefficients between settlements and other archaeological sites dating to the 2nd century AD.

First-Order Properties of 2nd century AD Settlements – Pearson Correlation Coefficients						
	Settlements	**Cluster of Buildings**	**Farms**	**Towns**	**Rural Mansions**	**Villages**
Agricultural Installations	Weak	-	-	-	-	-
Agricultural Processing Installations	-	Weak	Moderate	Very Weak	Weak	Very Weak
Agricultural Storing Installations	-	Weak	Very Weak	Moderate	Very Weak	Weak
Agricultural Terraces/Fields	-	Very Weak	Weak	Very Weak	Weak	Very Weak
Communication Infrastructures	Weak	-	-	-	-	-
Caravanserais	-	Weak	Very Weak	Very Weak	Very Weak	Very Weak
Road Marker	-	-	-	-	-	-
Road Stations	-	Very Weak	Weak	Very Weak	Weak	Very Weak
Roads	-	Weak	Moderate	Very Weak	Very Weak	Very Weak
Routes/Tracks (naqb)	-	Weak	Weak	Very Weak	Weak	Weak
Exploitation/Industrial Sites	Weak	-	-	-	-	-
Industrial/Exploitation Installations	-	Very Weak	Weak	Very Weak	Strong	Very Weak
Funerary Structures	Weak	-	-	-	-	-
Cemeteries	-	Very Weak	Weak	Very Weak	Moderate	Weak
Isolated Funerary Monuments	-	Very Weak	Weak	Very Weak	Moderate	Weak
Military Structures	Weak	-	-	-	-	-
Forts	-	Weak	Very Weak	Weak	Very Weak	Weak
Fortlets	-	Moderate	Weak	Very Weak	Weak	Moderate
Fortresses	-	-	-	-	-	-
Watchtower	-	Very Weak	Moderate	Very Weak	Weak	Very Weak
Religious Structures	Very Weak	-	-	-	-	-
Isolated Cultic Installations	-	Very Weak	Very Weak	Very Weak	Weak	Very Weak
Sanctuaries	-	Very Weak	Weak	Very Weak	Weak	Very Weak
Significant Religious/Cultic Structures	-	-	-	-	-	-
Settlements	-	-	-	-	-	-
Clusters of Buildings	-	-	Weak	Very Weak	Very Weak	Moderate
Farms	-	Weak	-	Very Weak	Very Weak	Very Weak
Towns	-	Very Weak	Very Weak	-	Very Weak	Very Weak
Rural Mansions	-	Very Weak	Very Weak	Very Weak	-	Weak
Villages	-	Moderate	Weak	Very Weak	Weak	-
Other Structure(s) and/or Feature(s)	Weak	-	-	-	-	-
Epigraphical Sites or Locations	-	Very Weak	Weak	Very Weak	Weak	Very Weak
Find Clusters	-	Weak	Very Weak	Weak	Moderate	Very Weak
Natural and/or Rock-cut Structures of Undetermined Function	-	Weak	Moderate	Very Weak	Weak	Very Weak
Structures of Undetermined Function	-	Weak	Moderate	Very Weak	Very Weak	Very Weak
Walls of Undetermined Function	-	Weak	Weak	Weak	Moderate	Weak
Water Structures	Weak	-	-	-	-	-
Dams/Barrages	-	Very Weak	Very Weak	Very Weak	Very Weak	Very Weak
Springs	-	Weak	Very Weak	Weak	Very Weak	Weak
Water Conduits	-	Very Weak	Very Weak	Very Weak	Weak	Very Weak
Water Storage Installations	-	Weak	Weak	Very Weak	Weak	Very Weak
Wells	-	Weak	Weak	Very Weak	Weak	Weak

TAB. 25 Qualified list of Pearson correlation coefficients between settlements and other archaeological sites dating to the 3rd century AD.

First-Order Properties of 3rd century AD Settlements – Pearson Correlation Coefficients						
	Settlements	**Cluster of Buildings**	**Farms**	**Towns**	**Rural Mansions**	**Villages**
Agricultural Installations	Very Weak	-	-	-	-	-
Agricultural Processing Installations	-	Very Weak	Very Weak	Very Weak	Moderate	Very Weak
Agricultural Storing Installations	-	Weak	Very Weak	Strong	Very Weak	Weak
Agricultural Terraces/Fields	-	Very Weak	Weak	Very Weak	Strong	Very Weak
Communication Infrastructures	Weak	-	-	-	-	-
Caravanserais	-	Very Weak	Very Weak	Very Weak	Very Weak	Very Weak
Road Marker	-	-	-	-	-	-
Road Stations	-	Moderate	Very Weak	Very Weak	Weak	Very Weak
Roads	-	Very Weak	Weak	Weak	Very Weak	Very Weak
Routes/Tracks (naqb)	-	Moderate	Moderate	Weak	Very Weak	Weak
Exploitation/Industrial Sites	Very Weak	-	-	-	-	-
Industrial/Exploitation Installations	-	Very Weak	Very Weak	Very Weak	Weak	Very Weak
Funerary Structures	Very Weak	-	-	-	-	-
Cemeteries	-	Weak	Very Weak	Strong	Very Weak	Very Weak
Isolated Funerary Monuments	-	Weak	Very Weak	Strong	Very Weak	Very Weak
Military Structures	Moderate	-	-	-	-	-
Forts	-	Weak	Very Weak	Strong	Very Weak	Weak
Fortlets	-	Strong	Moderate	Weak	Very Weak	Weak
Fortresses	-	-	-	-	-	-
Watchtower	-	Very Weak	Weak	Weak	Weak	Very Weak
Religious Structures	Very Weak	-	-	-	-	-
Isolated Cultic Installations	-	Very Weak	Weak	Weak	Moderate	Very Weak
Sanctuaries	-	Very Weak	Very Weak	Very Weak	Moderate	Very Weak
Significant Religious/Cultic Structures	-	-	-	-	-	-
Settlements	-	-	-	-	-	-
Clusters of Buildings	-	-	Moderate	Weak	Very Weak	Weak
Farms	-	Moderate	-	Very Weak	Very Weak	Weak
Towns	-	Weak	Very Weak	-	Very Weak	Weak
Rural Mansions	-	Very Weak	Very Weak	Very Weak	-	Very Weak
Villages	-	Weak	Weak	Weak	Very Weak	-
Other Structure(s) and/or Feature(s)	Moderate	-	-	-	-	-
Epigraphical Sites or Locations	-	Weak	Weak	Very Weak	Moderate	Very Weak
Find Clusters	-	Very Weak	Very Weak	Weak	Weak	Very Weak
Natural and/or Rock-cut Structures of Undetermined Function	-	Weak	Weak	Very Weak	Moderate	Very Weak
Structures of Undetermined Function	-	Moderate	Moderate	Weak	Very Weak	Weak
Walls of Undetermined Function	-	Weak	Weak	Weak	Moderate	Weak
Water Structures	Weak	-	-	-	-	-
Dams/Barrages	-	Very Weak	Very Weak	Very Weak	Very Weak	Very Weak
Springs	-	Weak	Very Weak	Strong	Very Weak	Weak
Water Conduits	-	Very Weak	Very Weak	Very Weak	Very Weak	Very Weak
Water Storage Installations	-	Weak	Weak	Very Weak	Weak	Very Weak
Wells	-	Weak	Weak	Weak	Weak	Weak

TAB. 26 Qualified list of Pearson correlation coefficients between settlements and other archaeological sites dating to the 4th century AD.

First-Order Properties of 4th century AD Settlements – Pearson Correlation Coefficients

	Settlements	Cluster of Buildings	Farms	Towns	Rural Mansions	Villages
Agricultural Installations	Very Weak	-	-	-	-	-
Agricultural Processing Installations	-	Very Weak	Very Weak	Very Weak	Strong	Very Weak
Agricultural Storing Installations	-	Weak	Very Weak	Very Strong	Very Weak	Weak
Agricultural Terraces/Fields	-	Very Weak	Very Weak	Very Weak	Very Strong	Very Weak
Communication Infrastructures	Moderate	-	-	-	-	-
Caravanserais	-	Very Weak	Very Weak	Very Weak	Very Weak	Very Weak
Road Marker	-	-	-	-	-	-
Road Stations	-	Moderate	Moderate	Very Weak	Strong	Weak
Roads	-	Very Weak	Moderate	Weak	Weak	Weak
Routes/Tracks (naqb)	-	Moderate	Moderate	Moderate	Weak	Moderate
Exploitation/Industrial Sites	Very Weak	-	-	-	-	-
Industrial/Exploitation Installations	-	Very Weak	Very Weak	Very Weak	Weak	Very Weak
Funerary Structures	-	-	-	-	-	-
Cemeteries	-	-	-	-	-	-
Isolated Funerary Monuments	-	-	-	-	-	-
Military Structures	Moderate	-	-	-	-	-
Forts	-	Moderate	Weak	Strong	Very Weak	Moderate
Fortlets	-	Strong	Moderate	Moderate	Weak	Weak
Fortresses	-	Very Weak	Very Weak	Moderate	Very Weak	Very Weak
Watchtower	-	Weak	Weak	Moderate	Moderate	Weak
Religious Structures	-	-	-	-	-	-
Isolated Cultic Installations	-	-	-	-	-	-
Sanctuaries	-	-	-	-	-	-
Significant Religious/Cultic Structures	-	-	-	-	-	-
Settlements	-	-	-	-	-	-
Clusters of Buildings	-	-	Strong	Moderate	Weak	Moderate
Farms	-	Strong	-	Weak	Weak	Weak
Towns	-	Moderate	Weak	-	Very Weak	Moderate
Rural Mansions	-	Weak	Weak	Very Weak	-	Very Weak
Villages	-	Moderate	Weak	Moderate	Very Weak	-
Other Structure(s) and/or Feature(s)	Moderate	-	-	-	-	-
Epigraphical Sites or Locations	-	Weak	Weak	Very Weak	Very Strong	Very Weak
Find Clusters	-	Very Weak	Very Weak	Moderate	Weak	Weak
Natural and/or Rock-cut Structures of Undetermined Function	-	Weak	Moderate	Weak	Moderate	Very Weak
Structures of Undetermined Function	-	Moderate	Strong	Moderate	Weak	Weak
Walls of Undetermined Function	-	Weak	Weak	Moderate	Very Strong	Weak
Water Structures	Moderate	-	-	-	-	-
Dams/Barrages	-	Very Weak	Very Weak	Very Weak	Weak	Very Weak
Springs	-	Weak	Weak	Strong	Very Weak	Moderate
Water Conduits	-	Very Weak	Very Weak	Very Weak	Very Weak	Very Weak
Water Storage Installations	-	Moderate	Strong	Very Weak	Weak	Weak
Wells	-	Moderate	Moderate	Moderate	Moderate	Weak

TAB. 27 Qualified list of Pearson correlation coefficients between settlements and other archaeological sites dating to the 5th century AD.

First-Order Properties of 5th century AD Settlements – Pearson Correlation Coefficients						
	Settlements	**Cluster of Buildings**	**Farms**	**Towns**	**Rural Mansions**	**Villages**
Agricultural Installations	Weak	-	-	-	-	-
Agricultural Processing Installations	-	Weak	Very Weak	Very Weak	Strong	Weak
Agricultural Storing Installations	-	Moderate	Weak	Very Strong	Very Weak	Weak
Agricultural Terraces/Fields	-	Very Weak	Very Weak	Very Weak	Very Weak	Weak
Communication Infrastructures	Moderate	-	-	-	-	-
Caravanserais	-	Moderate	Moderate	Weak	Weak	Very Weak
Road Marker	-	-	-	-	-	-
Road Stations	-	Strong	Moderate	Moderate	Moderate	Moderate
Roads	-	Moderate	Strong	Weak	Weak	Weak
Routes/Tracks (naqb)	-	Moderate	Moderate	Weak	Weak	Weak
Exploitation/Industrial Sites	Weak	-	-	-	-	-
Industrial/Exploitation Installations	-	Very Weak	Weak	Very Weak	Moderate	Weak
Funerary Structures	-	-	-	-	-	-
Cemeteries	-	-	-	-	-	-
Isolated Funerary Monuments	-	-	-	-	-	-
Military Structures	Moderate	-	-	-	-	-
Forts	-	Moderate	Moderate	Strong	Very Weak	Moderate
Fortlets	-	Strong	Moderate	Weak	Weak	Moderate
Fortresses	-	-	-	-	-	-
Watchtower	-	Moderate	Moderate	Strong	Very Weak	Weak
Religious Structures	-	-	-	-	-	-
Isolated Cultic Installations	-	-	-	-	-	-
Sanctuaries	-	-	-	-	-	-
Significant Religious/Cultic Structures	-	-	-	-	-	-
Settlements	-	-	-	-	-	-
Clusters of Buildings	-	-	Strong	Moderate	Weak	Moderate
Farms	-	Strong	-	Moderate	Weak	Moderate
Towns	-	Moderate	Moderate	-	Very Weak	Weak
Rural Mansions	-	Weak	Weak	Very Weak	-	Very Weak
Villages	-	Moderate	Moderate	Weak	Very Weak	-
Other Structure(s) and/or Feature(s)	Strong	-	-	-	-	-
Epigraphical Sites or Locations	-	-	-	-	-	-
Find Clusters	-	Weak	Weak	Strong	Very Weak	Weak
Natural and/or Rock-cut Structures of Undetermined Function	-	Strong	Strong	Weak	Weak	Weak
Structures of Undetermined Function	-	Moderate	Strong	Moderate	Weak	Moderate
Walls of Undetermined Function	-	Moderate	Moderate	Strong	Weak	Moderate
Water Structures	Moderate	-	-	-	-	-
Dams/Barrages	-	Very Weak	Very Weak	Very Weak	Very Weak	Very Weak
Springs	-	Weak	Moderate	Strong	Very Weak	Weak
Water Conduits	-	Very Weak	Very Weak	Weak	Very Weak	Very Weak
Water Storage Installations	-	Strong	Moderate	Weak	Moderate	Moderate
Wells	-	Moderate	Moderate	Weak	Moderate	Weak

TAB. 28 Qualified list of Pearson correlation coefficients between settlements and other archaeological sites dating to the 6th century AD.

First-Order Properties of 6th century AD Settlements – Pearson Correlation Coefficients						
	Settlements	**Cluster of Buildings**	**Farms**	**Towns**	**Rural Mansions**	**Villages**
Agricultural Installations	Very Weak	-	-	-	-	-
Agricultural Processing Installations	-	Weak	Very Weak	Very Weak	Weak	Weak
Agricultural Storing Installations	-	Weak	Weak	Very Strong	Weak	Weak
Agricultural Terraces/Fields	-	Very Weak	Very Weak	Very Weak	Weak	Very Weak
Communication Infrastructures	Moderate	-	-	-	-	-
Caravanserais	-	Moderate	Moderate	Moderate	Weak	Moderate
Road Marker	-	-	-	-	-	-
Road Stations	-	Strong	Moderate	Moderate	Weak	Moderate
Roads	-	Weak	Moderate	Very Strong	Weak	Moderate
Routes/Tracks (naqb)	-	Moderate	Moderate	Weak	Weak	Moderate
Exploitation/Industrial Sites	Weak	-	-	-	-	-
Industrial/Exploitation Installations	-	Weak	Weak	Very Weak	Weak	Weak
Funerary Structures	-	-	-	-	-	-
Cemeteries	-	-	-	-	-	-
Isolated Funerary Monuments	-	-	-	-	-	-
Military Structures	Moderate	-	-	-	-	-
Forts	-	Weak	Moderate	Strong	Weak	Moderate
Fortlets	-	Moderate	Moderate	Weak	Weak	Moderate
Fortresses	-	-	-	-	-	-
Watchtower	-	Moderate	Moderate	Strong	Weak	Moderate
Religious Structures	-	-	-	-	-	-
Isolated Cultic Installations	-	-	-	-	-	-
Sanctuaries	-	-	-	-	-	-
Significant Religious/Cultic Structures	-	-	-	-	-	-
Settlements	-	-	-	-	-	-
Clusters of Buildings	-	-	Strong	Moderate	Weak	Moderate
Farms	-	Strong	-	Moderate	Weak	Moderate
Towns	-	Moderate	Moderate	-	Weak	Moderate
Rural Mansions	-	Moderate	Moderate	Very Weak	-	Moderate
Villages	-	Moderate	Moderate	Moderate	Weak	-
Other Structure(s) and/or Feature(s)	Strong	-	-	-	-	-
Epigraphical Sites or Locations	-	-	-	-	-	-
Find Clusters	-	Weak	Weak	Strong	Weak	Weak
Natural and/or Rock-cut Structures of Undetermined Function	-	Moderate	Moderate	Moderate	Weak	Moderate
Structures of Undetermined Function	-	Strong	Strong	Weak	Weak	Moderate
Walls of Undetermined Function	-	Moderate	Moderate	Strong	Weak	Moderate
Water Structures	Moderate	-	-	-	-	-
Dams/Barrages	-	Very Weak	Very Weak	Weak	Weak	Very Weak
Springs	-	Moderate	Moderate	Strong	Weak	Moderate
Water Conduits	-	Very Weak	Very Weak	Weak	Weak	Very Weak
Water Storage Installations	-	Strong	Moderate	Weak	Weak	Moderate
Wells	-	Moderate	Moderate	Weak	Weak	Weak

TAB. 29 Qualified list of Pearson correlation coefficients between settlements and other archaeological sites dating to the 7th century AD.

First-Order Properties of 7th century AD Settlements – Pearson Correlation Coefficients						
	Settlements	**Cluster of Buildings**	**Farms**	**Towns**	**Rural Mansions**	**Villages**
Agricultural Installations	Weak	-	-	-	-	-
Agricultural Processing Installations	-	Weak	Weak	Very Weak	Weak	Moderate
Agricultural Storing Installations	-	Weak	Weak	Very Strong	Weak	Weak
Agricultural Terraces/Fields	-	Very Weak	Very Weak	Very Weak	Weak	Very Weak
Communication Infrastructures	Moderate	-	-	-	-	-
Caravanserais	-	Moderate	Weak	Very Weak	Weak	Moderate
Road Marker	-	-	-	-	-	-
Road Stations	-	Moderate	Moderate	Moderate	Weak	Moderate
Roads	-	Weak	Moderate	Very Strong	Weak	Weak
Routes/Tracks (naqb)	-	Weak	Weak	Very Weak	Weak	Weak
Exploitation/Industrial Sites	Weak	-	-	-	-	-
Industrial/Exploitation Installations	-	Weak	Weak	Very Weak	Weak	Weak
Funerary Structures	-	-	-	-	-	-
Cemeteries	-	-	-	-	-	-
Isolated Funerary Monuments	-	-	-	-	-	-
Military Structures	Moderate	-	-	-	-	-
Forts	-	Weak	Moderate	Strong	Weak	Moderate
Fortlets	-	Moderate	Moderate	Weak	Weak	Moderate
Fortresses	-	-	-	-	-	-
Watchtower	-	Moderate	Moderate	Strong	Weak	Moderate
Religious Structures	-	-	-	-	-	-
Isolated Cultic Installations	-	-	-	-	-	-
Sanctuaries	-	-	-	-	-	-
Significant Religious/Cultic Structures	-	-	-	-	-	-
Settlements	-	-	-	-	-	-
Clusters of Buildings	-	-	Strong	Weak	Weak	Moderate
Farms	-	Strong	-	Moderate	Weak	Moderate
Towns	-	Weak	Moderate	-	Weak	Moderate
Rural Mansions	-	Weak	Moderate	Very Weak	-	Moderate
Villages	-	Moderate	Moderate	Moderate	Weak	-
Other Structure(s) and/or Feature(s)	Strong	-	-	-	-	-
Epigraphical Sites or Locations	-	-	-	-	-	-
Find Clusters	-	Weak	Weak	Strong	Weak	Weak
Natural and/or Rock-cut Structures of Undetermined Function	-	Moderate	Moderate	Moderate	Weak	Moderate
Structures of Undetermined Function	-	Strong	Moderate	Weak	Weak	Moderate
Walls of Undetermined Function	-	Moderate	Moderate	Strong	Weak	Strong
Water Structures	Moderate	-	-	-	-	-
Dams/Barrages	-	Very Weak	Very Weak	Very Weak	Weak	Very Weak
Springs	-	Weak	Weak	Strong	Weak	Weak
Water Conduits	-	Very Weak	Very Weak	Weak	Weak	Very Weak
Water Storage Installations	-	Moderate	Moderate	Weak	Weak	Moderate
Wells	-	Moderate	Weak	Weak	Weak	Weak

TAB. 30 Overview of the archaeological characteristics and datings of the identified forts in the Petraean hinterland.

Characteristics of Presumed Forts in the Petraean Hinterland																							
Site No.	**Site Name**	**Size**	**Archaeological Characteristics**	**Location**	**12th C. BC**	**11th C. BC**	**10th C. BC**	**9th C. BC**	**8th C. BC**	**7th C. BC**	**6th C. BC**	**5th C. BC**	**4th C. BC**	**3rd C. BC**	**2nd C. BC**	**1st C. BC**	**1st C. AD**	**2nd C. AD**	**3rd C. AD**	**4th C. AD**	**5th C. AD**	**6th C. AD**	**7th C. AD**
Abudanh Survey No. 055	Tell Abara	c. 1,8 ha	Rectangular enclosure with low, poor quality walls. Gate to the E. Possible external *clavicula*.	Hilltop	-	-	-	-	-	-	-	-	-	-	-	?	?	X	?	-	-	-	-
Abudanh Survey No. 192	Khirbet Ayl	c. 0,4 ha	Rectangular structure built of thick walls. Corner tower (c. 8m^2) standing c. 2,5m high.	Hilltop/ Roadside	X	X	X	X	X	X	X	-	-	-	-	-	X	X	X	X	?	?	X
Bir Madkhur	Bir Mad-khur	c. 0,11 ha	Late Roman *quadriburgium*	Roadside	-	-	-	-	-	-	-	-	-	-	-	X	X	-	-	X	X	X	X
Saddaqa	Saddaqa	c. 0,96 ha	Corner and interval towers. Extensive internal divisions.	Roadside	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X	X	X	X
ShamAyl Site No. 024	Khirbet ar-Ruways	c. 0,23 ha	Rectangular structure. Thick perimeter wall with internal divisions and possible tower within fort at structure's high point.	Hilltop/ Roadside	X	X	X	X	X	X	X	-	-	-	-	X	X	X	X	X	-	-	-
ShamAyl Site No. 034	Kh. Dubayl	c. 0,28 ha	Rectangular structure on edge of Jabal Shara escarpment overlooking Wadi Arabah along Darb ar-Rasif. Thick perimeter wall (c. 1–1,5m) with possible tower at high point within the fort. Internal divisions and possible gate.	Escarpment/ Roadside	-	-	X	X	X	X	X	-	-	-	-	-	-	-	-	-	-	-	-
ShamAyl Site No. 162	Mulgan East	c. 0,19 ha	Rectangular structure of thick walls overlooking village of and spring of Mulgan.	Slope/ Roadside	-	-	-	-	-	-	-	-	-	-	-	X	X	X	X	X	X	X	X
ShamAyl Site No. 190	Unknown	c. 0,16 ha	Large rectangular structure with two thick perimter walls, two possible gates and potential interior tower. Internal divisions also possible.	Slope	-	-	-	-	-	-	-	-	-	-	-	X	X	X	X	X	X	X	X
ShamAyl Site No. 236	Unknown	0,26 ha	Large rectangular structure on hilltop with good visibility of surrounding landscape. Built of 1m thick walls. Cistern nearby.	Hilltop	?	?	?	?	?	?	?	-	-	-	-	X	X	X	X	X	X	X	X
ShamAyl Site No. 251	Unknown	c. 0,42 ha	Large rectangular structure with tower at center high point with good visibility of surrounding landscape. Cistern nearby.	Hilltop	X	X	X	X	X	X	X	-	-	-	-	X	X	X	X	X	X	X	X
ShamAyl Site No. 255	Khirbet al-Teen	c. 0,21 ha	Rectangular structure with good visibility of surrounding landscape. Built of 1m thick walls. Cistern in NE corner of site.	Hilltop (?)	-	-	-	-	-	-	-	-	-	-	-	X	X	X	X	X	X	X	X

TAB. 31 Qualified list of Pearson correlation coefficients between military structures and other archaeological sites evidenced for the 2nd century AD.

First-Order Properties of 2nd century AD Military Structures – Pearson Correlation Coefficients			
	Forts	**Fortlets**	**Watchtowers**
Agricultural Installations	-	-	-
Agricultural Processing Installations	Very Weak	Very Weak	Moderate
Agricultural Storing Installations	Weak	Moderate	Very Weak
Agricultural Terraces/Fields	Very Weak	Very Weak	Weak
Communication Infrastructures	-	-	-
Caravanserais	Very Weak	Very Weak	Weak
Road Markers	Very Weak	Very Weak	Very Weak
Road Stations	Weak	Weak	Moderate
Roads	Weak	Weak	Very Weak
Routes/Tracks (naqb)	Moderate	Moderate	Weak
Exploitation/Industrial Sites	-	-	-
Industrial/Exploitation Installations	Very Weak	Weak	Weak
Funerary Structures	-	-	-
Cemeteries	Very Weak	Weak	Moderate
Isolated Funerary Monuments	Very Weak	Weak	Moderate
Military Structures	-	-	-
Forts	-	Weak	Very Weak
Fortlets	Weak	-	Very Weak
Fortresses	-	-	-
Watchtower	Very Weak	Very Weak	-
Religious Structures	-	-	-
Isolated Cultic Installations	Very Weak	Very Weak	Weak
Sanctuaries	Very Weak	Very Weak	Weak
Significant Religious/Cultic Structures	Very Weak	Very Weak	Very Weak
Settlements	-	-	-
Cities	-	-	-
Clusters of Buildings	Weak	Moderate	Very Weak
Farms	Very Weak	Weak	Moderate
Towns	Weak	Very Weak	Very Weak
Rural Mansions	Very Weak	Weak	Weak
Villages	Weak	Moderate	Very Weak
Other Structure(s) and/or Feature(s)	-	-	-
Epigraphical Sites or Locations	Very Weak	Very Weak	Moderate
Find Clusters	Very Weak	Weak	Moderate
Natural and/or Rock-cut Structures of Undetermined Function	Very Weak	Weak	Moderate
Structures of Undetermined Function	Very Weak	Weak	Moderate
Walls of Undetermined Function	Weak	Weak	Moderate
Water Structures	-	-	-
Dams/Barrages	Very Weak	Very Weak	Very Weak
Springs	Strong	Weak	Weak
Water Conduits	Very Weak	Very Weak	Weak
Water Storage Installations	Weak	Very Weak	Moderate
Wells	Weak	Weak	Weak

TAB. 32 Overview of the archaeological characteristics and datings of the possible fortlets/road stations in the Petraean hinterland.

Characteristics of Possible Fortlets/Road Stations in the Petraean Hinterland

Plate No.	Site No.	Site Name	Size	Archaeological Characteristics	Location	12th C. BC	11th C. BC	10th C. BC	9th C. BC	8th C. BC	7th C. BC	6th C. BC	5th C. BC	4th C. BC	3rd C. BC	2nd C. BC	1st C. BC	1st C. AD	2nd C. AD	3rd C. AD	4th C. AD	5th C. AD	6th C. AD	7th C. AD
1	ARNAS Site No. 92	At-Tiyir	c. 0,07 ha	Rectangular structure on slope facing Fardakh. Built of thick walls (c. 2m wide) with internal divisions and possible gate.	Slope/ Road-side?	X	X	X	X	X	X	X	-	X	X	X	X	X	X	X	X	X	X	X
2	ShamAyl Site No. 114	Unknown	c. 0,08 ha	Rectangular structure on a hilltop.	Hilltop	-	-	X	X	X	X	X	-	-	-	-	X	X	X	X	X	X	X	X
3	PHSP Site 121	Seil Abu Mrerah	c. 0,04 ha	Rectangular structure with possible internal division and thick (c. 1m wide) walls along Naqb Abu Mrerah.	Roadside	-	-	-	-	-	-	-	-	-	-	-	X	X	X	-	-	-	-	-
4	Abudanh Survey No. 219	Abu Danna	c. 0,05 ha	Squarish structure with internal division and large enclosed area, possibly an open courtyard. Overlooking settlement of Abu Danna.	Hilltop/ Roadside	-	-	-	-	-	-	-	-	-	-	-	X	X	X	X	-	-	-	-
5	Qasr et-Tayyiba	Qasr et-Tayyiba	c. 0,06 ha	Squarish structure with 1,15 thick external walls and possible tower/gate.		-	-	-	-	-	-	-	-	-	-	-	X	X	X	-	-	-	-	-
6	ShamAyl Site No. 131	Unknown	c. 0,04 ha	Rectangular structure with possible internal divisions built of thick walls with good visibility over surrounding landscape.	Plain	-	-	-	-	-	-	-	-	-	-	-	X	X	X	X	X	X	X	X
7	ARNAS Site No. 039	Khirbet ar-Rakham	c. 0,06 ha	Rectangular structure with internal divisions around possible small open courtyard.	Hilltop/ Roadside	-	-	-	-	-	-	-	-	-	-	-	X	X	X	X	X	X	X	X
8	ARNAS Site No. 042	?	c. 0,04 ha	Square structure with internal divisions with "podium" in front, which may have been an open courtyard.	Roadside												X	X	X	X	X	X	X	X
9	ShamAyl Site No. 177	Unknown	c. 0,08 ha	Rectangular structure built along stretch of VNT between Wadi Musa and Nejel.	Roadside	-	-	-	-	-	-	-	-	-	-	-	X	X	X	X	X	X	X	X
10	Sabra	Sabra	c.0,05 ha	Rectangular structure with internal division and possible courtyard.	Slope/ Roadside	-	-	-	-	-	-	-	-	-	-	-	?	?	?	?	?	-	-	-
11	ShamAyl Site No. 347	Rujum Batahe	c. 0,03 ha	Rectangular structure with internal divisions.	Plain/ Roadside	-	-	-	-	-	-	-	-	-	-	-	X	X	X	X	X	X	X	X
12	Qasr Umm Rattam	Qasr Umm Rattam	c. 0,06 ha	Squarish structure along Wadi Musa route.	Roadside	-	-	-	-	-	-	-	-	-	-	-	X	X	X	X	X	-	-	-
13	Abudanh Survey No. 144	Umm Hilal	c. 0,05 ha	Rectangular structure with internal divisions around possible courtyard.	Hilltop/ Roadside	-	-	-	-	-	-	-	-	-	-	-	-	X	X	-	-	-	-	-
14	Abudanh Survey No. 233	Khirbet al-Hasaieh	c. 0,06 ha	Rectangular structure with internal divisions near spring.	Plain	-	-	-	-	-	-	-	-	-	-	-	-	X	X	X	?	?	?	?
15	Abudanh Survey No. 274	Khirbet al-Unaiq	c. 0,05 ha	Squarish structure with thick (1m) perimeter walls and internal divisions. Possible open courtyard adjacent to structure.	Hilltop	-	-	-	-	-	-	-	-	-	-	-	-	X	X	?	?	?	?	?

TAB. 33 Overview of the archaeological characteristics and datings of the possible watchtowers in the Petraean hinterland.

Characteristics of Possible Watchtowers in the Petraean Hinterland

Plate No.	Site No.	Site Name	Size	Archaeological Characteristics	Location	12th C. BC	11th C. BC	10th C. BC	9th C. BC	8th C. BC	7th C. BC	6th C. BC	5th C. BC	4th C. BC	3rd C. BC	2nd C. BC	1st C. BC	1st C. AD	2nd C. AD	3rd C. AD	4th C. AD	5th C. AD	6th C. AD	7th C. AD
1	Abudanh Survey No. 020	Tell Qrah	c. 0,005 ha ($54m^2$)	Isolated rectangular structure on hilltop.	Hilltop	X	X	X	X	X	X	X	-	-	-	-	X	X	-	-	-	-	-	-
2	Abudanh Survey No. 260/ARNAS Site No. 002	Ayl	c. 0,004 ha ($36m^2$)	Isolated rectangular structure on hilltop overlooking Khirbet Ayl and associated spring.	Hilltop	X	X	X	X	X	X	X	-	-	-	-	X	X	-	-	X	X	X	X
3	ARNAS Site No. 017	unknown	c. 0,006 ha ($64m^2$)	Isolated rectangular structure on hilltop along Darb ar-Rasif.	Hilltop/ Roadside	-	-	X	X	X	X	X	-	-	-	-	-	-	-	-	-	-	-	-
4	ARNAS Site No. 018	unknown	c. 0,003 ha ($25m^2$)	Isolated rectangular structure on hilltop overlooking Sadaqqa.	Hilltop	-	-	X	X	X	X	X	-	-	-	-	-	-	-	-	X	X	X	X
5	ARNAS Site No. 022	unknown	c. 0,003 ha ($30m^2$)	Isolated rectangular structure on hilltop overlooking Darb ar-Rasif, Rujm Sadaqqa, Ayl tower.	Hilltop/ Roadside	-	-	X	X	X	X	X	-	-	-	-	X	X	X	X	X	-	-	-
6	ShamAyl Site No. 116	Rujm Basta	c. 0,004 ha ($36m^2$)	Isolated rectangular structure with (probably modern) corrals on hilltop N of Basta with good view of surroundings.	Hilltop	-	-	X	X	X	X	X	-	-	-	-	X	X	X	X	X	-	-	-
7	ShamAyl Site No. 208	Unknown	c. 0,006 ha ($63m^2$)	Isolated rectangular structure on steep slope with good view of surroundings to S and W (esp. Ain Arja spring).	Slope	-	-	?	?	?	?	?	-	-	-	-	X	X	X	X	X	X	X	X
8	ShamAyl Site No. 269	Unknown	c. 0,003 ha ($25m^2$) each	2 isolated square structures 20m apart on prominent hilltop W of the Khatt Shebib.	Hilltop	-	-	X	X	X	X	X	-	-	-	-	X	X	X	X	X	X	X	X
9	IUBP_ST10	Umm al-Biyara	c. 0,007 ha ($70m^2$)	Isolated rectangular structure on SW edge of Umm al-Biyara with good view of surroundings.	Hilltop	-	-	-	-	-	X	X	-	-	-	-	X	X	X	-	-	-	-	-
10	Qasr Umm Rattam	Qasr Umm Rattam	c. 0,01 ha ($63m^2$)	Rectangular structure on hilltop overlooking Wadi Musa pass and main *qasr*.	Hilltop/ Roadside	-	-	-	-	-	-	-	-	-	-	-	X	X	X	X	X	-	-	-
11	Abudanh Survey No. 108	Umm al-Futtus	c. 0,004 ha ($35m^2$)	Isolated rectangular structure on hilltop with good view of surroundings.	Hilltop	-	-	-	-	-	-	-	-	-	-	-	X	X	X	X	X	X	X	X
12	Abudanh Survey No. 134	Rujm al-Khatebieh	c. 0,003 ha ($25m^2$)	Isolated rectangular structure on hilltop overlooking surroundings.	Hilltop	-	-	-	-	-	-	-	-	-	-	-	X	X	-	-	-	-	-	-
13	Abudanh Survey No. 159	Ras al-Mshbush	c. 0,002 ha ($18{,}5m^2$)	Isolated square structure on hilltop overlooking surroundings, incl. Abudanh's Zhara road.	Hilltop/ Roadside	-	-	-	-	-	-	-	-	-	-	-	X	X	X	X	X	-	-	-

Plate No.	Site No.	Site Name	Size	Archaeological Characteristics	Location	12th C. BC	11th C. BC	10th C. BC	9th C. BC	8th C. BC	7th C. BC	6th C. BC	5th C. BC	4th C. BC	3rd C. BC	2nd C. BC	1st C. BC	1st C. AD	2nd C. AD	3rd C. AD	4th C. AD	5th C. AD	6th C. AD	7th C. AD
14	Abudanh Survey No. 222	Rujm Abu Halaqeh	c. 0,004 ha ($42m^2$)	Isolated square structure on hilltop overlooking surroundings.	Hilltop	-	-	-	-	-	-	-	-	-	-	-	X	X	X	?	-	-	-	-
15	Abudanh Survey No. 238_1	Ayl	c. 0,004 ha ($36m^2$)	Isolated square structure on hilltop with good view of surroundings.	Hilltop	-	-	-	-	-	-	-	-	-	-	-	X	X	-	?	X	-	-	-
16	ARNAS Site No. 154	unknown	c. 0,003 ha ($35m^2$)	Isolated rectangular structure on hilltop along Darb ar-Rasif. Good view to nearby (military) structures.	Hilltop	-	-	-	-	-	-	-	-	-	-	-	X	X	X	X	X	-	-	-
17	ARNAS Site No. 306	unknown	c. 0,002 ha ($25m^2$)	Isolated square structure on hilltop. Good view of surroundings. Supposedly associated with ARNAS Site No. 307.	Hilltop	-	-	-	-	-	-	-	-	-	-	-	X	X	X	X	X	-	-	-
18	FJHP S54	Rujm ar-Ruba'i	c. 0,009 ha ($92{,}64m^2$)	Isolated square structure on hilltop along Naqb ar-Ruba'i with good view over surroundings.	Hilltop	-	-	-	-	-	-	-	-	-	-	-	X	X	X	?	X	X	-	-
19	ShamAyl Site No. 6	Rujum	c. 0,003 ha ($30m^2$)	Isolated squarish structure on hilltop with good view of its surroundings.	Hilltop	-	-	-	-	-	-	-	-	-	-	-	X	X	X	X	X	X	X	X
20	ShamAyl Site No. 258	Unknown	c. 0,002 ha ($20m^2$)	Isolated squarish structure on slope overlooking plain and possibly associated with a boundary wall.	Slope	-	-	-	-	-	-	-	-	-	-	-	X	X	X	X	X	X	X	X
21	PHSP Site 037	North Ridge	c. 0,004 ha ($39m^2$)	Rectangular structure on W edge of the "North Ridge" in Petra with clear view of city center and northen outskirts of Petra.	Hilltop	-	-	-	-	-	-	-	-	-	-	-	-	X	X	-	-	-	-	-
22	PHSP Site 080	ar-Rajif	c. 0,004 ha ($36m^2$)	Isolated rectangular structure on hilltop overlooking al-Farasha and as-Sto'e plains south of Petra as well as Darb ar-Rasif.	Hilltop/ Roadside	-	-	-	-	-	-	-	-	-	-	-	-	X	X	X	X	X	X	X
23	PHSP Site 003-ST006	Jabal al-Khubtah-West	c. 0,003 ha ($31m^2$)	Rectangular structure on western edge of the "highplace" on Jabal al-Khubtah with excellent view over Petra's city center.	Hilltop	-	-	-	-	-	-	-	-	-	-	-	-	X	X	-	-	-	-	-
24	PHSP Site 016-ST026	Ras Suleiman	c. 0,003 ha ($30m^2$)	Rectangular structure on hilltop of Ras Suleiman associated with additional large structure on hilltop. Clear view over Petra's city center and as-Sto'e plain.	Hilltop	-	-	-	-	-	-	-	-	-	-	-	-	X	X	X	X	-	-	-
25	FJHP Ext079	Abu Khushayba	c. 0,004 ha ($36m^2$)	Isolated square structure built on steep slope/hill overlooking Abu Khusheiba and Naqb Saqqara.	Hilltop/ Roadside	-	-	-	-	-	-	-	-	-	-	-	-	X	X	-	X	X	X	-
26	JSS 084	unknown	c. 0,001 ha ($12m^2$)	Isolated rectangular structure on hilltop with good view.	Hilltop	-	-	-	-	-	-	-	-	-	-	-	-	X	X	-	-	-	-	-
27	as-Shara_1	unknown	c. 0,006 ha ($56m^2$)	Isolated rectangular structure on slope with good view.	Slope	-	-	-	-	-	-	-	-	-	-	-	-	X	X	-	-	-	-	-

Plate No.	Site No.	Site Name	Size	Archaeological Characteristics	Location	12th C. BC	11th C. BC	10th C. BC	9th C. BC	8th C. BC	7th C. BC	6th C. BC	5th C. BC	4th C. BC	3rd C. BC	2nd C. BC	1st C. BC	1st C. AD	2nd C. AD	3rd C. AD	4th C. AD	5th C. AD	6th C. AD	7th C. AD
28	PHSP Site 077	Fok al-Magbara al-Bdul	c. 0,003 ha ($30m^2$)	Isolated rectangular structure on hilltop with good view of surroun-dings.	Hilltop	-	-	-	-	-	-	-	-	-	-	-	-	X	X	-	-	-	-	-
29	Abudanh Survey No. 132	Umm al-Jarad	c. 0,002 ha ($24m^2$)	Isolated rectangular structure on hilltop with good view of surroun-dings.	Hilltop	-	-	-	-	-	-	-	-	-	-	-	-	-	X	?	-	-	-	-
30	Abudanh Survey No. 177	Rujm Mu-haidhrat	c. 0,003 ha ($34m^2$)	Isolated squarish structure on hilltop with good view of surroundings.	Hilltop	-	-	-	-	-	-	-	-	-	-	-	-	-	-	?	X	-	-	-
31	FJHP Ext071	unknown	c. 0,004 ha ($42m^2$)	Isolated rectangular structure on slope overlooking surroundings.	Slope/ Roadside	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X	X	-	-
32	Abudanh Survey No. 038	Rujm al-Minbijis	c. 0,009 ha ($90m^2$)	Isolated squarish structure on hilltop with good view of surroundings.	Hilltop	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X	X	X	X

TAB. 34 Overview of the archaeological characteristics and datings of other structures of possible military and/or non-military function in the Petraean hinterland.

Characteristics of Other Structures of Possible Military/Communication Function in the Petraean Hinterland																								
Plate No.	Site No.	Site Name	Size	Archaeological Characteristics	Location	12th C. BC	11th C. BC	10th C. BC	9th C. BC	8th C. BC	7th C. BC	6th C. BC	5th C. BC	4th C. BC	3rd C. BC	2nd C. BC	1st C. BC	1st C. AD	2nd C. AD	3rd C. AD	4th C. AD	5th C. AD	6th C. AD	7th C. AD
1	Abudanh Survey Site No. 047/ ShamAyl Site No. 152	Tell Udhruh (Dubais)	0,037 ha ($368m^2$)	Isolated rectangular structure on prominent hilltop SE of Udruh. Internal divisions and cave inside. Outer earthen ditch.	Hilltop/ Roadside	X	X	X	X	X	X	X	X	X	-	-	-	-	X	-	-	-	-	-
2	Abudanh Survey No. 030	Rujm al-Jarba	c. 0,017 ha ($165m^2$)	Isolated rectangular structure on hilltop S of Khirbet al-Jarba with possible internal divisions.	Hilltop	X	X	X	X	X	X	X	-	-	-	-	-	-	-	-	-	-	-	-
-	L2HE_2006_045	Khirbet al-Iraq	?	Structure on hilltop. Presumed Iron Age fort/tower.	Hilltop	?	?	?	?	?	?	?	-	-	-	-	-	-	-	-	-	-	-	-
3	ARNAS Site No. 045	Ras 'Urayta	c. 0,03 ha	Rectangular structure built of thick perimeter walls and possible tower associated with it. Situated on hilltop.	Hilltop	-	-	?	?	?	?	?	-	-	-	-	X	X	X	X	X	X	X	X
4	Abudanh Survey No. 045/ ShaymAyl Site No. 154	Jabal al-Tahkeem (al-'Ashari)	c. 0,04 ha	L-shaped structure with thick external walls commanding good view over surroundings.	Hilltop	-	-	X	X	X	X	X	-	-	-	-	X	X	X	?	?	X	X	X
5	ShamAyl Site No. 200	Rujm Abu Al-Alaq	c. 0,04 ha ($400m^2$)	Rectangular structure on prominent hilltop. Good visibility to/from the site.	Hilltop	-	-	X	X	X	X	X	-	-	-	-	X	X	X	X	X	X	X	X
6	ARNAS Site No. 024	Rujum 'Utayq	c. 0,026 ha ($225m^2$)	Isolated rectangular structure along Darb ar-Rasif with view to Rujm Sadaqqa and Ain Juwayza West.	Roadside	-	-	X	X	X	X	X	-	-	-	-	-	-	-	-	-	-	-	-
7	ARNAS Site No. 008/ Abudanh Survey No. 286	Rujm Sadaqqa	c. 0,034 ha ($341m^2$)	Isolated square structure on hilltop with good view of surroundings. Excavation revealed tomb. Possible later watchtower.	Hilltop	-	-	X	X	X	X	X	-	-	-	-	X	X	X	X	X	X	X	X
8	ARNAS Site No. 020	unknown	c. 0,023 ha ($225m^2$)	Isolated rectangular structure on hilltop within agricultural area overlooking Darb ar-Rasif.	Hilltop/ Roadside /Agricultural Area	-	-	X	X	X	X	X	-	-	-	-	-	-	-	-	X	X	X	X
9	Abudanh Survey No. 032	Rujm al-Mattwi	c. 0,024 ($245m^2$)	Isolated square structure on low hill with good view of surroundings.	Hilltop	-	-	-	-	-	-	-	-	-	-	-	X	X	-	-	X	X	X	X
10	ShamAyl Site No. 094	Kh. al-Farqadiyyah	c. 0,06 ha	Rectangular structure with internal divisions and incorporated cistern on a flat hill overlooking a nearby spring.	Hilltop	-	-	-	-	-	-	-	-	-	-	-	X	X	X	X	X	X	X	X
11	ARNAS Site No. 071	unknown	c. 0,03 ha	Rectangular structure on hilltop overlooking surroundings.	Hilltop	-	-	-	-	-	-	-	-	-	-	-	X	X	X	X	X	X	X	X
12	ShamAyl Site No. 185	Unknown	c. 0,07 ha	Rectangular structure built along stretch of VNT, N of the site.	Roadside	-	-	-	-	-	-	-	-	-	-	-	X	X	X	X	X	X	X	X
13	ShamAyl Site No. 126	Rujm al-Khatabiyya	c. 0,023 ha ($225m^2$)	Isolated structure with good view of surroundings.	?	-	-	-	-	-	-	-	-	-	-	-	X	X	X	X	X	X	X	X

Plate No.	Site No.	Site Name	Size	Archaeological Characteristics	Location	12th C. BC	11th C. BC	10th C. BC	9th C. BC	8th C. BC	7th C. BC	6th C. BC	5th C. BC	4th C. BC	3rd C. BC	2nd C. BC	1st C. BC	1st C. AD	2nd C. AD	3rd C. AD	4th C. AD	5th C. AD	6th C. AD	7th C. AD
14	Abudanh Survey No. 102	Rujm al-Bitar	c. 0,03 ha	Rectangular structure/mound of c. 2,5m preserved height.	Hilltop/ Roadside	-	-	-	-	-	-	-	-	-	-	-	X	X	X	-	-	-	-	-
15	ShamAyl Site No. 318	Unknown	c. 0,08 ha	Rectangular structure. Good visibility of landscape and nearby spring.	?	-	-	-	-	-	-	-	-	-	-	-	X	X	X	X	X	-	-	-
16	Abudanh Survey No. 264	Khirbet al-Hajareen	c. 0,04 ha	Rectangular structure with thick perimeter walls and internal divisions around courtyard.	Slope	-	-	-	-	-	-	-	-	-	-	-	X	X	?	X	X	X	X	X
17	ShamAyl Site No. 303	Unknown	c. 0,012 ha ($120m^2$)	Isolated rectangular structure on hilltop overlooking Kh. Jarba and road to Udruh.	Hilltop	X	X	X	X	X	X	X	-	-	-	-	X	X	X	X	X	X	X	X
18	ShamAyl Site No. 133	Unknown	0,007 ha ($72m^2$)	Isolated rectangular structure with view to Rujm Basta (limited view to W and S).	Hilltop?	X	X	X	X	X	X	X	-	-	-	-	-	-	-	-	X	X	X	X
19	ShamAyl Site No. 163	Unknown	c. 0,005 ha ($48m^2$)	Isolated rectangular structure on slope in agricultural area with good view of surroundings.	Slope/ Agricul-tural area	-	-	?	?	?	?	?	-	-	-	-	X	X	X	X	X	-	-	-
20	ShamAyl Site No. 085	Rujm 'Ayn al-Hajim	c. 0,012 ha ($120m^2$)	Several structures with one central structure on a "high terrace" over-looking a nearby spring.	Hilltop	-	-	X	X	X	X	X	-	-	-	-	X	X	X	X	X	X	X	X
21	ARNAS Site No. 188	unknown	c. 0,012 ha ($121m^2$)	Isolated square structure on hilltop with internal depressions and good view of surroundings.	Hilltop	-	-	-	-	-	-	-	-	-	-	-	X	X	X	X	X	X	X	X
21	JSS 070	unknown	c. 0,01 ha	Rectangular structure with thick walls and internal divisions situated on hilltop. With possible cistern.	Hilltop	-	-	-	-	-	-	-	-	-	-	-	X	X	X	-	-	-	-	-
23	ShamAyl Site No. 76	Unknown	c. 0,007 ha ($66m^2$)	Isolated rectangular structure on hilltop with good visibility over sur-roundings, incl. agricultural area.	Hilltop/ Agricul-tural area	-	-	-	-	-	-	-	-	-	-	-	X	X	X	X	X	X	X	X
24	Abudanh Survey No. 236	Ayl	c. 0,01ha ($100m^2$)	Isolated square structure on hilltop with good view of surroundings, particularly agricultural area to the SE and E below.	Hilltop/ Agri-cultural Area	-	-	-	-	-	-	-	-	-	-	-	X	X	X	X	X	-	-	-
-	PHSP Site 144	Wadi al-Arrja	?	Rectilinear structure with thick pe-rimeter walls along modern al-Jarba – Wadi Musa road.	Hilltop/ Roadside	-	-	-	-	-	-	-	-	-	-	-	X	X	X	-	-	-	-	-
	Raikes' Site B29	?	?	Raike describes structure as a "Naba-taean fort or guard post." No further information.	Plain	-	-	-	-	-	-	-	-	-	-	-	X	X	X	-	-	-	-	-
25	FJHP Ext101	unknown	c. 0,01 ha ($100m^2$)	Isolated square structure on hilltop with good view of surrounding landscape.	Hilltop	-	-	-	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-
-	WMWS 1996 Bayda 28	Khirbat al-Qarn	?	Nabatean „fortress"on hilltop near Beidha with associated structures below.	Hilltop	-	-	-	-	-	-	-	-	-	-	-	-	X	X	-	-	-	-	-
-	JSS 048	unknown	?	Presumed "defensive" structure.	Roadside	-	-	-	-	-	-	-	-	-	-	-	-	-	X	X	X	X	X	X

TAB. 35 General distribution characteristics for 1st century AD religious structures in the Petraean hinterland (standard distances and GIV).

	1st century AD	
	Standard Distance Between Points (m)	**Global Intensity Value (per km²) (GIV)**
Religious Structures	3276,96	0,024
Isolated Cultic Installations	3387,50	0,018
Sanctuaries	2811,74	0,006
Significant Religious/Cultic Structures	-	0,006

TAB. 36 Environmental characteristics of 1st century AD religious structures in the Petraean hinterland.

	Slope Values (%)			**Elevation Values (m)**			**Distance to Streams (m)**			**Geological Zones covered (%)***												
	Min	**Max**	**Avg**	**Min**	**Max**	**Avg**	**Min**	**Max**	**Avg**	**L**	**U**	**LSl**	**S**	**F**	**V**	**G**	**Q**	**C**	**A**	**LS**	**AF**	**FG**
1st century AD																						
Religious Structures	4,22	96,33	30,05	926,92	1265,79	1044,36	0	755,07	209,15	-	-	-	92,11	5,26	2,63	-	-	-	-	-	-	-
Isolated Cultic Installations	4,78	81,39	29,35	926,92	1265,79	1043,82	0	750,93	168,10	-	-	-	93,3	6,70	-	-	-	-	-	-	-	-
Sanctuaries	4,22	96,33	32,32	931,85	1258	1046,07	0	755,07	341,39	65,28	4,17	1,39	88,89	-	11,11	-	-	-	-	-	-	-
Significant Religious/Cultic Structures	16,50	16,50	-	1316,16	1316,16	-	62,36	62,36	-	-	-	-	-	100	-	-	-	-	-	-	-	-

*: **L**= Limestone; **U**= Undifferentiated; **LSl**= Landslip; **S**= Sandstone; **F**= Fluviatile; **V**= Volcanic; **G**= Gravel; **Q**= Quartz; **C**= Conglomerate; **A**= Alluvium; **LS**= Lake Sediments; **AF**= Alluvial Fan; **FG**= Fluviatile Gravel

TAB. 37 Qualified list of Pearson correlation coefficients between religious structures and other archaeological sites dating to the 1st century AD.

First-Order Properties of 1st century AD Religious Structures – Pearson Correlation Coefficients

	Religious Structures	Isolated Cultic Installations	Sanctuaries	Significant Religious/ Cultic Structures
Agricultural Installations	Moderate	Strong	Moderate	-
Agricultural Processing Installations	Weak	Moderate	Moderate	-
Agricultural Storing Installations	Moderate	Very Weak	Very Weak	-
Agricultural Terraces/Fields	Moderate	Strong	Moderate	-
Communication Infrastructures	Very Weak	Very Weak	Very Weak	-
Caravanserais	Very Weak	Very Weak	Very Weak	-
Road Marker	Very Weak	Very Weak	Very Weak	-
Road Stations	Very Weak	Very Weak	Very Weak	-
Roads	Very Weak	Very Weak	Very Weak	-
Routes/Tracks (naqb)	Very Weak	Very Weak	Very Weak	-
Exploitation/Industrial Sites	Strong	Strong	Strong	-
Industrial/Exploitation Installations	Strong	Strong	Strong	-
Funerary Structures	Strong	Strong	Moderate	-
Cemeteries	Moderate	Moderate	Moderate	-
Isolated Funerary Monuments	Moderate	Strong	Moderate	-
Military Structures	Weak	Moderate	Weak	-
Forts	Very Weak	Very Weak	Very Weak	-
Fortlets	Very Weak	Very Weak	Very Weak	-
Fortresses	Very Weak	Very Weak	Very Weak	-
Watchtower	Moderate	Moderate	Weak	-
Religious Structures	-	-	-	-
Isolated Cultic Installations	-	-	Moderate	-
Sanctuaries	-	Moderate	-	-
Significant Religious/Cultic Structures	-	-	-	-
Settlements	Weak	Very Weak	Weak	-
Cities	-	-	-	-
Clusters of Buildings	Very Weak	Very Weak	Very Weak	-
Farms	Very Weak	Very Weak	Weak	-
Towns	Very Weak	Very Weak	Very Weak	-
Rural Mansions	Moderate	Weak	Moderate	-
Villages	Very Weak	Very Weak	Very Weak	-
Other Structure(s) and/or Feature(s)	Weak	Moderate	Moderate	-
Epigraphical Sites or Locations	Strong	Strong	Moderate	-
Find Clusters	Moderate	Moderate	Moderate	-
Natural and/or Rock-cut Structures of Undetermined Function	Strong	Strong	Moderate	-
Structures of Undetermined Function	Weak	Moderate	Weak	-
Walls of Undetermined Function	Weak	Moderate	Weak	-
Water Structures	Weak	Strong	Very Weak	-
Dams/Barrages	Moderate	Strong	Very Weak	-
Springs	Very Weak	Very Weak	Very Weak	-
Water Conduits	Weak	Moderate	Very Weak	-
Water Storage Installations	Weak	Moderate	Weak	-
Wells	Very Weak	Very Weak	Very Weak	-

TAB. 38 Characteristics of Class A routes in the western Petraean hinterland.

Class A Routes																
Naqb Name (English)	Naqb Name (Arabic)	Travel Mode	Min. Slope (%)	Max. Slope (%)	Avg. Slope (%)	Length (m)	Geological Zones covered (%)*							Seasonality	Beginning	Destination
							L	U	V	S	A	C	F			
Naqb al-Aqab	نقب العقب	Donkey, Horse, Mule, Camel	0	57,80	11,30	5358,25	22,17	0	5,56	24,35	0	0	0	All	Dawrum Dey	Al-Farsh plain; Beidha
Naqb al-Farsh	نقب الفرش	Donkey, Horse, Mule, Camel	0	38,92	9,43	4517,10	0	0	0	100	0	0	0	All	Al-Farsh plain	Beidha (Shammasa); Petra
Naqb ar-Risha'rish	نقب ارشاريش	Donkey, Horse, Mule, Camel	0,01	90,84	10,52	11186,49	0	1,54	11,28	48,21	0	0	38,97	All	Sabra	As-Sadeh
Wadi Sabra	وادي صبرة	Donkey, Horse, Mule, Camel	0,06	35,90	8,57	3953,17	0	0	0	12,43	0	0	87,57	All	Al-Farasha plain	Sabra
Naqb ar-Ruba'i	نقب الرباعي	Donkey, Horse, Mule, Camel	0,03	57,70	11,75	7368,64	45,37	0	15,34	35,46	0	3,51	0,32	All	Al-Farasha plain	Abu Khusheiba; Umm Qamar pass
Wadi Jawf Ahmar	-	Donkey, Mule, Camel	0	21,48	5,09	9992,12	38,55	1,32	0	0,66	45,81	0	13,66	All	Umm Qamar pass	Khirbet as-Faysif
Wadi al-Ghurab East	-	Donkey, Mule, Camel	0,02	38,30	7,70	2044,12	0	0	0	99,06	0	0	0,94	All	Naqb al-Farsh	Siq al-Amti; Beidha
Wadi Musa	-	Donkey, Mule, Camel	0	39,68	5,32	9864,37	30,13	2,46	0,67	28,12	45,45	0	13,17	All	Dawrum Dey	Naqb Abu Mrerah; Umm Rattam; (Khirbet as-Faysif)
Naqb ad-Dab'e	نقب ادبه	Donkey, Horse, Mule, Camel	0,06	41,54	15,95	1511,89	0	0	0	75,38	0	0	24,62	All	Al-Farsaha plain	Sabra
Naqb Abu Mrerah	نقب ابو مريره	Donkey, Horse, Mule, Camel	0	61,10	12,29	3992,13	71,60	9,26	5,56	12,35	0	0	1,23	All	Wadi Musa	(Bir Madkhur); Naqb al-Aqab
Naqb as-Sto'e North	-	Donkey, Horse, Mule, Camel	0,02	45,91	8,14	6618,27	0	0	0	100	0	0	0	All	Petra	Al-Farasha plain (north)
Naqb as-Sto'e South	-	Donkey, Horse, Mule, Camel	0,05	29,11	6,99	4167,97	0	0	0	73,73	0	0	26,26	All	Petra	Al-Farasha plain (south)
Wadi Turkmaniye	-	Donkey, Horse, Mule, Camel	0,01	35,46	9,05	2828,73	0	0	0	100	0	0	0	All	Umm Sayhoun	Petra
Darb al-Lethie	-	Donkey, Horse, Mule, Camel	0	25,19	5,42	1381,10	0	0	0	95,31	0	0	4,69	All	Al-Begh'ah (Naqb Namala)	Wadi al-Ghurab (East)
Naqb ad-Beidab	-	Donkey, Horse Mule, Camel	0,09	50,85	12,49	3818,36	4,82	0	25,90	66,27	0	0	3,01	All	Sabra	Abu Khusheiba
Mean Values:			**0,023**	**44,65**	**9,33**	**5240,18**	**14,18**	**0,97**	**4,29**	**58,09**	**6,08**	**0,23**	**14,30**			

*: **L** = Limestone; **U**= Undifferentiated; **V**= Volcanic; **S**= Sandstone; **A**= Alluvium; **C**= Conglomerate; **F**= Fluviatile.

TAB. 39 Characteristics of Class B routes in the western Petraean hinterland.

Class B Routes

Naqb Name (English)	Naqb Name (Arabic)	Travel Mode	Min. Slope (%)	Max. Slope (%)	Avg. Slope (%)	Length (m)	Geological Zones covered (%)*							Seasonality	Beginning	Destination
							L	U	V	S	A	C	F			
Naqb al-Asmar Sheiq an-Nisr	نقب السمر شق النسر	Donkey, Mule, Walking	0,58	83,35	19,19	2698,08	23,68	0	36,84	39,47	0	0	0	All	Naqb al-Aqab-Naqb Abu Mrerah junction (Hamade al-Somrah)	Al-Farsh plain (Jabal Qarun); Naqb al-Farsh
Naqb al-Ghirbe[1]	نقب عقيربه	Donkey, Mule, Walking	0,05	65,67	13,01	7677,67	4,92	7,69	37,23	41,54	0	3,69	0	Dry weather	Al-Farasha plain (Jabal Harun)	Dawrum Dey
Naqb Mistalgile[2]	نقب المستعجاه	Donkey, Mule, Walking	0,06	68,46	21,57	8428,45	17,36	4,82	34,41	8,36	24,76	0	10,29	All	Al-Farasha plain	Umm Qamar pass; Umm Rattam
Naqb Slaysil[3]	نقب سليسالل	Donkey, Walking	1,23	86,67	28,07	4990,45	0	0	64,79	34,74	0	0	0,47	Dry weather	Ras Slaysil; (Beid-ha)	Dawrum Dey
Naqb Namala[4]	نقب نمله	Donkey, Mule, Walking	0	48,97	8,48	28147,36	0,86	2,57	26,64	41,20	1,17	0	15,50	All	Petra	Beidha; ad-Thankia; Bir Madkhur (Wadi Arabah)
Umm Qamar	ام كمعر	Donkey, Mule, Walking	0	36,19	5,33	5568,54	88,45	0	0	0	11,55	0	0	All	Naqb ar-Ruba'i-Wadi Jawf-Ahmar junction	Khirbet as-Faysif (Wadi Arabah); Abu Khusheiba
Naqb Saqqara	نقب الزكره	Donkey, Walking	0,04	48,80	15,55	3298,07	10,53	0	20,30	50,38	0	0	18,80	All	Al-Farasha plain	Abu Khusheiba
Naqb Seir al-Begh'er	نقب سحير البقر	Walking	0,42	90,73	42,20	780,62	0	0	100	0	0	0	0	Dry weather	Seir al-Begh'er	Naqb Slaysil
Siq[5]	-	Donkey, Walking	0,02	83,81	10,18	7245,61	16	0,61	0	43,69	0	0	0	All	Gaia (Wadi Musa)	Petra
En-Geb	-	Donkey, Walking	0,05	89,82	12,28	4158,14	0	0	0	100	0	0	0	All	Gaia (Wadi Musa)	Petra
Wadi al-Mu'aysirah East	-	Donkey, Walking	0,06	93,49	12,82	4076,90	0	0	0	100	0	0	0	All	Al-Begh'ah plain (Shammasa)	Petra
Wadi al-Mu'aysirah West	-	Donkey, Walking	0	118,73	11,57	4119,29	0	0	0	100	0	0	0	All	Al-Begh'ah plain (Shammasa)	Petra
Wadi as-Siyyagh	-	Donkey, Walking	0,47	66,74	17,85	1912,77	0	0	100	0	0	0	0	Dry weather	Wadi Marwan	Seir al Begh'er
Wadi Marwan	-	Donkey, Walking	0,1	100,20	22,63	3154,29	0	0	51,56	48,44	0	0	0	Dry weather	Naqb al-Farsh	Wadi Siyyagh
Mean Values:	**0,22**	**77,26**	**17,20**	**6161,16**	**11,56**	**1,12**	**33,70**	**43,42**	**2,68**	**0,26**	**3,22**					

*: **L** = Limestone; **U**= Undifferentiated; **V**= Volcanic; **S**= Sandstone; **A**= Alluvium; **C**= Conglomerate; **F**= Fluviatile.

[1] Naqb al-Ghirbe also covers granite to 4,92 %.

[2] The slope values listed here represent the upper part of Naqb Mistalgile.

[3] The slope values listed here represent Naqb Slaysil from its actual beginning at Ras Slaysil.

[4] Naqb Namala also covers fluviatile gravel to 12,07 %.

[5] The Siq also covers landslip to 39,69 %.

TAB. 40 Qualitative and quantitative assessment of route-related structures along Class A and B routes.

Stations	Count Class A Routes	Count Class B Routes	Connections	Presumed Function
Beidha	**2** (Naqb al-Farsh, Wadi al-Ghurab)	**1** (Naqb Namala)	Al-Farsh plain – Shammasa – Petra	Major caravan halt for groups coming via Naqb Abu Mrerah, Naqb al-Aqab, Naqb al-Farsh and Naqb Namala
Qasr Namala	-	**1** (Naqb Namala)	Petra – Bir Madkhur (Wadi Arabah)	Minor relay station
Bir Madkhur	**1** (Wadi Arabah)	**1** (Naqb Namala)	Qasr Namala – Khirbet as-Faysif – Khirbet Umm Qhuntera – (Faynan)	Major caravan halt along north-south axis in the Wadi Arabah
Khirbet as-Faysif	**2** (Wadi Jawf Ahmar, Wadi Arabah)	**1** (Umm Qamar)	Seir Umm Qamar – Khirbet Umm Qhuntera – Umm Rattam – Bir Madkhur – Qaa' as-Sayidiyeen	Major caravan halt and infrastructural hub (Petra–Gaza road)
Qasr Umm Rattam	**1** (Wadi Musa)	**1** (Naqb Mistalgile)	Dawrum Dey – Khirbet as-Faysif – Bir Makdhur – al-Farasha plain	Major caravan halt also serving less supraregional trade/travel purposes (local).
Dawrum Dey	**3** (Naqb al-Aqab, Wadi Musa, Naqb Abu Mrerah)	**2** (Naqb al-Ghirbe, Naqb Slaysil)	al-Farsh plain – Umm Rattam – Ras Slaysil	Major caravan halt. Possibly location for changing travel modes and re-loading
Seir Umm Qamar	**2** (Naqb ar-Ruba'i, Wadi Jawf Ahmar)	**2** (Umm Qamar, Naqb Mistalgile)	al-Farasha plain – Wadi Arabah – Khirbet as-Faysif	Relay station mostly serving local/regional trade/travel purposes
Sabra	**4** (Naqb ar-Risha' rish, Wadi Sabra, Naqb ad-Beidab, Naqb ad-Dab'e)	-	Al-Farasha plain – Abu Khusheiba – Wadi Arabah – as-Sadeh	Major caravan halt/town
Abu Khusheiba	**2** (Naqb ad-Beidab, Wadi Abu Khu-sheiba)	**1** (Naqb Saqqara)	al-Farasha plain -Sabra – Wadi Arabah	Significant trade-related settlement

TAB. 41 Environmental characteristics of 1st century AD funerary structures in the Petraean hinterland. Representative for earlier and later periods as well.

	Slope Values (%)			Elevation Values (m)			Distance to Streams (m)			Geological Zones covered (%)*													
	Min	**Max**	**Avg**	**Min**	**Max**	**Avg**	**Min**	**Max**	**Avg**	**L**	**U**	**LSl**	**S**	**F**	**V**	**G**	**Q**	**C**	**A**	**LS**	**AF**	**FG**
Funerary Structures	1,72	92,43	16,52	418,01	1670,14	1156,95	0	4995,48	642,70	25,82	-	3,45	58,62	3,45	-	-	-	-	1,72	-	-	-
Isolated Funerary Monuments	1,72	92,43	18,23	418,01	1670,14	1161,76	0	4861,49	578,77	27,08	-	4,17	56,25	4,17	-	-	-	-	-	-	-	-
Cemeteries	2,01	16,16	8,32	968,43	1574,88	1133,82	0	4995,48	949,57	20	-	-	70	-	-	-	-	-	10	-	-	-

*: **L**= Limestone; **U**= Undifferentiated; **LSl**= Landslip; **S**= Sandstone; **F**= Fluviatile; **V**= Volcanic; **G**= Gravel; **Q**= Quartz; **C**= Conglomerate; **A**= Alluvium; **LS**= Lake Sediments; **AF**= Alluvial Fan; **FG**= Fluviatile Gravel

TAB. 42 Qualified list of Pearson correlation coefficients between funerary structures and other archaeological sites dating to the 1st century AD. Representative for earlier and later periods as well.

First-Order Properties of 1st century AD Funerary Structures – Pearson Correlation Coefficients			
	Funerary Structures	**Isolated Funerary Monuments**	**Cemeteries**
Agricultural Installations	Moderate	Moderate	Moderate
Agricultural Processing Installations	Moderate	Moderate	Moderate
Agricultural Storing Installations	Very Weak	Weak	Weak
Agricultural Terraces/Fields	Moderate	Moderate	Strong
Communication Infrastructures	Weak	Weak	Very Weak
Caravanserais	Very Weak	Very Weak	Very Weak
Road Marker	Very Weak	Very Weak	Very Weak
Road Stations	Weak	Weak	Moderate
Roads	Very Weak	Very Weak	Very Weak
Routes/Tracks (naqb)	Weak	Weak	Weak
Exploitation/Industrial Sites	Strong	Strong	Very Strong
Industrial/Exploitation Installations	Strong	Strong	Very Strong
Funerary Structures	-	-	-
Cemeteries	-		-
Isolated Funerary Monuments	-	Strong	Strong
Military Structures	Weak	Weak	Moderate
Forts	Very Weak	Very Weak	Very Weak
Fortlets	Very Weak	Very Weak	Weak
Fortresses	Very Weak	Very Weak	Very Weak
Watchtower	Moderate	Moderate	Moderate
Religious Structures	Strong	Moderate	Moderate
Isolated Cultic Installations	Strong	Moderate	Moderate
Sanctuaries	Moderate	Moderate	Moderate
Significant Religious/Cultic Structures	Moderate	Very Weak	Moderate
Settlements	Very Weak	Weak	Weak
Cities	Very Weak	Moderate	Weak
Clusters of Buildings	Very Weak	Very Weak	Very Weak
Farms	Very Weak	Weak	Weak
Towns	Very Weak	Very Weak	Very Weak
Rural Mansions	Weak	Moderate	Moderate
Villages	Very Weak	Very Weak	Very Weak
Other Structure(s) and/or Feature(s)	Moderate	Weak	Weak
Epigraphical Sites or Locations	Strong	Moderate	Moderate
Find Clusters	Very Strong	Strong	Strong
Natural and/or Rock-cut Structures of Undetermined Function	Moderate	Moderate	Moderate
Structures of Undetermined Function	Moderate	Weak	Weak
Walls of Undetermined Function	Moderate	Moderate	Strong
Water Structures	Strong	Moderate	Moderate
Dams/Barrages	Moderate	Moderate	Weak
Springs	Very Weak	Very Weak	Very Weak
Water Conduits	Strong	Moderate	Moderate
Water Storage Installations	Strong	Moderate	Moderate
Wells	Very Weak	Very Weak	Weak

List of Figures and Tables

List of Figures

itary Organization in the Region of Udruh (southern Jordan) in the Roman and Byzantine Periods I-II (Ph.D. diss. University of Newcastle upon Tyne, Newcastle upon Tyne 2006) 565. C: H. Hayajneh, Ancient North Arabian Inscriptions, Rock Drawings and Tribal Brands (wasms) from the Sammah/ ʼAyl (ʼEl) Region, Southern Jordan, in: B. MacDonald – G.A. Clark – L.G. Herr – D.S. Quaintance – H. Hayajneh – J. Eggler (ed.), The Shammakh to Ayl Archaeological Survey, Southern Jordan (2010–2012), Archaeological Reports 24 (Boston 2016) 521, fig. 6.10b. D: H. Hayajneh, Ancient North Arabian Inscriptions, Rock Drawings and Tribal Brands (wasms) from the Sammah/ ʼAyl (ʼEl) Region, Southern Jordan, in: B. MacDonald – G.A. Clark – L.G. Herr – D.S. Quaintance – H. Hayajneh – J. Eggler (ed.), The Shammakh to Ayl Archaeological Survey, Southern Jordan (2010–2012), Archaeological Reports 24 (Boston 2016) 529, fig. 6.20A. Courtesy of F. Abudanh and H. Hayajneh. © F. Abudanh and H. Hayajneh

Figs. 122–124
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Fig. 125
Left: S. A. Rosen, The Nabateans as Pastoral Nomads. An Archaeological Perspective, in: K. D. Politis (ed.), The World of the Herods and the Nabataeans. Volume 2 of the International Conference "The World of the Herods and the Nabataeans," held at the British Museum, 17–19 April 2001 (Stuttgart 2007) 355, fig. 8. Right: S. A. Rosen, The Nabateans as Pastoral Nomads. An Archaeological Perspective, in: K. D. Politis (ed.), The World of the Herods and the Nabataeans. Volume 2 of the International Conference "The World of the Herods and the Nabataeans," held at the British Museum, 17–19 April 2001 (Stuttgart 2007) 353, fig. 7. Courtesy of S. A. Rosen. © S. A. Rosen

Fig. 126
Left: S. A. Rosen, The Nabateans as Pastoral Nomads. An Archaeological Perspective, in: K. D. Politis (ed.), The World of the Herods and the Nabataeans. Volume 2 of the International Conference "The World of the Herods and the Nabataeans," held at the British Museum, 17–19 April 2001 (Stuttgart 2007) 363, fig. 14. Upper Right: S. A. Rosen, The Nabateans as Pastoral Nomads. An Archaeological Perspective, in: K. D. Politis (ed.), The World of the Herods and the Nabataeans. Volume 2 of the International Conference "The World of the Herods and the Nabataeans," held at the British Museum, 17–19 April 2001 (Stuttgart 2007) 366, fig. 17 and 365, fig. 16. Lower Right: S. A. Rosen, The Nabateans as Pastoral Nomads. An Archaeological Perspective, in: K. D. Politis (ed.), The World of the Herods and the Nabataeans. Volume 2 of the International Conference "The World of the Herods and the Nabataeans," held at the British Museum, 17–19 April 2001 (Stuttgart 2007) 367, fig. 18. Courtesy of S. A. Rosen. © S. A. Rosen

Fig. 127
A: S. Silvonen – P. Kouki – A. Eklund – E. Hertell – M. Lavento – H. Ynnilä, The FJHP Site Catalog, in: P. Kouki – M. Lavento (eds.), Petra - The Mountain of Aaron. The Finnish Archaeological Project in Jordan. Volume III. The Archaeologcial Survey (Helsinki 2013) 384, fig. 92. Plan by S. Silvonen, P. Kouki and M. Holappa. Courtesy of P. Kouki. © Societas Scientiarum Fennica. B - D: Photographs by W. M. Kennedy. © W. M. Kennedy

Fig. 128
© W. M. Kennedy

Fig. 129
A: APAAME_20101016_SES-0213. Photograph by Stafford Smith. Courtesy of APAAME. © APAAME. B: F. Abudanh, Settlement Patterns and Military Organization in the Region of Udruh (southern Jordan) in the Roman and Byzantine Periods I-II (Ph.D. diss. University of Newcastle upon Tyne, Newcastle upon Tyne 2006), 433. Courtesy of F. Abudanh. © F. Abudanh. C and D: Photographs by W. M. Kennedy. © W. M. Kennedy

Fig. 130
A: APAAME_20090930_DLK-0276.Photograph by David Kennedy. Courtesy of APAAME. B: APAAME_20090930_DLK-0262. Photograph by David Kennedy. Courtesy of APAAME. © APAAME

Figs. 131–132
© W. M. Kennedy

Fig. 133
APAAME_20051002_RHB-0075. Photograph by Robert Bewley. Courtesy of APAAME. © APAAME

Fig. 134
D. L. Kennedy – R. Banks, The Khatt Shebib in Jordan: From the Air and Space, Zeitschrift für Orient-Archäologie 8, 2015, 150, fig. 21. Drawing by R. Banks. Courtesy of D. L. Kennedy. © D. L. Kennedy and R. Banks

Figs. 135–146
© W. M. Kennedy

Fig. 147
APAAME_20070419_DLK-0271. Photograph by David Kennedy. Courtesy of APAAME. © APAAME

Figs. 148–149
© W. M. Kennedy

List of Tables

List of Abbreviations

General

ACS	Accumulated cost surface
APAAME	Aerial Photographic Archive For Archaeology In the Middle East
approx.	Approximately
ARNAS	Ayl to Ras an-Naqab Archaeological Survey
BMP	Bir Madkhur Project
BS	Beidha Ethnoarchaeological Survey
CIL	Corpus inscriptionum Latinarum
CIS	Corpus Inscriptionum Semiticarum
DAS	Dana Archaeological Survey
DEM	Digital Elevation Model
ES	Edom Survey
FJHP	Finnish Jabal Harun Project
IGLS	Inscriptions Grecques et Latines de la Syrie
IGR	Inscriptiones Graecae ad res Romanas pertinentes
JSS	Jabal Shara Survey
KHJ	King's Highway Junction
L2HE	Showbak-Dana L2HE Survey
LCP	Least-cost path
LSJ	Liddell – Scott – Jones
M. P.	Milia passuum
P. Mich.	Papyrus Collection University of Michigan
PAWS	Petra Area and Wadi Slaysil Survey
PHSP	Petra Hinterland Survey Project
PHTP	Petra Hinterland Tombs Project
PNRP	Petra North Ridge Project
POxy	The Oxyrhynchus Papyri
PRP	Petra Routes Project
PSI	Zenonpapyrus
s. v.	Sub verbo, voce, see under
SAAS	Southeast Araba Archaeological Survey
ShamAyl	Shammakh to Ayl Archaeological Survey
SRTM	Shuttle Radar Topographic Mission
UAP	Udruh Archaeological Project
WMWS	Archaeological Survey of the Wadi Musa Water Supply and Wastewater Project

Ancient Sources

If not otherwise noted, the following list of abbreviations for ancient sources follows the English version of *Brill's New Pauly*.

Amm.	Ammianus Marcellinus
App. Mith.	Appianus, Mithridatius
App. Syr.	Appianus, Syriaca
Bell. Alex.	Bellum Alexandrinum
Cass. Dio	Cassius Dio
Diod. Sic.	Diodorus Siculus
Diosk. mat.med.[2159]	Dioskurides, De materia medica
Epiph. Panar.[2160]	Epiphanius, Panarion
Eus. On.	Eusebios, Onomasticon
Fest.	Festus, breviarium
Hdt.	Herodotos
Jos. Ant. Iud.	Josephos, Antiquitates Iudaicae
Jos. BI.	Josephos, Bellum Iudaicum
Just. Nov.[2161]	Justinian, Novellae
Ma.[2162]	Macabees
Not. Dign. Or.	Notitia dignitatum orientis
Oros.	Orosius, Historiae adversum paganos
P.Mil.Vogl.[2163]	Poseidippus of Pella, Epigrammata
Plin. Ep.	Plinius minor, Epistulae
Plin. HN	Plinius maior, Naturalis Historiae
Plut. Ant.	Plutarchos, Antonius
Plut. Demtr.[2164]	Plutarchos, Demetrios
Plut. Pomp.	Plutarchos, Pompeius
Procop. Pers.	Procopius, Bellum Persicum
Ptol. Geog.	Ptolemaius, Geographia
Sozom. Hist. eccl.	Sozomenus, Historia Ecclesiastica
St. Byz.[2165]	Stephanus of Byzantium
Str.	Strabo, Geographica
Tac. Hist.	Tacitus, Historiae

2159 After Hackl et al. 2003.
2160 After Fiema et al. 2015.
2161 After Liddell-Scott-Jones Greek-English Lexicon.
2162 After Liddell-Scott-Jones Greek-English Lexicon.
2163 After Hackl et al. 2003.
2164 After Hackl et al. 2003.
2165 After Liddell-Scott-Jones Greek-English Lexicon.

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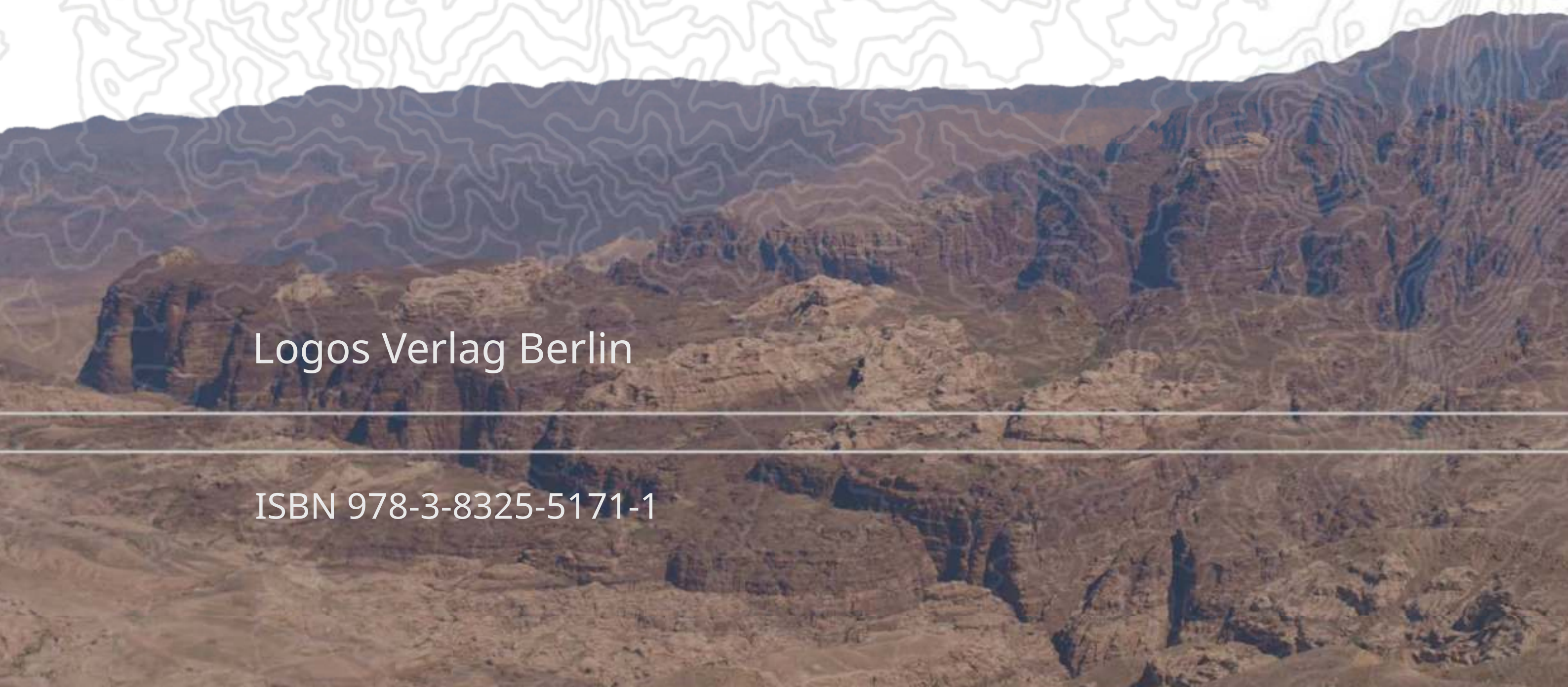
To better understand the ancient Nabataean capital of Petra, it is important to consider its rural surroundings as well. The city's unfavorable geostrategic location makes this already clear: Situated in a deep valley and flanked by high mountain ranges, Petra's urban development was only possible through a well-structured organization of its surrounding landscape.
This study presents a first comprehensive archaeological and culture-historical characterization of the Petraean hinterland and researches overall strategies of the spatial organization of the city's rural environs.
Based on an extensive set of archaeological survey data from the Petra region, this study explores a variety of archaeological site types and features diachronically. While the main chronological focus is clearly set on the Nabataean and Roman periods, it also considers the preceding Iron Age and Hellenistic periods, as well as the subsequent Byzantine period.
The aim is to examine rural settlement patterns and subsistence strategies, aspects of rural water management, the extensive infrastructural network, the funerary and religious landscape, the military disposition, as well as the industrial potential of rural Petra.
Following a unique landscape archaeological approach, this study provides a differentiated analysis of the various archaeological sites and features for a broad, regional understanding of the Petraean hinterland and offers new insights into the socio-political and administrative, military, economic and infrastructural development of *Terra Petraea* through time.



Logos Verlag Berlin

ISBN 978-3-8325-5171-1