Imperial Practices and Provincial Realities: The Construction of Baths in the Roman East

by

Craig A. Harvey

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Doctoral Committee:

Professor Christopher J. Ratté, Chair
Professor Emerita Elaine Gazda
Professor David Potter
Professor Nicola Terrenato

Craig A. Harvey

caharvey@umich.edu

ORCID iD: 0000-0002-3831-625X

Dedication

In loving memory of my mother,

Donna Jean Harvey

Les étoiles sont belles, à cause d'une fleur que l'on ne voit pas...

Antoine de Saint-Exupéry

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Abstract

This dissertation examines how local populations in the Roman East responded to empire-wide trends by focusing on the construction of Roman-style baths. Specifically, it explores the degree to which provincial building industries applied their own well-developed and deeply entrenched building traditions to the construction of these baths. It also pays special attention to the environmental factors that conditioned these local building traditions and limited the choice of construction materials and techniques at the disposal of those tasked with building these facilities.

To investigate the reception of Roman-style baths by provincial communities as well as the means by which local building industries overcame the structural and technical challenges posed by these novel structures, this dissertation examines the construction of 90 bathing facilities throughout the Roman East, from Cilicia to Arabia. In doing so, it demonstrates that while Roman-style baths were universally adopted by provincial communities, they were not passively received. Instead, wherever possible, the construction of baths was adapted to fit the environmental contexts and architectural traditions of local building industries. At the same time, this dissertation explores how, when faced with the technical challenges presented by Roman-style baths (such as the vaulting and heating systems), the builders of these facilities imported western techniques or developed innovative solutions derived from their own building practices. The investigation of these instances of importation and innovation elucidates vehicles of

technological transmission to (and within) the Roman East as well as the ingenuity of provincial builders.

Rather than presenting a comprehensive analysis of all known Roman-style baths from the Roman East, this dissertation draws from a representative sample and focuses on the construction of the walls, vaults, and heating systems of these facilities, where innovation and local influences are most visible. The focus on these three elements allows for architectural analysis at the necessary level of detail, while the transregional scope of this study enables the broader, interregional contextualization of cultural trends previously identified by regional or localized studies.

Chapter 1 Introduction

It is a truism that the provinces of the Roman Empire exhibited broad cultural diversity. While the historical study of these territories has traditionally focused on identifying and qualifying the ways in which they became less diverse through Roman "influence," recent decades have seen a growing interest in complicating this narrative. Increasingly, scholarship has begun to explore how provincial communities responded actively to Roman imperialism and negotiated their place within a changing Mediterranean world.[1] Similarly, there has been a parallel effort to broaden the scope of study away from provincial elites (who tend to be more visible in textual and archaeological sources) and to include the less visible social groups that represented the vast majority of provincial inhabitants.[2]

Among these non-elite members of society were local builders and craftspeople, who belonged to provincial building industries. Although these local industries were responsible for constructing many of buildings that formed the Roman provincial landscape, the agency and influence that they exerted on these projects have not been fully explored. Tasked with the construction of newly introduced architectural forms, provincial builders displayed a keen ability for adapting local materials and techniques to the construction of non-local building types.[3]

The ingenuity and accomplishments of provincial building industries can be seen throughout the Roman Empire. In the Roman East, the diverse cultures that inhabited the territory extending

[1] For example, see Millett 1990; Alcock 1993; Woolf 1994; 2000; Laurence et al. 2011; Raja 2012.
[2] Webster 2001; Dossey 2010; Grey 2011; Smith et al. 2016.
[3] See Lancaster 2015, for a discussion of innovative vaulting techniques developed in the provinces.

form Cilicia to Arabia were home to an array of deeply entrenched architectural traditions that in some cases were older than those of Rome. Local builders and building industries in the eastern provinces were masters of highly developed construction techniques that were tailored to local materials and the specific architectural traditions of their own cultures. In many cases, however, the materials and techniques at their disposal were ill-suited for the new building types and architectural forms that were introduced in the Roman period. This study examines how the local builders and construction industries of this part of the empire responded to the resulting challenges through the innovative adaptation of existing methods and materials to new needs, as well as through the adoption of non-local building practices.

Although the advent of Roman hegemony in the region saw the introduction of many new building types, this study focuses on Roman-style baths. These ubiquitous, technologically challenging, and culturally significant buildings are well suited in many respects to the investigation of the influence and agency of local building industries. Attended regularly and often housed in monumental structures, baths were central to Roman identity. As the adoption of Roman customs spread beyond the Italian peninsula, public bathing emerged as a shared practice that created a sense of belonging to the emerging pan-Mediterranean community. Attending the baths allowed provincials who had never set foot in Rome to act out their *urbanitas*, while the construction of these facilities enabled cities and settlements across the East (and wider empire) to display their prestige and participation in the Roman world. For these reasons Roman-style baths were constructed in all regions of the eastern provinces. The result is a ubiquitous and standardized corpus for studying how different communities applied their own building techniques and materials to the construction of a specific building type.

At the same time, Roman-style baths presented complex engineering challenges, such as vaulting and heating systems, which required the importation of western techniques or the development of local solutions. Many of these challenges stemmed from the difficulty of reproducing Roman-style baths using locally available materials that differed from the materials traditionally used in bath construction. While vast quantities of fuel and water were required for the operation of these baths, large amounts of both these resources were also needed for their construction, particularly for the manufacture of ceramic bricks as well as mortars and plasters. In the arid and semiarid regions of the Roman East, alternative materials or other solutions often had to be found. Thus, these provincial building industries had to overcome local environmental limitations in order to fulfil the cultural expectations of public bathing.

To investigate how these industries overcame these challenges as well as the reception of Roman-style baths by provincial communities, this study examines the construction of these facilities throughout the Roman East. Specifically, it investigates how provincial communities applied their own well-developed and deeply entrenched building traditions to the construction of these novel facilities. In this way, this study will demonstrate that – while Roman-style baths were universally adopted by provincial communities – they were not received passively. Instead, the construction of these baths was adapted to fit local environmental limitations and architectural traditions. At the same time, this study explores how, when faced with the technical challenges that the Roman-style bath presented (such as the vaulting and heating systems), the builders of these facilities either imported western techniques or developed innovative solutions from their own building practices. The investigation of these instances of importation and innovation will help elucidate the vehicles of technological transmission to (and within) the East as well as the ingenuity of provincial building industries.

In order to explore the involvement of these local industries and the degree to which they influenced the construction of Roman-style baths, a survey was conducted of the building materials and techniques used in baths across the Roman East. Particular attention was paid to identifying regional variations and practices in order to assess the influence of preexisting building industries as well as instances of local innovation. Furthermore, examples of non-local or western building practices were investigated to explore vehicles of technological transmission. As will be discussed in greater detail below, this survey focused on three structural elements of baths where innovation and local influences are most visible, namely walls, vaults, and heating systems.

Geographic Scope of the Study

This study focuses on the construction of Roman-style baths in the Roman East (Figure 1). For the purposes of this study, *the Roman East* refers to the contiguous territory that stretches from the Taurus Mountains in the north to the Negev Desert in the south and as far east as the Euphrates River (roughly corresponding to five Roman provinces as they existed during the time of Hadrian: Cilicia (Figure 2), Cyprus (Figure 3), Syria (Figure 4), Judea (Figure 5), and Arabia (Figure 6)). As will be discussed in the next chapter, these regions comprised many communities and environments that gave rise to a range of localized building traditions and were also home to a large corpus of well-preserved, well-excavated, and well-published baths. This variety allows for analysis and comparisons of bath construction to be made on regional and transregional scales not previously attempted. As a result, it is possible to identify and consider the ways in which the building materials and techniques used in bath construction varied from region to region or conformed to a universal (or transregional) standard. Furthermore, it is only through this multiregional examination that it will be possible to explore the full diversity of the ways provincial communities overcame the environmental and technological challenges of building Roman-style baths. At the same time, these regions represent a cohesive unit, with shared histories under pre-Roman imperial control (e.g. Seleucid, Parisian, etc.) as well as cultural and economic connections. Furthermore, this territory was situation between two other discrete regions of the Roman world: western Anatolia and Egypt.

Western Anatolia was home to a cultural history that was markedly different from that of the regions covered in this study. Much of this cultural difference resulted from a closer and earlier connection to Greece and Hellenistic culture, and this relationship is reflected in the Roman-style baths of western Anatolia.[4] As this region had a bathing culture (and larger cultural history) that was closer to Greece than to the Levant, it would be more appropriate to study western Anatolia's baths in conjunction with those of Greece rather than with those examined here. Furthermore, western Anatolia is home to a very larger number of Roman baths, the study of which has a long history. In addition to regional studies on baths, such as those for Lycia,[5] Caria,[6] and Pamphylia,[7] larger studies for specific types of baths have also been carried out, including studies on so-called bath-gymnasia[8] and private baths.[9] The inclusion of these western Anatolian baths in this study would result in an overextended and unmanageable project. Unlike the regions of western Anatolia, Cilicia is included in this study largely because of its proximity as well as its economic and cultural connections to the provinces along the Levantine coast.

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[4] Farrington 1987, 55-6, 58; for bath-gymnasia see, Yegül 1992, 250-313.
[5] Farrington 1995.
[6] Nováková 2007.
[7] Abbasoğlu 1982.
[8] Yegül 1992, 250-313.
[9] Uytterhoeven 2011.

Like western Anatolia, Roman Egypt was a culturally discrete territory from the regions covered by this study, and this uniqueness extended to its hydrology and history of communal bathing.[10] Indeed, this province was home to a long history of communal bathing, with numerous Hellenistic and Roman period baths having been uncovered through excavation and mentioned in papyri.[11] As a result of these differences and the large size of this province, an investigation of the Roman-style baths of Egypt is truly a different topic and deserves a separate and focused study.

Temporal Scope of the Study

Although the geographic scope of this study is defined using five provinces as they existed at the time of Hadrian, the temporal scope of this investigation stretches from the late first century BCE (when Roman-style baths were first introduced to the region) to the early fifth century CE (in order to exclude subsequent transitions to late antique baths) (Table 1).[12] This wide range allows for a diachronic analysis of the construction methods used for Roman-style baths in the East.

The wide temporal range of this study is also partly the result of necessity, as Roman-style baths do not appear in all regions of the Roman East at the same time. In Syria for example, baths first appear about a century after their introduction to Judea. Furthermore, the common practice of renovating and rebuilding baths has resulted in many instances where the extant

[10] Trümper 2009, 149-51, 162; Fournet and Redon 2017.
[11] An excellent source for recent scholarship on Hellenistic and Roman baths in Egypt can be found in two edited volumes dedicated to the subject: Bousac et al. 2009 and Redon 2017. For the study of these baths through papyrological sources, see Blouin 2014; Faucher and Redon 2014; Stobel 2014.
[12] For discussion on this transformation and its larger social and cultural contexts, see Yegül 1992, 314-49; Charpentier 1995; Yegül 2010, 199-212; and Maréchal 2020.

remains of baths date much later than the initial construction of the bathing complex. For instance, the visible remains of the Western Baths of Scythopolis (modern of Bet She'an, Israel) date to the late fourth to early fifth century CE, but these remains lie overtop the site's earlier second century CE baths.[13] Similarly, although the large bath excavated in central Beirut may have been built as early as the first century CE, extant elements of its heating system may date to the fifth century CE.[14]

Table 1: Date of construciton of baths in the present study.

Baths	**Site, Province**	**Date of Initial construction**
Large Baths	Masada, Judea	Between 30 and 20 BCE
Bathing suite in Herod's Second Palace	Jericho, Judea	Around 25 BCE
Bathing suite in Northern Wing of Herod's Third palace	Jericho, Judea	15 or 14 BCE
Summit Baths	Cypros, Judea	Herodian period
Shoulder Baths	Cypros, Judea	Herodian period
Ramat Hanadiv baths	Ramat Hanadiv, Judea	Herodian period
Upper Baths	Herodium, Judea	Late first century BCE
Wadi Ramm baths	Wadi Ramm, Arabia	Late first century BCE
Bath-gymnasium complex	Salamis, Cyprus	Reign of Augustus
Acropolis Baths	Kourion, Cyprus	Beginning of the first century CE
Baths on the Petra North Ridge	Petra, Arabia	First century CE?
Pella baths	Pella, Judea	First century CE?
Harbor Baths	Elaeussa Sebaste, Cilicia	First century CE?
Eastern Bath	Scythopolis, Judea	First century CE
Selaema baths	Selaema, Syria	Late first century CE
Mamshit baths	Mamshit/Mampsis, Arabia	Late Nabatean period
Baths on Jebal Khubthah	Petra, Arabia	Turn of the first and second centuries CE

[13] Mazor 1999, 295.
[14] Butcher and Thorpe 1997, 303-304.

Sabrah baths	Sabrah, Arabia	Turn of the first and second centuries CE
Reticulate Baths	Elaeussa Sebaste, Cilicia	Turn of the first and second centuries CE
River Baths	Selinus, Cilicia	Late first or the early second centuries CE?
Amathus baths	Amathus, Cyprus	First or second centuries CE
Baths at the Sanctuary of Apollo Hylates	Near Kourion, Cyprus	101/102 CE
Baths next to the Petra Great Temple	Petra, Arabia	Around 106 CE
Baths of L. Julius Agrippa	Apamea, Syria	Shortly after 115 CE
Bath 5B	Iotape, Cilicia	Reign of Trajan?
Hauarra baths	Hauarra, Arabia	Early second century?
Kanatha baths	Kanatha, Syria	First half of the second century CE
North Baths	Bosra, Arabia	First half of the second century CE?
Hammat Gader baths	Hammat Gader, Judea	Reign of Antonius Pius (138-161 CE)
Northeast Quarter Baths	Apamea, Syria	Second century CE
Baalbek baths	Baalbek, Syria	Second century CE
Southern Bathhouse	Hippos-Sussita, Judea	Second century CE
Western Bath	Scythopolis, Judea	Second century CE
Bathhouse in Area VII	Jerusalem, Judea	Second century CE
Southern Baths	Anazarbos, Cilicia	Second century CE
Northern Baths	Anazarbos, Cilicia	Second century CE
Central Baths	Bosra, Arabia	Second century CE
South Baths	Bosra, Arabia	Second half of the second century CE
Large Baths	Elaeussa Sebaste, Cilicia	No earlier than the second century CE
East Baths	Gerasa, Arabia	Not before second half of the second century CE
Baths of Diocletian	Palmyra, Syria	Second half of the second century CE (or Severan)
Bath II 7 A	Anemurium, Cilicia	Before 200 CE
Upper Baths	Ein Yael, Judea	End of the second century CE
Lower Baths	Ein Yael, Judea	End of the second century CE
Bath F3	Dura Europos, Syria	Between 165 and 216 CE
Little Western Baths	Anazarbos, Cilicia	Between the second and third centuries CE
Ziegel Bauten 01	Anazarbos, Cilicia	Between the second and third centuries CE
Birketain baths	Birketain, Arabia	Between the second and third centuries CE
Tarsus baths	Tarsus, Cilicia	Between the second and third centuries CE

Great Baths	Antiocheia ad Cragum, Cilicia	Between the late second and early third centuries CE
Extramural Baths	Antiocheia ad Cragum, Cilicia	Late second or early third centuries CE
Baths in the House of Orpheus	Paphos, Cyprus	Late second to early third centuries CE
Sha’arah baths	Sha’arah, Syria	End the second or start of third centuries CE
Zeugma baths	Zeugma, Syria	Early third century CE
Baths C3	Dura Europos, Syria	Between 210 and 215 CE
Baths E3	Dura Europos, Syria	Between 210 and 215 CE
Baths M7	Dura Europos, Syria	Between 210 and 215 CE
Bath C	Antioch, Syria	Early or mid-third century CE
Bath III 2 B	Anemurium, Cilicia	Third century CE
South Bathhouse	Scythopolis, Judea	Third century CE
Emmaus baths	Emmaus, Judea	Between the turn of the second century and beginning of the fourth century CE
Philippopolis baths	Philippopolis, Syria	Reign of Philip (241-245 CE)
Barade baths	Barade, Syria	Mid-third century CE
Central Baths	Gerasa, Arabia	Late third century CE
Arieldela baths	Arieldela, Arabia	Tetrarchic period
Osia baths	Osia, Arabia	Tetrarchic period
Principia Baths	Athis, Syria	Post Diocletian
Tamara baths	Tamara, Arabia	End of third century CE
Baths in the Villa of Theseus	Paphos, Cyprus	End of third century CE
Byzantine Baths	Gadara, Judea	Early fourth century CE
Betthorus garrison baths	Betthorus, Arabia	Between 300 and 363 CE
Earlier extramural baths	Athis, Syria	Fourth century CE
Oboda baths	Oboda, Arabia	Fourth century CE
Bath A	Antioch, Syria	Second half of the fourth century CE
Later extramural baths	Athis, Syria	452/53 CE
Larger Baths	Küçük Bernaz, Cilicia	Fourth or fifth centuries CE
Smaller Baths	Küçük Bernaz, Cilicia	Fourth or fifth centuries CE
Ayios Georgios of Peyeia baths	Ayios Georgios of Peyeia, Cyprus	Fifth century CE
Seia baths	Seia, Syria	Roman
Beirut baths	Beirut, Syria	Roman/Byzantine
Rehovot-in-the-Negev baths	Rehovot-in-the-Negev	Byzantine

Comprehensiveness

The geographic and temporal scope of this study encompasses a large corpus of Roman-style baths. An inventory of baths conducted in 2014 counted approximately 224 Roman period baths in the provinces of Cyprus, Syria, Judea, and Arabia,[15] while a separate inventory of baths in the province of Cilicia recorded 27 thermal complexes as of 2003.[16] Subsequent excavation has only added to the number of known baths from this region.

In terms of the total number of Roman-style baths that may have once existed in this area, it is difficult (if not impossible) to say with any certainty how many there were. It is, however, possible to give a very rough approximation using recorded numbers of baths and population estimates from other regions of the Roman world. In the city of Rome, for instance, Pliny the Elder seems to imply that there were 170 bathing establishments in 33 BCE, which Agrippa opened for free bathing (Pliny *NH* 36.121).[17] As the population of the city has been estimated to have been at 750,000 in 14 CE,[18] this number would equate to roughly one bath per 4,412 people. During the fourth century CE, when the population of Rome is roughly estimated to have been just under 800,000,[19] the *Notitia Urbis Regionum* and the *Curiosum Urbis Romae* record a total of 856 small baths plus ten or eleven large *thermae*.[20] If these numbers are to be trusted, they would suggest that there was at least one bath for every 923 inhabitants. Finally, the *Notitia Urbis Constantinopolitanae* records 153 small baths and eight large *thermae* in Constantinople in

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[15] Fournet and Redon 2014, 17-40. This number includes 60 baths in modern Syria, 13 in Lebanon, 37 in Jordan, 99 in Israel and Palestine, and 15 on Cyprus.
[16] Spanu 2003, 12, n. 60.
[17] Yegül 1992, 45. Fagan (1993; 1999, 42) disputes this interpretation and argues that this number refers, not necessarily to the number of baths in the city, but rather to the number of bathing opportunities provided by Agrippa (e.g. one bathing facility for 170 days).
[18] Frier 2000, 813.
[19] Lo Cascio 2006, 59.
[20] Fagan 1999, 41; Yegül 2010, 2-3.

the early fifth century CE.[21] The population of the city at this point is not entirely clear, but it is estimated to have been around 500,000 in the year 500 CE.[22] Assuming these numbers are correct and remained relatively steady, there may have been at one point roughly one bath per 3,106 inhabitants.

These numbers (4,412, 923, and 3,106 inhabitants per bathing facility) vary, and their contexts within imperial capitals make them ill-suited for comparison to the Roman East. Nevertheless, taking these numbers as indicators for the uppermost limits of baths per capita, it is possible to use them to estimate the maximum number of Roman-style baths in the region. Bruce Frier has suggested that in the year 164 CE, the population of Greater Syria was around 4,800,000 while that of Cyprus was roughly 200,000.[23] Applying the ratios of baths per capita above to these estimated populations, results in numbers ranging from 1,088 to 5,200 baths in Greater Syria and 45 to 216 baths on Cyprus alone.[24] Again, these numbers are very rough estimates and should be taken only as the upper limit of baths that possibly existed. They suggest, however, that the approximately 224 known baths from this region (Cyprus, Syria, Judea, and Arabia) may be only fraction of the baths that once existed.

A further difficulty that this investigation faces is the fact that many of the known baths available for examination vary widely in terms of preservation and study. In many cases, those which are known are poorly preserved or are now completely destroyed or lost, having been dismantled or covered by later development. In other cases, the known Roman-style baths are

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[21] Yegül 2010, 3.
[22] Ward-Perkins 2000, 66.
[23] Frier 2000, table 6.
[24] The first century BCE/first century CE ratio for Rome gives 1,088 baths in Greater Syria and 45 baths on Cyprus; The fourth century ratio for Rome gives 5,200 baths in Greater Syria and 216 baths on Cyprus; and the fifth century ratio for Constantinople gives 1,545 baths in Greater Syria and 64 baths on Cyprus.

simply unexcavated, with very little known about them. Unfortunately, even when excavated, these structures are not always published in sufficient detail to allow for an examination into their construction techniques.

This study makes no attempt to examine all known baths in this region, but rather focuses on those most fully excavated, preserved, and published. This sample strategy is partially the result of the extensive geographic scope of this investigation, as it allows for focus to be on the sites where the most data is available for analysis. In this study, a total of 90 Roman-style baths are discussed, 55 of which I personally visited during a series of research trips to the Middle East.[25]

The survey of Roman-style baths presented here is therefore not a comprehensive study, but rather aims to be representative, while also reflecting the wide range of materials and techniques used in bath construction in all regions of the Roman East. At the same time, this survey highlights exceptions to the general trends to allow for a discussion of vehicles of technological transmission.

Elements of Construction

Just as it is not possible to include all known Roman-style baths in this study, it is not feasible to analyze and discuss every element of the baths' construction. As a means of focusing this study and in order to help identify patterns of building materials and techniques, this examination will concentrate on three elements of bath construction as case studies. In the order

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[25] In 2017, a research trip to Turkey was supported by a Rackham Summer Award from the University of Michigan. In 2018, a series of research trips were supported by a Rackham International Research Award from the University of Michigan (for Israel), a Danielle Parks Memorial Fellowship from the Cyprus American Archaeological Research Institute (for Cyprus), and a Bert and Sally de Vries Fellowship from the American Center of Oriental Research (for Jordan).

of their discussion, these three elements are the walls, vaulting, and heating systems of Roman-style baths.

The first case study examines the masonry techniques used in the structural walls of baths, which in nearly all cases remain at least partially extant, and are at times the only surviving elements of a bathing complex. As these walls could be easily built using local methods, it is here where one would most expect to the see evidence for the involvement of local builders and building industries. Conversely, the use of non-local and imported masonry practices in wall construction will be used to explore the direct involvement of foreign builders.

The second case study explores the vaulting that was characteristic of Roman-style baths. In the pre-Roman Near East, vaults were rarely employed in above-ground structures; however, they became far more common with the introduction of these baths, where vaults typically covered the heated halls. Although these vaults do not always survive to the present day, those that do attest to the skill of those that designed and constructed them. The engineering challenges that these vaults posed to the builders of the baths often led to the development of innovative vaulting techniques, particularly in the provinces where the use of Roman concrete was not well developed or feasible to produce and use.[26] A study of the surviving vaults in the baths of the Eastern provinces will help identify the means by which they were built, whether through the importation of foreign techniques or the innovative adaptation of local building materials and practices.

The third and final case study investigates the heating systems of these baths, including the furnace, underfloor hypocaust, and wall-heating apparatus. The focus of this case study is on the

[26] See Lancaster 2015.

space heating systems and not the heating of water, which was equally important, but for reasons which will be discussed below, is not included in this study. The intense heat to which these heating systems were exposed required that they be constructed from ceramic building materials, such as kiln-baked bricks and ceramic pipes, a material not commonly used in all regions of the Roman East before the advent of Roman-style baths. A close examination of these heating systems will reveal the variety of innovative solutions that the building industries across the Roman East created for adapting local building practices to the construction of these technologically complex foreign heating systems.

The three elements highlighted in this study are certainly not the only building elements of Roman-style baths and are not the only ones that are worthy of discussion. Similar analysis could also be done on the water installations, roofs, and decoration of the baths. Water, as will be discussed below, was integral to the function of the baths. The supply, storage, and use of this resource required a vast assortment of installations to be built in and around bathing complexes that included, but were not limited to, aqueducts, cisterns (or wells), reservoirs (or storage tanks), piping, basins, pools, fountains, and drains. Although an extremely important aspect of bath construction, the hydraulic infrastructure of baths is simply too large a topic to be covered in this study and requires its own separate investigation.

In terms of roofing, whereas vaults and domes are well-attested in bathing complexes (particularly above heated halls), it is somewhat less clear whether these vaults were covered by wooden roof structures or left uncovered. Given that there are no such pitched roofs preserved in the baths of the Roman East (outside the presence of rooftiles at several sites), this element of construction will not be explored at length in this study. It is certainly not the case, however, that this lack of preservation is evidence that the baths of this region were built without pitched and tiled roofs, and it is perhaps worthwhile to briefly comment on this issue here.

It seems likely that, in a few cases, the vaulting of baths was purposefully left uncovered by wooden roof structures. Ward-Perkins, for instance, has gone so far as to suggest that it was unexpectedly common, even in Rome, for the vaulting of large baths to be "candidly displayed".[27] Evidence for vaulting that was left uncovered comes from the well-preserved Hunting Baths at Leptis Magna in Libya.[28] Depictions of baths in art also suggest their vaults and domes may have been visible. For example, Roman glass flasks with incised representations of the urban topography of Baiae and Puteoli show buildings thought to be baths with exposed vaults.[29] Similarly, the late fourth century CE Mosaic of Dominus Julius, from Carthage, depicts a private estate that includes four un-tiled domes with smoke rising from them, likely representing a bathing facility (Figure 7).[30]

There is, however, also evidence that pitched and tiled roofs were built overtop the vaults and domes of baths. Although originally not built as a bathing structure, Room A1 in the cult complex at Argos, Greece, displays an innovative way by which a pitched roof of concrete could be constructed overtop a barrel vault.[31] Evidence for pitched and tiled roofs over baths also comes from the many ceramic roof tiles that are often found during the excavation of these structures in the East and elsewhere. Large numbers of roof tiles found with the debris of the Bath-Gymnasium Complex at Sardis, for example, led to the conclusion that its vaults were not

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[27] Ward-Perkins 1981, 384.
[28] Ward-Perkins 1981, fig. 251; Sear 1982, 199-200, fig. 124.
[29] Fujii 2001, 76.
[30] Dunbabin 1999, 118-19, fig. 122.
[31] Vitti 2008; Lancaster 2015, 56-57, figs. 31-32.

exposed, but rather covered by a variety of wood framed roofs supporting ceramic tiles.[32] In the Roman East, large quantities of roof tiles have been found at the baths at the Sanctuary of Apollo Hylates near Kourion, Cyprus,[33] and Bath C at Antioch,[34] suggesting that these structures also once had pitched roofs. Iconographic evidence also supports the likelihood that baths in the Roman East could have tiled roofs. A mosaic found in a house at Daphne (near Antioch) depicts the fifth century Baths of Ardaburius as having small domes covered in what appears to be red tiles.[35]

In the arid and semiarid regions of the Roman East, the annual rainfall did not always warrant the construction of pitched roofs covered by ceramic tiles. Such roofs, however, were at times more than a protective covering and often carried cultural meaning as well. In the ancient city of Petra, pitched and tiled roofs created a more Hellenized roofscape and served to impress inhabitants and visitors by displaying the wealth and power of those who commissioned them.[36] When placed over the vaults of baths these tiled roofs likely reinforced the message of prestige and civic success that these monumental structures were often built to display. Thus, even in the arid and semiarid regions of the Roman East where pitched roofs were unnecessary, large urban baths could still be built with them. Conversely, in cases where grandeur was less important or where using tiles was simply not feasible, the vaulting of baths could also be left uncovered, similar to the vaults of the Hunting Baths at Leptis Magna. Given that it is not always clear

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[32] Yegül 1986, 128, fig. 12.
[33] McFadden 1950, 21.
[34] Fisher 1934a, 31.
[35] Lassus 1934, 131, fig. 11; Yegül 2000, 148, fig. 2.
[36] Hamari 2017, 106-109.

which baths had tiled roofs and which did not, the analysis of these roofing systems is not attempted here.

The decoration of Roman-style baths will also not be examined in detail in this study, as it is a different topic to the one investigated here. Although artistic displays, such as frescoes, mosaics, and statuary, were very important elements of the bathing experience, the examination of this decoration is ill-suited to answer the questions examined in this study, which focus on the extent to which local building industries were involved in bath construction and the innovative techniques developed to overcome engineering and technical challenges. While regional artistic styles did exist and local artisans were likely commissioned for work in baths, the decoration of baths did not typically reflect the availability of building resources or local artistic tastes. Instead, they followed the pan-Mediterranean visual language employing universally used materials that were transported over great distances. For example, an empire-wide trading network existed to support the supply of marble and decorative stones used for the statues and veneering that decorated baths and other monumental structures.[37] Within the East Baths of Gerasa (modern Jerash), for instance, the marble used for the statues found in the facility's North Hall came from Thasos in Greece, as well as quarries in Asia Minor.[38] Likewise, the decorative stone used in the baths at Palmyra came from quarries throughout the Mediterranean.[39] The interior of baths could also be painted with colorful frescoes, such as those found in Herodian baths. Although regional painting styles did exist, they often followed a Mediterranean koine or were blends of western and eastern styles. For instance, the wall-paintings that decorated the Herodian palaces, including

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[37] See, Fischer 1998, especially 231-65; Russell 2013.
[38] Friedland 2003, 415-16.
[39] Dodge 1988, 227-28.

their Roman-style bathing suites, show a mix of Hellenistic and Italian influences.[40] Like marble and decorative stone, however, the pigments used for the paint were sourced from across the Mediterranean world and traded over long distances. In addition to locally sourced pigments, analysis of these Herodian paints identified the use of cinnabar from Spain (for red), Egyptian blue from Egypt (for blue), and green earth from Italy and Cyprus (for green).[41] Regional mosaic styles also existed, especially in locations with mosaic schools, like Antioch. Here again, however, the raw materials were shipped in from abroad. Analysis of *tesserae* from several Antioch mosaics suggested quarries in Asia Minor, Greece, and Italy as possible sources for the stone.[42] The extra-regional trade that existed for these decorative materials reveals a lot about the globalizing effect of baths and the adoption of Roman artistic tastes. It does not, however, help answer the questions posed by this study, and thus will not be examined here.

Organization of the Study

This study begins with an introduction to Roman-style baths, the Roman East, and the history of bathing in this region, including the introduction of Roman-style baths. Following an overview of previous scholarship on Roman-style baths in the region, the three cases studies that comprise this study are presented as individual chapters, the first of which examines the masonry techniques used in the Romans-style baths of the East. The second case study looks at the vaulting of these structures, and the third covers their heating systems. Each of these three chapters begins with an introduction to the case study as well as brief discussions of the most frequently used building techniques that will be discussed. Individual baths are then discussed by

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[40] Rozenberg 2014, 120.
[41] Porat and Ilani 1998, 81-84; Edwards et al. 1999, 363; Rozenberg 2009, 257-58.
[42] Archambeault 2004, 93-94, 103.

site in geographical order and organized by province as they existed at the time of Hadrian (beginning with Cilicia and followed by Cyprus, Syria, Judea, and finally Arabia). Brief syntheses are provided for each province, while transregional observations and conclusions are given at the ends of the chapters.

The subdivision of this study by province makes it possible to highlight localized building practices while also discussing interregional trends. The decision to subdivide this study by Hadrianic provinces stems in part from the fact that these territories are easily recognizable and familiar (in contrast to later administrative units, such as *Phoenice Libanensis*). In addition (and relating to this familiarity), these administrative units are the ones commonly used by modern scholarship of the Roman East. Furthermore, although this study looks at baths across a wide temporal scope, the explosion of bath construction that took place in the second century CE means that many (but far from all) of the baths examined here were built at the time these provincial boundaries existed.

Defining the exact location of these borders has been fraught with difficulty, especially between the provinces of Syria and Arabia.[43] For the purposes of this study, the borders of Arabia that demarcate this province from Syria and Judea are those described by Bowersock.[44] The discrepancy between this study's geographic and temporal scope has also led to an issue concerning Dura Europos, which was not truly part of the Roman Empire until 165 CE, after Hadrian's reign. Nevertheless, for this study, the baths of Dura Europos are included in the province of Syria.

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[43] Bowersock 1983, 90, 99-102; Millar 1993, 535-36.
[44] Bowersock 1983, 90-92, 99-102.

As a result of this geographic organization, individual baths are often discussed in each chapter and thus appear three separate times in this study. In other cases, when the vaulting or heating system of a bathing facility does not survive, there is no reason for it to appear in the chapters on vaulting or heating systems. For example, the baths at Palmyra are not published in great detail, and no descriptions of this facility's vaulting or heating systems are known to be published. As a result, these baths are discussed only in the masonry chapter. Similarly, the thermal baths at Hammat Gader were heated by the adjacent thermal springs and thus did not have the tradition Roman hypocaust system. Thus, these baths do not appear in the chapter on heating systems, despite appearing in the other two. Furthermore, to avoid excessive repetition, not all of the baths examined in this study appear in the chapter on masonry, despite the fact that elements of their walls do survive. To aid with the use of this work, the baths discussed in this study are listed by site in the Site Index at the end of this work.

The organization of this study allows for the easy examination of the selected construction elements (walls, vaults, and heating systems) on a regional and transregional scale. The intent of this design is to make it easier to identify localized practices that developed from pre-existing building industries. On the other hand, this organization does hinder a holistic understanding of an individual bathing facility's construction. Furthermore, it makes it slightly more difficult to observe and comment on changes that took place over time in a given area as well as the effect that the size[45] and type (i.e. public or private) of the baths had on the construction materials and techniques used. Nevertheless, brief comments are made on such trends wherever possible.

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[45] Whenever possible, the size (in m^2) is always provided for each of the baths presented here. When not explicitly stated in publication, the size of the baths is calculated from published plans of these facilities.

In addition to the limitations imposed by this study's organization, it is worth restating that the investigation presented here is intended to be an extensive survey of bath construction in the East rather than an intensive and comprehensive examination of all known Roman-style baths in the region. By focusing only on the best-preserved and the most fully published of these facilities, the aim of this study is to provide an overview of general trends while also highlighting anomalies.

Chapter 2 Roman Baths and Bathing in the Roman East

Roman-style Baths and Bathing

Roman-style baths were as technologically complex as they were socially and cultural important, and any attempt to define these facilities requires an equal discussion of both their physical components and the social institutions that they supported. As will be discussed in greater detail below, the Romans were not the only ancient society in the greater Mediterranean region to construct and use baths. Of all these cultures, however, the Romans had the closest relationship with baths and bathing, a fact that is clear from both the discussion of baths in Roman literature and their ubiquitous presence throughout the Roman world.

Before further discussion of these baths, an important point must be made regarding terminology. In this study, the pluralized term, *baths*, is preferred to the singular, *bath*. This preference reflects the fact that there was typically more than one bathing installation is a single structure. This use of the plural also reflects the pluralized Latin terms the Romans themselves used for baths, *thermae* and *balnea*.[46] The terms *bathing facility*, *bathing complex*, etc. are also used throughout this text when referring to Roman-style baths.

From a physical standpoint, there were several characteristics that differentiated Roman-style baths from those of other cultures. One of these defining features was the complex heating

[46] See Varro *De Ling. Lat.* 8.25, 9.41. For further discussion on these terms, see Nielsen 1990, 3; Fagan 1999, 14-19.

systems that served to heat not only the bath water but also the overall environment of the bathing rooms. This space heating created a relaxing climate within the facilities and was required for inducing sweat, an essential part of the cleaning process. The Roman-style baths were heated by distinctive underfloor heating systems, called hypocausts, that consisted of a series of pillars (known as *pilae*), which supported a raised floor and created a void through which hot air and gasses from an adjacent furnace could circulate and heat the room above (Figure 8). Wall-heating systems connected to the hypocaust also contributed to the heating of the rooms.

Another distinguishing feature of Roman-style baths was that they comprised a series of heated and unheated rooms that together formed a circuit through which the bathers would progress during their visit. Many of these rooms contained pools, tubs, or basins for washing. Bathing in the Roman fashion was thus a process, analogous to the use of modern Turkish baths.

Modern scholars traditionally assign specific Latin names to the rooms of Roman-style baths that either describe the degree to which they were heated or the primary activity for which they are assumed to be used.[47] The most common of these rooms include the *caldarium* (typically the hottest room in the baths, owing to its placement nearest the furnace, and considered to the principle room of the faculty, in which there was usually a hot water immersion pool), the *tepidarium* (a heated room that was less hot that the *caldarium* and was used for acclimatization between hot and unheated rooms), the *frigidarium* (an unheated room that typically contained cold-water pools for swimming and could also act as a social hall, especially in the late Roman period), the *apodyterium* (the changing room that was typically located at the entrance to the

[47] Nielsen 1990, 153-60.

baths and could contain benches and cubbyholes for storage), and the *laconicum* or *sudatorium* (the sweat-rooms, the difference between which is debated among scholars, but both were heated, typically smaller than the *caldarium*, and used to induce sweating).

While useful for the study of these baths, such terminology can be problematic. When these labels are applied to excavated baths (as they often are) there is sometimes a great deal of speculation, as the preserved remains of the rooms do not always allow for a definitive understanding of their original function. Nevertheless, these names were used by Roman writers themselves when describing their baths,[48] and their use by modern scholars has proven beneficial for comparative studies of these structures.

In addition to the rooms listed above, many baths also included a palaestra (an open-air courtyard) for exercising, while the largest of these complexes housed libraries, lecture halls, and galleries for the display of art. In many cases, Roman-style baths were thus far more than simple bathing facilities. They were cultural centers and places for socialization, conducting business, and relaxation. Vivid descriptions of the daily activities that took place in these facilities are recounted in the writings of authors, such as Seneca (*ep*. 56.1-2) and Martial (e.g. 1.59; 6.42; 12.82, to name only a few).[49]

Architecturally, Roman-style baths were visually impressive and emblematic of luxury and prosperity. Their large halls, covered by soaring vaults and domes, could be richly decorated with frescoes, mosaics, molded plasterwork, and marble veneering. While the largest and most ornate of these baths were those in Rome commissioned by emperors (such as the Baths of

[48] Nielsen 1990, 153-60.
[49] For further discussion on the activities that took place in baths and ancient sources that discuss them, see Fagan 1999, 12-39; Yegül 2010, 11-21

Trajan, the Baths of Caracalla, and the Baths of Diocletian) smaller and less lavish baths were also widespread. Additionally, it was common for the wealthy to have private bathing facilities on their estates and urban properties.

As the Roman Empire spread across the Mediterranean world so too did Roman-style baths. The army played a major role in the diffusion of baths and bathing culture across the empire, as military forts were often outfitted with their own bathing facilities.[50] Within western and eastern provincial communities, baths became symbols of acculturation, status, and civic pride. While cities and communities across the Roman Empire built Roman-style baths to compete with their neighbors as they negotiated their new standing under imperial control, the individuals of these communities used these baths to act out their *urbanitas* and integrate themselves into a pan-Mediterranean society.

Although Roman-style baths spread throughout the Mediterranean world and could reach a colossal size, it was not the Romans who invented the practice of communal bathing in heated baths or even the concept of underfloor heating. Long before the emergence of the Roman-style baths, the Greek communities of mainland Greece and elsewhere in the Mediterranean (such as Magna Graecia) had developed their own public baths and bathing habits.[51] First attested at Athens in the fifth century BCE, the Greek baths reached their peak during the Hellenistic period, by which point they were found in Greek and Hellenistic settlements in both the western and eastern Mediterranean (including in several of the regions investigated in this study). These facilities were often characterized by individual immersion pools and circular rooms (*tholoi*)

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[50] Reeves 1996, 30, 116-70; Revell 2007; Darby 2015a.
[51] For overviews of Greek public baths, see Ginouvès 1962, especially 183-224; Yegül 1992, 24-29; Lucore 2016.

ringed with individual hip baths. While many of the early Greek-style baths had simple furnaces for heating the bath water, these facilities were also the first to be outfitted with underfloor heating systems, the predecessors to the Roman hypocausts.

The traditional narrative concerning the development of the hypocaust system is recorded by Pliny the Elder, who credits a certain Sergius Orata with inventing the underfloor heating system in the early first century BCE to heat pools for the cultivation of oysters (*Nat. Hist*., IX.168). Although this account was once generally accepted by modern scholars, it is now abundantly clear that early hypocaust systems were employed in Greek-style baths well before Sergius Orata's time.[52] Indeed, the earliest known hypocaust system comes from late fourth century BCE baths at Gela, on Sicily.[53] Over the succeeding centuries, this heating technology would spread to the Greek-style baths of the East.[54]

It was from Greek-style baths that the Roman-style baths developed, although the transition from one to another was not always clear.[55] Recent excavation and scholarship have increasingly pointed towards the Hellenistic Greek-style baths of Magna Graecia as playing a key role in the development of the Roman-style baths. Examples of such baths (all of which contain early hypocaust systems comprising underfloor brick-lined channels) include the third century BCE baths at Locri Epizefiri,[56] the third century BCE public baths at Caulonia,[57] and the baths at Velia, dating to the second half of the third century BCE.[58] A critical link in understanding the origins of the Roman-style baths and their transition from Greek-style baths was found at

52 Fagan 1996, 56.
53 Lucore 2013, 151-53.
54 Trümper 2009, 159.
55 For a useful, but now somewhat outdated summary, see Fagan 2001.
56 Sabbione 2013, 146-49.
57 Iannelli and Cuteri 2013, 136-41.
58 Greco and Di Nicuolo 2013, 116-23.

Fregellae, in Latium. Here, excavation uncovered a third century BCE Greek-style bathing facility that was replaced in the first half of the second century BCE with baths that included many elements of the Roman-style baths, including a full-floor hypocaust system supported by pillars, wall heating pipes, communal heated pools, and what may be an organization of spaces by function.[59] This bathing facility represents the first archaeological evidence for many of these characteristic features and an important forerunner of the Roman-style baths studied here. As Roman-style baths grew in popularity and spread throughout the Roman world, they were introduced to regions of the Mediterranean that were already familiar with Hellenistic bathing traditions, including territories of the Roman East covered by this study.

The Roman East

As already mentioned in the Introduction, for the purposes of this study, the term *the Roman East* refers to the territory roughly corresponding to the Roman provinces of Cilicia, Cyprus, Syria, Judea, and Arabia, during the reign of Hadrian, stretching from the Taurus Mountains in the north to the Negev Desert in the south, and from the Mediterranean Sea in the west to the Euphrates River in the east (Figure 1). The provinces that form this study area are culturally rich regions of Roman world with distinctive, cultures, geographies, and histories of incorporation into the Roman world. These regions also differed in terms of the introduction of Roman baths and bathing.

The province of Cilicia was located in southeastern Anatolia, between the Taurus Mountains to the north and the Mediterranean to the south (Figure 2). Since antiquity, this region has

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[59] Tsiolis 2001; 2008; 2013.

traditionally been divided into two parts, the rugged and mountainous Rough Cilicia in the west and Flat Cilicia comprising a rich alluvial plain in the east.[60] Famous as a safe haven for pirates, Cilicia was brought under Roman control over the course of the first half of the first century BCE. Flat Cilicia was part of the province of Syria for a time, and Rough Cilicia was mostly left in the hands of a series of allied kings, a situation that lasted until 72 CE when the entire region was reorganized into a single province.[61] Owing to this indirect control and its rugged coastline, Rough Cilicia has been viewed as being somewhat on the fringe of the empire, despite its acculturation and adoption of Roman material culture and customs.[62]

The island of Cyprus was a thoroughly Hellenized region by the time of its initial annexation by Rome in 58 BCE (Figure 3). After its return to Rome after a brief resumption of Ptolemaic control under Cleopatra VII, the island prospered as a Roman province and was largely peaceful apart from notable uprisings in the second and fourth centuries CE.[63]

The large and diverse province of Syria was brought under Roman control by Pompey the Great in 64 BCE (Figure 4).[64] At the time of its conquest, the Mediterranean coast of this province as well as the uplands and Orontes River valley further inland were home to several Hellenized cities, including its capital at Antioch. Further east, the more sparsely populated Syrian desert was punctuated by several important cities, such as Palmyra and Dura Europos, home to distinctive cultures arising from their strategic positions along cultural and economic crossroads. To the south, the province of Syria also incorporated the Hauran region,

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[60] See Strabo 14.5.1
[61] See Mitford 1980a for a historical overview of the province.
[62] See Elton 2002.
[63] For an overview of Roman Cyprus, see Mitford 1980b.
[64] For a general overview of this province and its history, see Kennedy 1996; Sartre 2000; Butcher 2003.

characterized by its distinctive vernacular architecture using the region's ubiquitous basalt. The northernmost of the Decapolis cities, a collection of Hellenized and Greek-speaking settlements, were also located in Syria.

Like Syria, the region of Judea was brought into the Roman sphere of influence by Pompey in 64 BCE (Figure 5).[65] Located mostly between the Mediterranean coast and the Dead Sea, the province of Judea comprised the territory north of the Negev Desert to the Galilee. It also encompassed several of the Decapolis cities, including Gadara and Pella, east of the Jordan River. Significantly, much of this territory during the Augustan period was ruled by Herod the Great, whose prolific building projects resulted in the importation of Roman and western architectural forms and building materials.[66]

Arabia Petraea (Arabia) was the last of the five provinces discussed here to be brought under Roman control (in 106 CE) (Figure 6).[67] Situated to the east of Judea, the province of Arabia stretched from the provincial capital of Bosra in the north to Hegra in the south and included much of the Negev Desert and the Sinai Peninsula to the west. Prior to its absorption into the Roman Empire, this region formed the Nabataean Kingdom, a Roman client state that profited from the incense trade.[68]

Pre-Roman Baths and Bathing in the East

Long before the introduction of Roman-style baths, the regions that would form the Roman East were home to their own bathing traditions. Throughout antiquity, concepts of ritual

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[65] For a historical overview of this province, see Goodman 1996; 2000.
[66] See Netzer 2006; Hohfelder et al. 2007.
[67] For an overview of this province, see Bowersock 1983; Sartre 2000.
[68] See Anderson 2005 and the articles in Politis (ed.) 2007.

purification were widespread throughout Mesopotamia, Anatolia, Egypt, Phoenicia, and the wider Levant. Unifying these beliefs was the central importance of water in purification rituals.[69] Of course, ritual purity is not the same as physical cleanliness, and the archaeology and ancient literature of this region also provides a great deal of evidence for the existence of baths and bathing habits for personal hygiene. In the Sumero-Akkadian script, for example, scholars have identified several terms to denote ritual and hygienic bathing facilities, which were used by royalty.[70] Excavation at a number of Syro-Mesopotamian sites (such as Uruk, Tell Beydar, and Mari) uncovered rooms tentatively identified as baths based on the presence of drains and a floor waterproofed by asphalt, stone, or brick paving.[71] These rooms may have served multiple purposes, but if they were indeed used for self-cleaning, they may have functioned as "showers" with water being poured over the user and evacuated through the drain. It is also possible that several Mesopotamian cultures bathed through immersion. At several late Assyrian sites, early nineteenth century scholars uncovered large bronze chests that they misidentified as bathtubs. Although these containers are now recognized as coffins, there is evidence that some were later reused as tubs at the site of Ur.[72]

In the region covered by this study, the best evidence for pre-Roman baths comes from the southern Levant. The abundance of pre-Roman bathing facilities here is likely the result of the region's mix of cultures (Judean, Phoenician, Hellenistic) as well as the extensive archaeological work that has taken place since the formation of the modern state of Israel. Early traditions are not always clear, but there is evidence from Iron Age Israel that simple hygienic practices such

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[69] See, Frevel and Nihan 2013.
[70] Muller et al. 2014, 46.
[71] Muller et al. 2014, 47-48.
[72] Curtis 1983, 86-87.

as foot and hand washing was widespread, while social elites had access to domestic bathtubs for body-washing.[73]

It was this region that saw the development and use of the *miqveh* (pl. *miqva'ot*), or Jewish ritual bath.[74] These stepped immersion pools were used by members of the Jewish community to attain ritual purity, a practice that has evolved and continues to this day. Whereas Roman-style baths accommodated communal bathing and had a large social component, the *miqveh* was likely used by a single person at a time and was intended only to be used for religious purposes. Unlike Roman-style baths, ancient *miqva'ot* were not heated. The earliest *miqva'ot* that have been found date to the second century BCE and appear to have been most popular before the destruction of the Second Temple (70 CE), during which time they were installed in public as well as private locations.[75]

In addition to the hundreds of *miqva'ot*, archaeological excavation throughout the southern Levant has also uncovered a much smaller number of individual bathing tubs that date to the Hellenistic period. These private baths have been found at Beth Yerah, Mount Gerizim, Ramat Hanadiv, and Horvath Ma'agura, and in all cases these installations comprised a single washing tub, although a few also had a small basin.[76] Unlike the *miqva'ot*, these baths were not used for ritual purification or full-body immersion, but instead likely served a hygienic role. They were also clearly designed for individual use, rather than the communal bathing that was practiced in

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[73] Neufeld 1970, 421-22.
[74] Hoss 2005, 103-119, 181-96; Lawrence 2006.
[75] Hoss 2005, 116-18.
[76] Hoss 2005, 38-39.

Hellenistic and Roman public baths. The degree to which these private baths were influenced by the earlier Near Eastern baths or Greek private baths is unclear.[77]

Recently, a different style of individual private bath has been identified in the southern Levant, which has been connected to Phoenician and Phoenician-influenced sites. These baths appear to reflect a Phoenician bathing culture and differ from the private Judean baths discussed above in that they are typically decorated and are located in proximity to entrances and reception spaces, suggesting that cleansing bathing was in some way connected to reception practices in these Phoenician settlements.[78] They also differ in the fact that these facilities did not include any immersion tubs, as the bathers would instead pour water over themselves that would flow into a small drain. An example of this type of bath was found in a late second to early first century BCE elite residence at Tel Anafa. Here, excavators uncovered a small bathing suite that was decorated with mosaics and stucco and had a "primitive hypocaust" comprising a series of irregular channels cut into the mudbrick foundation.[79] This heating system was similar to some of the early Greek hypocausts, but it differed significantly from the standard system employed in Roman-style baths in that it comprised a series of underfloor channels rather than a floor raised on pillars. A similar bathing facility, although without a heating system, was found at Ashkelon. This bathing suite dates to the second century BCE and contained a basin, painted stucco, and a simple mosaic floor.[80]

This regional preference for individual bathing continued into the first century BCE, as reflected in the bathing suites constructed by Hasmonaean kings in their palaces. These facilities

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[77] For a brief discussion of Greek private baths, see Cook 1959.
[78] Birney 2017, 216-19.
[79] Herbert 1994, 66-68.
[80] Birney 2017, 204-212.

typically contained a single plastered bathtub, minimal decoration in the form of mosaics or painted plaster, and a simple heating system for heating water.[81] Interestingly, these baths also contained stepped immersion pools that likely served as *miqva'ot*. Excavation of the Hasmonaean Winter Palaces' complex at Jericho uncovered three such baths, two of which likely date to the reign of Alexandra Salome (76-67 BCE).[82] Another example of baths in this style is the multi-room bathing suite in the Western Palace at Masada, which dates to the early Herodian period and featured a mosaiced floor, bathtub, *miqveh*, and furnace for heating water.[83] These palatial baths were the immediate predecessors of the Roman-style baths constructed by Herod in many of his palaces throughout his kingdom.[84]

Although the practice of communal bathing appears to have been largely rejected by the inhabitants of the southern Levant during the Hellenistic period, there are two known exceptions where communal baths have been found. The first of these communal baths was uncovered at the site of Gezer, where excavators uncovered the remains of a Hellenistic bathing facility containing six rooms, including three rooms with two plaster-lined bathtubs each, and a separate passage way with what appears to have been a furnace for heat.[85] The second example of communal baths was found at Beth Zur. This facility was smaller than the first and contained two larger tubs lined with plaster and twelve "foot baths".[86] The design and components of both these baths align more closely with Greek rather than Judean or Phoenician bathing traditions. As both facilities were connected to nearby military installations, they were likely intended to

[81] Netzer 1999, 48-49.
[82] Netzer 2001, 101-108, 157-62, 169-71.
[83] Netzer 1991, 251-63; Foerster 1995, 206-209.
[84] Gordon 2007, 16.
[85] Macalister 1911, 223–28.
[86] Sellers 1933, 16–19.

serve the forts' garrisoned troops who may have been more familiar and comfortable with communal bathing.

Elsewhere in the Roman East, pre-Roman communal baths have also been uncovered on Cyprus. Here, excavation uncovered two known Hellenistic period baths, one at Amathus and another at Kition. Both these small baths contained the circular *tholoi* ringed by hip baths (*pyeloi*) that are characteristic of Greek-style baths.[87] At Salamis, excavation of the site's monumental Roman baths uncovered the foundations of what may have been a Hellenistic gymnasium.[88] Gymnasia were typically equipped with small bathing facilities in the late Hellenistic period,[89] and thus it is likely that one existed here as well.

In the northern Levant, there is very little evidence for pre-Roman baths, and it seems that communal bathing may not have become popular until the Roman period.[90] Excavation of the Roman baths in Beirut uncovered the remains of an earlier structure that the excavator posited may have been a Hellenistic period bathing complex or gymnasium.[91] This possibility remains uncertain; however, the existence of bathing establishments at Hellenistic centers along the coast would not be surprising. While no Hellenistic period baths have been found at Antioch on the Orontes, Polybius relates that the Seleucid king, Antiochus IV Epiphanes, frequented public baths and bathed alongside commoners (*Hist*. 26.1.12f). Although this account is not firm evidence of Greek baths in Antioch *per se*, it suggests that the practice of communal bathing was at least familiar to the city's rulers during the first half of the second century BCE.

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[87] Christodoulou 2014, 84-86.
[88] Karageorghis 1969a, 167-68.
[89] Yegül 2013, 83.
[90] Fournet 2012a, 330-31.
[91] Thorpe 1998, 68.

The evidence for pre-Roman baths in the Roman East therefore suggests a wide variation of familiarity with baths and bathing. Throughout the region, water was centrally important for purification rituals, most tangibly seen in the living tradition of the *miqveh*. At the same time a variety of baths for physical hygiene are also attested in literature and the archaeological record. In the Mesopotamian, Judean, and Phoenician cultures, individual and private baths were the norm, with many examples being found in the southern Levant. Communal bathing seems to have been introduced by the Greeks, but this practice seems to have failed to spread widely in the region during the Hellenistic period. Greek communal baths are attested on Cyprus, at two sites in the Southern Levant, and may have existed along the northern Levantine coast. While bathing practices may very well have existed in the other regions of the study area, such as Cilicia and the Syrian steppe, they do not prominently appear in the archaeological record.

Introduction and History of Roman-style Baths in the East

It was into this mix of bathing traditions that the Roman-style baths were introduced, and just as pre-Roman bathing traditions varied from region to region so too did the introduction and spread of this new bathing facility (Table 1). While in some cases the introduction of these baths was connected to the pre-existing bathing traditions described above, in other cases they seem to have been introduced by the army or even through diplomacy. This variation complicates the development of a comprehensive understanding of the introduction and spread of Roman baths and bathing throughout the East. Further hindering this understanding is the absence of a recent and transregional study of the subject. The overview provided by Nielsen, while formative at the time of publication and still an invaluable resource, is broad in its treatment of the East and is in need of updating to reflect subsequent discoveries and scholarship.[92] More recent studies that have provided discussions on the adoption of Roman-style baths focus only on specific regions, such as Palestine[93] and southern Syria,[94] rather than the entire Roman Near East. It is not possible to give a comprehensive history of Roman-style baths in the East here; however, what follows is a brief overview of their introduction and spread.

The earliest of the known Roman-style baths in the East are those found within the palaces of Herod the Great, the Roman client king of Judea and prolific builder. These palaces were located throughout his kingdom and date to between ca. 35 and 15 BCE. Of the nineteen known baths associated with Herod's many palaces, fifteen were built in the Roman style.[95] These baths were characterized by the presence of a changing room (*apodyterium*), a cold room (*frigidarium*) that usually contained a stepped pool (which likely served as a *miqveh*), and a hot room (*caldarium*) that featured the complex Roman heating system comprising a hypocaust and *tubuli* (wall heating pipes).[96] The Herodian baths therefore contain a mixture of both local (e.g. *miqva'ot*) and Roman (e.g. hypocausts) elements, and thus while they represent a significant shift in bath design and function, they are nevertheless a continuation of Hasmonaean bathing traditions.[97]

The first of these Herodian baths believed to have been built are those in Herod's First Palace at Jericho, which were likely constructed between the years 36-30 BCE.[98] Despite its early date, this bathing facility features a fully developed Roman-style heating system complete with a

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92 Nielsen 1990, 95-116.
93 Hoss 2005, 38-66.
94 Fournet 2012a, 330-34.
95 Netzer 2006, 258; Gordon 2007, 23-40.
96 Netzer 1999, 49-51; 2006, 255-57.
97 Gordon 91, 95-6.
98 Netzer 2001, 338.

hypocaust and *tubuli*.[99] In fact, these *tubuli* are some of the earliest known examples found outside of Italy. This wholesale adoption of a fully developed Roman heating system strongly suggests that it was constructed by builders familiar with the design and function of Roman-style baths. Herod himself would have likely experienced Roman-style baths and bathing during his time spent in Rome (Jos. *BJ* 1.281-85; *AntJ* 14.379-89). It is possible that Judean builders travelled to Italy to learn to construct these baths, or that Italian builders were brought to Judea. The later possibility seems more likely to have been the case, particularly considering the masonry of the baths in Herod's Third Palace at Jericho. As will be discussed in greater detail in the next chapter, this bathing suite was partially constructed using *opus reticulatum* (an Italian masonry technique) and is thus considered to have been built by Italian workers, possibly sent to Herod as a gift.[100]

Such importation or granting of specialized builders had a long history in the ancient Near East.[101] It also seems to have been a common Roman diplomatic practice, as the discovery of *opus reticulatum* at Caesarea-Iol (in Mauretania), Emesa (in Emesa), and Elaeussa Sebaste (in Cappadocia) attests to the presence of Roman builders and craftspeople in these Roman client kingdoms.[102] In the case of Elaeussa Sebaste, *opus reticulatum* was employed in the construction of what may have been another early bathing facility built by Italians. This structure, known as the Harbor Baths, was initially constructed between the mid-first century BCE and the mid-first

[99] Pritchard 1958, 10-12, pls.7-9.
[100] Kelso and Baramki 1955, 5; Deichmann 1979, 474-75; Netzer 2006, 315.
[101] See Zaccagnini 1983, passim,
[102] Jacobson 2001, 28.

century CE, but its function as baths is not known for certain until its later second phase, which is also characterized by the use of *opus reticulatum* and predates the mid-second century CE.[103]

In Judea, the newly introduced Roman-style baths quickly spread beyond Herod's palaces and were adopted by the local elite, as demonstrated by the discovery of such baths at several rural and urban villas.[104] In a few cases, these bathing facilities were also equipped with a *miqveh*. One of the best preserved and published of these early baths is the late first century BCE baths at Ramat Hanadiv, which (although smaller and less ornate than the typical Herodian palatial bath) boasted a full Roman heating system, compete with boiler, hypocaust, and wall *tubuli*.[105] In the southern Levant, it therefore seems that the introduction of Roman-style baths initially piggybacked on the preexisting bathing culture centered around private baths in elite residences.

Over the course of the next century (i.e. the first century CE), these Roman-style baths spread to the Nabataean Kingdom to the East, where numerous private baths with Roman-style hypocaust and *tubulus* systems have been found that date to the first century CE. Examples of these first century private baths include those found at Wadi Ramm,[106] Wadi Musa,[107] the Petra North Ridge,[108] and Zantur, Petra.[109] Interestingly, these baths were built up to almost a century before Roman annexation and direct control of the region in 106 CE. The popularity of these Roman-style baths in Nabataea not only reflects this region's close ties with Judea (Herod's mother, for instance, was Nabataean), but is also perhaps indicative of a preexisting bathing

[103] Borgia and Spanu 2003, 270, 299-310.
[104] Gordon 2007, 41-48.
[105] Hirschfeld 2000, 311-29.
[106] Dudley and Reeves 1997, 92-106; 2007, 404-407.
[107] 'Amr et al. 1997, 470, fig. 5.
[108] Parker and Perry (Forthcoming).
[109] Stucky et al. 1994, 275, fig. 8.

tradition that was similar to that of Judea. In addition to baths associated with elite private residences, first century CE Roman-style baths in this region have also been found associated with Nabataean sanctuaries, such as those at Sabrah,[110] the Pond Temple at Petra,[111] and possibly at Selaema (modern Salim).[112] It is possible that the early baths at Wadi Ramm, mentioned above, were also associated with an adjacent temple dedicated to the Nabataean goddess Allat.[113] Thus, these bathing facilities may have potentially been used for ritual purification in Nabataean religion.

Elsewhere in the Roman East, the beginning of the first century CE saw the introduction of Roman-style baths in monumental and public form. In western Anatolia, it was around this time that Roman-style baths began being built next to Hellenistic gymnasia, giving rise to the so-called bath-gymnasia.[114] Further east, in the region covered by this study, such public Roman-style baths first appear in Hellenized cities. On Cyprus, for example, the monumental baths at Salamis were constructed during the reign of Augustus,[115] while the large public baths on the acropolis of Kourion were initially built at the beginning of the first century CE.[116] Early first century CE baths are also known from Antioch. According to the chronicler John Malalas, at least two baths were constructed under Augustus (Malal. 9.14), while a third was built under Tiberius (Malal. 10.10).[117] Further south, first century CE baths were also constructed in the

[110] Fournet and Tholbecq 2015, 42.
[111] Lindner and Gunsam 1995, 206-207, fig. 19.
[112] Fournet 2010, 331.
[113] Dudley and Reeves 1997, 82-83.
[114] For an overview of bath-gymnasium complexes, see Yegül 1992, 307-313.
[115] Christodoulou 2014, 90.
[116] Christodoulou 2014, 88.
[117] There does not appear to be a standard method of citing the *Chronographia* of John Malalas. The numbers provided here refer to the books and paragraphs according to the 1986 translation by Jeffreys et al.

Decapolis region, such as the Eastern Bath of Scythopolis[118] and the bathing complex at Pella.[119] It is likely that other first century CE Roman baths existed elsewhere in the Decapolis region or along the Levantine coast; however, later renovations to these facilities in antiquity, modern urban development, and a lack of excavation has prevented their discovery. It therefore appears that the large public baths, which were soon to dominate the urban landscape of the Roman East, first appeared in the region's Hellenized cities.

In regions without a strong Hellenistic connection or preexisting bathing tradition, the Roman military was often the vehicle by which the Roman-style baths were introduced. It has been suggested, for instance, that it was Roman soldiers who introduced public baths and bathing to Cilicia, where they quickly grew in popularity over the course of the second century CE.[120] Later, in the third century, the military was also likely responsible for the introduction of Roman baths to regions along the eastern frontier, such as the city of Dura Europos on the Euphrates and in the Lajat region (Trachonitis) in the northern Hauran (modern day southern Syria).[121]

During the second century CE, the construction of public baths exploded throughout the East, with large urban bathing complexes built in all five provinces studied here. In Cilicia, for example, the second century saw the construction of monumental public baths at Antiocheia ad Cragum,[122] Elaeussa Sebaste,[123] and Anazarbos,[124] among others. At Salamis, on Cyprus, the large Augustan bathing complex was reconstructed under Trajan and Hadrian, after a devastating

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[118] Tsafrir and Foerster 1997, 98.
[119] Smith and Day 1989, 18.
[120] Hoff 2013, 145-46.
[121] Fournet 2012a, 332.
[122] Staggs 2014, 95.
[123] Spanu 1999, 103.
[124] Casagrande Cicci 2013, 151.

earthquake in 76/77 CE.[125] This trend also continues in Syria, where two of the known baths at Apamea (and likely several of the unexcavated baths) also date to the second century,[126] as do the large public baths excavated at Palmyra[127] and Baalbek[128]. In the province of Judea, examples of second century baths include the Southern Bathhouse at Hippos-Sussita,[129] the thermal baths at Hammat Gader,[130] and the Western Bath of Scythopolis.[131] Finally, in Arabia, the three large baths that are known in Bosra were all initially constructed in the second century CE,[132] as were the monumental East Baths of Gerasa (modern Jerash).[133]

This proliferation resulted, on one hand, from a growing popularity of this building type in previously Hellenized regions of the East and, on the other hand, from the introduction of public baths to new places, such as Cilicia and Arabia. Ultimately, however, the explosion of bath building in the Roman East was part of an empire-wide phenomenon whereby baths and bathing in the Roman-style became associated with membership in the larger Roman society. On an individual level, bathing in a Roman fashion was a performative act, akin to attending a Greek gymnasium, in which a provincial who had never set foot in Rome could engage with a cultural institution and participate in a recreational activity that integrated them into Roman culture. Thus, attending the Roman baths and bathing in the Roman fashion was a means of demonstrating one's social status and cosmopolitan sensibilities. This mentality was perhaps most famously expressed by Tacitus, when he stated that the newly conquered Britons willingly

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[125] Karageorghis 1969a, 185; Christodoulou 2014, 190.
[126] Vannesse 2015, 101-102.
[127] Vannesse 2015, 115.
[128] Brünenberg 2009, 191.
[129] Kowalewska 2019a, 189; 2019b, 274.
[130] Hirschfeld 1997, 477-78.
[131] Mazor 1999, 295.
[132] Fournet 2012b, 192, 201, 209.
[133] Lepaon 2008, 65, fig. 12.

accepted Roman-style baths and bathing as part of the trappings of civilization (*humanitas*) (Tac. *Agr*. 21).[134] For the Greeks of the Roman East who were already familiar with public bathing, attending Roman-style baths was a way of engaging with the broader Roman culture, while still maintaining their layered Greek identity.[135]

If bathing in the Roman style was one of the ways a provincial could act out their *urbanitas*, then the construction of Roman-style baths was how cities and towns could provide that opportunity to their citizens, while also expressing their civic identity as Roman and civilized. Furthermore, the liberal use of water used in these baths (discussed in greater detail below) acted as an ostentatious display of a city's wealth and abundance. Similar public exhibitions of water wealth, such as fountains, were a common feature of Roman urban topographies.[136] In the arid and semi-arid regions of the Roman East, these displays of water were even more profligate, given the scarcity of this resource. As a result, such displays are not as common as they are in the West, although several prominent eastern cities did have lavish public displays of water.[137] It should be noted that in some regions of the East, most notably in the Nabataean Kingdom, such lavish displays of water pre-dated the Roman period.[138]

Public baths were thus emblems of civic pride, used alongside other monumental public buildings to compete with neighboring cities as the communities across the Mediterranean world negotiated their place under Roman hegemony. Far from being limited to the Roman East, this

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[134] *Paulatimque discessum ad delenimenta vitiorum, porticus et balinea et conviviorum elegantiam. Idque apud imperitos humanitas vocabatur, cum pars servitutis esset*. "And gradually they were led to the charms of vices, such as arcades, baths, and the refinement of banquets. And out of ignorance, it was called civilization, when it was actually part of their subjugation." (translation by author).
[135] Woolf 1994, 130.
[136] Rogers 2018, 46-56.
[137] Kamash 2012, 85-88.
[138] See Bedal 2002.

surge in bath construction was part of a larger trend throughout the empire. A similar proliferation of Roman-style baths was seen in the western provinces of Britain, Gaul, Germany, and Spain, where archaeological evidence suggests that the majority of datable baths were constructed in the late first and early second centuries CE.[139] In northern Africa, this surge began in the mid second century and continued into the third and fourth centuries as cities and towns constructed new baths and renovated old ones.[140] The proliferation of baths in the Roman East thus appears to have taken place more or less contemporaneously with these other regions of the Roman world.

In terms of funding for these large-scale building projects, money could come from a number of sources.[141] Public baths could be built through imperial benefaction, whereby the emperor would provide funds from his personal *fiscus*. In the Roman East, the chronicler John Malalas records numerous emperors funding the construction of baths in the city of Antioch.[142] Another example of imperial benefaction comes from Salamis, where an inscription was found commemorating Trajan's restoration of the roof over the gymnasium's swimming pool.[143] In addition to imperial benefaction, public baths could also be financed through euergetism, the ancient practice of affluent individuals distributing wealth to the community or funding public projects. One such example from the Roman East is the Baths of L. Julius Agrippa, at Apamea, which were constructed by their namesake's expense after an earthquake in 115 CE.[144] Elsewhere, an inscription found near the baths at the Sanctuary of Apollo Hylates, near Kourion,

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139 Laurence et al. 2011, 219.
140 Laurence et al. 2011, 224.
141 Nielsen 1990, 119-22; Yegül 1992, 43-46.
142 Yegül 2000, 148-49.
143 Christodoulou 2010, 284-85.
144 Balty 1988, 91-92; Vannesse 2015, 98.

Cyprus, records that this facility was funded through public subscription, whereby individual citizens made promises of donations to be settled later.[145] In the absence of private funding, a bathing facility could also be constructed at public expense, such as through taxes.[146] Another common source of public funds was the *summa honoraria*, which were the monetary payments made by magistrates upon entering civic office in the cities across the Roman Empire. Although not from this study's region of focus, Pliny states that the citizens of Claudiopolis, in the province of Bithynia-Pontus, were using funds from their *summa honoraria* to finance a new bathing complex in their city (Plin. *Ep.* 10.39).

The identity of the architects and builders of baths is a large topic that is not possible to cover in full here. Complicating their identification is the fact that often only the names of those financing the construction of baths are recorded.[147] Nevertheless, it is clear that the construction of Roman-style baths was a long and technical process that could involve the participation of thousands of individuals, including architects, specialist builders, and simple laborers. DeLaine in her study of the Baths of Caracalla, for example, estimates that a total of 16,000 individuals were involved in the construction of the monumental baths, roughly one third of whom were unskilled laborers.[148] Even small bathing entablements required careful planning and the involvement of skilled builders.[149] Chief among these builders were trained architects, and

[145] Mitford 1971, no. 110, 214-15; Christodoulou 2010, 289.
[146] In his letter to Pliny, Trajan states that no new taxes are to be raised in order to pay for the construction of the new baths at Prusa, in the province of Bithynia-Pontus (Plin. *Ep.* 10.24). The emperor Severus Alexander is recorded as having imposed a new tax on a number of craftspeople and used the revenue for the maintenance of public baths (SHA *Alex. Sev.* 24.5-6).
[147] An exception is found in the writings of Cassius Dio, who records that the architect Apollodorus of Damascus had constructed a γυμνάσιον for Trajan (69.4.1). It is likely that this gymnasium is a reference to the Baths of Trajan in Rome (Anderson 1985, 502).
[148] DeLaine 1997, 196.
[149] The writings of Aulus Gellus, for example, describe how Cornelius Fronto was found inspecting several plans of baths drawn on parchment which were presented by hired builders (Aul. Gell. *N.A.* 19.10.1-3).

although these specialists could be brought in from elsewhere, Pliny's correspondence with Trajan reveals that, by the second century, architects for the construction of baths could be found in all provinces of the Roman Empire (Plin. *Ep.* 10.40).

There is very little information on contracts for construction work, but evidence from Asia Minor suggests that the architects and overseers of public building projects like baths contracted parts of the projects to groups of free workmen, who may have travelled from one project to another.[150] There is also evidence that builders could be organized into guilds of specialists. Although not from a bathing structure, an inscription found at Gadara (modern Umm Qais) refers to a guild of builders (συντεχνία οἰκοδόμων),[151] while a papyrus found in Oxyrhynchos was written by the president of a guild of carpenters, who was connected to repairs being carried out in a bathing facility.[152] Indeed, many different specialists were required for the construction of Roman-style baths, including masons, brick makers, brick layers, carpenters (for centering and scaffolding), smiths, and decorators, among others. The diversity of craftspeople at ancient building sites is represented in two similar mosaics depicting the construction of the Tower of Babel, which were found in the synagogues at Khirbet Wadi Hamam[153] and Huqoq (Figure 9).[154] Regarding non-specialist work and labor, DeLaine accepts the likelihood that much of the heavy labor for the construction of the Baths of Caracalla was carried out by urban poor rather than slaves, but she also recognizes that the laborers, specialist builders and even architects could be slaves, freedmen or free-born.[155] It is likely that the building yards of Rome' eastern provinces

[150] Zuiderhoek 2016, 33-34.
[151] Batayneh et al. 1994, 379.
[152] P. Oxy. 1, 53 = P. Lond. III 751.
[153] Leibner and Miller 2010, 241-49, fig. 2, colour fig. A.
[154] Magness et al. 2018, 115-17, figs. 48-49.
[155] DeLaine 1997, 106-107.

were equally diverse and filled with a mix of individuals with different skills, origins, and legal statuses. It is likely that the Roman army play a major role in the construction of baths associated with military installations, with labor and specialist skill being drawn from the ranks.[156]

Although generally similar to those of Italy and the West, the public baths constructed in the Roman East did display regional differences in both design and layout. Unlike many of the monumental urban baths of Rome and the West, for example, some of the earliest public baths in southern Syria were not built with axial symmetry, possibly as a result of uncertainty with these monumental models or because of the absence of space in the already crowded urban centers.[157] It was not until the third and fourth centuries that additions to these complexes and newly constructed baths reflected the axiality of their western counterparts. Another notable difference between western baths and those built in certain regions of the East was the presence of palaestrae, open-air courtyards used for games and exercises. While the palaestra was a common feature of western and Anatolian baths, they appear to have been gradually phased out of Syrian baths and those further south, possibly because they were not suitable for the heat of the East or because outdoor exercising was less appealing to the indigenous cultures of this part of the Roman world.[158]

In the third and fourth centuries, the construction of public baths continued across the East as older baths were renovated and new ones were constructed. At Antioch, this continuing trend is reflected in the succession of imperial benefactions resulting in new public baths throughout this period.[159] Rather than decreasing in size, this period saw the construction some of the largest

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[156] Reeves 1996, 25-26.
[157] Fournet 2012a, 332; 2012b, 217-18.
[158] Yegül 1992, 326-29; Yegül and Favro 2019, 726-27.
[159] Yegül 2000, 148-49.

baths in the region, with successive additions and renovations creating sprawling complexes.[160] This gradual enlargement is seen in the two monumental baths at the Decapolis city of Gerasa (modern Jerash). Both the West Baths and the East Baths underwent renovations resulting in ever-larger complexes, and in the case of the East Baths culminated in a structure covering an area of over 15,000 m^2.[161] Beginning in the third century, there was also a gradual shift in use of the *frigidarium* from the western model as a large hall with a public swimming pool to the so-called "social halls", where bath attendees could rest, socially gather, and be entertained.[162] In addition, there is a visible trend away from multi-person immersion pools in the heated rooms to individual tubs, suggesting a shift in bathing practices from communal to more individual.[163]

Alongside the rise of the Roman-style public bathing complex in the East, private baths continued to be built in elite residences. One such example is the late second or early third century bathing suite in the House of Orpheus at Paphos, on the island of Cyprus.[164] In Judea, where private Roman-style baths were likely first introduced to the East, excavation at the site of Ein Yael, west of Jerusalem, uncovered two bathing suites in a villa complex that was occupied between the end of the second century and the mid-third century CE.[165] Private baths evidently continued to be a feature of elite residences into late antiquity as demonstrated by the mid-fifth century Baths of Flaccus in the Decapolis city of Gerasa (modern Jerash).[166] These private baths are only a few of the known examples, and more are certain to be found through future excavation. While several private baths are included in this study, the examination of these

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[160] Fournet 2012a 332-33, fig. 3
[161] Lepaon 2008, 54-56, 62-65, figs. 5, 12, 13.
[162] Yegül 1992, 329; Fournet 2012a, 332; Yegül and Favro 2019, 727.
[163] Fournet 2012a, 332.
[164] Christodoulou 2014, 92.
[165] Edelstein 1990, 40.
[166] Fisher 1938a, 265-69; Lepaon 2015.

bathing suites has in large part been hindered by insufficient excavation and publication of domestic spaces in the Roman East outside of a few specific sites. In other regions of the Roman world, private baths in elite residences also had a long tradition of construction and use.[167]

The Roman military also continued to play a role in the spread and proliferation of baths into the third and fourth centuries. The early third century baths of Dura Europos, which were likely built to serve the city's garrisoned troops, have already been mentioned. The impact of the military is perhaps best seen in the explosion of bath construction that took place during Diocletian reorganization of the eastern frontier and the build-up of troops along the *Limes Arabicus*. These baths included those within legionary fortresses, such as the one at Betthorus (modern Lejjun),[168] and the many garrisons baths associated with the newly founded *castella* along the frontier.[169]

The construction and evolution of Roman-style baths in the East continued into late antiquity, well past the chronologic focus of this study. An example of this evolution was the gradual introduction of steam to replace the dry heat that was typical of earlier Roman-style baths. This shift to stem baths is perhaps first seen in several small baths of northern Syria.[170] Ultimately, this evolution of late antique Roman-style baths led to their transition to the early Islamic *hammam*.

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[167] For private baths in Asia Minor, see Uytterhoeven 2011, especially 294-310. For private baths in North Africa, see Hewitt 2000.
[168] de Vries and Lain 2006.
[169] Darby 2015a.
[170] Charpentier 2015, 231-32.

Resources for the Operation of Baths – Fuel and Water

One of the major issues with which the builders of these Roman-style baths had to contend was the availability and supply of resources needed for the facility's operation. Baths were unique among ancient buildings in that their proper function required the introduction of fire and water, two elements that were typically destructive to buildings. In the arid regions of the East, ensuring a sufficient supply of fuel and water was a difficult challenge, but one that was met with the ingenuity that characterizes the wider introduction of this building type to this region.

Roman-style baths required large amounts of fuel for the heating of both space and water. Numerous studies from across the Roman Empire have attempted to quantify the amount of fuel needed for maintaining the heating systems, in some cases with experimental archaeology using reconstructed heating systems and in others with mathematical formulae. In all cases, these studies have concluded that copious quantities of fuel were needed for the heating of baths. The early experiment by Kretzschmer, for example, found that a small room (20 m^2) took a full 24 hours to heat up, suggesting that the *praefurnia* required continuous operation to maintain the temperatures of the baths.[171] Subsequent studies have supported the likelihood that the furnaces needed to be maintained continually to ensure the proper temperatures.[172] In 1998, a modern and functioning replica of a small Roman-style bathing facility was constructed at Sardis by several Roman bath scholars. This structure was heated up for a full week before being used, requiring

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[171] Kretzschmer 1953, 24-27.
[172] The interior temperature of Roman-style baths is not known for certain, but it is believed to have been at least 37-38°C in order to induce sweating (Mietz 2016, 19). The floors and walls of the baths would have been much hotter to maintain this ambient heat. This fact is reflected in the accounts of M. Cornelius Fronto, who describes being burned when he was dashed against the hot entrance of a bathing facility (Fronto, *Ep*. 5.59), and of Pliny, who describes the attempted murder of Larcius Macedo, who was thrown to the floor to see if he was feigning death (Plin. *Ep.* 3.14).

15 kg of oak firewood per hour.[173] Another reconstruction of the Roman baths at Xanten, Germany, found that in winter months an initial 120 kg of wood was needed for six days in order to reach a thermal equilibrium, and after 11 days, the fuel could be dropped to around 100 kg a day while maintaining temperatures of 31°C.[174] During the summer months, this same experiment found that 150 kg of wood was initially needed for seven days to reach equilibrium, after which 100 kg of wood was needed, and by the eleventh day a constant 37°C could be maintained with only 67 kg of wood per day.

Using the results from these reconstructed heating systems, several other studies have attempted to calculate the fuel requirements of actual baths. Using the data collected by Kretzschmer's experiment, it was estimated that the small third century Welwyn Baths in Britain continuously required 13 kg of wood every hour, for a total of 114 metric tonnes per year.[175] A similar study suggested that the Small Baths at Phaselis, Lydia, needed 15.45 kg of firewood per hour, which would equate to 135 metric tonnes per year if burning continually.[176] An investigation of the much larger second century baths at Sagalassos has suggested that up to 3,100 ± 730 tons of wood were needed per year.[177]

In all of these experiments, wood or charcoal was used as fuel, and there is plenty of evidence to suggest that these were the fuels of choice for most baths across the Roman world.[178] In certain forested regions of the Roman East, such as Cilicia and along the Mediterranean coast, wood may have been available in sufficient quantities to be the primary fuel used in baths. Even

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[173] Yegül et al. 2003, 167.
[174] Grassmann 2011, 24-25.
[175] Rook 1978, 281.
[176] Basaran and Ilken 1998, 5.
[177] Janssen et al. 2017, 595-97, table 2.
[178] Mietz 2016, 58-67.

in regions of the East where this resource was less common, there is evidence that wood was sought out. From Dura Europos, a papyrus dating to 223-225 CE, which has been identified as a possible morning report of the *cohort* XX *Palmyreni*, mentions a soldier being sent out to collect wood for the baths.[179] Given the nature of this document, the fact that only one man was sent, and the absence of wood around Dura Europos, it seems more likely that this soldier was sent to requisition wood rather than collect it.[180]

In other arid or semi-arid regions of the Roman East, where firewood was too rare or difficult to acquire, the operators of baths relied on a variety of alternative fuels. Local vegetation was one option. Excavation of the *praefurnium* of the baths at Hauarra (modern Humayma, Jordan) uncovered the charred remains (radiocarbon dated to 416 ± 83 CE) of jointed saltwood (*Haloxylon articulatum* or *Hammada scoparia*), which is a common bush found throughout the site today.[181] Desert shrub was also assumed to have been used to heat the baths at Mamshit (Mampsis) in the Negev Desert.[182]

In regions where orchards were cultivated, the regular pruning of branches was not only necessary for maintaining the health of the trees, but it also produced an important source of fuel in the ancient Mediterranean (Cato *Agr*. 7.1, 37.5, 50.2; John 15:6). Excavation within Jerusalem has demonstrated that fruit tree branches, roots, and tubers were brought into the city as a fuel source.[183] Evidence for using such agricultural biproducts in the *praefurnia* of baths comes from

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[179] P.Dura 82, see Campbell 1994, 112.
[180] Reeves 1996, 86.
[181] Oleson 2010, 229.
[182] Negev 1988, 169.
[183] Roth et al. 2019, 81.

Bosra, where excavation of an ash heap from the baths of "Trajan's Palace" uncovered the charred remains of cereals and fruits.[184]

Another type of agricultural biproduct that has regularly been found in the heating systems of baths is olive pressings left over from the production of olive oil. The archaeobotanical analysis of ash from *praefurnia* of several baths in the Roman East have identified large quantities of olive pits or seeds, suggesting olive oil pressing waste, or pomace, was used as fuel. Several baths in this region have produced evidence for the use of pomace in their heating systems.[185] Specific examples include the Byzantine Baths at the Decapolis city of Gadara (modern Umm Qais), which was constructed in the early fourth century CE,[186] and the second century CE public baths at Khirbet edh-Dharih, located ca. 100 km north of Petra.[187] Throughout the olive-growing regions of the Roman world, pomace was produced in large quantities and was an important fuel source for urban centers and arid regions without sufficient firewood supplies.[188]

Perhaps most peculiar was the use of animal bones in the Central Baths at Bosra. Excavation within one of the *praefurnia* of this bathing complex found large quantities of butchered bones and animal dung, which were likely used alongside wood in order to meet the huge demand for fuel that this facility required.[189]

This use of animal bones along with the variety of other material used as fuel for the heating of baths demonstrates the resourcefulness of bath operators. The use of these fuels, however, did not begin with the introduction of the Roman-style baths, but rather they were widely used long

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[184] Bouchaud 2014, 600.
[185] Bouchaud 2014, 600-601.
[186] Holm-Nielsen et al. 1986, 226.
[187] Durand 2015, n. 11.
[188] Rowan 2019.
[189] Fournet and Lepetz 2014, 615-20.

before the Roman period. Olive pressings, for instance, had a long history of use as fuel in the ancient Near East and the wider Mediterranean.[190] Similarly, animal dung was widely used in the region prior to the advent of Roman hegemony.[191] The use of these alternative fuels in Roman baths therefore represents a continuation of their regional use. It is, furthermore, one of the many ways that the Roman-style baths had to and successfully did adapt to the region as well as to the available resources and preexisting traditions therein.

Given the scarcity of fuel in many regions of the Roman East and the large amounts of fuel required for the operation of baths, one would expect the builders of these facilities to seek out fuel-efficient heating systems, in order to cut down on the amount of fuel needed. The construction and testing of the model baths at Sardis, for instance, found that using *tubuli* created a more efficient system than one built without them by reducing the amount of fuel required by around 20%, and it found that encasing the water boiler in masonry and using double-glazed windows could also result in substantial fuel savings.[192]

Indeed, window glass was commonly used in Roman-style baths throughout the empire, not only to prevent the escape of hot air from the heated rooms, but also to allow solar radiation to contribute to their heating.[193] The use of window glass in the baths of the Roman East is demonstrated by its discovery at several sites, including Anemurium,[194] Dura Europos,[195] Gadara (modern Umm Qais),[196] and Hauarra (modern Humayma),[197] to name a few. Close examination

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[190] Rowan 2015, 468-71, table 1.
[191] Forbes 1966, 14.
[192] Yegül et al. 2003, 175.
[193] See, Broise 1991; Ring 1996; Miliaresis 2019.
[194] Onurkan 1967, 79.
[195] Brown 1936a, 92.
[196] Holm-Nielsen et al. 1986, 229.
[197] Reeves et al. 2009, 234.

of extant window openings has also identified evidence for double-glazed windows as well as wooden shutters (used for protection and extra insulation) in both the South Baths[198] and Central Baths[199] at Bosra. Similar installations have also been found at Selaema (modern Salim) in the Hauran.[200]

Roman-style baths also required copious amount of water for their operation, although the exact volume of water used by these facilities is often unclear. In his technical work on the water supply of Rome, for instance, Frontinus records that 44% of all water entering Rome was used for public purposes, 39% was for private parties, and 17% was at the emperor's disposal (Frontin. *Aq*. 78-86). Unfortunately, he does not state how much water was sent to baths, and since public, private, and imperial baths existed, it is possible that the city's baths drew from all three of these given categories. Complicating the issue further is that fact that the numbers provided by Frontinus are considered highly unreliable by modern scholars and are thus useless for calculating the requirements for individual baths.[201] A rough idea of how much water baths required can be obtained through an examination of the reservoir cisterns that were associated with some of the largest baths. These cisterns, which were likely filled at night to reduce the strain of the water supply system by baths during the day, could be monumental in size, such as the Sette Sale of Trajan's Baths in Rome (7,000 m^3), the reservoir for the Baths of Caracalla in Rome (11,500 m^3), and the Bordj Djedid cisterns of the Antonine Baths at Carthage (20,000 m^3).[202]

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[198] Broise 1991, 69-75.
[199] Fournet 2007, 252; 2008b, 124.
[200] Fournet 2010, 326.
[201] Fagan 1999, 69-73; Bruun 2004.
[202] Wilson 2009, 305.

In terms of calculating the daily water use of bathing facilities, there seems to be a surprising lacuna in scholarship. Such estimates may be hampered by the poor preservation of basins and pools (and thus their inability to be accurately measured) as well as what is often a poor understanding of rate of flow into baths. In rare cases, scholars have attempted to estimate the amount of water used by an individual bathing facility. One such attempt was made for the baths at Roman Aptera, Crete, which is estimated to have required 16 m^3 of water per day to fill its pools and basins.[203] If accurate, this estimate would equate to well over the volume of two Olympic-sized swimming pools each year.

There are few known studies that have attempted to calculate the water usage of a bathing facility in the Roman East, likely for the reasons mentioned above. Negev, for example, estimates that the baths at Mamshit (Mampsis) in the Negev Desert required only about 200 m^3 of water per year, although the calculations for this estimate are not entirely clear.[204] It is therefore worthwhile to speculate briefly on the water usage of the baths at Arieldela (modern ‘Ayn Gharandal), which is one of the best-preserved baths in the study region. Measuring least 84 m^2, these small baths were constructed in the Tetrarchic period and are located about 70 km north of the Gulf of Aqaba and about 40 km southwest of Petra. The small bathing facility has been nearly completely uncovered and contains only a single immersion tub (*alveus*) in the *caldarium*.[205] This tub, seemingly the only water installation in the facility, measures 2.35 m by

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[203] De Feo et al. 2012, 377.
[204] Negev 1988, 187. Negev states: “The capacity of the baths in the frigidarium was approximately half a cubic metre each; the capacity of the tepidarium was approximately the same, whereas the operation of the laconicum, or even a caldarium, would not need more than one cubic metre of water. Two hundred cubic metres of water would be enough to operate the bath house throughout the year” (Negev 1988, 187). These figures do not add up. It is possible that Negev is assuming that the baths were not in operation 365 days a year. If the baths were in operation every day and the capacities given are correct (2.5 m^3 of water per day), these baths would have required approximately 912.5 m^3 of water per year.
[205] Corbett et al. 2016, 676, fig. 25.

0.90 m and has a depth of roughly 0.95 m.[206] As such, this tub has a total capacity of roughly 2.0 m^3. Assuming, therefore, that the tub was filled and emptied once a day, it is likely that around 730 m^3 of water were required per year (the equivalent of less than a third of an Olympic-sized swimming pool). This volume does not include the water required for rinsing the bathers and cleaning of the baths itself. Of course, larger baths with bigger and more tubs and pools would have required much more water than this relatively small bathing facility.

For much of the Roman world, it was aqueducts that supplied Roman baths with their water; however, wells and cisterns were also used.[207] The largest Roman-style baths required the rate of flow that was only provided by aqueducts, and in many cases the new construction of monumental baths necessitated a new aqueduct to be built.[208] In the Roman East, baths in large urban centers and those located where perennial water sources were available could be provided with water directly from aqueducts. At Antioch on the Orontes, for example, Julius Caesar (Malal. 13.40), Trajan (Malal. 11.9), and Hadrian (Malal. 11.14) are all credited with building aqueducts along with baths bearing their names, suggesting that the former were built to supply the latter.[209] Smaller baths, even in arid environments, could also be supplied with water via aqueducts. The second century CE garrison bath at the site of Hauarra (45 km south of Petra) was fed by a water system that included an open-air reservoir and a 26.5 km long aqueduct that was spring-fed and originally built in the Nabataean period.[210]

[206] Darby and Darby 2015a, 41.
[207] Nielsen 1990, 23-24; Yegül 1992, 389-95.
[208] Hodge 2002, 6, 267.
[209] There does not appear to be a standard method of citing the *Chronographia* of John Malalas. The numbers provided here refer to the books and paragraphs according to the 1986 translation by Jeffreys et al. For the remains of the extant Antioch aqueduct, see Wilber 1938 and Benjelloun et al. 2015.
[210] Oleson 2010, 223.

In the arid and semi-arid environments of the Roman East where water was scarce or intermittent, it was not always possible to have a continuous stream of water piped in through aqueducts. In these cases, it was common for baths to be supplied with water from cisterns or reservoirs. Whether filled by aqueducts, rainwater catchment systems, or some other means, these cisterns served to store water for use by the bath during dry periods. Where rainfall was infrequent or seasonal, such rainwater catchment and storage systems were vital not only for the continued operation of baths but also for the survival of entire communities. Roman-style baths connected to reservoirs or cisterns have been found at Mamshit (Mampsis) in the Negev Desert,[211] and at numerous other sites across the Roman East.[212]

In a few rare cases, wells were used to supply Roman baths. In the Negev Desert, wells have been found associated with the baths at Oboda (modern Avdat)[213] and Rehovot-in-the-Negev.[214] In these cases, it is possible that a mechanical water lifting device was used for supplying the baths.[215]

In situations where neither aqueducts nor near-by wells and cisterns could supply baths with water, it was possible to deliver water by hand or pack-animal using jars. Although not from the region of focus here, excavation of an early Roman bath at Apollinopolis Magna (modern Edfu) in Upper Egypt uncovered Greek and Latin records written on ostraca that give evidence for the supply of water to this establishment using "double jars".[216] Such systems of supply could have

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[211] Negev 1988, 178.
[212] Kamash 2012, 90; Kowalewska 2019a, 231.
[213] Woolley and Lawrence 1915, 106; Negev 1997, 173.
[214] Musil 1908, 79-80; Woolley and Lawrence 1915, 116; Rosenthal-Heginbottom 1988, 20.
[215] See Oleson 1984.
[216] Youtie 1949, 269-70.

only existed for the smallest baths, and it is possible that similar arrangements also existed for Roman-style baths in the region studied here.

There is also evidence to suggest that rainwater was collected by the bath itself for its own use. At the Decapolis city of Scythopolis (modern Bet She'an), excavators found rainwater catchment systems in both the Western Bath[217] and the South Bathhouse[218] to supply their pools. It is likely that other baths in the region contained similar systems to augment their primary water supply.

The means by which a bathing facility received its water likely affected the bathing experiences it could offer. Baths that were connected to aqueducts and thus received a continuous flow of water could accommodate large pools with continuously circulating water and ornamental features such as fountains. Smaller baths, or those that relied on cisterns and wells, were more likely to have immersion tubs that were filled and emptied regularly but did not have continuously circulating water. In the most water-poor circumstances where the conservation of water was paramount, immersion tubs could be replaced by splash basins and jars for pouring water on the bathers.

The diversity of water supply systems utilized by Roman-style baths in the East is a clear testament to their flexibility and ability to function in a range of different environments. Credit for the success of these baths, however, is also due in large part to the pre-Roman societies that had long developed complex water management systems to collect, store, and consume water as efficiently as possible.[219] The builders of Roman-style baths were thus able to "tap" into these

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[217] Bar-Nathan and Mazor 1993, 40.
[218] Mazor 1999, 302.
[219] Oleson 2007; Baker 2019, 155-72.

preexisting and well-developed systems and by doing so ensured the functionality and the ultimate success of this foreign building type.[220]

Challenges of Building Baths in the Roman East

Just as large amounts of fuel and water were needed for the operation of baths, so too were they needed for construction of these facilities. Given its susceptibility to fire and water damage, timber was rarely used as the primary building material in thermal baths.[221] Nevertheless, materials (such as brick and concrete) that were commonly used for the construction of baths in Italy and the West required copious amounts of water and fuel for their manufacture.

In her quantification of the materials used in the construction of the Baths of Caracalla, Janet DeLaine provides a revealing look at the enormous quantities of resources required for this mega-project. While she takes a holistic approach to the materials used and focuses on the labor hours required, it is possible to use her estimates and calculations to investigate the vast amount of wood that was needed for the project. For example, DeLaine estimates that roughly 2,020,000 *bessales* (small bricks) were used in the foundations and substructures of the baths.[222] Assuming (as she does) that 0.45 tonnes of wood were necessary to fire 1000 *bessales*,[223] over 900 tonnes of wood were needed to produce these bricks. It should be noted that this is the amount of fuel needed to produce only the 2,020,000 *bessales* used in the foundations and substructures of the baths, and it does not include amount needed for the hundreds of thousands of larger bricks (i.e.

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[220] Kamash 2012, 90.
[221] Although exceptions did exist. See Bidwell 2002.
[222] DeLaine 1997, table 10.
[223] DeLaine 1997, 117.

sesquipedales and *bipedales*) that were used in the baths' foundations or the millions of bricks of all sizes that were required for the construction of the superstructure of the central block.[224]

Wood was also needed to produce quicklime, and Delaine suggest that an average of 2.5 tonnes of wood was required to make 1 m^3 of quicklime.[225] Given that an estimated total of 29,400 m^3 of quicklime was used in the superstructure and substructure of the Baths of Caracalla,[226] an astounding 73,500 tonnes of wood was needed to produce this material.

During the construction process, wood and timber were also required for the scaffolding, centering, and boarding, although much of this temporary material could be deconstructed and reused elsewhere.[227] DeLaine estimates that if the major vaults were all built at the same time, 23,400 m^2 of boarding and 3,000 m^3 of timbers would have been required.[228] Although only estimates based on partial calculations, it is clear that, between fuel for brick and lime production and the timber needed for the construction of vaults, monumental bathing complexes like the Baths of Caracalla could have required enormous amounts of wood over the course of its construction, before the facility's furnaces were ever lit.

Another study on the quantification of building materials was undertaken by Elizabeth Shirley for the Roman Fort at Inchtuthil, Scotland. Included in her analysis are estimates for the materials needed for the construction of the fort's Small Bathhouse, which was built primarily of stone and was approximately 400 m^2 in size.[229] As a stone-built structure, these baths used much less brick and concrete for its size than brick-faced concrete structures like the Baths of

[224] DeLaine 1997, tables 10-11.
[225] DeLaine 1997, 113.
[226] DeLaine 1997, tables 10-11.
[227] It is also possible that any timber not able to be reused for centering could alternatively have been used as fuel.
[228] DeLaine 1997, 125.
[229] Shirley 2000, 72-73, table 5.29.

Caracalla. Nevertheless, large amounts of fuel and water were still required for roof tiles and bricks in the hypocaust system as well as for the mortar used for the masonry. Shirley estimates that the Small Bathhouse required 8,200 roof tiles (4000 *tegulae* and 4200 *imbrices*) and 3720 hypocaust bricks (300 *bipedales*, 670 *sesquipedales*, 250 *pedales*, and 2500 *bessales*). According to DeLaine's calculations (0.45 tonnes of wood per 1000 *bessales*), the firing of the 2500 *bessales* alone would have needed 1.25 tonnes of wood. Shirley also suggests that the walls and foundations of this bathing facility required roughly 354 m^3 of stone and 177 m^3 of mortar. By her calculations this mortar would have needed 26,550 L of water and 44.25 m^3 of lime (which, by DeLaine's calculations, needed over 110 tonnes of fuel to produce). Regarding the presumed Main Bathhouse at Inchtuthil that had yet to be constructed by the time of the fort's abandonment, Shirley suggests that this facility could have been up to 6,000 m^2 (fifteen times larger than the fort's Small Bathhouse) and thus estimates that it required roughly fifteen times the materials needed for the smaller facility.[230]

Both DeLaine's and Shirley's quantification studies are based on rough estimates and are thus not intended to produce highly accurate results. Nevertheless, both studies demonstrate that the construction of Roman-style baths (and particularly the production of ceramic building materials and mortar) required enormous amounts of fuel and water.

In the arid and semiarid regions of the Roman East, the need for such large quantities of fuel and water would certainly have been a challenge, but one that was evidently overcome. As was done for the fuel and water needed for the baths' operation, it is likely that the builders of these facilities were able to rely on the preexisting water supply systems and wood-alternative fuels

[230] Shirley 2000, 75, table 5.29.

when necessary. Indeed, there is plenty of evidence for the use of agricultural waste and animal dung for the production of ceramics and lime in wood-poor regions of the Middle East, both in antiquity and the modern times.[231] Thus, while the resources required for the construction of Roman-style baths may have posed a challenge, the ability of this building type and their builders to adapt to local conditions enabled them to overcome this difficulty.

Another major difficulty that the builders of these facilities in the Roman East faced was the novelty of the Roman-style bath in terms of the engineering and technical challenges it presented. Although this region was filled with many well-developed building traditions and industries that pre-dated Roman control, they were not familiar with all the architectural forms and technical features that comprised Roman-style baths. For example, the need for fire- and water-resistant materials in the heated rooms in these facilities necessitated the use of vaults and domes.[232] While subterranean vaults had long been built in this region, the construction of large freestanding vaults and domes (which were largely introduced to this region via the Roman bath) required new construction methods to ensure that the lateral thrusts of the vaulting were correctly transferred down through the abutments walls that also supported the weight of the vaults.[233]

Adding to this challenge was the construction of the technological complex heating systems that characterized Roman-style baths. These systems required a specialized understanding of thermal engineering, and the intense heat that they generated necessitated their construction out of ceramic building materials such as kiln-baked bricks. Prior to the introduction of Roman-style baths, much of the Roman East lacked a developed brick industry, and thus these required

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[231] Forbes 1966, 15; Martin 2019.
[232] See discussion in Chapter 4.
[233] For a discussion of the structural properties and behavior of domes and vaults, see Lancaster 2005, 130-165 and Lancaster 2015, 177-191.

materials were not always on hand.[234] Local brick industries therefore had to be developed throughout the region in order to supply this new demand.

While there is evidence that a few of the Roman-style baths in the East were constructed by Italian builders sent to the region,[235] it was neither logistically nor financially feasible to import Italian builders for every bath built in the Roman East. If a provincial community wished to construct Roman-style baths, it was necessary to rely upon local builders and building industries to do the job. Although these provincial building industries and craftspeople had well-developed and deeply entrenched building practices, the techniques and materials at their disposal were shaped by their local environment and cultural needs and were thus not always suited for the construction of Roman baths. As discussed above, the preexisting building industries were largely unfamiliar with the construction of vaults or the use of the ceramic building material that Roman-style baths demanded, and thus they were required to develop innovative solutions for adapting their local traditions to the construction of these foreign structures. It is this local involvement in the construction of Roman-style baths that is the focus of the present study.

Scholarship on the Construction of Roman-style Baths in the Roman East

Owing to the ubiquity, often good preservation, and social and cultural importance of Roman-style baths, their study in the Roman East has a long history. Since 2006, the study of these eastern baths has also been promoted by the Balnéorient Project, a French led initiative that has supported the study of baths and bathing in the Middle East and surrounding regions through the organization of international conferences and the publication of edited volumes on the

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[234] See discussion in Chapter 5.
[235] See discussion on Herodian baths above and, Kelso and Baramki 1955, 5; Deichmann 1979, 474-75; Netzer 2006, 315.

subject.[236] Although this earlier scholarship has often included descriptions or analysis of bath construction, the study presented here is the first transregional examination of the building materials and techniques specific to baths in the region. As such, this study relies (but also builds) on the important contributions that have been provided by previous scholarship that has often been more limited in scope than the investigation presented here.

Regional and transregional studies of baths have often touched upon the construction of these facilities in the eastern provinces; however, they are typically focused on developing regional typologies based on their floor plans and circulation patterns.[237] For instance, Inge Nielsen, in her work *Thermae et Balnea*, provides very little discussion of the building techniques and materials used in the baths of the Roman East, preferring to focus on the architectural floor plans of these baths and the distribution of their rooms.[238] Such studies have succeeded in identifying several regional patterns of bath architecture, including the so-called "hall-type" bath found primarily in Cilicia and late antique Northern Syria. As described by Fikret Yegül, the "hall-type" bath typically does not have a palaestra, but instead has a central interior hall that connects the heated rooms to the unheated rooms and may have acted as a multipurpose social space.[239] Michael Hoff, in his own study of several baths from western Rough Cilicia, also suggests that several of the Roman-style baths in Cilicia appear to be influenced by those in Lycia in terms of their architectural plans.[240] Another example of a regional bath plan is the so-called "Southern-type," which is commonly found in the Negev Desert and is characterized by a porticoed

[236] See https://balneorient.hypotheses.org/. Publications include: Boussac et al. 2009; Boussac et al. 2014; Redon 2017.
[237] Krencker 1929, 177-81. For a discussion, see Nielsen 1990, 4; Burkhardt 2016, 150-52.
[238] Nielsen 1990, 113-16.
[239] Yegül 1992, 301-304; 2010, 176-80.
[240] Hoff 2013, 155.

courtyard combined with a multi-purpose unheated room (or two in larger baths).[241] These indoor and outdoor areas were used seasonally and functioned as *frigidaria*, *apodyteria*, or social areas. The existence of regional variations in bath design demonstrates that (although ubiquitous) Roman-style baths were far from uniform and could be adapted to the social customs and needs of local populations. While studies that focus entirely on floor plans and circulation patterns have provided further evidence for the adaptability of Roman-style baths, they are not well suited for investigating the involvement of local building industries or fully exploring the innovative solutions developed for applying local techniques to these foreign buildings. Examining these issues requires a detailed analysis of the construction material and techniques themselves.

To the northwest of this study's area of focus, transregional and regional studies of Roman-style baths in western Anatolia have demonstrated that regional patterns and preferences also extended to the construction of these facilities. Fikret Yegül, for instance, provides a short but informative overview of building materials and techniques used in the masonry (and to a lesser extent the vaulting) of the baths of this region.[242] He concludes from this brief survey that the masonry traditions of western Anatolia as seen in bath construction varied greatly from region to region, but they all generally followed an economical and structural hierarchy of materials and techniques, with marble and high quality limestone ashlar at the top, followed by smaller ashlar, sub-ashlar, and brick, and then mortared rubble at the bottom. A similar study by Andrew Farrington examines the masonry techniques used in the baths of Lycia and the surrounding regions, finding that local and pre-Roman techniques continued to be used in the construction of

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[241] Gichon 1978, 51; Hoss 2005, 62-64, 96-97.
[242] Yegül 1992, 256-70.

Roman-style baths.[243] Both these studies point towards a regional variation in the masonry of Roman-style baths that was derived in part from a continuity of pre-Roman practices.

In this study's region of focus (i.e. Cilicia, Cyprus, Syria, Judea, and Arabia), regional studies of Roman-style baths often do provide some discussion on their construction; however, few follow this discussion with analysis that helps answer the questions posed by this investigation. A survey of five cities in western Cilicia, for example, identifies and describes the remains of their Roman-style baths, including observations on their construction as well as regional and extra-regional parallels for the masonry techniques used in their walls and vaults; however, the focus of the analysis is primarily on the identification of bath "types" characterized by floor plans rather than the building material and techniques.[244] A later investigation of six baths in this same region also makes passing yet important observations on their masonry and heating systems but does not attempt to identify regional patterns or justify the use of specific materials and techniques.[245] Skevi Christodoulou's publication on the baths of Cyprus provides a valuable and comprehensive synthesis of the known Roman-style baths on the island. Although Christodoulou describes the construction of the baths, she does not attempt to identify island-wide construction patterns or practices, with the exception of noting a prevalence of spacer pins in the wall-heating systems of the baths.[246]

In the province of Syria, the short study by Gérard Charpentier on the late antique baths in the north of this region rightly notes the regional similarity of building techniques and uses the evolving design and construction of heating systems to demonstrate a tangible shift from Roman

[243] Farrington 1995, 52-93.
[244] Onurkan 1967, passim.
[245] Hoff 2013.
[246] Christodoulou 2014, 95.

bath to Islamic *hammam*.[247] A much broader overview of the baths of Syria is provided by Fikret Yegül, who focuses on those in Antioch and also the evolution of bathing facilities in later antiquity, while making a few observations on their construction.[248] Conversely, Michaël Vannesse provides a much more focused and detailed study, which uses the baths of Apamea, Dura Europos, and Palmyra as case studies to demonstrate the dissimilarity of these structures throughout the province, including in terms of their construction materials.[249] Thibaud Fournet, who has published widely on baths from Egypt, Syria, and Jordan, has also produced a thorough and valuable study of the Roman style baths of southern Syria, in which he highlights the uniformity of bath construction in the Hauran region, specifically in regard to ubiquity of basalt masonry and the use of volcanic scoria in vaulting.[250]

Some of the most comprehensive and detailed studies of baths and bathing in the Roman East are those focusing on the province of Judea. A good example is Stefanie Hoss's study and catalogue of baths in this region, which presents a well-researched diachronic overview of these structures and includes consideration of their construction and engineering, albeit in a limited way.[251] Ehud Netzer, the excavator of multiple Herodian baths, published a short article on these facilities, in which he provides some brief comments on their construction without going into detail or providing much analysis.[252] A much deeper study of Herodian period baths can be found in the unpublished M.A. thesis of Ben Gordon, which is perhaps the most up to date and comprehensive work on the subject. Although focused on a small subset of the baths in this

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[247] Charpentier 1995, 227-28, 231-32.
[248] Yegül 2010, 188-98.
[249] Vannesse 2015, passim.
[250] Fournet 2012b, 190.
[251] Hoss 2005, 45-66.
[252] Netzer 1999, 52-53

region, this study includes an examination of their construction and a detailed analysis of their heating systems, which highlights the variety of techniques used in this limited region and time period.[253] A recent dissertation by Arleta Kowalewska builds on these earlier studies by incorporating the findings of recent excavations, including her own at Hippos-Sussita. Pertinent to the study presented here, Kowalewska also dedicates a section of her study to the analysis of building materials and techniques.[254] Many of her observations, particularly in regard to the variation of hypocaust construction, are also noted below.

Finally, in the province of Arabia, there has been few regional studies relative to the other regions of the Roman East. An exception is Robert Darby's short publication on the late Roman military bath in the Wadi Arabah, which focuses primarily on the placement and architectural plans of the baths, although his mention in passing of their construction does allow for some useful comparison.[255] Although valuable for comparing the construction of baths and identifying localized patterns of building material and techniques, these regional studies rarely go into detail or provide a transregional perspective.

In many cases, the greatest detail and best analysis of bath construction come from the individual archaeological survey and excavation reports. Of course, the detail that these publications provide depends largely on the preservation of the structures, the extent of the excavation or survey, the publication format, and the research interests and questions of the authors. Fortunately, a few reports on individual baths provide more than a simple description of their construction materials and techniques. Some of the most detailed reports are those of

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[253] Gordon 2007, 52-53, 69-84.
[254] Kowalewska 2019a, 235-44.
[255] Darby 2015a.

Marcello Spanu for the Large Baths,[256] the Reticulate Baths,[257] and the Harbor Baths[258] at Elaeussa Sebaste. Other examples of particularly detailed descriptions of the construction of baths in the Roman East include (but are not limited to) the report on the baths at the Sanctuary of Apollo Hylates, near Kourion,[259] Bath C at Antioch,[260] the baths at Kanatha (modern Qanawat),[261] the thermal bathing complex of Hammat Gader,[262] and the Byzantine Baths at Gadara(Modern Umm Qais),[263] and the Large baths at Masada.[264] The excavation reports on the baths of Dura Europos are also notably detailed for their date of publication and are to be commended for their use and analysis of the baths' building methods and materials for dating purposes.[265] Although this original analysis resulted in the misdating of Bath F3, a later reexamination of its construction materials and techniques was effectively able to reassign this facility to between 165 and 216 CE.[266] Thanks to the level of detail in these publications and others, the study presented here has been able to note patterns of construction that it would not otherwise have been able to, an example of which is the distribution and patterns of brick sizes and shapes used in hypocaust systems.[267]

In addition to regional studies and excavation reports focused on Roman-style baths, scholarship on general construction in the eastern provinces has also provided a significant

[256] Spanu 1999, 94-103.
[257] Spanu 1999, 103-114.
[258] Borgia and Spanu 2003.
[259] Scranton 1967, 57-62.
[260] Fisher 1934c.
[261] Peuser 2000.
[262] Solar 1997.
[263] Nielson et al. 1993.
[264] Netzer 1991, 76-93; Foerster 1995, 193-205.
[265] Brown 1936a, passim; 1936b, 49-63.
[266] Pollard 2004, 132-43.
[267] See discussion in Chapter 5.

contribution to the study of bath construction. General studies of Roman architecture often highlight regional and transregional trends in bath construction and place them into their wider contexts. The passing references to baths in J. B. Ward-Perkins' chapter on the Roman East in his *Roman Imperial Architecture*, for example, demonstrates the wide variety of construction techniques used for these facilities in this region as well as the blend of western and eastern influences they display.[268] While understandably selective in his overview, Ward-Perkins highlights several instances of notable baths construction (e.g. ashlar vaulting, the use of mortared rubble construction, etc.) that the study presented here examines in closer detail.

Many of these similar trends are also discussed in Hazel Dodge's scholarship, which has made valuable contributions to the study of construction materials and techniques in the Roman East.[269] While in many ways now out of date (such as in her discussion of *opus caementicium* being produced and used in the East), Dodge provides a succinct, yet detailed overview of the larger construction trends found throughout the region. She also recognizes and demonstrates the continued importance of local building traditions in the Roman period, such as ashlar masonry in certain regions.[270] More focused regional studies of building practices have also touched upon localized trends in bath construction and helped contextualized them in relation to other structures. Examples include G. R. H. Wright's study on building on Cyprus[271] and Netzer's work on Herod the Great's construction program.[272]

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[268] Ward-Perkins 1981, 307-361.
[269] e.g. Dodge 1984a; 1990.
[270] Dodge 1990, 114-15, 120.
[271] Wright 1992, especially 288-90.
[272] Netzer 2006, especially 255-58.

Earlier examinations of construction in the Roman East often stressed a unidirectional West to East transfer of techniques and practices. Studies by Marc Waelkens on the architecture of Anatolia (including Cilicia), for example, have presented valuable contributions to the study of construction, but they also focus primarily on the Roman influence on this region without fully considering the extent to which local traditions influenced the construction of Roman building types.[273] Later studies have responded with a more postcolonial approach. For example, in the region of Cilicia, the scholarship of Marcello Spanu convincingly demonstrates that, although the region saw a great deal of Roman influence, imported architectural forms such as the Roman-style bath were not passively received by the indigenous populations.[274] The study presented here continues this investigation of provincial influences on Roman architecture and demonstrates how local influences can be seen in bath construction throughout the Roman East.

There have also been a few studies focusing on specific elements of construction that are pertinent to this study. Lynn Lancaster's scholarship on vaulting has been extremely influential. Her work on innovative vaulting techniques demonstrates through tangible examples the building innovation that often took place in the Roman provinces. She also highlights the importance of the Roman-style bath as a vehicle of technological transmission within the Mediterranean world.[275]

Regional studies on the construction of heating systems in the Roman East are not common, but Marcello Spanu does provided a brief discussion of kiln-baked bricks from Cilicia, some of which come from the heating systems of the region's baths.[276] Spanu uses the sizing of these

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[273] Waelkens 1987; 1989, especially p. 87 for baths.
[274] Spanu 2003; 2010.
[275] Lancaster 2015, especially 192-95.
[276] Spanu 2003, 22-4, fig. 6; 2010, 403-407, fig. 7.

bricks to exemplify local Cilician influence on a Roman-introduced building material. My own unpublished MA thesis examines a similar instance of local innovation, whereby a variation of the standard Roman *tubulus* (wall heating pipe) was adopted and widely used in southern Roman Arabia.[277]

The study presented here builds on this earlier scholarship and represents the first transregional investigation focused on bath construction in the Roman East. The transregional scope of this study enables the identification of interregional trends and the broader contextualization of those previously identified by regional or localized studies. At the same time, its focus specifically on Roman-style baths allows for the detailed analysis that these complex structures warrant. Expanding upon previous studies of indigenous influence on Romans construction, this investigation explores the degree to which the local building industries throughout the East were involved in and influenced the construction of Roman-style baths. This influence can be seen in the application of pre-existing and deeply entrenched local building methods in bath construction and in the development of innovative solutions using local materials and techniques to overcome the technical challenges these buildings presented. The result of this ingenuity was the proliferation of Roman-style baths that were not passively accepted by provincial communities, but instead reflected membership in the wider Mediterranean world while also reflecting local needs and practices.

[277] Harvey 2013, 72-5.

Chapter 3 Masonry

Introduction

The aim of this chapter is to present and discuss the masonry techniques and materials used in the construction of Roman-style baths throughout the Roman East. It will demonstrate that although they varied from region to region, the construction of walls in these bathing structures largely followed local building practices. Exceptions to this general trend do exist, and examples where non-local and western construction materials and techniques (such as fired brick and *opus reticulatum*) are found in baths will also be discussed in detail. In these cases, where it is possible to see strong influence or direct involvement of Italian or western builders, emphasis will also be placed on considering the vehicles of transmission that contributed to the introduction and employment of these techniques in the Roman East.

As stated in the previous chapter, Roman-style baths were unique among ancient structures in that their proper function required the introduction of fire and water, two elements that were highly destructive to buildings. As a result, Roman-style baths needed to be built of materials that were not only fire-resistant and able to withstand high temperatures but that were also not susceptible to water and moisture damage. For these reasons, baths were almost always constructed out of stone or fired brick, typically bonded with lime mortar. Timber and mudbrick were almost never used, although exceptions did exist.[278] Given the preference for fired ceramic

[278] Although timber construction would seem to be a poor choice for bath buildings, several examples of timber baths do exist from Roman military establishments along the northern frontier, including Britain (Bidwell 2002).

brick over mudbrick in Roman-style baths, the generic term *brick* will be used in this chapter and successive ones to refer to ceramic brick fired in a kiln. The term *mudbrick*, on the other hand, will be used to refer specifically to unfired bricks that were baked in the sun.

Fortunately for the builders of Roman-style baths, much of the eastern Mediterranean had a long history of using stone for all manner of building.[279] The widespread availability of building stone, such as limestone and basalt, coupled with the relative absence of good quality timber in many parts of the eastern Mediterranean led to deeply entrenched building industries and practices centered on the use of stone. On Cyprus, for example, stone construction of one form or another dominated architecture for millennia.[280] In the volcanic Hauran region of southern Syria and northern Jordan, the lack of timber resulted in innovative corbeling and other roofing techniques using basalt slabs that continued to be employed throughout the Roman period and into the modern era.[281] Likewise, in parts of Flat Cilicia, polygonal and ashlar masonry techniques that were developed in pre-Roman times also continued to be used in temple and tomb construction in the Roman period and even in the Byzantine period for large ecclesiastical complexes.[282] While the widespread availability of building stone (which initially led to the development of these building practices in the eastern Mediterranean) allowed stone for the construction of Roman-style baths to be easily sourced, the familiarity of local communities with

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The construction of these wooden bathing facilities unsurprisingly required changes to their heating apparatus. Beyond these military baths, timber baths are also attested by the poet Martial in one of his epigrams (9.75). Mudbrick was equally rare, however, was sometimes used in walls not exposed to the humidity of the baths, such as in the baths at Karanis, Egypt (El-Nassery *el al.* 1976, 241-42, plan 2).

[279] Baker 2019, 21-27, 83-87.

[280] Wright 1992, 357-76.

[281] Braemer and Sorin 2010.

[282] Spanu 2010, 399.

using this material also enabled local industries and builders to contribute to the building of these of bathing facilities.

The type of stone used to construct baths was entirely dependent on local geology. Unlike decorative stone that was shipped over long distances for building projects,[283] building stone used for structural walls was typically sourced as close as possible to the construction site for economic reasons.[284] Indeed, one of the reasons why stone was so commonly used in the Roman East was because of its near ubiquitous availability and thus low cost.

Not all local stone, however, was equally well suited for use in construction, and those quarrying and using this material had to be keenly aware of its structural properties.[285] Although harder stones like basalt and granite were better at withstanding heat, water, and weathering and were thus ideal for building elements that bore the most weight such as foundations and support walls, they were also difficult to quarry and work. Softer limestone was much more easily carved; however, it was not as durable as harder stones. Finally, soft stones, like sandstone and chalk, were very easy to quarry and carve, but also weathered quickly. It was not uncommon for ancient builders to use more than one type of stone in masonry when possible, often taking advantage of each stone's structural properties. For example, in the Decapolis region and around the Sea of Galilee, many monumental buildings were constructed of both limestone and basalt. In these structures, the softer and lighter limestone was used in the upper courses and in the vault where lighter materials and accurate cuts were required, while blocks of basalt were used in the foundations and lower courses, which bore the weight of the entire structure.

[283] Dodge 1988; Fischer 2007; Russell 2013.
[284] Butcher 2003, 174.
[285] Baker 2019, 26.

The Roman period saw the use of several new building materials and techniques in regions of the Near East, one of which was fired brick. This material had been produced in Mesopotamia as early as the fourth millennium BCE for architectural elements and to face walls.[286] The use of fired bricks for masonry, however, did not spread widely in the region, and it was not until the Roman period that brick construction was introduced to places such as Flat Cilicia, where it was embraced by the local population.[287] Even still, brick masonry was not universally adopted throughout the region, and many regions of the East maintained their masonry traditions throughout the Roman period even for the construction of Roman-style baths. As will be discussed in this chapter, there were several reasons preventing the widespread use of bricks for wall construction, including the limited availability of clay for brick production, the ubiquity of good quality stone, and the deeply entrenched building traditions of local crafts people and industries.

Another important building material used in the masonry of most Roman-style baths was mortar, specifically lime mortar, and to a lesser extent gypsum mortar.[288] First used as a plaster, lime and gypsum mortar has a long history in the Near East.[289] For the construction of Roman-style baths, the use of mortar provided increased insulation and a waterproof barrier. Equally important, mortar increased the strength and stability of walls, helping them to absorb the lateral thrusts created by the vaults they often supported. Mortar was also a requirement when building with brick.

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[286] Baker 2019, 58.
[287] Spanu 2010, 403-407.
[288] Whereas lime mortar is produced by mixing water and aggregate (such as sand) with lime, gypsum mortar is made by mixing these ingredients with gypsum. As gypsum required a lower firing temperature, it was easier to produce than lime mortar and was quicker to set; however, it is less durable than lime mortar, especially in wet conditions.
[289] Kingery et al. 1988; Philokyprou 2012; Baker 2019, 52, 55.

Masonry Techniques

Throughout the ancient Near East, a wide variety of masonry techniques were used in the construction of walls. The technique used largely depended on the availability of material, the function of the wall, and the prestige of the building. It is impossible to provide a discussion of all masonry techniques used throughout the study area, as the techniques often blend into each other. Adding to this difficulty is that masonry techniques are not always described in enough detail in publications to categorize them accurately. Nevertheless, it is worth providing brief descriptions of some of the most common masonry techniques found in the construction of Roman-style baths in the Roman Near East. In the following sections, brief descriptions of several common masonry techniques will be provided beginning with techniques employing stone.

Ashlar Construction

The term *ashlar* is used to denote well-cut quadrangular blocks of stone. In most cases, these blocks were well-dressed (often chisel-dressed) with drafted corners allowing them to create a tight fit between adjacent blocks (Figure 10.1). As a result, ashlar masonry is often laid dry without the use of bonding agents; however, mortar could also be used to increase the bond between blocks.[290] In many regions these blocks are large enough that they require lifting devises and are thus typically reserved for monumental building projects. In rare cases, however, well-cut and dry-laid ashlars are small enough to be lifted by two people. Walls built of ashlars could be of solid masonry, or (as will be discussed below) ashlars could be used as a facing material for a mortared core. Typically, ashlar masonry is laid in horizontal courses.

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[290] Rababeh 2005, 48; Netzer 2006, 313.

Scholars have developed a variety of terms to label specific construction techniques using ashlar blocks. The term *isodomic ashlar masonry* refers to a construction using uniformly sized blocks, or in some cases courses of blocks of equal height (but differing lengths). *Pseudo-isodomic masonry* denotes horizontal courses of masonry that alternate or differ in height.

Specific terms are also applied to the ways in which the blocks are laid. An ashlar block that is laid with its long side exposed along the face of a wall is known as a *stretcher block*, whereas a block that is laid with its narrow side exposed (and thus its length buried into the thickness of the wall) is a *header block*. Masonry where the horizontal courses are composed of alternating headers and stretchers is known as *header/stretcher bond* (*Flemish bond* in modern brickwork). Alternating courses composed entirely of headers with courses composed entirely of stretchers is known as an *English bond* in modern brickwork.

In the context of Roman construction, the use of ashlars is typically known as *opus quadratum*. As this term denotes a sense of Roman influence, its use will be avoided in this chapter. Indeed, the use of ashlar construction has a long history in the Near East, dating back to the Bronze and Iron Age in different regions.[291]

Sub-ashlar Construction

Unlike ashlar construction, sub-ashlar masonry uses roughly cut stone blocks that are usually small enough to be lifted by one to two people (Figure 10.2). These blocks are typically roughly dressed with a simple point and are almost always laid in mortar. These mortar joints help correct for slight differences in size and allow for blocks of slightly different height to be laid in

[291] Baker 2019, 26, 84. For the history of ashlar construction in Cyprus, see Wright 1992, 368-75; for its use in southern Syria and Palestine, see Wright 1985, 401-407; and for Cilicia, see Spanu 2010, 398-400.

the same course. Like ashlar blocks, these roughly cut blocks can be laid by themselves or with a mortared rubble core.

Rubble or Fieldstone Construction

Freestanding walls were also commonly constructed of unworked stones (Figure 10.3). The construction of such fieldstone walls did not require the carful cutting of blocks to desired sizes. While this masonry technique could be used without mortar, often a simple bonding agent such as mud mortar was applied. Despite the irregular shape of the stones, field stone walls were often laid in courses, with large stones being placed first and smaller stones being used to fill in gaps to create a level surface for the next course above. This technique is sometimes referred to as *boulder-and-chink* masonry. In some cases, the stones used in fieldstone walls could be minimally worked to help them better fit or to create a flat surface for the face of the wall.

Rubble and fieldstone construction can be found in all regions of the Near East regardless of local building stone. The simplicity of sourcing the stone and the fact that no masonry tools were required also meant that this construction technique is one of the earliest recorded.[292] Rubble and fieldstone walls rarely had cores and were typically of uniform construction.

Stone-faced Mortared Rubble

Another masonry technique was to create walls with cores that differed in material or technique from that of their faces. These so-called cast walls were often faced with rubble, sub-ashlar blocks, or in some cases ashlar blocks. Between the two faces was a core typically comprising rubble and copious amounts of mortar. A major benefit of these cast walls was that

[292] For rubble and fieldstone construction in Cyprus, see Wright 1992, 360-62; for its use in southern Syria and Palestine, see Wright 1985, 397-400.

they allowed for walls to be thickened without the need for vastly more manufactured material such as ashlar or brick to fill them.

An example of cast walls is ashlar-face mortared rubble walls, used for a few monumental baths in the East. The faces of these walls were formed by regular courses of ashlar masonry between which was a core of rubble and lime mortar that hardened to a concrete. Unlike modern concrete that is poured in place, this mortared rubble was laid by hand or trowel in layers, with the ashlars acting as permanent formwork. Although these mortared rubble cores are generally seen as a development dating to the Roman period, it is possible to see them as a replacement of the earth and rubble fill that characterized the Hellenistic *emplekton* walls.[293]

Opus Reticulatum

Another type of cast wall that was used (albeit extremely rarely) in the construction of Roman-style baths in the East was *opus reticulatum*, a term used to denote a very specific type of Italian masonry (Figure 10.4). *Opus reticulatum*, which developed over the course of the first century BCE and first century CE, was created using pyramidal-cut stones, known as *cubilia*, set in a diagonal grid pattern as a facing for a mortared rubble core.[294] The diagonal pattern of these facing stones created its distinctive netting look. The reason behind this peculiar placement is thought to be an attempt to avoid vertical or horizontal cracks from forming in the masonry.[295]

Opus reticulatum, being of Italian origin, is rarely found in the eastern Mediterranean and is only known from a few sites.[296] Other Latin terms for construction techniques, such as *opus*

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[293] Waelkens 1989, 78.
[294] Adam 1994, 129-34.
[295] Adam 1994, 131; Netzer 2006, 314.
[296] Deichmann 1979, 473-76, fig. 1; Netzer 2006, 314-15.

quadratum (described above), will generally be avoided both for the sake of clarity and because such terms can imply Roman influence that was not present. Given the uniqueness of *opus reticulatum* and the fact that its use in the East is generally recognized to be the result of direct Roman influence, this term will continue to be used throughout this work.

Brick Construction

As previously mentioned, fired ceramic brick was also used as a masonry material in certain regions of the Roman Near East, such as in Flat Cilicia and in parts of the province of Syria, particularly where building stone was not easily sourced and where abundant clay, fuel, and water for the manufacture of brick was available. Brick masonry always used mortar as a bonding agent, and often the bricks acted as facings of a mortared rubble core, though solid brick walls were also constructed (Figure 10.5). Brick could also be used alongside stone as facing material, in which cases it was often laid in bands separating courses of rubble masonry.[297] While there seems to be a lacuna in scholarship on brick manufacture and construction in Roman Syria, brick masonry is generally considered to have been introduced to Flat Cilicia by the Romans in the late first century CE.[298]

Just as ashlar construction is also known as *opus quadratum*, brick masonry is often labelled *opus testaceum* or *opus latericium* when in a Roman context.[299] For the same reasons that the term *opus quadratum* will be avoided, this study will not use the terms *opus testaceum* or *opus latericium* as they imply Roman or Italian construction. While brick masonry in the Roman East, such as in Flat Cilicia, was introduced by Rome, it was not passively adopted by provincial

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[297] Butcher 2003, 175.
[298] Spanu 2010, 403-404.
[299] For a brief discussion about Roman Brick masonry, see Adam 1994, 145-50.

builders. Local influence is seen in both the size of the bricks and the way in which brick walls were constructed. Typical Roman bricks followed Roman modules of measure (i.e. the *pes monetalis* - 0.296 m).[300] The bricks produced in Cilicia, on the other hand, often followed local units of measure.[301] Similarly, there seems to have been a distinctive Cilician style of brick masonry. Typically, brickwork in Roman masonry acted only as a facing for a mortared rubble core. In Cilicia and a few other regions of the eastern Mediterranean, however, it was common for regularly spaced courses of brick to run through the core of the walls, in a sense capping the mortared rubble core at intervals.[302] Unfortunately, there has yet to be any detailed analysis of brick forms or brick construction in northern Syria, where this masonry technique was also adopted.

Examples of Masonry from Roman-style Baths in the Roman East

In the following sections, examples of masonry from Roman-style baths are presented in geographical order by site. As outlined in the Introduction, these sites are organized by Roman province as they roughly existed under Hadrian (i.e. Cilicia, Cyprus, Syria, Judea, Arabia). The aim is to provide a representative sample that shows the typical masonry techniques used in the Roman-style baths of each region. At the same time, examples of "foreign" construction techniques (even if they are rare and atypical) will be highlighted. In many cases, the decision of which sites to include was limited by the availability of published data. The following examples, therefore, do not represent a comprehensive survey of masonry techniques used in the

[300] Brodribb 1987, 2, 34-43; Adam 1994, 147.
[301] Spanu 2003, 23-24, fig. 6; 2015, 177, fig. 6.
[302] Spanu 2003, 22.

construction of Roman-style baths in the East, but instead provide a representative overview of the techniques used across the selected regions.

Masonry of Roman-style Baths in Cilicia

The study of building materials and techniques in Roman Cilicia has benefited greatly from the work of Marcello Spanu, who has published several works on the topic, including excavation reports on the baths of Elaeussa Sebaste. His research, for example, has demonstrated that during the Hellenistic period and before annexation by Rome, dry-stone masonry was typically used in Cilicia for all building types, both public and private.[303] The advent of Roman control brought about the use of fired brick and mortar, which changed masonry techniques in some building types in this region. Dry-stone masonry, however, was still used for large-scale ashlar masonry in traditional building types such as temples and tombs.

The brick and mortar construction found in parts of Flat Cilicia bears a resemblance to Italian masonry practices, and it is likely that there was a degree of direct influence from central Italy.[304] As already discussed, however, notable differences do exist. In some brick-faced walls, courses of brick run right through the core, unlike brickwork in the West.[305] Another difference is in the size of the bricks. Whereas bricks in Italy and most of the western Roman Empire followed Roman modules of measure (i.e. the *pes monetalis*), the bricks produced in Cilicia often followed local units of measure, although what these measures might be is not clear.[306]

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303 Spanu 2010, 399.
304 Waelkens 1987, 99-100.
305 Spanu 2003, 22.
306 Spanu 2003, 23-24, fig. 6; 2015, 177, fig. 6.

The widespread use mortared rubble in Cilicia also gave rise to a longstanding but erroneous theory that local volcanic sand was used as a stand-in for pozzolana, thus making Cilician mortared rubble construction akin to Roman concrete in strength and versatility.[307] This theory has been called into question, however, as volcanic sand was only available in certain areas of eastern Cilicia, and without large scale exploitation of this material (for which there is no evidence), most of Cilicia used non-volcanic sand in their mortars.[308] Analysis of mortar samples from Elaeussa Sebaste confirm that these binding agents (some of which having hydraulic characteristics) were not made from volcanic sand, but rather with sand from nearby rivers.[309]

The geology of Cilicia had a major influence on the materials used for wall construction. Strabo, in his famous work on geography (14.5.1), divided Cilicia into two regions: the rugged and mountainous Rough Cilicia (Κιλικία Τραχεῖα) in the west and Flat Cilicia (Κιλικία Πεδιάς) comprising a rich alluvial plain in the east. In Rough Cilicia, the primary building material was limestone, which dominated the geological landscape of the region, although other local stone such as micaceous slate was also used. In the alluvial plains of Flat Cilicia, where building stone is much less abundant, fired brick construction was relatively common in the Roman period. Volcanic stone was also used in the eastern edge of Flat Cilicia, in the area has been referred to as Black Cilicia by some modern scholars on account of the area's volcanic deposits.[310]

There are many Roman-style baths known to scholars in Cilicia, and it would not be feasible to discuss them all here at length.[311] Instead the following discussion includes only a selection of

[307] e.g. Boëthius and Ward-Perkins 1970, 387; Waelkens 1987, 99.
[308] Spanu 2010, 407.
[309] Burragato and Santarelli 2003.
[310] Spanu 2003, 20-21; Tobin 2004.
[311] For a partial list of known Roman-style baths in Cilicia, see Spanu 2003, 12, n. 60.

the known baths in the region. While not comprehensive, the selected baths are representative of all of the masonry techniques employed in the construction of Roman-style baths throughout Cilicia.

Iotape

On the western coast of Rough Cilicia lies the small site of Iotape. Here, on the eastern edge of a small inlet are the remains of two well-preserved baths. The first of these bathing structures (Bath 5B) measures 567 m^2 and was constructed of roughly dressed blocks of quarried limestone and the odd tile or brick (Figure 11).[312] The lintels were of large blocks of limestone. During my own personal examination of this structure, this masonry, if indeed quarried, appeared to be of very irregular blocks set in mortar. One of the lintel blocks contained a dedicatory inscription to Trajan, possibly providing a date for this structure.[313]

Adjacent to Bath 5B is another similarly well-preserved structure ("Building 6"), which measures roughly 414 m^2 (Figure 12). Comprising several halls, this building has not yet been excavated, and as a result its date and original function are not entirely clear. Its plan and the presence of vertical piping set into its walls, however, have led scholars to identify it as a bathing facility.[314] The masonry of these possible baths is similar to that of Bath 5B, with irregular blocks of quarried limestone bound by mortar with broken bricks and tiles (Figure 13 & Figure 14).[315] It was clear, during my own personal examination of this structure, that these stones were very irregular in shape, appearing to be more rubble than quarried stone.

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[312] Huber 1967, 40.
[313] Huber 1967, 41.
[314] Farrington 1995, 168, n. 94.
[315] Huber 1967, 42.

The masonry technique used for both of these structures appears to be similar to that used for the other structures at Iotape. For example, both “Building 7” and “Building 8” were likewise built of roughly dressed blocks of quarried limestone.[316] This masonry technique clearly resulted from a decision to use locally sourced building materials and likely local craftspeople and laborers as well.

Antiocheia ad Cragum

Further south along the coast, the site of Antiocheia ad Cragum is home to at least two Roman-style baths, the largest of which is aptly named the Great Baths, which stretched over 1700 m^2 (Figure 15). The walls of this bathing complex were largely constructed from rough-cut blocks of micaceous slate, although limestone blocks were also used in parts (Figure 16 & Figure 17).[317] In all cases, these sub-ashlar blocks were bound by mortar. The construction of these baths is thought to have occurred between the late second and early third centuries CE.[318]

To the east of the Great Baths is the so-called Extramural Baths, which measure roughly 365 m^2 and were likely constructed in the late second or early third century CE (Figure 18).[319] The substructure and walls of this building are of quarried rough-cut, sub-ashlar blocks of micaceous slate and the odd brick bound in mortar (Figure 19 & Figure 20).[320] My own personal observation of these baths confirmed this use of micaceous slate.

Both the Great Baths and the Extramural Baths were largely constructed with locally sourced building materials, although the Great Baths seem to have been constructed with more care than

[316] Huber 1967, 42-43.
[317] Huber 1967, 25-26; Staggs 2014, 98.
[318] Staggs 2014, 95.
[319] Staggs 2014, 104.
[320] Huber 1967, 27; Staggs 2014, 107.

the Extramural Baths and most other neighboring structures.[321] Although other materials, like limestone and mortar, were used in the construction of the baths, the primary building stone used in their construction and throughout the site was quarried micaceous slate.[322]

Anemurium

West of Antiocheia ad Cragum, near the southernmost point of Rough Cilicia, is the site of Anemurium. The Roman-style baths of this site were all constructed with a similar masonry technique, using irregular sub-ashlar blocks of quarried limestone bonded by mortar. This was the technique used in the impressively well-preserved Bath II 7 A, which covers an area of roughly 500 m^2 and is located south of the theater (Figure 21 & Figure 22).[323] Excavation of the hypocausts of these baths dated their construction to no later than around 200 CE.[324]

Northeast of these baths lie two other baths. One of these bathing complexes, Bath III 2 B, likely stopped being used as baths in the mid-fourth century CE, possibly less than a century after its initial construction (Figure 23).[325] This structure measures roughly 957 m^2 and, like the baths discussed above, was built of roughly dressed quarried limestone with large blocks of limestone to form lintels (Figure 24).[326]

The third bathing complex at Anemurium to be discussed here is located immediately southwest of Bath III 2 B. These undated baths, Bath II 11 B (Figure 25), cover an area of roughly 1160 m^2 and are similarly built with irregular limestone blocks bonded by mortar.[327]

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[321] Staggs 2014, 111-12, 116.
[322] Huber 1967, 29.
[323] Huber 1967, 8.
[324] Akok et al. 1980, 203.
[325] Russell 1980, 264.
[326] Huber 1967, 13.
[327] Huber 1967, 11.

Although not mentioned in any publication on these structures, during my own personal observation of these three baths, their walls appeared to be of solid masonry, that is, without separate core and facing materials (Figure 26).

This use of irregular blocks of quarried limestone bonded by mortar appears to have been the primary masonry technique of Anemurium. It was used for the construction of other buildings at the site, such as the odeon[328] and an exedra.[329] My own personal observation of this site also confirmed the widespread use of this building technique at Anemurium.

Corycus

Northeast of Anemurium, the seaside site of Corycus, is home to two possible baths, both of which are undated and of undetermined size. Neither structure is well published. The masonry of the upper baths is largely of mortared rubble, although there is some use of ashlar in the walls and of brick for a flat arch above a doorway.[330] The lower baths are better preserved and consist of three vaulted halls. The masonry of this structure seems to be of sub-ashlar, as it is described as being of concrete (likely a reference to mortared rubble) faced with "small blocks of limestone, coursed but not squared".[331]

Elaeussa Sebaste

Further east along the coast and on the eastern edge of Rough Cilicia, is the ancient city of Elaeussa Sebaste where at least three separate bathing complexes are known. All three of these baths display non-local masonry techniques and (in the case of two baths) direct involvement by

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[328] Huber 1967, 4.
[329] Huber 1967, 9.
[330] Ward-Perkins 1958, 98.
[331] Ward-Perkins 1958, 98.

foreign builders. The largest of these baths is the Large Baths (or Agora Baths), located east of the site's agora and theater. The thermal block of this structure measures around 1000 m^2 (not including the associated palaestra and non-extant remains) (Figure 27). The walls of this monumental structure are faced with regular and irregular sub-ashlar blocks of limestone and have a mortared rubble fill (Figure 28 & Figure 29).[332] Investigation of this structure has not determined its exact date of construction; however, it is thought to have been built no earlier than the second century CE.[333] Although the cut limestone blocks that form the facing of these baths call to mind the ashlar blocks of pre-Roman construction in Cilicia, the mortared rubble core is not of local origin.

As its naming suggests, western influence can also be seen in the construction of the Reticulate Baths (also known as the Bath in *Opus Mixtum*) (Figure 30). This structure, which measures roughly 215 m^2, is one of the few buildings in the Roman East that was constructed using *opus mixtum* (Figure 31 & Figure 32). Throughout these baths, the walls have a mortared rubble fill and are faced with *opus reticulatum* and rows of ceramic brick (i.e. *opus latericium*).[334] On the basis of this construction material and technique, these baths have been dated to between the end of the first century CE and the middle of the second century.[335]

Similar masonry techniques are seen in the Harbor Baths of Elaeussa Sebaste, which stretched over an area of roughly 420 m^2 (Figure 33). The careful excavation and detailed study of these baths has resulted in an impressive understanding of their construction and use, including the identification of three separate phases of construction characterized by different

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[332] Spanu 1999, 96, 101.
[333] Spanu 1999, 103.
[334] Spanu 1999, 103-104, figs. 46-56.
[335] Spanu 1999, 113.

masonry styles. In the first phase (dated to between the mid-first century BCE and the mid-first century CE), the initial construction of the building was carried out in *opus reticulatum*; however, there is no evidence that the structure functioned as baths at this time.[336] Its use as a bathing facility only becomes clear in the second phase, after an undated renovation characterized by the construction of several walls in *opus reticulatum* and flat brick (Figure 34).[337] The third phase of this structure (in which it continued to be used as baths) was marked by a major renovation in the mid-second century using limestone blocks and brick masonry, but not *opus reticulatum*.[338] While the initial use of *opus reticulatum* in the first phase of this structure predates its function as a bathing facility, its use in the second phase is a clear example of non-local masonry techniques used for bath construction in the Roman East.

This use of central Italian masonry techniques has led scholars to conclude that both the Reticulate Baths and the Harbor Baths of Elaeussa Sebaste were the products of foreign builders.[339] The Roman army is unlikely to have been the vehicle of technological transmission in this instance, as there is no evidence for a military presence in the region at this time; however, it is likely that the foreign builders of these baths were present in the region as a result of the need to construct important infrastructure projects in the years following the reorganization of the region under Vespasian in 72 CE.[340]

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[336] Borgia and Spanu 2003, 270, 299-301.
[337] Borgia and Spanu 2003, 270, 301-305.
[338] Borgia and Spanu 2003, 270, 305-310.
[339] Spanu 2003, 11; Borgia and Spanu 2003, 328.
[340] Spanu 1999, 114.

Augusta Ciliciae

In Flat Cilicia, the lack of building stones and the abundance of good quality clay led to a preference for brick construction. This preference is seen in the baths at the site of Augusta Ciliciae, north of modern Adana (Figure 35). These undated baths were constructed of brick-faced walls with mortared rubble cores built in courses (Figure 36).[341] The visible remains of this structure cover 800 m^2. This construction is identical to the masonry used in the so-called "West Hall" at the site.[342]

Anazarbos

Brick-faced walls with mortared rubble cores are also found in the baths of Anazarbos, located northeast of Augusta Ciliciae. The largest baths in the city, the so-called Northern Baths (sometimes referred to as the North-Western Baths), were also built with brick facing and a mortared rubble core (Figure 37). The use of two distinct sizes of brick in this structure has led scholars to suggest that it underwent a renovation, possibly in the Byzantine period.[343] Elsewhere, the Southern Baths (also referred to as the Black Pumice Baths or the South-Western Baths) were mainly constructed with a brick facing that covered a mortared rubble core (Figure 38), though limestone blocks were also used in the supporting walls.[344] The Little Western Baths, which are located northwest of the Northern Baths, were likewise constructed with a mortared rubble core faced with bricks as well as stone blocks used for supporting elements.[345] The fourth of the known baths in the city (referred to as the Northern Baths or Ziegel Bauten 01) is the

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341 Gough 1956, 173-75, pls. XV b and XVI a.
342 Gough 1956, 172-73.
343 Gough 1952, 105-106; Casagrande Cicci 2013, 145.
344 Casagrande Cicci 2013, 144.
345 Casagrande Cicci 2013, 146.

northernmost and the least understood bathing facility at Anazarbos. Like the others, these baths are also constructed with brick facing.[346] Regarding chronology, the Southern Baths and Northern Baths have been dated to the second century CE, while the other two baths have been dated to between the second and third centuries.[347] Only the Northern Baths have a known size (approximately 1000 m^2), while the other three are smaller.

Küçük Bernaz

South of Anazarbos, on the coast of the Gulf of Alexandretta (İskenderun), is the site of Küçük Bernaz, which is home to two unexcavated baths. On the basis of their construction, they have been tentatively dated to the fourth or fifth centuries CE.[348] The Larger Baths (measuring roughly 325 m^2) were primarily constructed with walls of mortared rubble faced with fired brick and carefully shaped polygonal basalt stones (Figure 39 & Figure 40).[349] The site's Smaller Baths (measuring roughly 160 m^2) are similarly constructed with walls of mortared rubble faced with brick and (to a lesser degree) roughly shaped polygonal basalt stones (Figure 41 & Figure 42).[350] In some walls of the Smaller Baths, solid mortared brick walls were also used. All of these masonry techniques are common at Küçük Bernaz and are found in in the other visible architecture at the site.[351]

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346 Casagrande Cicci 2013, 147.
347 Casagrande Cicci 2013, 151.
348 Tobin 2004, 53-55.
349 Tobin 2004, 42-44.
350 Tobin 2004, 31-37.
351 Tobin 2004, 24-25.

Conclusions

In the province of Cilicia, a range of masonry techniques was used in the construction of Roman-style baths. Apart from the two early baths at Elaeussa Sebaste that use Italian masonry techniques, neither size nor date appear to have had a bearing on the masonry technique used in these baths. Instead, the location (and specifically the proximity to different building materials) was the largest factor determining what materials and techniques were used.

With the notable exception of two of the baths at Elaeussa Sebaste, the masonry techniques used for the construction of Cilician baths are also the same as those used throughout the respected sites, namely brick and sub-ashlar masonry bonded with mortar. While these masonry practices may not have been indigenous to Cilicia, the fact that these techniques were used for almost all manner of construction indicates that they were adopted by local builders. Therefore, the use of these masonry techniques in the building of Roman-style baths of this region suggests that there was direct involvement of local masons and laborers in their construction.

As will be discussed at the end of this chapter as well as in the next chapter, the use of brick in Flat Cilicia was likely connected to the presence of a large-scale pre-Roman tile industry in the region. This industry took advantage of the abundant clay, water, and fuel that existed in the alluvial plains of Flat Cilicia and supplied a network that stretched down the Levantine Coast. Although no kiln sites are known to have been found, analysis of roof-tiles from excavations in Beirut have shown that this material was produced in Cilicia, especially during the Seleucid and Late Hellenistic periods (fabrics BER2.1 and BER2.2).[352] It is likely that the production centers in Cilicia that produced these roof tiles could have easily shifted to the production of brick

[352] Mills 2013, 55-62, 84.

during the Roman period.[353] The preexisting supply and distribution networks that supported the tile industry could likewise have shifted to accommodate the newly introduced brick industry. An alternative theory is that the elite landowners of Flat Cilicia may have wished to emulate Roman construction methods or the mode of land exploitation popular in Rome, in which landowners invested in brickyards, resulting in an overabundance of cheap bricks.[354] It is possible that both the pre-existing tile industry and land-use practices could have contributed to the use of brick masonry in Cilicia.

In the case of the Reticulate Baths and the Harbor Baths of Elaeussa Sebaste, the use of non-local (namely Italian) masonry techniques such as *opus reticulatum* is clear evidence for the involvement of non-local masons in the construction of baths at this site. At least two phases exist for the use of these techniques at Elaeussa Sebaste. The initial construction of the Harbor Baths using *opus reticulatum* between the mid-first century BCE and the mid-first century CE parallels the use of this construction technique in the Herodian baths at Jericho (to be discussed below). The later renovation of the Harbor Baths and the construction of the Reticulate Baths between the end of the first century CE to the middle of the second century may be connected to the presence of Roman or Italian builders in the region, immediately after the reorganization of Cilicia under Vespasian in 72 CE. Further discussion of these non-local masonry techniques will be provided at the end of this chapter.

[353] Spanu 2010, 403.
[354] Lancaster 2015, 67.

Masonry of Roman-style Baths on Cyprus

Like other regions of the eastern Mediterranean, Cyprus had a long history of using stone for construction.[355] This use of stone included rubble, ashlar, and mixed-stone masonry, as well as the use of mortar as a bonding agent in the Greco-Roman period.[356] In addition to the use of mortar, there was a general continuity between the masonry practices of the Hellenistic and Roman periods.[357] This continuity is also seen in the construction of the Roman-style baths on Cyprus, which exhibit local masonry techniques, such as ashlar and rubble masonry bond in mortar.

Cyprus is home to sixteen known baths that date to between the second and sixth centuries CE.[358] These baths range in terms of their preservation and are spread across the island. Unfortunately, no final publication exists for any other these baths, and the interim reports and subsequent studies fail to provide detailed descriptions of their construction. The sites selected for comment below were chosen based on the availability of published information as well as what was visible during my own personal visits to the sites.

Salamis

The city of Salamis, on the east coast of Cyprus, is home to a bath-gymnasium complex, the largest baths on the island at roughly 7360 m^2 (including its palaestra) (Figure 43).[359] Excavation of this bath-gymnasium has revealed several phases of the structure's construction. The earliest of these phases is represented by a wall of limestone ashlars, which was dated by pottery to the

[355] For an overview of the use of stone on Cyprus, see Wright 1992, 357-76.
[356] Tsakiridis and Toumbakari 2010.
[357] Wright 1992, 410-12.
[358] Christodoulou 2014, 86.
[359] For an overview of bath-gymnasium complexes, see Yegül 1992, 307-313.

Hellenistic period and is likely the remains of a monumental gymnasium.[360] After the destruction of the Hellenistic gymnasium, these ashlar blocks were used as the foundation for the Augustan gymnasium and its accompanying bath complex, which were built of well-dressed sandstone ashlars on the footprint of the earlier structure.[361] Destroyed again in 76/77 CE by an earthquake, this complex was rebuilt on a grander scale under Trajan and Hadrian. Like the Augustan structure, the second century CE complex used large sandstone ashlars (Figure 44).[362] The published descriptions of these baths do not provide much detail about the structure's masonry, such as the dimensions of the large blocks or if any binding agents were used.

Amathus

Located on the island's southern coast, the site of Amathus is home to small but well-preserved Roman-style baths on the eastern edge of the city's agora (Figure 45). These baths cover an area of approximately 143 m^2 and were constructed in the first or second century CE.[363] Unfortunately, there is no final excavation report of this structure, and the publications that do exist fail to detail the masonry techniques used in its construction.[364] During my own personal examination of these baths, the walls appeared to be of sub-ashlar masonry with cut limestone blocks of various sizes laid in mortar (Figure 46).[365] In some cases, these blocks could be up to 50 cm long. The masonry of these baths is similar to the construction of other structures around the site's agora.

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[360] Karageorghis 1969a, 167-68.
[361] Karageorghis 1969a, 168.
[362] Karageorghis 1965, 287.
[363] Christodoulou 2014, 97
[364] Karageorghis 1989, 827-28; Aupert 2000, 42-43; Christodoulou 2014, 86-87.
[365] The use of these limestone ashlars is also visible in Karageorghis 1989, fig. 112.

Kourion

Perhaps the best-published bathing complex on Cyprus is the well-preserved baths at the Sanctuary of Apollo Hylates, near Kourion (Figure 47). This facility covers an area of roughly 250 m^2. An inscription found in its vicinity dates the construction of these baths to 101/102 CE.[366] The walls of this structure are described as being of unfinished blocks of ashlar mixed with stretches of rubble (Figure 48).[367] This use of mixed stone bonded with mortar was also visible during my own personal observation of the baths. This material and masonry technique were in keeping with the construction of the other structures on site, suggesting that local industry was employed in the building of these baths.

Southeast of the Sanctuary of Apollo Hylates is the settlement of Kourion, which is home to an expansive public bathing complex that measures over 3000 m^2 (Figure 49). This structure, located on the city's acropolis, was built in several stages starting at the beginning of the first century CE.[368] As with the other baths on Cyprus, no final publication exists for the excavation or this structure, and the publications that do exist provide little detail about its construction. During my own personal visit to these baths, the use of large ashlars, including pseudo-isodomic ashlar construction, was clearly visible (Figure 50). This ashlar construction is also seen in what few images of these baths are published.[369] The masonry of these baths is similar to the pseudo-isodomic ashlar construction found in the Hellenistic theater at Kourion.[370]

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[366] Mitford 1971, no. 110, 214-15; Christodoulou 2010, 289.
[367] Scranton 1967, 57-58.
[368] Christodoulou 2014, 88.
[369] Herscher 1998, fig. 29.
[370] Stillwell 1961, 68-69.

Conclusions

It is very unfortunate that the baths of Cyprus are not published in greater detail that would allow for a more nuanced understanding of possible changes in stone construction practices on the island. Despite this absence of detail, the limited scholarship available suggests that there was indeed a continuation of local building practices, such as ashlar masonry and sub-ashlar masonry bonded with mortar, for the construction of Roman-style baths on Cyprus. Perhaps unsurprisingly, ashlar construction is found only in the largest bathing complexes, the bath-gymnasium at Salamis and the public baths at Kourion. It should also be noted that characteristic Roman masonry techniques, such as brick and stone-faced concrete (i.e. *opus reticulatum, opus incertum, opus testaceum,* etc.) do not appear in any bath building and are virtually non-existent on the island.[371] The continued use of Cypriot masonry techniques for bath construction is evidence for the involvement of local masons and craftspeople in these building projects.

Masonry of Roman-style Baths in Syria

Like the rest of the Roman East, Syria remained faithful to the pre-Roman tradition of ashlar masonry for monumental and public architecture. The varying geological landscapes of this province, however, resulted in a variety of local building stones being used in construction. In northern and central Syria, the abundance and versatility of limestone resulted in its continued use in the region long after ashlar construction was replaced with brick and mortar elsewhere in the Roman world.[372] In the Hauran region of southern Syria and in the vicinity of Emesa (near the modern city of Homs), basalt was common, and this volcanic stone was regularly used as the

[371] Wright 1992, 417.
[372] Butcher 2003, 175.

building material of choice.[373] The hardness of this stone, however, made cutting difficult, and well-dressed basalt ashlars were rarely used. Instead, roughly cut blocks with chinking and cores of smaller rubble was the common masonry technique. Along the coast, sandstone was at times used, although the ease with which it weathered made it a poor substitute for limestone.[374] In the Syrian desert, mudbrick was the preferred construction material, but local stone was also used when necessary, such as gypsum at Dura Europos.[375]

In addition to this use of stone, fired brick masonry was also used, albeit very rarely. Its use is more prevalent in the north, where it also became more commonly used in the late Roman period.[376] As will be discussed, it was most commonly found in the construction of baths.

Like Cilicia, the province of Syria was home to a large number of Roman-style baths, and it is not possible to discuss the construction of all of them here. As a result, the following examples are only a selection of the known baths in this province. Nevertheless, an attempt was made to provide as representative a sample as possible, and the chosen examples come from all regions of the province and display the wide variety of masonry techniques used in the construction of Roman-style baths.

Antioch

Being the third largest city in the Roman Empire, it is no surprise that Antioch was home to a large number of bathing establishments, with six baths (Baths A-F) being uncovered by the Princeton excavations of Antioch in the 1930s. The sixth-century chronicler John Malalas also

[373] Butcher 2003, 175-76.
[374] Butcher 2003, 176.
[375] Leriche 2015, 102-103.
[376] Butcher 2003, 175.

recorded the construction of about a dozen baths in the Imperial Period, none of which seem to correspond to the baths discovered through excavation.[377] Despite the large number of baths known from Antioch, none of those found by the Princeton team were well preserved. The continued use of these baths as quarry sites for building materials resulted in much of their masonry being taken away for use elsewhere; however, excavation of these structures found enough material remaining to allow for some idea of the masonry techniques used.

The excavation of Bath A, for example, revealed a bathing complex covering roughly 800 m^2, the core of which was constructed of mortared rubble walls faced with bricks (Figure 51).[378] Occasionally, the builders of these baths laid a course of brick through the entire width of the wall, in effect capping the mortared rubble core. This practice is also seen in Antioch's Bath C (see below) and in other brick faced walls in the wider region.[379] The excavators of these baths dated their construction to the second half of the fourth century CE.[380]

East of Bath A is the slightly smaller Bath B (ca. 150 m^2), which may have been a private bathing facility and was seemingly undated by its excavators (Figure 52). The walls of these baths were brick faced and are described as comprising "small rounded stones and triangular facing bricks in a hard concrete of lime and sand with some ash".[381] Nothing else is recorded of its masonry.

By far the largest bathing complex found at Antioch was the monumental Bath C, which stretched over an area of about 2600 m^2 (Figure 53). The original excavators of these baths

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[377] Yegül 2000, 150.
[378] Fisher 1934b, 5.
[379] Spanu 2003, 22.
[380] Fisher 1934b, 6-7.
[381] Fisher 1934c, 10.

suggested that they were built in the second half of the fourth century CE overtop the ruins of earlier baths, which they dated to the early second century.[382] This dating has been disputed, however, and Yegül has proposed that the initial baths were constructed in the early or mid-third century and then underwent major renovations in the fourth century.[383] As with the other baths at Antioch, Bath C was heavily robbed for its building material, and little of it has remained extant above floor level. Nevertheless, that which does remain reveals that this massive structure was largely built with two different masonry techniques. The heated rooms, which formed the southern section of the complex, were all constructed of brick-faced mortared rubble that included broken bricks.[384] Like the walls of Bath A, these walls were also coursed at irregular intervals with a layer of brick. The northern wing of the baths, which comprised the unheated rooms and a monumental octagonal hall, was built with reused ashlar blocks of limestone set in extremely hard lime mortar (Figure 54).[385] Some of these blocks were 84 cm high. The exedrae of this hall were also built of solid limestone and mortar masonry, but the corner pillars that supported the dome had a mortared rubble core. The excavation report of Bath C noted that the brick faced walls of the heated rooms bonded with the stone masonry of the unheated rooms, indicating that these two different masonry techniques belong to the same phase.[386] As brick is far more resistant to damage from heat than limestone, it makes sense for brick to be used to construct the walls of the heated rooms. This is likely why Bath A and Bath B were also built

[382] Fisher 1934a, 31.
[383] Yegül 1992, 326; 2000, 150, n. 9.
[384] Fisher 1934c, 26, 30.
[385] Fisher 1934c, 22, 30-31, fig. 5.
[386] Fisher 1934c, 26.

with brick faced walls.[387] Evidently it was deemed unnecessary or too expensive to construct the entirety of Bath C out of brick, and thus limestone was used for the structure's unheated rooms.

Unfortunately, no comprehensive study of the building materials of ancient Antioch exists. It is certain that brick masonry was introduced to the site during the Roman period, but it is not clear how widely bricks were used outside of bath construction. At least one such example of brick masonry at Antioch is in the piers of an aqueduct likely built in the Trajanic period.[388] A petrographic analysis of brick samples from this aqueduct suggest that they were manufactured locally.[389] The average size of bricks used in this aqueduct is about 30 cm square, although some were as long as 64 cm.[390] This average measurement is close to the Roman foot (or *pes monetalis*, 0.296 m). Interestingly, the only bricks used in the baths for which measurements are provided do not follow this Roman standard. Bricks used in the *praefurnia* of Bath C measured 34 cm square and 4.5 cm thick.[391] These bricks are identical in size to the bricks found lining the floor of a drain elsewhere on site, at the so-called Tower Area.[392] Elsewhere, large bricks lining the floor of a room added to the North of Bath B after its initial construction were recorded as measuring 56 cm by 59 cm and 5 cm thick.[393]

Blocks of limestone appear to have been much more commonly used in local construction, especially in monumental buildings. In addition to the above-mentioned aqueduct, limestone

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[387] While it was important for surfaces directly exposed to heat from the hypocaust to be lined with ceramic material, it was unnecessary for the entire wall (both interior and exterior faces) to be faced with brick. Perhaps this material was chosen to make the entire construction fireproof.
[388] Wilber 1938, 54, fig. 5.
[389] Benjelloun et al. 2015, 178.
[390] Wilber 1938, 54.
[391] Fisher 1934a, 27.
[392] Fisher 1934d, 2.
[393] Fisher 1934c, 9.

blocks were also used in the construction of the circus of Antioch. This structure, just like the northern rooms of Bath C, was largely built of mortared rubble faced with limestone blocks.[394]

Apamea

South of Antioch, the site of Apamea is home to at least five known Roman-style baths, two of which have undergone excavation. One of these excavated baths is the so-called Northeast Quarter Baths, which measures about 425 m^2 and is located just inside the northern gate of the city (Figure 55). Initially constructed in the second century and reconstructed in the fourth century CE, these baths are built almost entirely out of brick-faced walls (Figure 56).[395] An analysis of the bricks that formed the walls of the first phase found that a majority of them (75%) measured between 20.5 cm and 31 cm in length and between 3.5 and 4 cm in thickness.[396] This very broad range of measures allows for the possibility that they were meant to conform to the Roman foot, but this is far from certain.

About 400 m south of the Northeast Quarter Baths are the Baths of L. Julius Agrippa (Figure 57). This bathing facility was constructed shortly after the devastating earthquake of 115 CE.[397] Approximately 800 m^2 of these baths have been uncovered through excavation, but the structure may have once been as large as 2500 m^2.[398] While bricks were used for the heating system and the vaults of this structure, the walls were primarily of well-cut limestone ashlars and in some places remain standing to a height of around 6 m (Figure 58).[399] It is unclear if these ashlar walls were built with mortar.

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[394] Campbell 1934, 35.
[395] Paridaens and Vannesse 2014, 335-36, figs. 5-8; Vannesse 2015, 101.
[396] Vannesse 2015, 101, n. 12.
[397] Balty 1988, 91-92.
[398] Fournet 2012b, 233.
[399] Khoury 2014, 362, figs. 2-3; Vannesse 2015, 98.

At least three other unexcavated structures at Apamea have been tentatively identified as baths. All are found in neighborhoods dating to the second century CE, and all were constructed of brick.[400] As was the case with Antioch, there has been no comprehensive study of the building material used in Roman Apamea. During my visit to this site in 2010, limestone ashlar masonry seemed to be the preferred local building method. For example, the Roman theater at Apamea was constructed entirely out of limestone ashlars.[401] The use of fired brick in many of the Apamean baths seems, therefore, to be a break with local building practices. There has yet to be, however, any study of these bricks to determine their source or elucidate further information about their use.

Zeugma

To the northeast of Antioch, the site of Zeugma once sat on the western bank of the Euphrates River and is now covered by the reservoir of the Birecik Dam. Before its inundation, rescue excavations located or partially uncovered several Roman-style baths.[402] Only one of these baths, however, has been fully excavated and published (Figure 59). These baths, located near the dam, measured roughly 200 m^2 and were dated to the early third century CE.[403] The walls of this bathing facility were built primarily of cut stone bonded with mortar; however, a few of its walls were also constructed of rubble or rough-cut stone in mud mortar and even of mudbrick.[404]

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[400] Vannesse 2015, 102.
[401] Finlayson 2012, passim.
[402] Aylward 2013, n. 150.
[403] Ergeç and Önal 1998, 429-30.
[404] Ergeç and Önal 1998, 422-23.

Athis (modern Dibsi Faraj)

Once located east of Aleppo on the right bank of the Euphrates River, the site of Athis (modern Dibsi Faraj) was flooded after the construction of the Tabqa Dam and the creation of its reservoir. Between 1972 and 1974, the site was excavated by the Kelsey Museum of Archaeology at the University of Michigan and the Dumbarton Oaks Center for Byzantine Studies. These excavations uncovered three Roman-style baths at the site: a small bathing suite located in the so-called *principia* (Figure 60) and two larger public baths outside the site's walls.[405] Few details about these baths are published; however, the smaller bathing suite, which measures 500 m^2 and post-dates the Diocletianic fortifications, is described as brick-built (Figure 61).[406] The earlier of the two extramural baths, which measures about 600 m^2 and dates to the fourth century CE, was built of limestone blocks.[407] No other information about its masonry is provided. Later baths of an unknown size were constructed primarily of brick with some limestone rubble used in walls and were dated based on an inscription to 452/53 CE (Figure 62).[408] Across the site, fired brick was used only in the defenses and in public buildings, while well-cut limestone blocks and mudbrick were also used in other structures.[409]

Dura Europos

On the western bank of the Euphrates River, the site of Dura Europos is home to four known Roman-style baths. Three of these baths (Baths C3, E3, and M7) (Figure 63, Figure 64, and Figure 65), which range in size from 375 m^2 to roughly 900 m^2 and all date to between 210 and

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[405] Harper and Wilkinson 1975, 329-330, figs. 4a, 6a, 7a.
[406] Harper and Wilkinson 1975, 329, fig. 6a.
[407] Harper and Wilkinson 1975, 329.
[408] Harper and Wilkinson 1975, 329, fig. 7a.
[409] Harper and Wilkinson 1975, 325.

215 CE, were constructed in a similar manner, using fired brick set in mortar (Figure 66).[410] In Bath M7, two types of brick masonry were employed, using different sizes of brick.[411] Such brick masonry was very uncommon at Dura Europos. Outside of these baths, this material was only used as paving material in elite residences and in the ceilings of religious buildings, such as the synagogue and the Christian house.[412] This fired brick masonry may suggest that non-locals were involved in their construction, possibly even the Roman military, which these baths were likely built to accommodate. Interestingly, the size of the bricks used in these baths do not follow the standard size of Roman bricks (i.e. conforming to the *pes monetalis* – 0.296 m). While one type of brick used in Bath M7 measured 29 cm, many of the bricks used in the walls of these baths were slightly larger, measuring between 30 cm and 34 cm.[413] It is not clear why this discrepancy existed or what it suggests about the manufacture of these building materials. Further work is need on the manufacture of brick in this region in order to determine the extent to which its production was influenced by Roman or local practices.

The fourth known baths at Dura Europos differ markedly from the rest in terms of their construction (Figure 67). Whereas the other baths were built of fired brick masonry, Bath F3 (ca. 300 m^2) was constructed of sub-ashlar masonry using poorly cut blocks of gypsum laid in gypsum mortar, with the heated rooms built of an irregular header-stretcher system of these blocks (Figure 68).[414] The blocks ranged in size from 70 cm to 110 cm long and 35 cm to 60 cm high and deep, with thick mortar joints making up the differences in size of irregularly cut

[410] Brown 1936a, 102-104
[411] Brown 1936a, 85.
[412] Leriche 2015, 113.
[413] Brown 1936a, (Bath M7) 85, (Bath E3) 91, (Bath C3) 96.
[414] Brown 1936b, 49, 52.

stones. Similar construction of gypsum blocks and mortar was common throughout Dura Europos, as this material was locally available.[415] On the basis of this local masonry technique, these baths were initially dated to the third quarter of the first century CE; however, a reexamination of their construction materials and techniques has resulted in these baths being convincingly re-dated to between 165 and 216 CE.[416] The reasons why the construction of these baths differs so greatly from that of the other baths in Dura Europos remains unclear; however, this use of the locally preferred material suggests greater local involvement in its construction. Interestingly, as will be discussed in the next chapter, the vaults of these baths are built of vaulting tubes, a building technique relatively unknown in the region and one that was clearly imported from the West.[417]

Palmyra

West of Dura Europos is the caravan city of Palmyra. North of the colonnaded street and east of the theater is the Baths of Diocletian (also referred to as the Baths of Zenobia). This bathing facility was initially constructed in the second half of the second century CE or in the Severan period and was subsequently expanded with the addition of unheated rooms until it reached a size of around 3300 m^2 (Figure 69).[418] Interestingly, there is a clear distinction between the masonry of the heated rooms and that of the unheated rooms. Whereas the walls of the heated rooms were constructed of fired brick, those of the other rooms were of limestone.[419] This differentiation recalls the construction of Bath C at Antioch. Unfortunately, no other information

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415 Leriche 2015, 102-103.
416 Pollard 2004, 142.
417 Pollard 2004, 139.
418 Vannesse 2015, 115.
419 Dodge 1988, 227; Vannesse 2015, 117, n. 72.

is provided about the masonry of these baths including the use of mortar or the size of the bricks or limestone blocks.

The use of brick in the Palmyra baths (like its use in the Apamea baths) breaks with local building practices. While it is unclear exactly how widespread the use of brick was at Palmyra, most of the site's structures were built of the local limestone masonry used in the un-heated rooms of the baths.[420] Given the arid climate, however, and the resource intensity of brick production, it is likely that fired bricks were costly to produce at the site, and were thus used only when thought necessary. The use of bricks in these baths also raises the issue of non-local involvement in their construction.

Baalbek

Further west, the site of Baalbek is situated in the Beqaa Valley of modern Lebanon. The monumental baths of this site cover an area of about 5000 m^2 but remain in a poor state of preservation (Figure 70). In at least one section of this complex, up to three courses of limestone ashlars remain extant.[421] No further information is provided about the masonry of these baths, which were likely initially constructed in the second century CE.[422] The use of limestone ashlars is in keeping with the masonry techniques used elsewhere at Baalbek.

Beirut

West of Baalbek, on the Mediterranean coast, excavation in the heart of Beirut uncovered a large bathing complex that is regrettably of poor preservation (Figure 71). This archaeological

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[420] Schmidt-Colinet 1995, 53.
[421] Brünenberg 2009, 194, fig. 3; 2014, 320.
[422] Brünenberg 2009, 191.

work has revealed 1700 m^2 of this structure, which may have once been as large as 8000 m^2.[423] The phasing of these baths is tenuous and has not been finalized, but the excavators of this structure identify several phases of its construction and use.[424] The earliest walls of this complex (Building 701) comprise a foundation of transverse laid ashlars and upper courses of longitudinal ashlars, which may belong to a Hellenistic bath/gymnasium.[425] The majority of the extant remains (Building 709) belong to the Roman/Byzantine baths constructed of ashlar walls in the initial phase.[426] The excavation reports mention little else about the masonry of these walls. Upon my own personal examination of this structure, however, these blocks (some of which are over a meter in length) appeared to be limestone and laid in regular (isodomic) courses. This ashlar construction was typical of Hellenistic and early Roman Beirut.[427]

Sha'arah

The site of Sha'arah is in the Hauran of southern Syria, a region characterized by the ubiquitous use of basalt in all manner of buildings, including baths.[428] Despite the difficulty of cutting this hard stone, the local builders of this region developed a keen skill in constructing monumental architecture out of basalt ashlars laid dry, without mortar.[429] The application of this masonry technique to the construction of Roman-style baths is perhaps best demonstrated in the baths at Sha'arah (Figure 72), in which the service rooms were built with walls in the local style of dry-stone ashlar masonry. The main core of the baths, however, was built of pseudo-isodomic

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[423] Fournet 2012b, 233.
[424] Thorpe 1998, 75-78.
[425] Thorpe 1998, 75.
[426] Thorpe 1998, 68, fig. 24.
[427] Butcher and Thorpe 1997, 291.
[428] Fournet 2012b, 190.
[429] Butler 1903, 313; Segal 2008, 119,

masonry using finely cut and well-dressed ashlars bound in lime mortar (Figure 73).[430] Unfortunately, the exact sizes of the stone blocks are not recorded, but many appear to be over 60 cm in length. The use of mortar as a binding agent is significant, as it does not seem to have been regularly used in the Hauran region for masonry (particularly for ashlar construction) before the advent of Roman control. Excavation of the baths at Sha'arah, which stretch over roughly 950 m^2, has dated this structure to between the end of the second century and the start of the third century CE.[431]

Philippopolis (modern Shahba)

One of the largest baths in the Hauran is the monumental bathing complex at Philippopolis, which was built during the reign of Philip (241-245 CE) and covers an area of approximately 5500 m^2 (Figure 74). The massive walls of this structure are around 1.20 m thick and comprise a core constructed of large irregular stones laid carefully in mortar, which is then faced with finely dressed basalt ashlars in even courses (Figure 75).[432] While the use of finely cut basalt ashlars was in keeping with local building practices, their use as facings for a mortared rubble core is not. Interestingly, numerous other buildings at ancient Philippopolis were built with ashlar-faced walls with mortared rubble cores.[433] Given that the building program initiated by Philip seems to have transformed this small village into a manufactured city, it is likely that this masonry technique was brought to the site by non-local architects involved with the construction projects.

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[430] Fournet 2008a, 160.
[431] Fournet 2010, 317.
[432] Butler 1903, 388.
[433] Butler 1903, 378-83, 395.

The combination of mortared rubble cores with a facing of basalt ashlars is thus an example of blended construction techniques.

Selaema (modern Salim)

South of Philippopolis is the town of Selaema (modern Salim), which is home to a bathing facility that continues to be occupied as a residence (Figure 76). Examination of this structure has suggested that, on the basis of its architecture, an associated inscription, and its potential connection to a nearby temple, it dates to the late first century CE, a date that would make it earliest known Roman-baths in southern Syria.[434] The visible remains of this structure cover an area of about 200 m^2. Unfortunately, the publication of these baths does not explicitly mention the masonry techniques used. The published photographs, however, suggest that it was largely constructed of large well-cut and finely-dressed basalt ashlars, though whether or not mortar was used in their joins remains unclear (Figure 77).[435]

Kanatha (modern Qanawat)

The baths at Kanatha (modern Qanawat), to the southwest of Salim, were also constructed largely of well-cut and dressed basalt ashlars (Figure 78 & Figure 79).[436] Although the excavation report mentions the use of mortar for the construction of the hypocaust system, it is unclear where or not mortar was used in the masonry of the walls. This bathing complex (measuring over 300 m^2) is thought to have been constructed in the first half of the second

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[434] Fournet 2010, 331.
[435] Fournet 2010, figs. 9-10, 13-15, 17-19.
[436] Peuser 2000, 229.

century CE.[437] Ashlar masonry was common throughout Kanatha, where it was introduced in the Hellenistic period and seems to have reached a maturity during the first century BCE.[438]

Seia (modern Sīʿ)

Further southwest, at the sanctuary site of Seia, there is small structure with a circular room that has been identified as a bating facility (Figure 80). The walls of this building, which is roughly dated to the Roman period and measures 437 m^2, were constructed of finely dressed basalt ashlars laid in mortar.[439] Given the use of mortar in other Hauran baths, the identification of this structure as a bathing facility is likely correct. Like the other sites in the region, the monumental architecture of Seia is also dominated by basalt ashlars laid without mortar.[440]

Conclusions

The Roman-style baths of Syria display an interesting blend of local Hellenistic traditions of ashlar construction and western masonry practices, including the use of mortar and bricks. Many of the baths in this region were built using ashlar or sub-ashlar construction. Interestingly, even when large blocks of well-cut ashlars were used, these blocks were still at times set in mortar, such as the limestone blocks of Bath C at Antioch, which were 84 cm in height. In all cases, the building stone used was of local origin and was likely the product of pre-existing stone cutting industries. For example, local limestone blocks were used in the construction of Bath C at Antioch, the Baths of L. Julius Agrippa at Apamea, as well as the baths at Palmyra, Baalbek, and

[437] Peuser 2000, 229.
[438] Ertel 2015a, 7-9.
[439] Butler 1919, 399.
[440] Butler 1919, 374-402.

Beirut. Roughly cut blocks of gypsum, on the other had were used in Bath F3 at Dura Europos, and basalt was used for the baths in the Hauran.

Brick masonry is also seen in a number of baths in Syria, particularly in the northern regions. In all cases, this use of brick seems to have been a break with local building traditions of stone masonry. In Apamea, Dura Europos, and Palmyra, brick masonry seems to have been only used in the construction of baths. It is possible that this material may have been used specifically because of its ability to withstand the high temperatures of the heating system, or it may indicate involvement of non-local craftspeople such as specialists connected to the Roman military. Unfortunately, the general lack of scholarship on the production and trade of ceramic brick in Syria, prevents a firm understanding of how or why this material was used.

Concerning the use of mortar, the excavation reports of these baths rarely mention whether or not this material was used as a bonding agent. No baths were described as entirely built of dry-stone masonry; however, the use of mortar to bond stone blocks was recorded in Bath C at Antioch, Bath F3 at Dura Europos, and the baths at Sha'arah and Seia in the Hauran. It is entirely possible, and even likely, that mortar was used in the masonry of the other baths, but simply not mentioned in their publication.

While bonding agents were used in pre-Roman Syria, they were not often used in stone construction.[441] The combination of mortar and stone masonry in Roman-style baths is thus a clear break with traditional building practices. This discontinuity is perhaps most clear in the baths at Sha'arah. While the main core of this structure was built of basalt blocks set in lime mortar, the service rooms of the baths were built using the local technique of dry-stone ashlar

[441] Dodge 1990, 114.

masonry.[442] Similarly, the small baths at Seia were the only structure at that site where the use of mortar as a binding agent was recorded.[443]

The reason for its use in Roman-style baths is likely connected with the vaulting that typically covered these structures. The mortar served to strengthen the abutment walls that not only carried the weight of the vaults but also resisted their lateral thrusts. This mortar may have also increased insulation to retain the heat of the heated rooms and to make the walls more impermeable to moisture.

Another example of the blending of masonry techniques is seen in two of the largest baths in the region, the monumental Bath C at Antioch and in the similarly large baths at Philippopolis. In both complexes, the massive walls were constructed out of mortared rubble cores faced with cut-stone blocks. This was likely done as a cost-saving measure to reduce the number of cut-stone blocks needed for the core of the walls. While the use of cut stone is a clear continuation of local ashlar traditions, the mortared rubble construction of these walls' cores is of western origin. It is, however, possible to see this mortared rubble core as a simple replacement of the earth and rubble fill of Hellenistic *emplekton* walls.[444] This construction technique is also found further south at Bosra, in the South Baths.[445]

Western influence is also seen in the use of fired brick, often as a facing for a mortared rubble core. This technique is mostly seen in the north, such as in the baths at Antioch and Apamea, though brick construction is also found in several baths in Dura Europos and at Palmyra. In the case of Dura Europos, this use of brick was likely the result of direct western

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[442] Fournet 2008a, 160.
[443] Butler 1919, 374-402.
[444] Waelkens 1989, 78.
[445] Butler 1919, 260.

influence, as these brick-built baths seem to have been connected to the presence of Roman troops in the city.[446] It is possible that the use of brick in the late second century baths at Palmyra is likewise the result of Roman influence (possibly through patronage by the provincial governor), as this material was not used for masonry before the Roman period.[447] On the other hand, the use of brick in the construction of the baths in Antioch and Apamea may have resulted from the establishment of local brick industries. While little is known about the production of ceramic building materials at Apamea, the city of Antioch was situated very close to the region of Cilicia, where brick masonry was relatively common. As discussed above, the baths at Augusta Ciliciae, Anazarbos, and Küçük Bernaz were all constructed of brick, and it seems that Antioch was likewise able to capitalize on this locally produced material.

Interestingly, there are a few baths in Syria that display a distinct difference between the construction of their heated section and their unheated section. The heated rooms of Antioch's Bath C, for example, were constructed of brick-faced mortared rubble, while the unheated rooms were built of blocks of limestone. Where these two techniques met, the brick faced walls bonded with the walls of cut-stone, revealing that they belong to the same phase. Similarly, the builders of the baths at Palmyra used brick for the heated rooms and limestone blocks for the unheated rooms. This duality in construction method seems to be a reflection of the builders' desire to build the heated rooms out of fire-proof material (brick) while using a familiar and more accessible material (limestone) for the rest of the structure.

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[446] Brown 1936a, 103-104.
[447] Vannesse 2015, 118.

Masonry of Roman-style Baths in Judea

Like many other regions of the eastern Mediterranean, wall construction in ancient Judea was dominated by the use of stone, which had a long history of use in the region.[448] To a large degree, this preference for stone construction was a result of the material's abundance as well as the relative scarcity of alternative building materials like timber and clay. In Herodian construction, mudbrick walls were sometimes built; however, field stone and ashlar walls were far more common.[449] In nearly all cases, the walls were covered in plaster, thus hiding their construction technique. This preference for stone extended to domestic architecture; private buildings in Roman period Palestine were regularly built of field stone or worked stone.[450]

It is no surprise then that the earliest Roman-style baths in the region, those built in the Herodian period, were constructed largely of stone. These bathing facilities were typically constructed of field stones or ashlars.[451] One striking exception, however, is the bathing suite in Herod's Third Winter Palace at Jericho, which was built of *opus reticulatum* and, like the baths at Elaeussa Sebaste, is a rare example of this technique being used outside of Italy.

Although much smaller in area than the province of Syria, Judea was home to a number of Roman-style baths.[452] As with the other regions, no attempt has been made to discuss all these known baths in the following section. Instead, the baths selected for discussion are those that

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[448] Wright 1985, 396-408.
[449] Netzer 2006, 311-13.
[450] Hirschfeld 1995, 218-21.
[451] Netzer 1999, 52-53.
[452] Though not conforming the boundaries of Ancient Judea, a catalogue of Hellenistic, Roman, and Byzantine baths in modern Israel, Palestine, and Jordan counted 148 bathing structures as of March 2004 (Hoss 2005, 123-77). A subsequent count in June 2013 listed 141 Roman and Byzantine period baths in this same region (Boussac et al. 2014, 29-34).

reflect the typical masonry techniques of the region as well as examples of “foreign” construction techniques, namely the use of *opus reticulatum* at Jericho.

Hippos-Sussita

Located on the eastern edge of the Sea of Galilee, the ancient city of Hippos-Sussita was part of the Decapolis and is home to three known Roman-style baths. Only one of these baths, the so-called Southern Bathhouse, has been extensively excavated. This structure dates to the second century CE and is situated along the southern city wall where it extends over 1050 m^2 (Figure 81).[453] It is built of local building stone, with large basalt ashlars forming the foundation for all the walls, and well-cut limestone ashlars forming the upper courses (Figure 82).[454] The size of the blocks is not recorded, but images suggest they are up to a meter long (a fact confirmed during my own personal visit to the site). As will be shown below, this combination of both basalt and limestone ashlar masonry was a common practice for construction in the region, including in the construction of baths. This technique exploited the strengths of both stones, as the harder and heavier basalt increased the stability of the foundation and the easier to cut and lighter limestone was better suited for the upper courses of monumental walls. Interestingly, the masonry of at least part of Hippos-Sussita’s Southern Bathhouse appears to comprise isodomic courses of limestone blocks alternating between headers and stretchers (sometimes known as English bond).[455] This masonry technique is seen elsewhere at Hippos-Sussita such as in the outer western wall of the site’s late first century CE basilica.[456] The masonry of the Southern

[453] Kowalewska 2019b, 274.
[454] Kowalewska 2019b, 268.
[455] Kowalewska 2019b, fig. 5.
[456] Kowalewska and Eisenberg 2019, fig. 4.

Bathhouse, therefore, seems to correspond to the local masonry techniques used at the site, suggesting that local craftspeople and builders were heavily involved in its construction.

Hammat Gader

South of Hippos-Sussita, the thermal bathing complex of Hammat Gader sits on the northern bank of the Yarmouk River (Figure 83). These monumental and well-preserved baths cover an area of about 3300 m^2 and were dated by its excavators to the mid-second century during reign of Antonius Pius (138-161 CE).[457] Subsequent examination, however, has revealed multiple phases of construction, with most of the walls constructed in the initial phase (possibly during the reign of Antonius Pius) and the second phase of construction (between the mid-second and end of the fourth century CE).[458] There appears to be no clear distinction between the masonry used in each phase.

Fortunately, the masonry of this bathing complex is meticulously described in detail by its excavators.[459] The walls of the baths are of basalt and limestone blocks with cores of mortared rubble (Figure 84). As was case at Hippos-Sussita, the builders of this complex carefully chose where to use the limestone and basalt blocks in order to exploit the bearing capacity, density, and workability of each type of stone most effectively. Basalt, being heavier and denser than limestone, forms the majority of the walls. Limestone, on the other hand, was used in only a few areas where the relative softness of this stone was desired. In Area D, for example, limestone was selected likely to facilitate the carving of the many intricate niches that surround this hall. It is evident that the builders recognized the relative weakness of limestone compared to basalt's

[457] Hirschfeld 1997, 477-78.
[458] Broise 2003, 234, figs. 4-5.
[459] Solar 1997, 17-20.

compressive strength, as the limestone walls of this hall were thickened in order to help them better support the weight of the vault. Limestone blocks also were used in a few other areas of the baths, including in the repair of a columned portal of Area C where it was laid in alternating courses of headers and stretchers (i.e. English bond). The mortar that bonded the facing blocks as well as the rubble in the cores was a mixture of lime and aggregates of pebbles, gravel, and basalt chips. In most cases, the basalt blocks were roughly dressed, with small fragments filling the mortared joints between blocks. In a few places finely dressed basalt blocks were used. Perhaps the most curious type of masonry found in these baths was employed in the foundations of two walls set in mud. Given the difficulty of stabilizing these foundations, these foundation stones are joined together by dovetail joints so that adjacent blocks interlock.[460] Unfortunately, the publication of these baths does not give the dimensions of the ashlar blocks; however, based on published images and my own personal observation of the structure, it is clear that these blocks were large enough to require lifting devises.

The construction of the thermal bathing complex of Hammat Gader clearly reflects the traditional Hellenistic preference for ashlar construction that was common in this region before the advent of Roman control. On the other hand, the use of mortared rubble cores and mortar as a bonding agent in the masonry of the baths have their origins in western building practices. Thus, as was the case for many of the Roman-style baths in this region, the thermal complex Hammat Gader displays a blend of local and non-local building techniques.

[460] Solar 1997, fig. 5.

Gadara (modern Umm Qais)

South of Hammat Gader, the ancient Decapolis city of Gadara (modern Umm Qais) is home to several Roman-style baths, but only one of which has been extensively excavated and studied. These baths, the so-called Byzantine Baths, extended over 2300 m^2 and were initially constructed in the early fourth century CE before undergoing subsequent renovations and repair after an undated earthquake (Figure 85).[461] The original ashlar walls of this bathing complex were well-constructed of large blocks of limestone and basalt (Figure 86).[462] The limestone blocks, which were locally quarried, have a height that varies between 40 and 70 cm, a width of around 60 cm, and a length that varies between 90 and 170 cm. Slightly smaller blocks of basalt were used to form the foundation of this structure. These blocks measure 40 to 50 cm by 40 to 60 cm by 75 to 100 cm. The masonry used to repair the baths after the undated earthquake differs from the original stonework and uses smaller blocks of limestone, measuring 50 cm by 60 cm by 20-25 cm.[463] As with the construction of other baths in the region, the use of basalt in the foundation was the result of this material's superior compression strength compared to limestone. Conversely, the relative softness of limestone made this material easier to cut into blocks for use in the superstructure of these baths. The excavators of these baths also recorded the presence of a fine white mortar used as a bonding agent in a few places; however, it is entirely possible that this "mortar" was in fact the remains of plaster that had covered the walls' surfaces.

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[461] Holm-Nielsen et al. 1986, 220.
[462] Nielsen et al. 1993, 133.
[463] Nielsen et al. 1993, 137.

Pella

Further south is the site of Pella, another Decapolis city. The water table in the wadi valley where this site is located is of such a height that it greatly hampered the excavation of the site's baths. As a result, very little is known about the bathing complex at Pella. Only about 200 m^2 of these baths has been uncovered, but they likely covered a much larger area (Figure 87). The excavation of this structure partially revealed several walls, including a first century CE apsidal wall of limestone ashlars laid in courses about 60 cm high without the use of mortar (Figure 88).[464] The masonry of this wall was noted as being similar to that of the site's odeon.[465] Sometime after the construction of this apsidal wall, between the second and fifth century CE, a series of vaulted chambers was added to the north of the exedra. The walls supporting these vaults were of the same width of the apsidal wall and were similarly built of limestone ashlars laid in regular courses, but a large about of mortar was used in their construction.[466]

Scythopolis (modern Bet She'an)

Around 12 km northwest of Pella and west of the Jordan River was the Decapolis city of Scythopolis (modern Bet She'an). Excavation in this large city has uncovered at least four Roman-style baths, including two monumental bathing complexes in the heart of the city. As with the other monumental baths in the Decapolis, such as the baths at Hammat Gader, Hippos-Sussita, and Gadara, these baths were constructed of local basalt and limestone blocks. In the city of Scythopolis, local basalt and soft limestone (*nari*) were the primary building materials for all

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[464] Smith and Day 1989, 11, pl. 3; Smith et al. 1992, 146, pl. 85.
[465] Smith and Day 1989, 10.
[466] Smith and Day 1989, 15.

construction, though by the second century the soft limestone was gradually replaced by a much harder limestone quarried some 7 km to the southwest of the city.[467]

The Eastern Bath of Scythopolis was initially built in the first century CE and was thoroughly rebuilt in the second century, by which time it covered an area of no less than 4900 m^2 (Figure 89).[468] The core of these baths is marked by four large piers of limestone ashlars with basalt walls built between them, on their east and west sides (Figure 90).[469] Other walls of this bathing complex, which were added during the Byzantine period, were constructed with basalt and limestone blocks, with basalt being used for the lower parts of the walls and limestone being used for the upper parts.[470] Although the sizes of these blocks are not recorded in publication, it was clear during my own personal examination of these baths that some of them measure over a meter in length.

The Western Bath of Scythopolis was similarly constructed of large ashlar blocks (Figure 91). The visible remains of this structure were constructed in the late fourth to early fifth century CE overtop earlier second century CE baths.[471] This monumental bathing facility stretched over 8500 m^2 and was built on a foundation of basalt ashlars.[472] During my own personal examination of these baths, limestone ashlars were also visible in the superstructure (Figure 92). This use of both limestone and basalt blocks (and specifically with limestone courses laid above courses of basalt) follows the regional practice of monumental bath construction found throughout the Decapolis region. In fact, ancient Scythopolis demonstrates that this use of limestone and basalt

[467] Tsafrir and Foerster 1997, 89.
[468] Tsafrir and Foerster 1997, 98.
[469] Mazor 1999, 299.
[470] Mazor and Bar-Nathan 1998, 13.
[471] Mazor 1999, 295.
[472] Mazor 1999, 297.

was not limited to bath construction, as the theater is similarly constructed with the lower courses of its walls in basalt and its upper courses in limestone[473]. The publications of these baths do not describe the blocks used in detail, but during my own personal examination of this structure, it was clear that the builders had used large well-cut ashlars as well as more roughly shaped basalt blocks that were bonded with mortar and small chinking stones.

A third and much smaller bathing complex (ca. 264.5 m^2) was uncovered at Bet She'an between the theater and the amphitheater (Figure 93). Excavators dated the initial construction of these public baths (named the South Bathhouse) to the third century, and these baths continued to be in use until the fifth century. Descriptions of the masonry of these baths differ between publications, with the walls being described as built of "smoothed stones",[474] "well-dressed masonry",[475] and "roughly dressed stones".[476] No other information is provided about the masonry of these baths, including whether mortar was used. Published photographs of the excavated remains, however, suggest that the structure was built of limestone rubble with a few sub-ashlar blocks (Figure 94).[477]

Ramat Hanadiv

West of Scythopolis and near the Mediterranean coast, the site of Ramat Hanadiv is home to a small (125 m^2) bathing complex dating to the Herodian period (Figure 95). Fed by a short aqueduct from a nearby spring, these baths were constructed of sub-ashlar masonry using local limestone blocks (measuring an average of 30 by 60 cm) that were finely dressed and laid as

[473] Bar-Nathan and Mazor 1993, 33.
[474] Peleg 1987–1988, 44.
[475] Mazor 1999, 301.
[476] Peleg 2004, 55.
[477] Peleg 2004, figs. 16 and 18.

headers and stretchers in fine-grained white mortar (Figure 96).[478] While most of the structure's walls were built of these blocks alternating between headers and stretchers along horizontal courses, the outer face of the eastern wall of the *tepidarium* was constructed of courses entirely of headers alternating with courses of entirely of stretchers (i.e. English bond).[479]

Jericho

Of all the Roman-style baths in Judea, the bathing suite in the North Wing of Herod's Third Palace at Jericho presents the clearest example of direct Roman influence in the construction of its walls (Figure 97). While much of the palace was built of mudbrick, the bathing suite (234.5 m^2) was constructed of mortared rubble walls (described as concrete or *opus caementicium*) faced with *opus reticulatum* and *opus quadratum* (i.e. ashlar).[480] The *opus reticulatum* survives in many of the heated rooms above the foundation level (Figure 98).[481] The *opus quadratum*, on the other hand, was employed primarily at exterior corners, door jambs, and piers.[482]

The use of this Italian masonry technique places this bathing suite alongside the Reticulate Baths (also known as the Bath in *Opus Mixtum*) and Harbor Baths of Elaeussa Sebaste, as one of the few structures in the eastern Mediterranean where such characteristically Italian building techniques are found. As in the case with Elaeussa Sebaste, the use of *opus reticulatum* at Jericho has led scholars to conclude that these baths were the product of a team of Italian builders.[483] It is possible that this team was sent to Judea by Marcus Agrippa after his visit to Herod's kingdom in

[478] Hirschfeld 2000, 313.
[479] Hirschfeld 2000, 318.
[480] Netzer 2001, 318.
[481] Netzer 2001, 256-59. figs. 386-87, 390-92.
[482] Kelso and Baramki 1955, 5.
[483] Kelso and Baramki 1955, 5.

15 BCE.[484] More will be discussed about the use of these Italian techniques at the end of this chapter.

Cypros

Overlooking the Herodian palaces at Jericho is the mountain-top palace of Cypros, also built by Herod the Great. This palatial complex contained two bathing suites, one at the summit (ca. 50 m^2) (Figure 99) and another on the slope's shoulder (ca. 192 m^2) (Figure 100). While little is recorded of the masonry from the baths at the summit, the walls of the baths on the shoulder are recorded as being 85 cm wide and constructed largely of field stones, with ashlars being used for doorjambs and in the partition walls of several of its rooms.[485] They are further described as being built of "soft friable local stone".[486] The excavators of Cypros do not provide a specific date for either of the site's baths.

Herodium

South of Jerusalem, excavation at Herodium has uncovered several Roman-style baths, including one situated within the palace-fortress that dominates the site (Figure 101). This bathing facility, which measures over 135 m^2 in size and dates to the late first century BCE, was constructed of well-cut ashlars (Figure 102).[487] Mortar was also used in the construction of this facility, both as a bonding agent and as a fill for the core between wall facings. The excavators of these baths describe the walls of the *tepidarium* as being faced on both sides with blocks, between which a liquid mortar consisting of lime and ash was poured to fill all voids.[488] If this

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[484] Netzer 2006, 315.
[485] Netzer and Damanti 2004, 266.
[486] Netzer and Damanti 2004, 278.
[487] Corbo 1989, 46-48, pls. 77-83; Netzer 1999, 52-53, fig. 7.
[488] Corbo 1989, 47.

interpretation is correct, this technique differs significantly from the typical use of mortar in wall cores, which was usually laid by hand and trowel along with un-worked field stones (i.e. mortared rubble). Though not explicitly mentioned in publications, the ashlars appear in published images to be of local limestone.[489]

Ein Yael

Two smaller, but much later bathing suites were uncovered by archaeologists at the site of Ein Yael, located just west of Jerusalem. These baths were part of a villa complex that was constructed at the end of the second century CE and remained occupied until the mid-third century (Figure 103).[490] While the construction of the lower bathing complex is not described, the Roman walls of the upper baths, which measure about 10 m^2, are recorded as being of ashlar masonry.[491] No further information is provided about the masonry of these walls or the construction of the other parts of the villa. The location of this complex on limestone terraces, makes it more than likely that the ashlars used in the walls of the baths were of this local and commonly used building stone.

Emmaus

To the west of Jerusalem, the site of Emmaus is home to what is possible the best preserved Roman-style baths in the province of Judea (Figure 104). All the walls of this structure (which covers an area of 105 m^2) remain standing to their original heights and were constructed of isodomic courses of well-dress ashlars of local limestone that appear to be up to one meter in

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[489] Corbo 1989, color pls. 1-2.
[490] Edelstein 1990, 40.
[491] Edelstein 1990, 40; 1993, 118.

length (Figure 105).[492] The publication of these baths provides little further evidence of the masonry techniques used, and the remarkable level of the walls' preservation would nevertheless prevent a detailed understanding of their core structure.

Masada

Excavation at the site of Masada, west of the Dead Sea, has uncovered the remains of at least five baths. Not all these bathing structures, however, have been published in sufficient detail to allow for an examination of their masonry. The largest and one of the best preserved of these baths is the Large Baths (sometimes referred to as the Independent Bath), which covers an area of 239 m^2 (Figure 106). Like most of the other structures at Masada, the walls of this bathing complex were constructed of roughly worked local dolomite[493] stones with small cobbles to fill in gaps (Figure 107).[494] The sub-ashlar masonry of these baths is unique, however, in that the walls of the *caldarium* are the only ones at Masada that used lime-based mortar; all others used earth reinforced with straw.[495] In all likelihood, this use of lime mortar was intended as a precaution against the humidity to which the walls of the *caldarium* were to be subjected.

Conclusions

In the province of Judea, bath construction displays a preference for stone masonry, often following local pre-Roman traditions. In all cases, local stone was preferred. For many regions of the province, limestone was the most accessible and thus most common building material used for masonry. In the area surrounding the Sea of Galilee, basalt also existed in sufficient

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[492] Gichon 1979, 102, pl. 12.
[493] Dolomite, like limestone, is a sedimentary carbonate rock; however, while limestone is a calcium carbonate, dolomite is a calcium magnesium carbonate.
[494] Netzer 1991, 607-608, ill. 917.4.
[495] Netzer 1991, 608.

quantities to have been used as an important building material. Unlike in the Hauran, however, where basalt was the primary material used in wall construction, the major baths of these Decapolis cities, such as those at Hippos-Sussita, Hammat Gader, Gadara, and Scythopolis, were built with both basalt and local limestone. As was the case in the construction of other monumental buildings in this region, the builders employed the denser and heavier basalt in the foundations and lower wall courses, while using the lighter and easier to cut limestone in the walls' upper courses and in the vaults (as will be discussed in the next chapter). Outside these monumental baths, smaller bathing structures were largely built of cut stone blocks, although the use of fieldstone is recorded in baths at Cypros and Masada.

Although not always recorded, several baths are described as using lime mortar (or "white" mortar), including those at Hammat Gader, Gadara, Ramat Hanadiv, Herodium, and Masada. The use of this mortar at Masada is notable in that the Large Baths (or Independent Bath) was the only structure at the site to use lime mortar rather than the otherwise typical earth mixed with straw. The decision to use lime mortar reflected a precaution against the moist environment found in Roman-style baths. The one exception to this use of mortar is in the original apsidal wall of the bathing complex at Pella, where excavators note that no mortar was visible.[496]

The clearest exception to the preference for stone masonry in bath construction in Judea is the cast walls of mortared rubble faced with *opus reticulatum* and *opus quadratum* (i.e. ashlar) found in the bathing suite in the North Wing of Herod's Third Palace at Jericho. This characteristically Italian masonry style is strongly suggestive that a Roman or Italian construction team was heavily involved in the building of these Roman-style baths. Throughout

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[496] Smith and Day 1989, 11.

the Roman East, only a few structures were constructed using the masonry technique of *opus reticulatum*.[497] The bathing suite at Jericho in one of three known structures in Judea that employed *opus reticulatum*, with the other known examples coming from Jerusalem and Banias.[498] The only other known baths in the eastern Mediterranean that were constructed using this Italian masonry technique are the Reticulate Baths (or *Opus Mixtum* Baths) and Harbor Baths at Elaeussa Sebaste, in Cilicia. Here too it is thought that there was direct Roman influence on the construction of these bathing structures. While the Reticulate Baths (dated between the end of the first century CE and the middle of the second century) postdate Herod's Third palace at Jericho, the initial phase of the Harbor Baths date to between the mid-first century BCE and the mid-first century CE and are thus contemporaneous to these Herodian baths.

Masonry of Roman-style Baths in Arabia

Like in the province of Judea, the Roman-style baths built in the province of Arabia were largely constructed of local building stone. The abundance of this construction material in this region as well as the absence of any suitable alternatives, led to the development of deeply entrenched stone building industries in pre-Roman times. In the northern area of this province, which encompassed parts of the volcanic Hauran region, basalt masonry dominated all architecture as it did in other regions of the Hauran, such as those sites discussed above in the section on Syria. Further south, limestone was commonly used, as best demonstrated by the ruins of Gerasa (modern day Jerash). Further south still, in the Nabataean heartland of the Petra region, sandstone dominates. Though more renowned for their rock-carved façade tombs, the

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[497] Deichmann 1979, 475, fig. 1.
[498] For the use of *opus reticulatum* in Jerusalem, see Netzer and Ben-Arieh 1983. For its use in Banias, see Netzer 2006, 218-22.

Nabataeans were equally skilled in ashlar masonry.[499] Indeed, these façade tombs, while under construction, often served as temporary quarries, as the rock being removed was often cut into blocks for use in ashlar construction elsewhere.

As was the case in all other regions, no attempt was made in the following section to address and discuss all known Roman-style baths in the province of Arabia. Instead, an attempt was made to provide a representative sample that reflects the typical materials and techniques used in the masonry of these bathing facilities from all regions of the province.

Bosra

The ancient city of Bosra was the capital of the province of Arabia. Located in the Hauran, the architecture of Bosra (including its baths) was primarily constructed of basalt ashlar masonry.[500] The size and importance of Bosra is reflected in the fact that this site was home to at least three known public baths, all built with the same materials and similar techniques to other baths in the Hauran previously discussed in the section on Syria. One of the largest baths at Bosra was the so-called South Baths, stretching over 8000 m^2 and located south of the principle east-west road and north of the theater (Figure 108). This monumental bathing complex was originally built on a smaller scale in the second half of the second century CE before being expanded over the subsequent centuries.[501] The walls of the structure that remains visible today were constructed of large ashlars with a mortared rubble core (Figure 109).[502] That the cut stone blocks are of the ubiquitous basalt is evident from published photographs of the bathing

[499] Rababeh 2005, 108-120.
[500] Fournet 2012b, 190.
[501] Broise and Fournet 2007, 221-24
[502] Butler 1919, 260.

complex.[503] Regarding materials and techniques used for wall construction, the South Baths of Bosra are similar to the monumental baths at Philippopolis, which are similarly constructed of ashlar-faced mortared rubble.[504]

Another monumental bathing complex in Bosra is the Central Baths, which are located just north of the South Baths and are possibly the largest bathing complex in Bosra, occupying roughly 9000 m^2 (Figure 110).[505] Although initial identified as a bath complex, it was later assumed to be part of a market and was subsequently referred to as the Khân id-Dibs.[506] More recent scholarship on this structure and its architecture has recognized that it is indeed a monumental bathing complex.[507] Unfortunately, the study of the Central Baths did not include a detailed examination of its masonry techniques. The published images of this structure, however, suggest that the walls are constructed out of well-cut blocks of basalt (Figure 111), possibly with a mortared rubble core, as was the case with the masonry of the South Baths.[508] The initial construction of the Central Baths took place in the second century CE, and they underwent several major renovations in subsequent centuries.[509]

A third bathing facility in Bosra is located north of the city center in the area known as the Roman camp. This structure, known as the North Baths or Baths of the Roman Camp, has been dated tentatively to the first half of the second century CE (Figure 112).[510] The remains of these baths cover an area of 2000 m^2 and are of much poorer preservation than the two previously

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[503] Broise and Fournet 2007; Fournet 2012b, fig. 4, 7.
[504] Butler 1903, 378-83, 395.
[505] Fournet 2012b, 197.
[506] Butler 1919, 264.
[507] Fournet 2007; 2008b.
[508] Fournet 2007; 2008b, figs. 3-7.
[509] Fournet 2007, 246; 2008b, 124.
[510] Fournet 2012b, 209.

discussed bathing facilities of Bosra, with only a single domed hall remaining standing (Figure 113). The walls of this hall are described as being built of large blocks of stone, many of which have been carried away for secondary use.[511] The size of these blocks and the fact that they are finely dressed is clearly visible in published images of the structure.[512] Unfortunately, no further detail on the masonry of these baths is provided in any known published report; however, additional information may come from a nearby structure.

In his report on the architecture of Bosra, Butler provides a description of a structure located 50 m southwest of the North Baths that he labelled the Northwest Baths (Figure 112). He recorded that the walls of these baths were "concrete double faced with blocks of basalt", and although he listed this structure as a separate structure, Butler also posited that both the Northwest Baths and the North Baths may have belonged to a single bathing complex.[513] If these two baths do indeed belong to a single complex, it is more than likely that the walls of the domed hall that comprises the North Baths were also constructed of mortared rubble, faced with basalt blocks. Not only would this masonry technique be in keeping with that used for the South Baths, but it is also supported by what is visible in published images of the structure.

Although the masonry materials and techniques of the three baths of Bosra highlighted above have not been fully documented, available information coupled with published images indicate that they were largely constructed of cut blocks of basalt, in keeping with the building traditions of the site and the wider Hauran region. In the South Baths (and possibly the Central Baths and North Baths) these basalt blocks were facings for cores of mortared rubble, a masonry technique

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[511] Butler 1919, 264.
[512] e.g. Fournet 2012b, fig. 13.
[513] Butler 1919, 265.

also seen in the baths at Philippopolis. It is possible that this use of mortared rubble cores, which is not a local construction practice, may have developed partly from Hellenistic *emplekton* masonry.[514] This technique was likely used as a cost saving measure, as it allowed for the massive walls of monumental baths to be thickened without the need to fill them with cut ashlars, which would have drastically increased the cost of construction.

Gerasa (modern Jerash)

The ancient city of Gerasa (modern day Jerash) was a member of the Decapolis and is located southwest of Bosra and southeast of the site of Pella. The architecture of Gerasa was characterized by the widespread use of limestone construction that in many cases remains visible today. These limestone blocks were sourced from the numerous quarry sites that surround the settlement.[515] The ancient city of Gerasa was also home to at least six Roman-style baths, with a seventh located just north of the city at the extramural sanctuary of Birketein (which will be discussed below).[516]

The largest of these baths is the East Baths, located in the eastern half of the ancient city, which is outside the archaeological park and is largely overbuilt by modern urbanization (Figure 114). Including its palaestra, this complex once covered an area of over 15000 m^2. Though much of these baths has been despoiled over the centuries, a great deal still remains standing, including several of the ashlar barrel vaults that cover the structure's large halls. The walls of these chambers were constructed of large well-cut limestone ashlars (Figure 115).[517] No in-depth study

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[514] Waelkens 1989, 78.
[515] Abu-Jaber et al. 2009.
[516] For a general overview of the baths of Gerasa, which does not include the recently discovered Central Baths, see Lepaon 2008.
[517] Friedland 2003, 419.

has been carried out on the masonry of this structure; however, during my own personal examination of the baths, all the structure's massive walls appeared to have been built of solid blocks of limestone, seemingly without the use of mortar. Scholars are still uncertain of the phasing of the East Baths, but the extant halls likely belong to the structure's initial construction that dates to the second half of the second century CE.[518]

To the west of the Chrysorhoas River that divided ancient Gerasa and within the modern archaeological park is the so-called West Baths (Figure 116). This monumental bathing facility, which measures about 4200 m^2 and is located east of the *cardo* and south of the northern *decumanus*, is relatively undocumented, yet much of its architecture remains standing, including a perfectly preserved ashlar dome over its eastern hall. No known publication describes the construction of its walls; however, its limestone ashlar masonry is clearly visible in published images.[519] Upon my own personal examination of the structure, it was evident that the walls were largely of solid ashlar masonry, although small cobbles may have also been used in the core between blocks (Figure 117). The largest of these blocks measure well over one meter in length. The absence of any excavation within this structure prevents a firm understanding of its phasing or date of construction.

Further south in the city, recent excavation has uncovered the remains of Roman-style baths under the ruins of a mosque at the intersection of the city's *cardo* and the south *decumanus*. This structure, the so-called Central Baths, was not nearly as large as either the East or West Baths, but measured over 500 m^2 (Figure 118). It is also not nearly as well preserved, as little remains of its walls above floor level. Nevertheless, excavation of the complex has revealed that its walls,

[518] Lepaon 2008, 65, fig. 12.
[519] e.g. Lepaon 2008, fig. 2.

like the majority of the structures in Gerasa, were built of limestone ashlars (Figure 119).[520] Although the Central Baths underwent several repairs and renovations in their roughly 400-year use, the excavators of the baths date its initial construction to the late third century CE.[521]

Birketein

Immediately north of Gerasa (ca. 2 km north of the city) is the sanctuary site of Birketein, so named from the double reservoirs that dominate the site. Southwest of these reservoirs is a bathing facility that is thought to have belonged to a sanctuary complex dedicated to Zeus Epikarpios, which also included a theater that borders the baths to the north (Figure 120). These baths were constructed on an artificial terrace supported by a retaining wall built of dry-stone ashlars, that is, without the use of mortar.[522] Unfortunately, the excavation report makes no detailed description of the materials or masonry techniques used in the walls of the baths, which cover an area of about 670 m². Nevertheless, the published images of the excavation report show walls of finely cut ashlars of what appears to be limestone (Figure 121).[523] My own personal examination of the structure confirmed the use of limestone ashlars, some of which measure up to one meter long (Figure 122). The extent to which mortar was used as a bonding agent in the baths’ walls, however, was not entirely clear, nor is it mentioned in any known publication. The baths, along with the other structures of Birketein, have been dated to the second and third centuries CE.[524]

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[520] Blanke 2015, 87.
[521] Blanke 2015, 86, 93.
[522] Lachat et al. 2015, 47.
[523] Lachat et al. 2015, figs. 5-6, 8, 10-11.
[524] Lachat et al. 2015, 46.

Betthorus (modern Lejjun)

South of Jerash, the garrison baths (223 m^2 in size) within the legionary fortress at Betthorus (modern day Lejjun) were largely constructed of limestone ashlars (Figure 123 & Figure 124). In addition to the finely cut limestone blocks, basalt blocks were used in a few areas of the baths, and several of the walls were constructed entirely or partially of semi-dressed blocks of chert.[525] This construction was similar to that found elsewhere in the fort and reflects the use of locally sourced materials. These construction materials and the care with which these baths were built led the excavators of these baths to date them to relatively early in the fort's history, after the initial construction of the curtain wall (in c. 300 CE) but before the earthquake of 363 CE.[526]

Petra

The ancient city of Petra was the capital of the Nabataean Kingdom before its annexation by Rome in 106 CE. Like the Herodian Kingdom to the east, the Nabataeans were early adopters of Roman-style baths, several of which have been identified in and around Petra, although not all are excavated or fully documented. The largest bathing complex known in Petra are the baths located immediately west of the so-called Petra Great Temple, which stretch over 1477.5 m^2 (Figure 125). These baths are thought to have been initially constructed around the time of the Roman annexation of Petra in 106 CE.[527] During my own personal examination of this structure, the widespread use of the well-cut sandstone ashlars that are typical of construction in Petra was visibly clear (Figure 126). These blocks were largely laid in isodomic courses. The published

[525] de Vries and Lain 2006, 214, 219.
[526] de Vries and Lain 2006, 221.
[527] Power 2017, 188.

report makes no mention of these blocks or the use of mortar. There is mention, however, of limestone and sandstone lintels above doorways.[528]

Another bathing facility excavated in Petra is a much smaller complex that is located on Jebal Khubthah and overlooks the city center from the east (Figure 127). No concrete date has been assigned to this structure, which covers an area of 225 m^2, although it likely dates to the turn of the first and second centuries CE and may be associated with peripheral urban development on this outcrop.[529] Perched on the edge of the mountain side, much of these baths has collapsed and little remains above floor level. That which does remain extant was constructed of sandstone ashlars (Figure 128).[530] As with the sandstone blocks used in the baths adjacent to the so-called Petra Great Temple, these ashlars were quarried in the immediate vicinity.

Sabrah

The small site of Sabrah is located a mere 6.5 km southwest of the city center of Petra. Here, archaeologists have identified a Roman-style bath complex associated with a temple and theater, in a similar fashion to the baths at Birketein, north of Gerasa. These baths remain unexcavated; however, their visible remains, which stretch over an area of about 756 m^2, comprise walls of double-faced sandstone ashlars (Figure 129).[531] Like those from the baths in Petra, these blocks likely came from nearby quarries and reflect standard Nabataean masonry practices. This bathing

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[528] Joukowsky 2007, 94, n. 10.
[529] Tholbecq et al. 2015, 31; Fournet and Paridaens 2016, 99.
[530] Fournet and Paridaens 2016, 83, fig. 11.
[531] Fournet and Tholbecq 2015, 37, fig. 5.

structure has been tentatively dated to the end of the first century CE to the beginning of the second century.[532]

Hauarra (modern Humayma)

Approximately 80 km south of Petra was the ancient city of Hauarra (modern Humayma). Founded by the Nabataeans on the trade route between Petra and the port of Aila (modern Aqaba), this site became home to the earliest Roman fort in the region soon after the annexation of the Nabataean Kingdom in 106 CE. Associated with this Trajanic fort is an extramural garrison bathhouse located approximately 160 m to its southwest (Figure 130).

Excavation of these Roman-style baths (roughly 450 m^2 in size) has revealed that the walls of the bathing complex partially incorporated the walls of an earlier Nabataean building built of well-dressed sandstone ashlars set in dark grey mortar and set as stretchers with occasional headers.[533] The earliest baths seem to have been built contemporaneously with the fort and thus likely date to the early second century CE, while later renovations and expansions took place in the later second and third centuries CE.[534] The walls of the later phases were constructed out of reused sandstone ashlars and roughly cut blocks that were laid in a much more irregular fashion than the well-cut ashlars of the earlier structure.[535]

Arieldela (modern ʻAyn Gharandal)

Another garrison bathing complex is found to the northwest of Hauarra at Arieldela (modern ʻAyn Gharandal), located on the eastern edge of the Wadi Arabah. This small outpost is home to

[532] Fournet and Tholbecq 2015, 42.
[533] Oleson 1990, 294; 2010, 223; Reeves et al. 2017, 108, fig. 5.
[534] Reeves et al. 2017, 111.
[535] Oleson 2010, 229.

a Late Roman *castellum* and its associated bathhouse, which is at least 84 m^2 large and remarkably well preserved (Figure 131). Standing up to 3 m in places, walls of this bathing facility are about 1 m wide and were constructed of roughly cut sub-ashlar blocks bonded by mortar (Figure 132).[536] These baths likely date to the initial founding of the adjacent *castellum*. The fortunate discovery of the fort's building inscription definitively dates the foundation of the fort (and by extension the baths) to the Tetrarchic period.[537]

Osia (modern Yotvata)

Southwest of Arieldela, on the opposite side of the Wadi Araba is the site of Osia (modern Yotvata). Here, a similar Late Roman *castellum* to the one at Arieldela was built, complete with its own garrison baths, measuring roughly 135 m^2 (Figure 133). Unlike the baths at Arieldela, however, Osia's bathhouse is very poorly preserved with only a few stones remaining extant above the floor surface. Nevertheless, the fact that the structure was built of cut stone blocks is evident from the cut stone blocks of the lowest courses that were found *in situ* as well as similar cut blocks that had fallen from other walls.[538] Unfortunately, nothing else survived or was recorded of the masonry of these baths. Like the Roman-style baths at Arieldela, the baths at Osia are likely contemporaneous with the adjacent fort, and thus were likely built under the Tetrarchs.[539]

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[536] Darby and Darby 2012, 408; 2015b, 464.
[537] Darby 2015b, 471-84.
[538] Davies and Magness 2015, 51.
[539] Davies and Magness 2014, 356.

Oboda (modern Avdat)

North of Osia, in the Negev Desert is the settlement of Oboda (modern Avdat), home to well-persevered Roman-style baths, measuring roughly 305 m^2 (Figure 134). Although a few of this structure's rooms have fallen into ruin, the walls of the main heating block remain nearly fully extant. These walls are described as being "built of medium-sized blocks of hard limestone, hammer-dressed and laid in regular courses with occasional small stones in the joints" (Figure 135 & Figure 136).[540] There is no explicit mention of mortar being used to bond these blocks, not is any mortar evident from the published photographs that show the limestone masonry.[541] Initially constructed in the fourth century CE, the Oboda baths seem to have undergone major renovations sometime after an early fifth century earthquake.[542]

Mamshit / Mampsis

Northeast of Oboda, another Roman-style bathing facility has been uncovered at Mamshit (Figure 137). These baths (measuring ca. 208 m^2) are not nearly as well-preserved as those at Oboda; however, this structure retains enough of its walls to discern the masonry techniques used in its construction. Interestingly, these baths comprise two units, which were built on two separate levels and differ in masonry technique. The higher level, which consists of the *apodyterium*, *frigidarium*, and *tepidarium*, was constructed of large course boulders, while the two *caldaria*, which were set at a slightly lower level, were constructed of carefully drafted ashlars (Figure 138).[543] The exterior wall of the *praefurnium*, which was adjacent to the *caldaria*,

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[540] Negev 1997, 171.
[541] Negev 1997, photos 272-77.
[542] Erickson-Gini 2014, 97.
[543] Negev 1988, 169, photo 169.

was constructed of small blocks of stone bonded with mortar and small chips of stone.[544] The date of this bathing complex is uncertain; however, the excavators dated its initial construction to the Late Nabataean period and stated it was also in use during the late Roman and Byzantine periods.[545]

Rehovot-in-the-Negev

The last baths from Arabia to be examined were located at Rehovot-in-the-Negev, west of Mamshit and northwest of Oboda (Figure 139). Although the remains of this small structure (ca. 91 m^2) remained well-preserved into the 20^{th} century, the baths were largely destroyed during the British Mandate Period after a police station was constructed at the site.[546] Before its destruction, this bathing complex was visited by several archaeological teams, including Woolley and Lawrence, who described the masonry of the walls as being of “well-cut stone”.[547] These stone blocks are visible in the photographs and illustrations published by Musil, another early visitor to the site (Figure 140).[548] Although the unfortunate destruction of these baths has prevented their excavation and proper dating, they have been initially dated broadly to the Byzantine period, and subsequent discussion of the structure has accepted this dating.[549]

Conclusions

The construction of Roman-style baths in the province of Arabia was dominated by the use of stone blocks, although the fineness of the cuts and dressing varied. In general, the larger baths

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[544] Negev 1988, 172.
[545] Negev 1988, 181.
[546] Tali Erickson-Gini, personal communication, Dec. 2019.
[547] Woolley and Lawrence 1915, 116.
[548] Musil 1908, figs. 47-48, 53.
[549] Woolley and Lawrence 1915, 117; Rosenthal-Heginbottom 1988, 20, ill. 28.

were built of ashlar, while the smaller ones were of sub-ashlar masonry. Sandstone ashlars were also common for some of the Nabataean baths built around the first century CE. Although well-cut and carefully dressed, these sandstone blocks were typically smaller than ashlars of limestone, because large blocks of sandstone were liable to crack.

The type of building stone depended on what was locally available. In all the cases discussed above, local materials and masonry techniques were employed in the construction of baths. This continuation of local building traditions was in part a result of the scarcity of alternative materials such as fired brick and the fact that these local traditions were well suited to the requirements of baths, namely they were fire resistant, not susceptible to moisture damage, and could support the weight of vaulting. It is notable that even in garrison bathhouses built to accommodate Roman troops, such as those at Betthorus (modern Lejjun), Hauarra (modern Humayma), Arieldela (modern ‘Ayn Gharandal), and Osia (modern Yotvata), the masonry comprised cut stone blocks.

Observations on the Masonry of Roman-style Baths in the Roman East

The overview of the materials and techniques used in the masonry of Roman-style baths presented in this chapter reveals that, in most regions of the Roman East, stone was the preferred material. More specifically, those responsible for constructing baths chose locally available stone, and typically employed masonry techniques that pre-existed Roman control in the region. Examples of this continuity include rubble masonry in Rough Cilicia, the use of basalt ashlars in the Haruan, the limestone ashlar construction of Cyprus, Judea, and the Negev Desert, as well as the mixed use of basalt and limestone ashlars in certain Decapolis sites south of the Sea of Galilee, such as Scythopolis.

This continuity shows, not surprisingly, that local building industries and craftspeople were involved in the construction of these bathing complexes. Such involvement may have included both the supply of the material (i.e. quarrying, transportation, and cutting of the stone) and the actual construction of the buildings. The involvement of local building industries for the construction of these bathing complexes is naturally to be expected. Not only would it have been unfeasible to import entire work teams from the West for all baths built in the Roman East, but the existing building industries in the Roman East were skilled and accustomed to working with stone, which was suitable for bath construction. In addition, building stone was widely available in many of these regions and thus cheap to acquire. Furthermore, the infrastructure relating to the production and supply of stone was already in place in these regions and did not require change or additional investment. In some places, it may have been too difficult to replace these pre-existing and deeply entrenched industries, because of the political power the guilds or owners of quarries and workshops enjoyed. In such cases, it was not only economically – but also socially – more expedient to use existing building industries and their associated craftspeople than to introduce new construction techniques.

The widespread continuity of masonry techniques for Roman-style baths does not mean that non-local techniques were completely absent. On the contrary, there are several examples throughout the Roman East where the construction materials and techniques used in the masonry of baths break with local tradition. One such example is in the use of lime mortar as a binding agent within masonry that typically did not require it. In the Hauran, the baths at both Sha'arah[550] and Seia[551] were possibly the only structures at these two sites where lime mortar was used to

[550] Fournet 2008a, 160.
[551] Butler 1919, 374-402.

bond the basalt ashlar masonry together. Likely, this mortar was required to strengthen the walls so that they could better resist the lateral thrusts of the vaults that covered them. This mortar may also have improved the insulation of the heated rooms, making them more efficient. Similarly, at the site of Masada in Judea, the Large Baths were the only building complex at the site to use lime mortar, rather than earth reinforced with straw, as a bonding element in fieldstone masonry construction. In addition to creating a stronger bond to help the walls support the covering vault, this lime mortar was less susceptible to water damage than the earth and straw used for the other structures. Unfortunately, the use of mortar is not always explicitly mentioned in excavation or architectural reports, and there may be more instances of lime mortar used specifically for bath construction, including for baths not included in this study.

One of most obvious examples of a non-local building material that was used in the construction of Roman-style baths is fired ceramic brick. As will be discussed in Chapter 5, fired ceramic brick was produced in all regions of the Roman East for use in hypocaust systems (as well as for roof tiles and pavers). The use of brick for masonry, however, was much more limited in this region and was used to construct bathing structures only in Flat Cilicia and parts of northern Syria, including Palmyra and Dura Europos. The reasons for using brick masonry seem to differ depending on the region.

In the case of Flat Cilicia, brick masonry was not limited to baths, but rather was used for a variety of structures, as seen at Augusta Ciliciae, Anazarbos, and Küçük Bernaz. It is likely that this widespread use of brick masonry resulted from a lack of good building stones and an abundance of clay in the region's alluvial plains.[552] Also contributing to the use of this building

[552] Spanu 2003, 21.

material may have been the large-scale pre-Roman tile industry that supplied a long-distance trade-network of roof tiles along the Levantine coast. Unfortunately, very little is known about this industry, as archaeological investigation of the region has not identified a single kiln site or even brick stamp that could provide clues about its organization.[553] Its existence is attested, however, by the large quantities of ceramic roof tiles that were shipped from this region to sites along the Levantine coast. At Beirut, for example, the most commonly found roof tiles used in the city during the Seleucid and Late Hellenistic periods came from Flat Cilicia (fabrics BER2.1 and BER2.2).[554] After the introduction of the fired brick to this region, this local tile industry would have been able to shift to the production of bricks. It is assumed that these tile kilns were likely the same ones to produce the specialized bricks for heating systems in the earliest baths in Cilicia.[555] With the further development of this industry, regional producers would have been able to use well-established supply and distribution networks to allow for an abundant supply of cheap bricks for use in the construction of all manner of buildings, including baths.

In the province of Syria, the use of brick masonry seems to be entirely different. Whereas brick masonry in Flat Cilicia may have been tied in part to the limited availability of building stone, in Syria all of the sites with brick-built baths also seem to have had abundant supplies of stone and in some cases longstanding traditions of stone masonry. In Dura Europos, for example, gypsum was widely used, while limestone was the preferred building material for the majority of buildings in Palmyra and Apamea and was also used widely at Antioch and Athis. Furthermore, apart from Athis, where brick was used in defense works, and Antioch, where this material is

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[553] Spanu 2003, 22.
[554] Mills 2013, 55-62, 84.
[555] Spanu 2010, 403.

also found in the aqueduct, Roman-style baths seem to have been the only building type constructed of brick masonry at these sites. For example, at Dura Europos, fired bricks were only found in the masonry of the baths and in the floors and ceilings of a few elite houses and religious buildings.[556] This correlation suggests that fired bricks were specifically produced for the construction of Roman-style baths. In Bath C at Antioch and in the baths at Palmyra, their use is further restricted to the heated rooms. The use of brick masonry in bath construction in Syria is notable, therefore, because the builders of these facilities could easily have used local building materials and techniques as was done in other regions of the Roman East, but instead they chose to use a non-local masonry technique.

This break with local tradition may be the result of a number of factors. It is possible that the builders of these facilities believed that the thermal properties of brick (i.e. the material's ability to withstand high temperatures) made it a requirement of bath construction, or at the very least necessary for the construction of the heated rooms. While ceramic brick can withstand thermal stress and shock much better than limestone, the countless limestone baths that were built in Judea and Arabia, show that it was possible to use this building stone for the construction of the heated room, provided that care was taken to envelope the hypocaust with brick. Alternatively, the foreign character of this material may have given brick a level of status that was "appropriate" for this foreign building type, or it may have simply been the expected way to build baths in this region. The difficulty and cost of manufacturing (or importing) large quantities fired brick specifically for baths (especially when perfectly suitable stone was availably) make this last explanation unconvincing. The use of brick in these baths could also be

[556] Leriche 2015, 113.

an indication of non-local involvement in their construction, with foreign teams using materials to which they were accustomed and deemed appropriate. The military may have been instrumental in the providing the impetus for these baths as well as the actual specialists for their construction. This possibility is particularly appealing for Dura Europos and Athis where there was a clear military presence.

Unfortunately, a lack of scholarship on brick production and trade in Syria complicates our understanding of how this material was used. Some of the few studies on brick and tiles in Syria are of the military tile stamps found in the region of Zeugma in the north of the province, which suggest that the Roman military produced their own ceramic building material in the vicinity.[557] In Flat Cilicia, it is clear that local units of measurement were used for brick production, indicating that their production was decentralized and in local hands.[558] For Syria, brick measurements are not always provided by excavators. Where they are available, the sizes indicate that they are not closely following the Roman standard, though it is equally not clear if a specific local standard is being followed.[559] What is clear is that whether through importation or local manufacture, there was sufficient availability of ceramic brick to use this material in the masonry of the baths, but this material was not so widely available that it was used for a wide array of other structures.

A very clear example of direct foreign involvement in the construction of Roman-style baths is the use of *opus reticulatum* in the Reticulate Baths (Figure 31 & Figure 32) and the Harbor

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[557] Wagner 1977, 525-26, fig. 2; Kennedy 1998, 133-35.
[558] Spanu 2003, 23-24, n. 98, fig. 6.
[559] Bricks used in the *praefurnia* of Bath C at Antioch measured 34 cm square and 4.5 cm thick (Fisher 1934c, 27); at Apamea, bricks in the masonry of the Northeast Quarter Baths measured between 20.5 cm and 31 cm in length and 3.5-4 cm thick (Vannesse 2015, 101, n. 12); and at Dura Europos, the typical brick used in the masonry of the baths measured between 30 cm and 34 cm square (Brown 1936a, (Bath M7) 85, (Bath E3) 91, (Bath C3) 96).

Baths (Figure 34) of Elaeussa Sebaste as well as in the bathing suite in Herod's Third Winter Palace at Jericho (Figure 98). The use of this Italian masonry technique at both these sites is seen as evidence for direct Roman involvement in building some of the earliest baths in these respective regions. In the case of the bathing suite at Jericho, it is thought that Marcus Agrippa may have sent a team of Italian builders to Judea to construct the baths as a gift to the client king Herod.[560] Similarly, it has been proposed that the Reticulate baths at Elaeussa Sebaste were a gift from Augustus to the client king Antiochus I of Cappadocia around 20 BCE.[561] Both of these examples were likely part of a recurring pattern in which local craftspeople were sent to Italy for training or Italian craftspeople were sent to client kingdoms to help diffuse Roman cultural influence among client kingdoms.[562] The use of *opus reticulatum* in the baths of Elaeussa Sebaste and Jericho thus demonstrates that non-local builders, other than specialist architects, were involved in the construction of Roman-style baths in the region, and it is possible that similar movement of builders may have influenced the construction of other baths in the region.

Conclusions

This chapter has provided a brief overview of the masonry materials and techniques used in Roman-style baths across the Roman East. While not possible to discuss the masonry of all known baths in this region, this chapter has attempted to present a representative sample while also highlighting notable examples. As is to be expected, fire- and water-resistant materials such as stone and fired ceramic brick were the primary building materials used for wall construction. Local geology seems to have played a major role in determining the material used, as most

[560] Netzer 2006, 315.
[561] Dodge 1990, 112.
[562] Jacobson 2001, 28-30.

regions (Rough Cilicia, Cyprus, southern Syria (including the Hauran), Judea, and Arabia) used local building stones. In the alluvial plain of Flat Cilicia, brick faced mortared rubble was used for baths at several sites. Interestingly, brick was also regularly used for bath construction in parts of northern Syria, despite this material not being widely used in other structures. This use of brick in Syria is a significant example of a break with the otherwise common practice of using local building materials and techniques in the masonry of Roman-style baths.

Chapter 4 Vaulting

Introduction

This chapter explores the building techniques and materials used in the construction of vaults and domes in Roman-style baths of the Roman East. Although vaulting rarely remains intact, enough partially or fully preserved examples do survive to allow for an investigation into their construction. After introducing the various vaulting techniques employed in the eastern provinces, this chapter will discuss the use and distribution of these techniques in the regions covered by this study. Following this region-by-region discussion, this chapter will conclude with a discussion of larger distribution patterns and the vehicles of technological transmission. The findings of this chapter rely and build on the work carried out by many scholars. Particularly helpful were the many important contributions to this subject by Lynne Lancaster.

Throughout the Roman world, baths were vaulted. The strong association between vaults and Roman-style baths is attested in both literary and archaeological evidence. Seneca, for example, lists glass-covered vaults in his critique of new bathing standards (*Ep*. 86.6), and Vitruvius dedicates a section of his short chapter on bath construction to vaulting techniques (5.10.3). Archaeological investigation of these structures across the Roman Empire has also demonstrated that regardless of location, size, and type, Roman-style baths were nearly always constructed with vaults. This strong association of the vault with bathing facilities is particularly evident in the regions of the Roman East where vaults and domes were not part of the local architectural repertoire, yet they nevertheless appear in nearly all baths in the region. Although vaults and domes were used to roof many of the rooms in baths, they are particularly prevalent in the heated rooms of these facilities.

There were many contributing factors that led to vaults and domes being the preferred roofing technique for Roman-style baths. First and foremost, was the desire to create a structure resistant to fire and water damage. Baths are unique among ancient structures in that both fire and water, which are normally damaging to buildings, were purposefully introduced to them. Indeed, the proper function of baths required both of these usually destructive elements. It was therefore necessary to avoid the use of timber or other similar materials that could burn and rot (or at the very least create a barrier of fireproof material to protect them).[563] For obvious reasons, heat and vapor damage was most likely to occur in the heated rooms.

The solution was to construct the ceilings of the heated rooms out of fire-proof materials such as such as stone, concrete, or ceramic brick. While the use of these materials made baths more resistant to fire and water damage, it also necessitated different construction methods. As stone, concrete, and ceramic brick are better suited to vaults than to flat-roof construction, the vault quickly emerged as the preferred roofing technique for bath complexes.

This preference for vaults made from fire-proof and water-resistant building is seen in the earliest Greek and Italian baths, from which Roman baths developed. In fact, the vaults of these early baths often display construction techniques at the forefront of engineering. The third century BCE baths at Morgantina, for example, contain some of the earliest known above-ground vaults in Greek architecture and are the first to employ ceramic tubes for their

[563]Vitruvius, for example, explicitly states that vaults in baths should be of masonry rather than timber frame construction, but he also provides instructions on protecting such timber construction from moisture by constructing a membrane of tiles suspended from iron rods (5.10.3).

construction.[564] Likewise, the baths at Fregellae, Italy, which are considered to represent a significant stage in the early development of Roman baths, contain an early barrel vault constructed entirely of terracotta in the first half of the second century BCE.[565]

Another benefit of domes and vaults was the fact that their inherent thickness as well as the materials used in their construction retained heat (and moisture) far better than timber construction. This increased insulation helped to keep heated rooms at their desired temperatures, and thus created a more efficient heating system. Significantly, this insulation reduced the amount of fuel needed to maintain the baths.

A further benefit of vault construction was its strength.[566] As the monumentality of baths slowly increased and larger and larger spaces were required to be enclosed, the builders of these complexes found that vaulting was the only construction method strong enough to span such large spaces.[567] Thus, while the initial use of vaulting in baths may have resulted from a preference for fire-proof and water-resistant building materials, the ability of well-constructed vaulting to span large distances ensured its continual use in monumental bathing complexes. The strength and stability of these vaults is exemplified in the remains (although rare) of intact vaulting that survive from antiquity in earthquake prone regions of the Roman East.

The use of vaults also made the interior of baths visually impressive, particularly in monumental baths, where the massive spans of such vaults embodied the architectural and engineering might of Roman culture. Regardless of size, the vaulted ceilings of baths also acted

[564] Lucore 2009, 46.
[565] Tsiolis 2013, 90-93.
[566] For a discussion of the structural properties and behavior of domes and vaults, see Lancaster 2005, 130-165 and Lancaster 2015, 177-191.
[567] Lancaster 2005, 169.

as massive tableaux upon which decorative arts, such as fresco, mosaic, or stuccowork could be displayed.

Although found in nearly all baths in the Roman East, vaulting and domes were not exclusive to bathing facilities and appear in numerous other building types. For instance, theaters and amphitheaters were often built with vaulted passageways, and vaults are also common features of cisterns and substructures. Typically, however, the vaults of baths display a much wider range of building techniques than those in other structures and were also more likely to use innovative construction techniques.

The reason why bathing facilities so often contain innovative vaulting techniques is that their overall construction required expert architects and engineers capable of designing complex heating and water systems. These specialists were also likely to be familiar with advanced vaulting techniques and were thus well-equipped to select from a variety of construction methods or to develop innovative new techniques when necessary.[568] In addition, the vaults of baths typically had to cover much greater spans than those in other structures and therefore benefitted more from the use of innovative techniques that reduced their weight, and thus increased their stability. An additional reason for the variability in construction technique for vaults in bathing facilities may have been the fact that several of these techniques used ceramic building material which have a much lower thermal conductivity than common building stone and therefore provided greater insulation to the hot and cold rooms of baths.[569] For other structures using vaults, the issue of thermal conductivity was not an issue.

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[568] Lancaster 2015, 193.
[569] Lancaster 2015, 193.

As will be discussed below, many of the vaulting techniques employed in Roman-style baths in the East were developed elsewhere in the Roman world and brought to the eastern provinces, in some cases specifically for the construction of baths. Other vaulting techniques that were used for bath construction predate the advent of Roman control in the region and the introduction of Roman-style baths. Although barrel vaults and domes are characteristic of Roman architecture, their use in the Near East dates much further back than the Roman period.

The earliest vaults in the Near East were constructed of mudbrick and seem to have been developed independently in both Egypt and Mesopotamia around the end of the fourth millennium BCE.[570] Subsequently, mudbrick vaulting spread to the Levant and new techniques were developed, including so-called "pitched vaulting" whereby bricks in a vault were laid at an angle and partially rested against the end wall of the vault or the adjacent arc of bricks (Figure 141).[571] This innovative technique avoided any need of wooden centering. While mudbrick vaulting did not spread widely to other areas of the Near East and eventually fell out of use in the Levant, mudbricks continued to be used for vaulting in Mesopotamia throughout antiquity, including in monumental Parthian constructions.[572]

An early use of cut stone for vaulting seems to have been in Macedonian tomb construction. The inspiration for these barrel vaults may have been introduced to Greek architecture from the east by Macedonian military engineers, following Alexander the Great's conquests.[573] An alternative theory suggests that stone vaulting was invented independently in Macedon for tomb

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[570] Van Beek 1987, 98.
[571] Van Beek 1987, 100.
[572] Kawami 1982, 61-64.
[573] Boyd 1978, 88-90.

construction.[574] Regardless of its origin, stone vaulting began to spread across the Hellenistic East, though only in limited application. In Asia Minor, vaulting was mostly restricted to substructures, theaters, and gates, all of which relied on earth or the solid mass provided by fortification walls to resist the lateral thrust of the vault.[575] On Cyprus, despite the existence of corbelled vaulting on the island from the Late Bronze Age, true vaulting did not appear until the Hellenistic period, at which point it began to be seen in multi-chambered tombs.[576] Vaulting was also not a common method of roofing in pre-Roman Syria; however, builders in the Hauran region of southern Syria and northern Jordan developed an innovative roofing technique using transverse arches. During the Hellenistic period in this region, the lack of timber resources and the ubiquity of basalt resulted in the popularity of using a series of transverse arches to support stone slabs laid horizontally to bridge the gap between them.[577] This technique is found throughout this region as well as in southern Jordan. During the Persian-Hellenistic period in the Levant, barrel vaults were built of purpose-cut stone, but they remained very rare.[578] During the reign of Herod the Great, the use of barrel vaults was limited to the construction of cisterns, subterranean spaces, bridges and aqueducts, and in rooms with high levels of moisture, such as the newly introduced Roman-style baths.[579] The construction of domes was even less common. Finally, in the Nabataean Kingdom, barrel vaulting was used in theaters, bridges, gates, and as supports in buttress facades.[580] The Nabataeans also built domes, best demonstrated in the two stone-built domes south of the Temenos Gate in Petra, in the structure incorrectly labeled as

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[574] Tomlinson 1987, 309-312.
[575] Waelkens 1989, 78.
[576] Wright 1992, 495-97.
[577] Ward-Perkins 1981, 343.
[578] Netzer 1992, 25.
[579] Netzer 2006, 317-18.
[580] Rababeh 2005, 160.

baths.[581] Thus, with the exception of the earliest mudbrick vaults, nearly all of the vaults in the pre-Roman Near East were built of ashlars or roughly shaped stones.

One of the underlying questions that this chapter considers is what role these pre-Roman vaulting techniques had on the construction of vaults in Roman-style baths. After the advent of Roman control in the region and the introduction of Roman-style baths, new materials and vaulting techniques were introduced to the region. Many of these foreign vaulting techniques were well suited for use in bathing facilities, having been previously used or even developed in bathing structures in the West. In fact, many of these vaulting techniques were first introduced and diffused into new regions via Roman-style baths.[582] As this chapter will demonstrate, despite the introduction of these new vaulting techniques, the traditional method of ashlar vaulting continued to be practiced in several regions. While this continuity may have partly resulted from the absence of alternative materials, local building practices also likely played a large role. This varying retention of local practices and the introduction of western ones resulted in a range of vaulting techniques existing throughout the Roman East.

Vaulting Techniques

Several different vaulting techniques appear in the Roman baths of the eastern provinces, some of which first appear in the region during the Roman period and may even have been introduced specifically for the construction of baths. The differences between these techniques

[581] Rababeh 2005, 166-69.
[582] Lancaster 2015, 193-95.

largely concerns the materials used to form the intrados of the vault, i.e. the inner curve or shell of the vault upon which packing material (often mortared rubble) was placed.[583]

Ashlar Masonry

As previously discussed, the construction of vaults using ashlar blocks seems to have been the preferred construction technique in what would become the Roman East before the advent of Roman control.[584] This preference likely stemmed from the ubiquitous availability of building stone in the region and the lack of alternative techniques. Nevertheless, the construction of ashlar vaulting required a high degree of skill. While the construction of all vaults required a firm understanding of vault behavior, those built of ashlar blocks also required expert masons who were needed to cut the wedged-shaped voussoir blocks to the proper dimensions. Furthermore, as with many of the other vaulting techniques, ashlar vaults required centering to support the structure before its completion. The construction of wooden centering was a specialized skill and required experienced woodworkers both to construct and deconstruct the centering.[585]

Despite the introduction of new (and at times innovative) vaulting techniques in the Roman period, ashlar vaulting continued to be used throughout the Roman East, including for the construction of monumental baths. In fact, ashlar vaulting was used to create impressively large vaults in bathing facilities, such as those in the West Baths and East Baths of Gerasa (modern

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[583] Structurally, the intrados played an important function during the construction of vaults. In almost all cases, the construction of vaulting required wooden centering and framework. These temporary wooden supports were left in place until the keystone of the intrados was laid, after which the intrados acted as permanent framework upon which packing could be built. In cases where no intrados was constructed and the vaulting consisted entirely of mortared rubble, the wooden centering and framework had to be left in place until the mortar cured and gained strength. The construction of a separate intrados, therefore, may have increased the speed of construction as it enabled the centering to be removed and reused elsewhere sooner than in vaults built without them.
[584] Waelkens 1989, 78; Netzer 1992, 25.
[585] For discussions of Roman centering, see Adam 1994, 174-77; Taylor 2003, 178-90.

Jerash).[586] There were likely many factors that led to the continued use of this vaulting method, such as the availability of materials and the presence of a deeply entrenched stone industry in the region that could influence construction decisions.[587]

As with the masonry of walls, the construction of ashlar vaults nearly always used locally sourced stone. In geologically diverse regions, where more than one building stone was available, the builders typically selected the lightest stone that would still be structurally stable – typically sandstone or tufa. In such cases, the visible remains of the bathing structure often reveal a clear difference between the stone used in wall construction and those used in the vault.

Above the intrados of ashlar blocks, ancient builders typically placed a fill of mortared rubble, or further masonry. This fill served to stabilize the structure by helping to transfer the lateral thrust of the vault down through the walls below. In some cases, this mortared fill is all that remains of the vaults, with the intrados having collapsed.

Mortared Rubble (*Opus Caementicium*)

Developed during the Republic and perfected in the first century CE, the use of *opus caementicium* was a common building technique for constructing vaults in central Italy and especially Rome.[588] Unlike modern concrete which is made with finer aggregate and is poured into place, *opus caementicium* used much larger stones (*caementa*) and was laid by hand and trowel. When used for vaulting, *opus caementicium* required wooden formwork and centering to support the vault until the concrete had set and gained sufficient strength for the centering to be

[586] Dodge 1990, 114.
[587] Lancaster 2015, 48.
[588] For a discussion on the development of Roman concrete, see Mogetta 2015.

removed.[589] In some cases, square ceramic bricks were placed on the framework before being covered with concrete, thereby forming a shell and preventing the concrete from adhering to the wooden framing.[590]

In central Italy, concrete vaults may have first began appearing at the end of the second century BCE and seem to have been firmly established by the first half of the first century BCE.[591] A breakthrough in concrete technology occurred when builders in central Italy began adding pozzolana, a volcanic ash, to lime mortar in order to increase its compressive and tensile strength. The secret to this hydraulic mortar's strength is the active ingredients of pozzolana, soluble silica and alumina, which create a strong chemical bond with lime and water. In the Roman East where pozzolana was not locally available, importation was sometimes required. Pozzolana mortar's unique ability to cure underwater made it a necessary material for harbor construction, and as a result pozzolana was shipped from Italy by sea for constructing harbors in the eastern Mediterranean.[592] There is no evidence, however, that this material was traded for use in vault construction.

Provincial building industries therefore had to rely on other means of creating high-strength mortar. Other additives, so-called pozzolans such as crushed terracotta, volcanic ash, and organic ash, could be added to lime mortar to create mortar with lower pozzolanic properties than those made from true pozzolana; however, given that the known uses of these additives do not come from vaults, it is not clear to what degree builders in the Roman East attempted to create vaults

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[589] Lancaster 2005, 22-50.
[590] Adam 1994, 178-79; Lancaster 2005, 29-32.
[591] MacDonald 1982, 3-10; Lancaster 2005, 3-6.
[592] Hohlfelder and Oleson 2014, 223-26.

using hydraulic mortar.[593] There had been a longstanding, but erroneous, belief that the prevalence of concrete vaults in Cilicia was the result of volcanic sand being used as a stand-in for pozzolana.[594] This theory, however, has been called into question as volcanic sand was only available in certain areas of Cilicia,[595] and analysis of mortar at Elaeussa Sebaste shows no use of volcanic sand.[596]

Even without access to pozzolanic mortar, the use of *opus caementicium* for vault construction could be structurally advantageous. The use of large stone aggregate (*caementa*) that characterized this building technique enabled builders to use lightweight rock as a means to lighten the entire weight of the vault mass and thereby better control its behavior. Typically, light-weight stones such as tufa or volcanic pumice and scoria were selected to reduce the vault mass. Perhaps the most famous uses of *opus caementicium* with lightweight stones is in the dome of the Pantheon.[597]

Unlike pozzolana, the use of light-weight rock in concrete vaulting was not limited to Italy, but instead has been found in provinces throughout the empire.[598] Unsurprisingly, this technique was limited to regions where appropriate volcanic or calcareous materials existed and were easily exploitable. Alternatively, the material could also be transported by land or sea. In the case of sea transport, it is possible that volcanic rock, intended for use as *caementa*, was transported as secondary cargo and used as ballast in cargo ships.[599] In the Roman East, the use of light-

[593] Lancaster 2015, 24-29.
[594] e.g. Boëthius and Ward-Perkins 1970, 387; Waelkens 1987, 99.
[595] Spanu 2010, 407.
[596] Burragato and Santarelli 2003.
[597] Lancaster 2009, 120-23.
[598] Lancaster 2015, 30-36, fig. 9B.
[599] Hohlfelder and Oleson 2014, 224-26.

weight rock in such vault construction was limited to Flat Cilicia and the Hauran region of southern Syria and northern Jordan where easily exploitable volcanic deposits existed.

Modern scholars, as a result of a perceived weakness of mortar construction in the provinces compared to that produced in Italy, have often preferred the term *mortared rubble* rather than *opus caementicium* to describe this construction technique.[600] The distinction between these terms is somewhat unclear and may even reflects outdated ideas of romanization. It is also noteworthy that the term *opus caementicium* does not appear in any of the surviving literature from antiquity; however, it does appear in at least two known inscriptions.[601] For the sake of clarity and consistency, all further discussion of this construction technique will employ the term *mortared rubble*.

It is difficult to ascertain with certainty when exactly mortared rubble vaulting was introduced into the Roman East. Some of the first mortared rubble vaults may have been those built in Herodian palaces. Excavators of these structures suggest that concrete domes may have existed in the baths at Lower Herodium and at Herod's Third Palace at Jericho.[602] Elsewhere in the Roman East, mortared rubble vaults begin appearing in Asia Minor in the first century CE. Some of the earliest examples are those from the Baths of Capito at Miletus, built during the reign of Claudius.[603] Mortared rubble vaulting quickly spread throughout Asia Minor and by the early second century appears in the Reticulate Baths at Elaeussa Sebaste, in Cilicia.[604]

[600] Waelkens 1987, 95; Dodge 1990, 114; Tobin 2004, 24; Lancaster 2015, 20.
[601] Oleson 2014, 11-36, Lancaster 2015, 20-21.
[602] Netzer 2006, 318.
[603] Ward-Perkins 1981, 274-75, fig. 174.
[604] Lancaster et al. 2010, 950, fig. 3.

Brick Vaulting

Another material used to construct vaults in the Roman world was fired brick. Although there were several different configurations that could be used when building vaults with bricks (as will be discussed below), they were typically only used to form the intrados of the vault. In this way, the bricks acted in the same fashion as the voussoirs of ashlar-built vaults. Above this shell, different material such as mortared rubble (sometimes including light-weight rock) was placed. In a few cases, such as in the Large Baths (III 2 B) at Anemurium, the bricks used in the vaults no longer remain extant, but their negatives are clearly visible impressed into the mortar packing that was placed over the intrados and still survives.[605]

Vaults made from bricks had several advantages over those made using other construction techniques, including speed of construction. Because the amount of mortar used between the bricks was much less than that used in mortared rubble construction, it cured more quickly and the bricks could act as voussoirs soon after being laid.[606] Bricks are also typically lighter than the stone used for rubble construction and ashlar masonry, and thus the use of this ceramic material resulted in a lighter vault.[607] Depending on the geology of the region, the bricks were also more easily sourced than cut stone.[608] In other cases, however, the absence of easily exploitable clay deposits or access to imported bricks made the use of this material less feasible.

There were several techniques by which the bricks were laid in a vault. In the Roman East, the two primary methods were laying the bricks radially or vertically (Figure 141). The most common of these two techniques was to lay bricks radially (like stone voussoirs) so that the

[605] Rosenbaum et al. 1967: 13, 74-7, pl. IV.2.
[606] DeLaine 1997, 164.
[607] Lancaster 2015, 45.
[608] Lancaster 2015, 48.

length of the brick was parallel to the direction of the barrel vault.[609] In contrast, vertically laid bricks were set transversely and thus perpendicular to the direction of the barrel vault.[610] The placement of bricks vertically in vaults seems to have been a Roman innovation developed from an earlier system of laying bricks at a pitched angle and introduced to the Roman world by military architects returning from Parthia where the technique was used widely.[611] In some cases, brick vaults employed a mixture of radial and vertical bricks, with the vertically laid bricks at the apex, possibly as a means to prevent cracks developing along the vault's crown.[612]

Although the use of fired brick for vault construction is generally considered to have been introduced to the eastern Mediterranean by the Romans,[613] the use of mudbricks for vaulting had a much longer history in the region, as has already been discussed above. Despite these longstanding building traditions, a few regions of the Roman East embraced the newly introduced technique of building vaults with fired brick. In particular, it was Asia Minor (including Cilicia) where this building technique grew in popularity between the late first and mid-second centuries CE. Both Syria[614] and Thrace[615] have been proposed as the regions from which this building technique arrived in Asia Minor. A more likely point of origin, however, is Roman Greece, where brick vaulting was adopted in the first century CE.[616]

It has been suggested that the adoption of brick vaulting in Asia Minor came about as a result of the region's inability to make high quality *opus caementicium*.[617] While partly true, the

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[609] For discussion, see Lancaster 2015, 42-49.
[610] For discussion, see Lancaster 2015, 50-64.
[611] Kawami 1982, 64-65; Lancaster 2010.
[612] Lancaster 2015, 60-61.
[613] Dodge 1984b, 13; Waelkens 1989, 78-9; Lancaster 2015, 66.
[614] Ward-Perkins 1978, 888.
[615] Ward-Perkins 1981, 251.
[616] Lancaster 2015, 43.
[617] Dodge 1984b, 10.

primary catalyst seems to have been the advent of the monumental Roman baths and the need to construct the massive vaults and domes this new architectural form required. The use of brick was only one such solution, but this cheap, versatile, strong, and relatively light-weight material soon became one of the preferred methods for constructing vaults in the region. The role that baths played in stimulating the adoption of brick vaulting in Asia Minor is exemplified by the fact that some of the earliest structures in the region to use this construction technique were baths, namely the Harbor Baths at Ephesus, the Humeitepe Baths at Miletus, and the Baths of Vespasian at Patara.[618]

It is difficult to say with certainty when exactly brick vaulting was introduced to Cilicia, as many of the baths and other structures that employ this technique are not accurately dated. The earliest use of brick vaults from Cilicia seem to be in the Reticulate Baths of Elaeussa Sebaste, dated roughly between the end of the first to the mid second centuries.[619] If true, it would suggest again that the adoption of fired brick vaults was connected with the advent of Roman baths in the region. Indeed, the majority of Roman-period brick vaults that have been identified in Cilicia come from baths.[620]

Vaulting Tubes

One of the more peculiar vaulting techniques seen in the Roman East and one that is clearly a western import is the use of vaulting tubes (Figure 142). These ceramic tubes are similar in form to the standard ceramic water pipes used in many regions during the Roman period. The tubes had a tapered nozzle on one end that was designed to fit into the hollow socket end of another.

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[618] Lancaster 2015, 43, n. 19.
[619] Spanu 1999, 113.
[620] Lancaster 2015, fig. 18

Placed end to end and secured with mortar, these tubes were used to form the intrados of vaults. The conical nozzles allowed the builders to place the tubes with the desired curve. When installed using quick-drying gypsum mortar, these vaulting tubes allowed builders to forgo the use of wooden centering when constructing vaults. This avoidance of wooden centering was particularly advantageous in arid climates where sufficiently large beams were difficult to source.[621]

Vaulting tubes are most commonly found in the Roman West, particularly in North Africa and Sicily, although examples have been found in many other regions including Italy, southern France, and Britain.[622] The earliest vaulting tubes come from the third century BCE North Baths of Morgantina in Sicily and were likely adapted from ceramic water pipes.[623] It has also been suggested that vaulting tubes had their origins in the pottery industry where pottery kilns sometimes had firing chambers with roofs built of interlocking ceramic vessels.[624] Over the following centuries, this vaulting technique spread throughout the western Mediterranean and into the East. In the case of North Africa, it is possible that the increase of exported agricultural products, which brought about improved land transportation networks and a growth in ceramic production for the required transport amphorae, resulted in an economically favorable environment for the use of vaulting tubes.[625]

In the Roman East, vaulting tubes seem to have been rarely used, yet their presence in at least four bathing facilities demonstrates that this vaulting technique was known to builders in the

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[621] For the study of vaulting tubes, see Wilson 1992; Storz 1994; Lancaster 2015, 99-128.
[622] Storz 1994, 72-91; Lancaster 2015, fig. 66.
[623] Lucore 2009, 46-50.
[624] Wilson 1992, 107-108.
[625] Lancaster 2012, 154-60.

region. Given their limited use in the eastern provinces, however, it is difficult to infer much about their introduction to the region. Nevertheless, the fact that outside of these four baths, the only other findspots of vaulting tubes are the fifth to sixth century Church of the Annunciation in Nazareth[626] and a stray find from the harbor at Caesarea Maritima,[627] it seem likely that the introduction of vaulting tubes to the Roman East was directly connected to the construction of baths. Further discussion on the introduction of vaulting tubes will be provided at the end of this chapter, following an overview of the vaulting techniques used in each region of this study.

Examples of Vaulting from Roman-style Baths in the Roman East

In the following sections, examples of vaulting from Roman-style baths are presented in geographical order by site. As outlined in the Introduction, these sites are organized by Roman province as they roughly existed under Hadrian (i.e. Cilicia, Cyprus, Syria, Judea, Arabia). Unfortunately, evidence for vaulting does not always survive, and intact vaults are even more rare. Therefore, in order to provide the largest available sample, the following examples comprise all known baths for which there is sufficient information published on the materials and techniques used in its vaulting. When taken together, the surviving evidence for vaulting in Roman-style baths in the East provides a much clearer picture of the distribution of vaulting materials and techniques than existed previously.

The Vaulting of Roman-style Baths in Cilicia

Historically, Ancient Cilicia has been divided into two geographic regions. In the west, Rough Cilicia (Κιλικία Τραχεῖα) is characterized by a rugged coastline where the Taurus

[626] Viaud 1910, 66-67.
[627] Vann 1993, 29, figs. 1-2.

Mountains meet the sea, often forming small coves or high cliffs. East of Rough Cilicia is Flat Cilicia (Κιλικία Πεδιάς), which comprises a rich alluvial plain through which the Cydnus, the Sarus, and the Pyramus Rivers flow. This division was recognized by Strabo (14.5.1) and is still largely used today. On the basis of geology, however, a third Cilicia exists on the eastern edge of Flat Cilicia, which is characterized by black volcanic rock and has thus been referred to as Black Cilicia.[628] Just as the geography of these three regions differed, so too did the preferred building materials (including those used in vault construction). Typically, the vaults of Cilicia were built of locally available building material, such as brick and stone, including lightweight tufa and scoria.[629] As the following overview will demonstrate, however, transport of building materials also took place in this region.

Iotape

The site of Iotape is located on a small natural harbor on the western edge of Rough Cilicia. The site contains at least two bathing structures with vaulting still preserved. Overlooking a small cove, the first of these baths (Bath 5B) (Figure 11) has quarried limestone walls and the partially collapsed remains of three vaults that were faced with sandstone and a fourth partially preserved barrel vault (in Room D) constructed of lime tufa.[630] These baths cover an area of 567 m^2. An inscribed lintel block bears a dedicatory inscription to Trajan, possibly providing a date for this structure.[631]

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[628] Spanu 2003, 20-21; Tobin 2004.

[629] Scoria, a vesicular igneous rock, is similar to pumice, but differs from it in several important respects. As a result of it forming from basaltic magmas, scoria is typically black or dark gray to reddish brown. Pumice, on the other hand, forms from rhyolitic magmas and tends to be white, light gray, or light tan. Another major difference between the two is that while the high concentration of air bubbles in pumice allows it to float in water, the thicker vesicle walls of scoria result in this stone being unable to float in water.

[630] Huber 1967, 40.

[631] Huber 1967, 41.

Adjacent to these baths is a second structure, "Building 6", which measures roughly 414 m^2 and was built of limestone rubble masonry and is roofed by vaults of porous and "sponge-like" lime-tufa (Figure 12).[632] No date has been assigned to this structure, which was not initially identified as baths by Huber, nor was it excavated to determine its use. Nevertheless, this building's plan and the presence of vertical tubes built into its walls support its identification as a bathing facility, and it has been identified as such in subsequent scholarship.[633] During my own personal visit to the site, it was clear that the tufa used in the vaults of these baths were of roughly cut blocks and uncut cobbles laid radially in mortar (Figure 13 & Figure 14).[634]

Selinus

South of Iotape is the site of Selinus, which is located on the Hacimusa River and occupies an area of 40 hectares. This large settlement contains the ruins of two known bathing complexes. The so-called Large Bath (ca. 441 m^2) is situated on the river plain west of the Cenotaph of Trajan and comprises three barrel-vaulted halls, at least one of which is apsidal (Figure 143).[635] The vaults of this structure are not well preserved, but their remains indicate they were constructed of roughly-cut limestone, mixed with broken bricks and tiles.[636] No date is suggested for the construction of this building.

The much smaller River Bath at Selinus is located on the south bank of the Hacimusa River near the sea and 20 m east of the city gate (Figure 144). These baths measure roughly 79 m^2 and consist of at least four barrel-vaulted rooms on an east-west axis. Although the southern section

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632 Huber 1967, 42.
633 Farrington 1995, 168, n. 94.
634 Farrington states that both these baths contained brick vaulting (Farrington 1995, 168, n. 93, n. 94). No such bricks, however, were visible during my own personal investigation of these structures.
635 Hoff 2013, 146-50.
636 Huber 1967, 33.

of the baths is embedded into the riverbank and thus remains well preserved with intact vaults, the northern section and wall is no longer extant, likely having been washed away by the river (Figure 145). Despite this damage and its precarious situation on the edge of the river, these baths offer an excellent opportunity to study the vaulting of baths in the region, as they have been in effect cross-sectioned by the adjacent river. While the published survey reports of this structure mention the existence of these vaults and the presence of a groin vault in the second room in from the west, they fail to mention the construction materials used.[637] Upon my own personal observation of these baths, however, it was clear that they were of uncut or roughly cut stone set in mortar. Although these baths have no firm date, a comparison has been made to the late first/second century Central Baths at Patara, on the basis of their similar arrangements and lack of apses.[638]

Antiocheia ad Cragum

Further south along the western coast of Rough Cilicia, the site of Antiocheia ad Cragum is home to at least two Roman-style baths that have partially intact vaulting. The largest of these, the Great Baths, covers an area of over 1700 m^2 (Figure 15). The walls of this structure were primarily built of limestone ashlars and micaceous slate blocks, while its vaults and arches were constructed from blocks of “sponge-like” lime tufa.[639] A more recent report on these baths mentions the use of limestone and ceramic bricks in the vaults.[640] During my own visit to these baths, however, only roughly cut lime tufa set in mortar were visible in the vaults, and there was

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[637] Huber 1967, 33; Hoff 2013, 150-51.
[638] Hoff 2013, 151.
[639] Huber 1967, 25-26.
[640] Staggs 2014, 98-99.

no evidence of brick (Figure 17). This use of porous tufa in the vaults contrasted with the use of limestone ashlars and micaceous slate blocks in the walls is a perfect example of light-weight building material being purposefully selected for vault construction in order to lighten the vault mass and increase its stability. This structure dates to the late second or early third century CE.[641]

East of the Great Baths and across the streambed that divides the site is the so-called Extramural Bath, measuring roughly 365 m^2 (Figure 18). Full barrel-vaults still cover several of the rooms, and it is clear many more once existed. The vaults have been described as being built entirely of limestone.[642] Elsewhere, these baths are recorded as having brick vaulting.[643] During my own visit to these baths, however, only vaults made from radially laid uncut limestone blocks set in mortar were visible (Figure 20). The Extramural Bath was constructed in the late second or early third century CE.[644]

Anemurium

Further examples of such mortared rubble vaulting can be found at Anemurium, located near the southernmost point of Rough Cilicia. One of the best-preserved bathing complexes at this site (Bath II 7 A) contains several examples of vaults and hemispherical domes built of irregular limestone blocks (Figure 21).[645] During my own personal observation of this structure, which measures roughly 500 m^2, it was clear that these blocks were set radially (Figure 146). Excavation within the baths' hypocausts has dated this facility's construction to no later than around 200 CE.[646]

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[641] Staggs 2014, 95.
[642] Huber 1967, 27.
[643] Staggs 2014, 106.
[644] Staggs 2014, 104.
[645] Huber 1967, 8.
[646] Akok et al. 1980, 203.

Another bathing complex at Anemurium (Bath III 2 B) used bricks for the construction of both window arches and for the large vaults that once covered its halls (Figure 23). Much of these vaults have now collapsed, and the bricks that formed the intrados have fallen away. Nevertheless, the mortared rubble that was used to cover the bricks remains in place and within this mortared mass the impressions of the bricks are still visible, clearing indicating the vaulting technique used (Figure 24 & Figure 147).[647] This structure (measuring approximately 957 m^2) seems to have ceased its function as a bathing establishment in the mid-fourth century CE, possibly less than a century after its initial construction.[648]

Corycus

Brick vaulting is also recorded northeast of Anemurium, at the site of Corycus. Here, on the eastern coast of Rough Cilicia, archaeologists have identified a bathing structure with three barrel-vaulted halls. The intrados of these vaults were constructed of brick; however, the packing above this brick shell included “porous brown limestone to lighten the mass of the vaults”.[649] This use of brick vaulting combined with mortared rubble containing light-weight rock is not unique, but is also found further east in Cilica, where black scoria was often used in vaulting. No date for this structure is given, nor is its size recorded.

Elaeussa Sebaste

Immediately northeast of Corycos, on the eastern edge of Rough Cilicia, is the site of Elaeussa Sebaste where at least three separate baths preserve elements of very different vaulting techniques. The largest of these baths, aptly named the Large Baths (Figure 27), is another

[647] Rosenbaum et al. 1967, 13, 74-7, pl. IV.2.
[648] Russell 1980, 264.
[649] Ward-Perkins 1958, 98-99, pl. 24A.

excellent example of light-weight material being specifically selected for vault construction. Whereas the walls of the Large Baths are built of limestone and conglomerate blocks, its vaults are of much lighter tufa and sandstone blocks (Figure 28 & Figure 29).[650] The visible remains of this facility's thermal block measures approximately 1000 m^2, although these baths likely once covered an area of over 2000 m^2. Although the exact date of these baths is uncertain, they were constructed no earlier than the second century CE.[651]

Elsewhere at Elaeussa Sebaste, the Reticulate Baths (so-named for their use of *opus reticulatum*)[652] display several different vaulting techniques (Figure 30). At least one vault in this structure (Room 4) was built of square bricks laid radially.[653] Other vaults, however, were constructed with an intrados of radially laid rough stones, backed by mortared rubble in horizontal layers, while its semi-dome was built of brick and black scoria (Figure 148).[654] This use volcanic scoria is surprising given that it is more commonly found in the vaults of baths in Flat Cilicia. Its use in the Reticulate Baths was limited to the crown of a few vaults (as well as for a few blocks of the reticulate). As a result of this sparse use, the scoria did not have any impact on significantly reducing the weight of the vault.[655] The construction of these baths (ca. 215 m^2) has been dated to between the end of the first century CE to the middle of the second century.[656]

The third bathing structure at Elaeussa Sebaste where vaulting is preserved is the Harbor Baths, which cover an area of roughly 420 m^2 (Figure 33). Although elements of this structure

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[650] Spanu 1999, 97.
[651] Spanu 1999, 103.
[652] For the same reason, these baths have also been called the *Opus Mixtum* Baths.
[653] Spanu 1999, 109.
[654] Ward-Perkins 1958, 96-97.
[655] Lancaster et al. 2010, 958, fig. 3,
[656] Spanu 1999, 113.

seem to have been constructed between the mid-first century BCE and the mid-first century CE, its function as a bathing facility is not clear until its second phase, which predates a major renovation of the baths in the mid-second century.[657] These baths contain an intact vault of radially laid square bricks covering a small room cut into bedrock (Room IIa).[658] The construction of this room dates to the second phase.[659] In addition, the remains of two amphorae were found embedded in the mortar of a vault which likely dates to the mid-second century renovation of the structure.[660]

Tarsus

Moving west into Flat Cilicia, a new vaulting material begins to emerge. Whereas the Reticulate Baths of Elaeussa Sebaste contained a few pieces of black scoria used as the *caementa* of its mortared rubble vaults, several baths in Flat Cilicia make extensive use of volcanic scoria in mortared rubble vaults to decrease the weight of the vault mass. The baths at Tarsus are one such example. Here, large quantities of black scoria are visible in the extant remains of the semi-dome of its *caldarium* (Figure 149).[661] The mortared rubble construction of this semi-dome was divided into horizontal layers by courses of brick,[662] below which was a vaulted niche made from a double layer of radially placed bricks. The size of these baths is not recorded, and their date is uncertain, but they were likely constructed between the second and third centuries.[663]

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[657] Borgia and Spanu 2003, 299-310.
[658] Borgia and Spanu 2003, 276, 320, fig. 257.
[659] Borgia and Spanu 2003, 307.
[660] Borgia and Spanu 2003, 308, 310, fig. 244.
[661] Spanu 2010, 408, fig. 11.
[662] Lancaster 2015, 36.
[663] Adak-Adibelli 2007, 144.

Augusta Ciliciae

Just as the massifs of Rough Cilicia encouraged the use of building stone, the alluvial plains of Flat Cilicia provided abundant clay resources for brick construction. At the site of Augusta Ciliciae, north of modern Adana, the use of brick was widespread, especially as a facing for walls with concrete cores. One such building was the baths of Augusta Ciliciae, the visible remains of which cover 800 m^2 (Figure 35). This undated structure comprises two extant rooms, one of which seems to have been vaulted while the other contains brick pendentives in the three surviving corners, suggesting it was once covered by a dome (Figure 36).[664] Given the extensive use of brick elsewhere in the structure, including in the pendentives, it is likely that this dome and the vault of the second room were both built of brick.

Anazarbos

The most visible use of scoria for vault construction in Flat Cilicia is at Anazarbos, located 60 km northeast of Adana. Here, this building technique is attested in at least three bath buildings. Its most obvious use is in the Southern Baths (also referred to as the Black Pumice Baths or the South-Western Baths) located in the center of this site, which are easily recognizable by their fallen vaults filled with black scoria used as *caementa* (Figure 150).[665] The volcanic stone used in this structure was cut into medium-sized (25 cm by 18 cm by 7 cm) and small (10 cm by 6 cm by 5 cm) regular blocks before being embedded in the mortar.[666] The use of scoria can also be found in the vaulting of the Northern Baths (sometimes referred to as the

[664] Gough 1956, 173-75, pls. XV b and XVI a.
[665] Posamentir and Sayar 2006, 328, n. 48.
[666] Casagrande Cicci 2013, 144-45.

North-Western Baths), although in a visibly less concentrated amount.[667] A large circular apse in this structure still contains part of its domed vaulting, which comprised a brick intrados supporting mortared rubble packing that included scoria (Figure 37 & Figure 151).[668] The so-called Little Western Baths, located northwest of the Northern Baths, also contains the remains of vaults partially constructed with scoria.[669] During my own personal visit to Anazarbos, it was evident that much of the vaulting (particularly the domes and half domes) in these baths and other structures had an intrados of brick above which the scoria was placed as packing. The Southern Baths and Northern Baths have been dated to the second century CE, while the Little Western Baths has been dated to the second to third century.[670] The largest baths at Anazarbos, the Northern Baths, measure approximately 1000 m^2, while the size of the other three baths are not clear.

Hierapolis Casabala

Another site in the region that used black scoria for vaulting was Hierapolis Castabala, located southeast of Anazarbos. The undated baths at this site were built of brick and had vaults of black scoria laid in courses with abundant mortar.[671] The size of this structure is not recorded. It is also not clear from the publication whether or not the intrados of the vault was once built of brick.[672]

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[667] Casagrande Cicci 2013, 145-46.
[668] Casagrande Cicci 2013, fig. 7.
[669] Casagrande Cicci 2013, 146.
[670] Casagrande Cicci 2013, 151.
[671] Verzone 1957, 57.
[672] Another small structure on a hill at the site displays vaulting also made using black scoria (Verzone 1957, 57).

Küçük Bernaz

Brick was also used for the construction of vaults at the site of Küçük Bernaz. Here, the ruins of the so-called Larger Baths (measuring roughly 325 m^2) (Figure 39) contain the remains of a dome and half dome which were constructed with a brick intrados supporting mortared rubble above (Figure 152).[673] A nearly perfectly preserved brick vault can also be found in the reservoir adjacent to the baths. This vault is constructed of radial bricks in the lower sections and vertical bricks in the upper sections.[674]

The vaulting in the site's Smaller Baths (measuring roughly 160 m^2) (Figure 41) is much better preserved and clearly displays its radial brickwork (Figure 153).[675] Just like the Larger Baths, the Smaller Baths of Küçük Bernaz also have a dedicated reservoir. This reservoir is built upon two well preserved vaults with lower sections of radial bricks and vertical bricks in their upper sections.[676]

Neither of these baths have been properly excavated, and thus there is no known date for their construction. Nevertheless, it has been suggested on the basis of their construction techniques that these structures may date to the fourth or fifth centuries.[677] Until excavations take place, however, this dating remains speculative.

Conclusions

Just as Cilicia is a geologically diverse region, so too are the materials used for vaulting in Roman-style baths. Both brick and stone were used regardless of the size of the facility, and it is

[673] Tobin 2004, 42-43, figs. 60 and 61.
[674] Tobin 2004, 42, figs. 53 and 55.
[675] Tobin 2004, 31, 34, figs. 31-35, 40, 42.
[676] Tobin 2004, 27-30.
[677] Tobin 2004, 53-55.

noteworthy that vaults of fired brick seem to be just as numerous in Rough Cilicia as they are in Flat Cilicia, given the different masonry practices between these two regions. In Flat Cilicia, which is poor in building stones but rich in clay deposits, it was far more common for Roman period buildings to be faced with brick than in Rough Cilicia, where clay resources are limited but there is a near endless supply of stone.[678] Nevertheless, these limited resources evidently did not stop the builders of baths in Rough Cilicia from using brick for their vaults. Some of these bricks may have been imported from other areas of Cilicia. It is also entirely possible, however, that they were locally produced.[679] Given that brick was often spoliated throughout antiquity and late antiquity, it is also likely that brick vaulting was even more widespread in both Rough and Flat Cilicia than it appears in the archaeological record.

In addition to bricks, mortared rubble with irregular stone blocks laid radially as the intrados was very common in Rough Cilicia, where the local geology provided plenty of suitable building stones. Where available, ancient builders used light-weight rocks such as tufa and sandstone to decrease the weight of the vaults as much as possible. One of the most common materials used for this purpose was black scoria. Unsurprisingly, the use of this light-weight volcanic rock was concentrated in Flat Cilicia, near the volcanic deposits of the Ceyhan-Osmaniye volcanic district, or along the coast where it could be easily imported.[680] Petrographic and geochemical analysis of collected samples from Anazarbos confirm that the scoria used at this site originated from these deposits.[681] The proximity of Anazarbos and Hierapolis Castabala to the scoria cones makes it likely that this material was brought to these sites overland, while Tarsus, which is further to the

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[678] Spanu 2003, 21.
[679] Spanu 2003, 24.
[680] Lancaster et al. 2010, fig. 2.
[681] Lancaster et al. 2010, 958.

west, was likely supplied with this material by sea and river.[682] The use of scoria is more surprising at Elaeussa Sebaste. Samples of the scoria used at this site also underwent petrographic and geochemical analysis, which revealed that it too came from the Ceyhan-Osmaniye volcanic district; however, it likely arrived as packing and secondary cargo on transport ships rather than as a specifically ordered shipment given its sparse use in the construction.[683]

The use of brick vaulting and light-weight stones were not mutually exclusive. In the case of Corycos, the vaulting of the baths had an intrados of brick and mortared rubble packing that contained porous brown limestone.[684] It is very likely that other baths in the region (perhaps even some of the structures discussed above) had vaults with a brick shell covered by mortared rubble using light-weight rock.

The Vaulting of Roman-style Baths on Cyprus

As a result of poor preservation, none of the Roman baths on Cyprus maintain fully preserved vaults. Nevertheless, enough evidence does exist, from excavation reports and preserved remains, to allow for a brief discussion of the vaulting in a few of these structures.

Salamis

Some of the best evidence for vaulting on the island comes from the bath-gymnasium at Salamis. This bathing facility is the largest on Cyprus and covers an area of roughly 7360 m^2 (including its palaestra) (Figure 43). Excavation in the massive halls of this structure uncovered the fallen blocks of the ashlar vault, which in some cases had collapsed and destroyed the

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[682] Spanu 2010, 408, fig. 12; Lancaster 2015, 30.
[683] Lancaster et al. 2010, 958.
[684] Ward-Perkins 1958, 98-99, pl. 24A.

hypocaust system (Figure 44).[685] Though nothing of the vaults remains intact, these large stone blocks reveal that the vaulting had been constructed of ashlars. The date of this vaulting remains unclear. The Augustan baths, which were themselves built overtop the ruins of a Hellenistic gymnasium, were damaged by an earthquake in 76/77 CE and subsequently rebuilt by Trajan and Hadrian.[686] An inscription, reused as a pavement stone in a later phase of the structure, commemorates the reconstruction by Trajan of a collapsed roof over a swimming pool in the gymnasium.[687] It is possible, though not certain, that the ashlar vaults of the heated room also date to this restoration.

Amathus

A second Roman bathing complex on Cyprus where there is evidence for vaulting is at the site of Amathus, located on the island's southern coast. Here, on the eastern edge of the agora, excavators uncovered the remains of a small (ca. 143 m^2) public bathing facility dating to the first to second century CE (Figure 45 & Figure 46). Although fairly well preserved, nothing of this structure's roof remains extant. The excavation report and subsequent scholarship on these baths do, however, mention that the heated section of the baths was vaulted, but no details are given regarding the materials or techniques used.[688]

Kourion

One of the best-published baths on Cyprus is the well-preserved bathing facility at the Sanctuary of Apollo Hylates, near Kourion, which covers an area of approximately 250 m^2

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[685] Karageorghis 1967, 348-50, fig. 156.
[686] Karageorghis 1969a, 167-68, 185.
[687] Mitford and Nicolaou 1974, 26-28; Christodoulou 2010, 284-85.
[688] Karageorghis 1989, 827-28; Christodoulou 2014, 87.

(Figure 47). While the detailed reports of these baths (which have been dated to 101/102 CE on the basis of an inscription) provide a great deal of information on their construction, no mention is made of their vaulting.[689] There is mention, however, of voussoir blocks, but these are thought to have come from an arch with a diameter of 2.15 m.[690] Subsequent scholarship on these baths has reinterpreted these voussoir blocks as belonging to a barrel vault.[691] If correct, this interpretation would suggest the baths at the Sanctuary of Apollo Hylates were built with a vault of ashlar blocks.

Ayios Georgios of Peyeia

On the western coast of Cyprus, at the site of Ayios Georgios of Peyeia on Cape Drepanon, there is located a small (ca. 150 m^2) bathing complex between two Christian basilicas (Figure 154).[692] Although these small baths likely date to the fifth century CE (and are therefore outside the temporal focus of this study), they preserve a small vault over a niche that does not appear in any known publication. During my own personal visit to these baths, it was clear that this vault was built of small cut blocks of sandstone laid radially with mortar (Figure 155). It was not evident, however, if this technique was used for other rooms of the bathing complex.

Conclusions

It is likely that all of the Roman baths on Cyprus were once covered by vaults, but few preserve any sign of their roofing today. Nevertheless, on the basis of what excavators have found from the baths at Salamis and Kourion and what is visible in the small baths at Ayios

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689 McFadden 1950; Scranton 1967, 57-62.
690 Scranton 1967, 59.
691 Faka et al. 2017, 95.
692 Christodoulou 2014, 94.

Georgios of Peyeia, stone vaults of cut blocks seem to have been the standard vaulting technique on Cyprus. Examination of other vaulted structures from Roman Cyprus, supports the likelihood that monumental vaulting on the island was of stone construction rather than of concrete or some other material.[693]

The Vaulting of Roman-style Baths in Syria

As with much of the Roman East, Syria is home to disappointingly few surviving examples of vaulting from Roman-style baths. This paucity is partially the result of the limited number of Roman baths excavated and published in the province as well as the poor preservation of those bathing complexes that are published (although the exceptions, such as the baths at Barade, are extraordinarily well-preserved). Like Cilicia, the province of Syria also comprises several different geographic regions, and thus a variety of vaulting techniques and materials were used within its borders.

Antioch

Located in the northwestern corner of the province of Syria, the city of Antioch was the third largest city in the Roman Empire and was home to a large number of bathing establishments. As discussed in the previous chapter, many of these bathing complexes were used as quarry sites for building materials after their destruction and/or abandonment. As a result, hardly any evidence remains of the vaults which surely once covered them.

One of the baths that produced frustratingly little information on the vaulting is Bath A, which measured roughly 800 m^2 and dated to the second half of the fourth century CE (Figure

[693] Wright 1992, 498.

51). The excavation report states that the largest of the heated rooms (Room 31) contained four recesses in each of its four walls, which were covered by vaults that supported a central dome, while another room (Room 33) was likewise covered by a vault resting on piers built into the room's four corners.[694] There is no mention or discussion, however, of the material or technique used in these vaults or dome, although the brick-faced mortared rubble construction of the walls makes it unlikely that the vaults were of ashlar masonry. Vaults of mortared rubble or brick are therefore more probable.

The largest baths excavated in Antioch (Bath C) provided excavators with a bit more information on the construction of the vaults, although the robbing of brick and stone for building materials left little for the excavators to find above floor level. This bathing complex covers an area of approximately 2600 m^2 (Figure 53). The excavators suggested that the baths as found were built in the second half of the fourth century CE above the ruins of earlier baths, dated to the early second century.[695] On the basis of the structure's monumental octagonal dome, however, Yegül has suggested that the original baths were constructed in the early or mid-third century and underwent major renovations in the fourth century.[696] This octagonal hall, likely the *frigidarium*, was the architectural centerpiece of the baths and contained exedrae built into four of its walls. The discovery of a large voussoir block with a double curve on its inner face suggests that these exedrae were constructed with semi-domes of masonry blocks.[697] The initial excavation report makes no mention of the material or technique used in the central dome covering the octagonal hall; however, subsequent discussion of this structure suggests that it was

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[694] Fisher 1934b, 5-6.
[695] Fisher 1934a, 31.
[696] Yegül 1992, 326; 2000, 150, n. 9.
[697] Fisher 1934a, 22.

built of “light aggregate,” likely a reference to mortared rubble.[698] A mortared rubble dome using lightweight aggregate would make sense given the size of the structure and the desire to make the dome as light as possible. Furthermore, the location of these baths in the third largest city in the Roman world and their monumental size and layout strongly suggest that they were the product of euergetism or even imperial patronage. Such financial support likely resulted in the participation of highly-skilled architects and engineers who were well-positioned to employ whatever construction techniques they thought most suitable. Further evidence also comes from Antioch’s circus, located a short distance to the northeast of Bath C. This monumental structure had vaults built of mortared rubble above an intrados of limestone blocks.[699] It seems entirely possible then that Bath C may also have been built with vaults comprising a limestone block intrados, above which mortared rubble with light-weight stones was placed.

Further evidence for vaulting in the Antiochene baths comes from a mosaic found in a house in Daphne that depicts the semi-private Baths of Ardaburius, which were built in the mid-fifth century and located between Antioch and Daphne next to the Olympic stadium.[700] Interpreting architecture from ancient art is fraught with difficulties, and despite the detail and fine workmanship of the mosaic, this example is no different. The artist depicts the structure with two small domes covered in what appears to be red tiles.[701] Nothing further can be said with certainty, and the apparent depiction of the domes with red tiles is certainly not sufficient evidence to suggest the intrados of these domes were of brick.

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[698] Yegül 1992, 326.
[699] Campbell 1934, 35.
[700] Yegül 2000, 148, fig. 2.
[701] Lassus 1934, 131, fig. 11.

Barade (modern Barad/Brad)

East of Antioch and northwest of Aleppo, within the borders of modern Syria, is the site of Barade, which is home to a remarkably well-preserved bathing complex that measures roughly 238 m^2 (Figure 156).[702] The vaults of this mid-third century public bathing facility owe their preservation to being partially buried and thus protected from damage or looting. Just like the walls of the baths, the vaults, dome, and half dome that cover this structure were all built of carefully cut stonework, described as being "as perfect to-day as they were when first finished, and present examples of the best type of masonry to be found in Syria".[703] The ubiquitous use of ashlar and polygonal masonry elsewhere at the site suggests the use of cut stone in these vaults is evidence for local influence or the use of local skilled labor.

Apamea

South of Antioch and Barade is the city of Apamea, home to no less than five baths, two of which have elements of their vaulting preserved. Just inside the northern gate of the city are the Northeast Quarter Baths (ca. 425 m^2), which were built in the second century and reconstructed in the fourth century CE (Figure 55). Vaulting in various levels of preservation is still extant over several rooms of this structure (Figure 56).[704] These vaults were constructed using bricks to form the intrados, which was then covered with rubble and small stones set in white mortar.[705]

About 400 m south of the Northeast Quarter Baths are the Baths of L. Julius Agrippa (Figure 57), which were built shortly after the devastating earthquake of 115 CE.[706] Only about 800 m^2

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[702] Butler 1920, 300-303, figs. 330, 331.
[703] Butler 1920, 302.
[704] Paridaens and Vannesse 2014, 336, 339, figs. 5-8.
[705] Viviers and Vokaer 2009, 106, 109.
[706] Balty 1988, 91-92.

of these baths has been uncovered, but the complex may have once been as large as 2500 m^2.[707] These baths are fairly well preserved with walls of large cut stone blocks preserved to the ceiling. A semi-dome built of brick is the only element of the vaulting that still survives; however, a proposed reconstruction of the baths includes a barrel vault of mortared rubble covering the main hall.[708] Given the use of brick in the surviving semi-dome, a barrel vault with a brick intrados is perhaps more likely. Above this shell, however, mortared rubble was likely used, just as was the case in the Northeast Quarter Baths.

Athis (modern Dibsi Faraj)

The site of Athis was located on the right bank of the Euphrates River, east of Aleppo, and is now flooded by the reservoir created by the Tabqa Dam. Excavation of the site took place between 1972 and 1974 by the Kelsey Museum of Archaeology at the University of Michigan and the Dumbarton Oaks Center for Byzantine Studies. Among other structures, these excavations uncovered the remains of three bathing complexes: a smaller bathing suite located in the assumed *principia* (Figure 60) and two extramural public baths.[709] None of these structures are described in great detail, nor are there published plans. The smaller (500 m^2) bathing complex, which post-dates the Diocletianic fortifications, is described as brick-built, and there is mention of brick vaults collapsing after a conflagration of the structure in the Early Islamic period.[710] Other than this single reference to brick vaulting, nothing more of the vaults is mentioned.

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[707] Fournet 2012b, 233.
[708] Khoury 2014, 362, fig. 2.
[709] Harper and Wilkinson 1975, 329-330, figs. 4a, 6a, 7a.
[710] Harper and Wilkinson 1975, 329.

Dura Europos

Excavation at Dura Europos produced at least four Roman-style baths, all of which were vaulted. Three of these baths (Baths E3, C3, and M7) all date to between 210 and 215 CE, and had mortared rubble vaults with large river pebbles set in hard sand and lime concrete.[711] In Bath E3 (ca. 625 m^2) (Figure 64), excavators found no extant remains of the vault, but concrete debris from the fallen ceiling attested to the existence of mortared rubble vaults.[712]

Excavation of Bath C3 (ca. 900 m^2) (Figure 63) also uncovered the remains of its collapsed vaults, which were built of large river pebbles set in hard grey mortar.[713] In this same structure, there is mention of fallen voussoir bricks from an arch.[714] It is unclear, however, if bricks were also used in the construction of the structure's vaults.

Conversely, bricks are known to have been used for vaulting in Bath M7 (ca. 375 m^2), which was located just inside the main gate of the city (Figure 65). The excavators of this structure uncovered a room built over a vaulted cellar. This barrel-vault is described as being constructed of fired bricks "laid flat endwise in the Mesopotamian fashion".[715] The term "Mesopotamian fashion" is clearly a reference to the pitched brick technique that was commonly found in Parthian architecture and was the predecessor to vertical brick vaulting.[716] The use of this vaulting technique is notable. Not only is this structure the only known Roman-style baths with pitched brick vaults, but the presence of this technique is one of the clearest examples of pre-Roman building traditions influencing vault construction in this building type. The excavation

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[711] Brown 1936a, 102-104.
[712] Brown 1936a, 91.
[713] Brown 1936a, 96.
[714] Brown 1936a, 97.
[715] Brown 1936a, 86.
[716] Kawami 1982, 64-65; Lancaster 2010.

report also states that Bath M7 contained vaults built of concrete, though it is not exactly clear in which rooms these were located.[717]

The fourth bathing facility excavated at Dura Europos (Bath F3) measures roughly 300 m^2 and had originally been dated by its excavator to the third quarter of the first century CE (Figure 67); however, on the basis of its construction materials and techniques, Pollard has convincingly argued for a later date between 165 and 216 CE.[718] The vaulting of these baths is noteworthy, as it is one of the few examples of vaulting tubes being used in the Roman East. In the *frigidarium* of Bath F3, excavators uncovered a collapsed fragment of the vault containing the remains of vaulting tubes embedded in mortar (Figure 157).[719] Judging from the photograph of this vault fragment, the vaulting tubes used at Dura Europos appear to be similar in form to the typical cylindrical water pipes used in this region, and it is possible that they were in fact water pipes repurposed for vaulting. Although these tubes were only found in the *frigidarium*, the excavators hypothesized that the vaults and domes of the baths' other rooms were also lined with vaulting tubes that had been robbed out in antiquity.[720] The excavators believed that these pipes were used in the vault not to form the initial intrados of the vault, but rather as a means to reduce its weight.[721] Given that the only published image of these tubes shows them seemingly embedded in the mortar,[722] this theory may possibly be correct, although efforts to reduce the weight of vaults typically used amphorae to do so.[723] Elsewhere in Bath F3, there is evidence for the construction of a dome. In the heated Rooms 2 and 3, stone lintel blocks were laid at the top of

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[717] Brown 1936a, 102.
[718] Pollard 2004, 142.
[719] Brown 1936b, 49-50, pl. 14.1.
[720] Brown 1936b, 55-56.
[721] Brown 1936b, 61.
[722] Brown 1936b, pl. 14.1.
[723] Lancaster 2005, 68-85.

the walls in the corners to convert the roughly square rooms into octagons (Figure 158).[724] One of the rooms had evidence of a further masonry course that would have converted the octagonal form into a sixteen-sided polygon. In so doing, these blocks acted as rudimentary pendentives that supported a no longer extant dome, likely built of mortared rubble.

The vaults of the Dura Europos baths are of particular interest to this study as they display both local and foreign influences. The use of mortared rubble, for instance, was clearly an imported building technique from the West. In addition, despite the original excavators' belief that the use of vaulting tubes in Bath F3 was a Near Eastern characteristic that subsequently spread west, scholarship has proven this idea untrue, and it is undisputed that this building technique was also a result of Roman influence.[725] The use of fired bricks in these baths is also an imported building technique.[726] On the other hand, the use of the pitched brick vaulting technique in Baths M7 reveals that local building practices were still influential in the construction of these baths. Pitched brick vaulting also seems to have been used elsewhere in Dura Europos, in the House of the Scribes. The description of this vault as being of small rectangular fired bricks placed edgewise, again suggests that this vault was built using the pitched brick method.[727]

Baalbek

On the opposite side of the province, the site of Baalbek is situated in the Beqaa Valley of modern Lebanon. Excavation in Baalbek's large Roman-style baths (Figure 70) uncovered the

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[724] Brown 1936b, 54-55, fig. 3; Pollard 2004, 136-38, pl. 9.
[725] Pollard 2004, 139.
[726] Pollard 2004, 134-35.
[727] Pearson 1936, 266-67.

remains of collapsed cross vaults built of brick.[728] No further information is provided about the construction of these vaults, which are thought to have covered many of the structure's halls and included cross vaults, barrel vaults, and a dome.[729] This bathing complex covered an area of approximately 5000 m^2 and is thought to have been initially constructed in the early Severan period, at the end of the second century CE.

Sha'arah

The site of Sha'arah is located in the Hauran, a region characterized by an abundance of basalt and other volcanic rock. Just like in Flat Cilicia, the presence volcanic scoria in this region resulted in its use as *caementa* in mortared rubble vaults as a means to lighten the weight of the vaulting. Although this use of scoria can be found in a range of buildings in the Hauran, it is considered a characteristic element of the region's baths.[730] The bathing complex at Sha'arah is no exception (Figure 72). This structure, covering an area of over roughly 950 m^2, is located on the northern edge of the ruins and comprises several rooms with vaulting still preserved.[731] While the walls and the arched coverings of some niches were made of finely cut stone blocks, the extant vaults were constructed of black scoria set into mortar.[732] On the basis of the construction techniques and room arrangement, scholars had initially dated these baths to between second half of second century and the end of the third century.[733] Excavation of this

[728] Brünenberg 2014, 321, n. 9.
[729] Brünenberg 2009, 198.
[730] Fournet 2012b, 190.
[731] Butler 1919, 439-40
[732] Fournet 2008a, 160, n. 4, fig. 15.
[733] Butler 1919, 440; Fournet 2008a, 163.

structure has confirmed this date and narrowed it to between the end of the second and start of the third century.[734]

Philippopolis (modern Shahba)

One of the best examples of scoria used in vaulting from the Hauran comes from the third century monumental baths at ancient Philippopolis, which cover an area of approximately 5500 m^2 (Figure 74). At least two thirds of this bathing complex are preserved up to the springing of the vault and one of the rooms has its vault still intact. The visible remains of the barrel vaults and domes of this structure are characterized by tightly arranged dark scoria set within hard mortar (Figure 75).[735] The stark contrast between the well-dressed ashlar walls of these baths and the mortared rubble scoria of the vaults exemplifies the selective use of materials for different elements of the structure. This use of mortared rubble, which appears similar to Roman concrete, led early scholars to conclude that Roman builders must have been directly involved in the construction of Philippopolis.[736] While the monumentality of the bathing complex may have required non-local specialists and patronage, the use of scoria set in mortar for vault construction had already been introduced into this region from the West by the time these baths were constructed during the reign of Philip (241-5 CE).

Selaema (modern Salim)

Elsewhere in the Hauran, the use of scoria for vaulting is also seen in the baths at Selaema, the remains of which measure approximately 200 m^2 (Figure 76). The *frigidarium* and the pools of this structure are still covered by a well-preserved vault built of this light-weight material set

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[734] Fournet 2010, 317.
[735] Butler 1903, 384-90; Ward-Perkins 1981, 343, fig. 222.
[736] Butler 1919, 359.

in mortar. Here, however, the construction of the vault differs from the others in the region as the mortared rubble is set inside coffers of vertically placed bricks that stretch along the longitudinal and transverse axes (Figure 160).[737] These baths, on the basis of their architecture, an inscription, and their potential association with a nearby temple, have been tentatively dated to the late first century CE, making them possibly the earliest baths in southern Syria.[738]

Kanatha (modern Qanawat)

Southwest of Selaema, the baths at Kanatha (modern Qanawat) also retain evidence of their vaulting (Figure 78). Although not fully preserved, the vaults that once spanned the rooms of these baths were constructed with the typical black scoria set in mortar.[739] As was the case with other baths in this region, a recessed niche in the wall of one of the heated rooms (Room D) was covered by a small vault built of basalt ashlars.[740] Similar basalt arches covering recesses are found in Hammat Gader.[741] The baths at Kanatha measure over 300 m^2 and likely date to the first half of second century CE.[742]

Seia (modern Sīʿ)

Further southwest, a possible bathing facility was located at the sanctuary site of Seia (Figure 80). This structure, measuring 437 m^2 and dating to the Roman period, contained a circular room that was identified as the *caldarium* and contained fragments of its "dome of concrete", likely a

[737] Fournet 2010, 324, fig. 12.
[738] Fournet 2010, 331.
[739] Peuser 2000, 228; Ertel 2015b, 300, 303.
[740] Peuser 2000, 226-27, pl. 45c.
[741] Solar 1997, 21.
[742] Peuser 2000, 229.

reference to mortared rubble construction.[743] There is, however, no specific mention of scoria being used.

Conclusions

From what little evidence remains, it is apparent that the vaults of Roman-style baths in the province of Syria were constructed using a range of materials and techniques; however, size does not seem to have been a major factor affecting the vaulting method. There is a clear contrast between the vaulting of the Roman-style baths in northern Syria and those in the Hauran region in the south. In northern Syria, building techniques imported from the West, such as fired bricks and mortared rubble, appear at several sites, including Apamea, Athis, Dura Europos, and possibly Antioch. The use of vaulting tubes at Dura Europos is particularly surprising. Common in the western Mediterranean, and particularly in North Africa, vaulting tubes are rarely found in the Roman East. It is likely that this technique was introduced to the eastern edge of the Roman empire by soldiers, possibly even by members of the North African *Legio III Augusta*, vexillations of which are attested in Syria and along the eastern frontier throughout the second century.[744]

In addition to this foreign influence, several baths in northern Syria display a continuation of local building methods in vault construction. The use of the pitched brick technique in the subterranean vault of Baths M7 at Dura Europos is one such example. The use of cut stone vaulting at Barad is a further example of a local construction technique being applied to non-local architectural forms.[745]

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[743] Butler 1919, 399.
[744] Pollard 2004, 143.
[745] Ward-Perkins 1981, 326; Ball 2000, 212.

In the Hauran of southern Syria, the ubiquitous use of basalt masonry did not extend to its use in vaulting likely because of the difficulty in accurately cutting this material as well as its weight, which made it ill-suited for vaulting. Fortunately, the local availability of light-weight scoria led to this material being widely used in mortared rubble vaulting. It is not entirely clear what material, if any, was used for the intrados of these mortared rubble vaults in the Hauran region. The absence of sufficient water, clay, and fuel resources seems to have prevented the establishment of a brick industry large enough to allow for brick vaulting. It is therefore possible that the mortared rubble was simply laid over wooden boarding until cured.

The Vaulting of Roman-style Baths in Judea

Like the rest of the Roman-style baths in the Roman East, those in the province of Judea rarely survive with their vaulting intact. Those that do survive include a few from the Decapolis region as well as several Herodian period baths, which represent some of the earliest Roman-style baths in the Levant. Before the arrival of this building type to the region, vault construction in Palestine was very rare. The few early vaults that are known were built of mudbrick, and it was not until the Hellenistic period that purpose-cut stone was used for vaulting.[746] By the Herodian period, vault construction was increasingly more common but still limited in its use to only a few building types, one of which was Roman-style baths.[747]

Hippos-Sussita

Overlooking the eastern shores of the Sea of Galilee, the Decapolis city of Hippos-Sussita was once home to at least three Roman-style baths, only one of which has been extensively

[746] Wright 1985, 462-63; Netzer 1992, 25-26.
[747] Netzer 2006, 317-18.

excavated and provides some idea of its vaulting. Located along the city's southern wall and covering an area of at least 1050 m^2, the so-called Southern Bathhouse dates to the second century CE (Figure 81).[748] As with many of the monumental baths of the Decapolis, these baths were constructed out of cut blocks of both basalt and limestone. Although none of the vaults in these baths survive intact, excavation of the bathing halls reveal that the vaults were built of limestone ashlars, in keeping with the regional building practice.[749] Being lighter and easier to cut than basalt, limestone was preferred over the heavier and harder basalt for vault construction both here and in the other monumental baths of the region.

Hammat Gader

South of Hippos-Sussita, on the North bank of the Yarmouk River, is the thermal bathing complex of Hammat Gader, which extends over approximately 3300 m^2 (Figure 83). As was the case with the Southern Bathhouse at Hippos-Sussita, the walls of these baths were constructed of basalt ashlars, while the vaults were made of lighter stone, namely limestone and tufa.[750] The largest preserved vault has its lower courses made from dressed limestone, while the upper courses are made light-weight tufa set in mortar (Figure 160).[751] Smaller vaults or the domes of niches are likewise made of limestone, while a few vaults (those between piers that needed to support the enormous weight of the vaulted roof) were made of basalt blocks. The excavators of these baths date their construction to the mid-second century during reign of Antonius Pius (138-161).[752] Subsequent research has identified multiple phases of construction, with many of the

[748] Kowalewska 2019b, 274.
[749] Kowalewska 2019, 268b, fig. 7.
[750] Solar 1997, 20-22.
[751] During my own personal observation of these baths, this tufa appeared to be of cut blocks rather than irregular stones.
[752] Hirschfeld 1997, 477-78.

vaulted halls being built in a second phase that dates somewhere between the mid-second and end of the fourth century.[753]

Gadara (modern Umm Qais)

Immediately South of Hammat Gader is the ancient Decapolis city of Gadara (modern Umm Qais), which is home to several bathing complexes. The best-recorded of these baths is the so-called Byzantine Baths, which cover an area over 2300 m^2 (Figure 85). The initial construction of this complex is dated to the early fourth century CE.[754] None of the structure's vaulting has survived from antiquity, other than the partial remains of an apsidal dome of cut stone from the undated second phase of the baths.[755] Nevertheless, excavation of this structure revealed that it had been roofed by barrel vaults of cut limestone, one of which was found collapsed in accumulated soil.[756]

Pella

South of Umm Qais, the Decapolis city of Pella is situated in a wadi valley overlooking the east bank of the Jordan River. Only about 200 m^2 of this site's bathing complex has been uncovered as a result of the extremely high water table that characterizes this valley (Figure 87). Nevertheless, the excavation of upper fill in this structure produced one of the few examples of vaulting tubes being used in the Roman East. In the baths' exedra, large numbers of "funnel-like ribbed ceramic jars" were discovered, which were recognized as having been used for vaulting.[757] These vaulting tubes have cylindrical bodies (12-14 cm wide) that taper with sloping

[753] Broise 2003, 234.
[754] Holm-Nielsen et al. 1986, 220.
[755] Holm-Nielsen et al. 1986, pls. 39.2, 41.1.
[756] Holm-Nielsen et al. 1986, 220, pl. 38.2.
[757] Smith and Day 1989, 13, 101-102, fig. 30, pl. 3B; Smith et al. 1992, 146, pl. 98.5.

shoulders to a conical nozzle and a 2-3 cm wide opening at end (Figure 161). In form, they are unlike those found at Dura Europos, but they appear similar to those that will be discussed from the South Bathhouse at Bet She'an. The excavators of the Pella baths dated these pipes to the late Roman to early Byzantine periods.

Immediately north of the exedra, excavators uncovered three rooms with vaults of stone blocks in various states of preservation (Figure 162).[758] The high water table of the site prevented excavation from reaching the foundations. As a result, a wide (and possibly tentative) date range of the second to the fifth century was assigned to these vaulted rooms.[759]

Scythopolis (modern Bet She'an)

Located only 12 km northwest of Pella and west of the Jordan River, the ancient city of Scythopolis (modern Bet She'an) was also once a member of the Decapolis. This large city, was home to at least four known baths, including two monumental bathing complexes in the city center built with large ashlar blocks, and like many of the monumental baths in this region, such as those at Hammat Gader, Hippos-Sussita, and Gadara, the lower courses are of basalt blocks, while the higher courses are of limestone. Although the main vaults of Scythopolis's Eastern Baths (Figure 89) no longer stand, the few semi-domes and small vaults over niches that do survive are all constructed of limestone, with the exception of one built of basalt.[760] Sections of these baths, which cover no less than 4900 m^2, also rest upon a substructure of subterranean vaults, the walls of which were built of basalt, while the vaults themselves were of limestone.[761]

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[758] Smith and Day 1989, 15-17, pl. 4; Smith et al. 1992, 146, pl. 86.
[759] Smith and Day 1989, 18.
[760] Mazor and Bar-Nathan 1998, 13-14.
[761] Mazor and Bar-Nathan 1998, 11.

Initially built in the first century CE, these baths were thoroughly rebuilt in the second century.[762]

This selective use of stone at Scythopolis and the other Decapolis cities is not surprising, as basalt was better suited for foundations, while the properties of limestone made it preferable for the superstructure and vaulting. The ability to construct walls and vaults of different stone required a degree of geological diversity that was not present in every region. At Scythopolis, both basalt and a very soft limestone were locally available, and by the beginning of the second century, use was also made of a slightly harder limestone quarried only 7 km from the city.[763]

In addition to ashlar vaulting, excavation at Scythopolis also produced possible evidence for the use of vaulting tubes. Between the theater and the amphitheater, excavators uncovered the remains of a small Late Roman or Byzantine period public bathing structure, named the South Bathhouse, which measures roughly 264.5 m^2 (Figure 93). In the *frigidarium* of these baths, roughly 170 “bottle-shaped pottery pipes” were found (Figure 163).[764] The excavators believed that these pipes were water or air pipes thrown into the baths after they were no longer in operation. This interpretation, however, is suspect, and the excavators offer no concrete evidence for their use as water or air pipes, such as the presence of calcareous water deposits on their interiors. Careful examination of the published images of these pipes[765] reveals that they bear a striking similarity to the vaulting tubes found only 12 km to the southeast at Pella (Figure 161).[766] As the excavators of the baths at Pella noted, the small diameter of these tubes’ nozzle

[762] Tsafrir and Foerster 1997, 98.
[763] Tsafrir and Foerster 1997, 89-90.
[764] Peleg 1987–1988, 44, fig. 27; Mazor 1999, 301; Peleg 2004, 59, figs. 11-13.
[765] Peleg 1987–1988, fig. 27; 2004, 12-13.
[766] Smith et al. 1992, pl. 98.5.

end would have greatly restricted water flow, thus limiting their usefulness as water pipes.[767] Given the similarity of these pipes to those found in Pella and their poor water conducting design, it is likely that they were not used as water or air pipes as the excavators suggested. Instead, they are more likely to have been used as vaulting tubes. This reinterpretation is further supported by the concentration of these pipes within the walls of the ruined baths.

Jericho

The bathing suite of Herod's Third Palace at Jericho (Figure 97) is one of the more interesting baths in the Roman East in terms of construction technique, given its extensive use of *opus reticulatum* in its walls. Conversely, much less is known about the construction of its vaults. During the excavation of the structure's *caldarium* and *tepidarium*, large fragments of concrete were uncovered and presumed to be the remains of collapsed vaulting.[768] One of these fragments seems to show radially set bricks, likely from the intrados of the vault (Figure 164).[769] On the basis of these remains, it seems that a vault with a radial-brick intrados and mortared rubble packing had at one point covered the bathing suite, which measured 234.5 m^2. Netzer dated the construction of the Third Palace to either 15 or 14 BCE based on its construction technique and the wall paintings uncovered.[770]

Herodium

At the Herodian palace site of Herodium, south of Jerusalem, two Roman-style baths were uncovered. Only the baths built within the walls of the palace-fortress of Upper Herodium,

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[767] Smith et al. 1992, 146.
[768] Netzer 2001, 256-57, figs. 388-390.
[769] Netzer 2001, 256, fig. 389; Gordon 2007, 52.
[770] Netzer 2001, 339-40.

however, have survived with their ceilings intact (Figure 101). Indeed, the vaults of this structure are some of the best preserved from baths in the province of Judea and were all built of ashlar masonry.[771] In the case of the *caldarium,* the large vault that once covered this room has collapsed, but a few cut voussoir stones remain extant along its northern wall (Figure 102).[772] Most impressive is the fully preserved dome built with ashlar blocks and a small cupola that still covers the *tepidarium* (Figure 165).[773] This dome has a span of 4.2 m and is one of the earliest examples of such construction in Palestine. This bathing installation covers an area of over 135 m^2 and dates to the late first century BCE.

Ein Yael

Excavations at Ein Yael, located near Jerusalem, uncovered two Roman period baths belonging to a villa complex that was constructed at the end of the second century CE and remained occupied until the mid-third century (Figure 103). The upper bathing suite (ca. 10 m^2) comprised two heated rooms, both of which contained remarkably well-preserved roofs, one a dome, the other a barrel-vault.[774] Unfortunately, the materials used in the construction of these ceilings are not described; however, images of them clearly show the domes and vaults were constructed of stone ashlars.[775]

Emmaus

One of the best-preserved baths in Judea is found at Emmaus, west of Jerusalem (Figure 104). This structure, which measures 105 m^2 and was built sometime between the turn of the

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[771] Corbo 1989, 46-50.
[772] Netzer 1999. fig. 7.
[773] Corbo 1989, 47, pl. 80; Nezter 2006, 186-87.
[774] Edelstein 1990, 38; 1993, 118.
[775] Kowalewska 2019a, 3.87, 3.90, 3.92.

second century and the beginning of the fourth century, comprises three small rooms, with a fourth added in a later phase. The *frigidarium* (Room 4) was roofed by a square pavilion vault of ashlar blocks, at the apex of which was a small copula built to let in light (Figure 105).[776] Adjacent to this room was the *tepidarium* (Room 3) which had two apsidal recesses covered by ashlar semi-domes and a central vault, originally of ashlar blocks, rebuilt with rooftiles, "either before, during or after the Crusader period".[777] The *caldarium* (Room 2) was built with two apsidal and one rectangular recess (all of which remain covered by ashlar semi-domes or vaults). The central dome, originally of ashlar, was replaced at some point with rubble set into mortar.[778] The dome of Room 4 and the vaults covering the recesses strongly suggest that the original vaulting of these baths was constructed of ashlar blocks.

Masada

South of Jerusalem, on the western shores of the Dead Sea, the stronghold of Masada contains a total of five baths. Of these, only the Large Baths (sometimes referred to as the Independent Bath) allow for some discussion of the construction of the vault that once covered the *caldarium* (Figure 106).[779] Excavation within this room uncovered the collapsed remains of an ashlar vault that originally spanned 6.7 m. The vault was constructed of greenish stones, some of which still survived *in situ* on the eastern wall (Figure 166). These baths measure 239 m^2 and

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[776] Gichon 1979, 104, figs. 2-3, pl. 12A.
[777] Gichon 1979, 105, fig. 2, pl. 12B.
[778] Gichon 1979, 107, fig. 2, pl. 13A. A typo in the publication mistakenly states, "the vault in Room 3 is composed of rubble set in cement rather than of tiles." Previous comments in the publication and the published images, however, suggest that this sentence is referring to the vault in Room 2.
[779] Yadin 1965, 30-31; Netzer 1991, 88-9, figs. 145-46.

were likely constructed between 30 and 20 BCE, undergoing limited alteration until their final abandonment at some point after the Trajanic period.[780]

Conclusions

In the province of Judea, the surviving examples of vault construction in Roman-style baths display a clear preference for stone vaulting, regardless of size or date. These stone-built vaults include those found in the Herodian period baths at Herodium and Masada as well as the small baths at Emmaus and the monumental baths of the Decapolis. The use of stone for vaulting at these sites was likely the result of a strong local building industry that was accustomed with ashlar construction and chose to continue this familiar building technique.

While cut stone was evidently the preferred vaulting technique in the province of Judea, exceptions do exist. The use of radial brick vaulting with mortared rubble packing in the bathing suite of Herod's Third Palace at Jericho is one such example. Here, the use of *opus reticulatum* for the structure's walls has led scholars to conclude that the bathing facility was constructed by a team of Roman builders brought from Italy specifically for the project.[781] If foreign builders were indeed responsible for the construction of these baths, their involvement may also have been the reason for the use of brick and mortared rubble in the vault, which remains the only known example of this vaulting technique in Roman-style baths in this province.

The use of vaulting tubes at Pella and possibly in the South Bathhouse at Scythopolis is also noteworthy. In addition to using a technique other than ashlar, these vaults also represent two of the three baths where vaulting tubes are used in the Roman East (the other being Bath F3 at Dura

[780] Foerster 1995, 205.
[781] Netzer 2006, 315.

Europos). Whereas the technique of using vaulting tubes may have been brought to Dura Europos via the Roman military, their introduction to the Decapolis is less clear. The proximity (12 km) of Pella to Scythopolis, however, suggests that the use of vaulting tubes in this area may have been a localized practice. This possibility is supported by their use in the fifth to sixth century Church of the Annunciation in nearby Nazareth, which is the only other structure in the region covered by this study that is known to use vaulting tubes.[782]

The Vaulting of Roman-style Baths in Arabia

As demonstrated in the previous chapter, although Arabia comprises many different geological regions, this region is characterized by a pre-Roman preference for stone construction, largely the result of insufficient alternative building materials. This reliance on stone led to an ingenious roofing technique involving the construction of transvers arches that were covered by long stone slabs laid between them, which is commonly found in both the Hauran[783] and further south at sites such as at Petra.[784] As with the other regions of the Roman East, true vaults were not common in above-ground architecture until the introduction of Roman-style baths.

Bosra

Bosra, the capital of Arabia, was also the largest settlement in the Hauran region. Like the baths at the other sites in the Hauran that were discussed in the section on Syria (Sha'arah, Philippopolis, Salaema, and Seia), the three known baths at Bosra used volcanic scoria as the primary *caementa* it their mortared rubble vaults. The largest of these baths is the massive

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[782] Viaud 1910, 66-67.
[783] Ward-Perkins 1981, 343.
[784] Rababeh 2005, 174-83.

Central Baths, which stretch over roughly 9000 m^2 (Figure 110).[785] This bathing complex was initially constructed in the second century CE; however, it underwent several major renovations throughout its use.[786] The many halls of this bathing complex were once covered by vaults and domes, none of which survive. Nevertheless, the elements of the vaulting that do survive reveal they were constructed of volcanic scoria set into mortar (Figure 111).[787]

The halls of Bosra's monumental South Baths, which cover an area of over 8000 m^2, also had barrel vaults and domes constructed in a similar fashion (Figure 108). This vaulting includes a still intact cloister, or pavilion, vault and the remains of an eight-sided dome over a large hall, both of which were built using scoria set in hard mortar (Figure 109).[788] These rooms were later additions to the structure and date to the third century CE.[789]

North of the city center, in the Roman Camp, are the remains of a third bathing complex, which is known as the North Baths (or Baths of the Roman Camp) (Figure 112). The ruins of this facility, roughly dated to the first half of the second century CE, stretch over an area of 2000 m^2, but little remains standing apart from a single vault of mortared rubble supported by four piers.[790] There is no direct mention that volcanic scoriae were used in the mortared rubble vault; however, its construction is described as similar to the vaults of the South Baths, suggesting that it too was built using this light-weight material.[791] The likelihood that scoria was used in the North Baths is further supported by this material's use elsewhere in Bosra. For example, the cryptoporticus on

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[785] Fournet 2012b, 197.
[786] Fournet 2007, 246; 2008b, 124.
[787] Visible in un-numbered photos in Fournet 2007, 243, 251.
[788] Butler 1919, 262-63, fig. 231.
[789] Broise and Fournet 2007, 223.
[790] Fournet 2012b, 208-209, fig. 13.
[791] Butler 1919, 264-65.

the north side of the site's principle east-west street is described as having vaults made of mortared rubble employing volcanic scoria.[792]

Gerasa (modern Jerash)

The Decapolis city of Gerasa is located southeast of Pella and is home to some of the best-preserved vaulting found in Roman-style baths in the region. In addition to several smaller bathing facilities, Gerasa boasts two monumental and relatively well-preserved public baths. In the archaeological park between the *cardo* and the Chrysorhoas River that divided ancient city, is the West Baths, which measured approximately 4200 m^2 (Figure 116). This complex was built of limestone ashlar blocks and still preserves elements of its vaulting. In fact, the intact dome that covers its eastern hall is considered to be one of the earliest known examples of pendentives being used to place a hemispherical dome over a square room (Figure 167).[793] Unfortunately, however, the absence of excavation prevents the firm dating of the structure. These baths originally contained three such hemispherical domes built over square rooms, all of which were of dry masonry, and the largest of which measured 15 m in diameter.[794]

Gerasa's second monumental bathing complex is the East Baths (Figure 114), located in the modern settlement in the eastern section of the ancient city. This bathing complex (including its palaestra) covered an area of over 15000 m^2. Like the West Baths, this structure still preserves elements of its massive ashlar vaults (Figure 168 & Figure 169).[795] The largest of these ashlar vaults can be reconstructed with a diameter of around 20 m.[796] Although the dating of this

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[792] Dentzer et al. 2002, 105.
[793] Fisher 1938b, 23, pl. 6b; Ward Perkins 1981, 338, fig. 218; Lepaon 2008, 52.
[794] Dodge 1990, 114; Lepaon 2008, 56, n. 11.
[795] Fisher 1938b, 24, pl. 7a; Lepaon 2008, 60.
[796] Dodge 1990, 114.

structure remains speculative, these vaults likely date to the structure's initial construction sometime in the second half of the second century CE.[797] The monumental ashlar vaulting of both the West and East Baths attest to the strong tradition of cut stone construction at Gerasa.

Betthorus (modern Lejjun)

In the legionary fort at Betthorus (modern Lejjun) south of Gerasa, excavation uncovered baths measuring 223 m^2 that were likely built soon after the initial construction of the fort in c. 300 CE (Figure 123).[798] Although this bathing facility was not completely uncovered, it was clear from its extant architecture and tumbled remains that the baths had once been covered by vaults of limestone ashlars.[799] None of these vaults remained standing above a few courses.

Petra

At Petra, the former capital of the Nabataean Kingdom, numerous baths have been identified, none of which, however, survive with their vaulting intact. The largest of these baths to have been fully-excavated is the complex immediately west of the so-called Great Temple, which has been dated to around the territory's annexation by Rome (106 CE) (Figure 125).[800] The excavation of this structure uncovered the fallen remains of sections of its vaulting that included curved limestone ashlars.[801] It is likely that the other vaults and domes of these baths, which measure over 1477.5 m^2, were also of ashlar construction.

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[797] Lepaon 2008, 65, fig. 12.
[798] de Vries and Lain 2006, 221.
[799] de Vries and Lain 2006, 218, figs. 7.2-7.3.
[800] Power 2017, 188.
[801] Power 2017, 191.

Newly excavated baths on Petra's North Ridge also provide possible evidence for ashlar vaulting. [802] Dating to the first century CE, this small (35 m^2) bathing suite comprised at least two rooms (Figure 170), one of which was heated, as evidenced by the presence of a hypocaust system. Within the fill of this heated room excavators uncovered the partial remains of a finely carved stone block with a central hole (Figure 171).[803] This cut stone likely formed the uppermost block of an ashlar dome as well as the frame for an oculus.[804] Given the size of this block, it is unlikely to have moved far from its original place of use and thus probably came from the vaulting of the baths, where such a dome would be expected. This finely cut oculus stone also suggests that the rest of the dome that covered this heated room was also built of ashlars.

The best-preserved domes in Petra come from a subterranean structure that has routinely been identified as baths; however, this identification is likely incorrect (Figure 172). Located immediately south of the Temenos Gate on the main colonnaded street, this structure has two perfectly preserved ashlar domes with oculi, one of which rests on pendentives (Figure 173).[805] It was these domes that led early surveyors of Petra to label this structure as baths.[806] Excavation of these rooms, however, found no traces of heating or hydraulic features, suggesting that these rooms more likely belong to some other monumental structure, possibly part of a palatial residence.[807] Although the true purpose of these rooms remains unclear, scholars continue to identify them as baths.[808] Their inclusion here is intended to address their continued

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[802] These baths were excavated by Sophie Tews, under the direction of Dr. S. Thomas Parker and Dr. Megan A. Perry, in 2016.
[803] Parker and Perry (Forthcoming).
[804] An almost identical oculus stone was found on the surface of an unexcavated area, east of Zantur IV, in Petra (Ueli Bellwald, personal communication, Dec. 2019).
[805] Rababeh 2005, 166-74, figs. 6.18-20.
[806] Brünnow and von Domaszewski 1904, 179, 316, no. 408; Bachman et al. 1921, 45-48, fig. 39.
[807] Zayadine 1987, 137-39.
[808] McKenzie 1990, 138; Power 2017, 201, n. 17.

misidentification and provide indicative examples of the types of ashlar domes that once covered the actual baths of Petra.

Tamara (modern En Hazeva)

Northwest of Petra, in a small oasis on the northwestern edge of the Wadi Arabah, is the site of Tamara (modern En Hazeva). Commanding a strategic position at the junction of two trade routes, this site was home to a Tetrarchic period *castellum* and associated caravanserai with a bathing facility, covering an area of roughly 230 m^2 (Figure 174). These small baths were constructed with ashlar vaulting that was extant until the middle of the 20th century (Figure 175).[809]

Arieldela (modern ‘Ayn Gharandal)

Further south on the eastern edge of the Wadi Arabah, is the site of Arieldela (modern ‘Ayn Gharandal), located about 70 km north of the Gulf of Aqaba and about 40 km southwest of Petra. Like Tamara, this Late Roman *castellum* site contains a small bathhouse associated with the fort (Figure 131). The preservation of these baths, which measure at least 84 m^2, is remarkable with walls surviving up to the springing of the vault. Two courses of finely-cut ashlar blocks remain extant, revealing that the vaults that once covered the heating rooms were stone-built (Figure 176).[810] The construction of this bathhouse was likely contemporaneous with the founding of the associated *castellum*, which has been dated to the Tetrarchic period on the basis of its building inscription.[811]

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[809] Darby 2015a, 68, fig. 2.
[810] Darby et al. 2010, 193, fig. 9; Darby 2015a, 78; Darby and Darby 2015b, 464.
[811] Darby 2015b, 471-484.

Osia (modern Yotvata)

Across the Wadi Arabah, to the southwest of Arieldela, a very similar Late Roman *castellum* and associated bathhouse exists at Osia (modern Yotvata) (Figure 133). Although this bathing structure is much less well-preserved than that at Arieldela , information on its vaulting can be gleaned from the collapsed remains of the vault found on either side of the *caldarium* and *tepidarium*. Interestingly, these remains suggest that the vaults were built of concrete, i.e. mortared rubble.[812] If correct, this vaulting technique would place the Osia baths alongside the baths at Rehovot-in-the-Negev (discussed below) as the only two known baths in the region that did not use cut stone for their vault construction. These baths cover an area of over 135 m^2 and are likely contemporaneous with the associated fort, which was constructed under the Tetrarchs.[813]

Oboda (modern Avdat)

Located in the Negev Desert, the site of Oboda (modern Avdat) is home to baths (ca. 305 m^2) comprising several well-preserved rooms (Figure 134). This high level of preservation includes intact vaults (Figure 136) and a partially intact dome of finely-cut ashlars.[814] The *caldarium* of these baths is cruciform in shape with four vaulted niches in each of its walls. An ashlar dome covers the center of this room and rests partially on squinches formed by a single stone slab in each of the four corners (Figure 177).[815] Found partially preserved, this dome has been

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[812] Davies and Magness 2011, 474; Darby 2015a, 82.
[813] Davies and Magness 2014, 356.
[814] Woolley and Lawrence 1915, 105, pl. 25.2.
[815] Negev 1997, 175-76, photos 280-81.

reconstructed. The baths' initial construction dates to the fourth century CE, but the structure underwent major renovations sometime after an early fifth century earthquake.[816]

Rehovot-in-the-Negev

Northwest of Oboda is the site of Rehovot-in-the-Negev. Just south of this settlement early visitors recorded the presence of a small (ca. 91 m^2) but well-preserved bathing complex with intact vaults and a dome (Figure 139 & Figure 140).[817] Interestingly, while the walls of this structure were built of well-cut stone, the vaults and dome were constructed of "a sort of concrete made of small stones and lime of rather poor quality".[818] If this description is accurate, this structure would be one of the only two baths in the region (along with the one at Osia) that had vaults made from mortared rubble rather than cut stone. These baths remain unexcavated, and the construction of a police station on the spot during the British Mandate Period has resulted in the destruction of much of the structure.[819] No concrete date, therefore, exists for the construction of these baths. Early visitors, however, dated the baths to the Byzantine Period, and subsequent discussion of the structure has accepted this theory.[820]

Conclusions

As with the Roman-style baths of Judea, those in Arabia were primarily constructed with ashlar vaults. Indeed, some of the best examples of ashlar vaulting, not only from Arabia but the entire Roman East, appear in the baths of Gerasa. Like the ashlar vaults of the baths in the other Decapolis cities, this building technique likely reflects both the local availability of building

[816] Erickson-Gini 2014, 97.
[817] Musil 1908, 79, figs. 47-53.
[818] Woolley and Lawrence 1915, 116.
[819] Tali Erickson-Gini, personal communication, Dec. 2019.
[820] Woolley and Lawrence 1915, 117; Rosenthal-Heginbottom 1988, 20, ill. 28.

stone as well as a deeply-entrenched pre-Roman tradition of cut stone construction. The importance of this local stone cutting industry is exemplified by the number of monumental ashlar structures still surviving to this day and by the presence of a sixth century water-powered stone sawmill in the city center.[821]

Cut stone vaults also seem to be the standard vaulting method in the baths of Petra and the other sites in the south. As was the case in the Decapolis region, this ashlar construction was likely in large part driven by both the abundance of building stone in the region and lack of alternative construction materials such as brick as well as local building practices. The indigenous Nabataeans were skilled builders with stone, whether carving from bedrock or constructing with ashlars.[822]

Exceptions to this preference for ashlar vaulting do exist in Arabia, most notably at Bosra, in the North. The vaults in the baths at this site are constructed of mortared rubble and volcanic scoria, in the same fashion as those elsewhere in the Hauran, such as at Sha'arah, Philippopolis, Salaema, and possibly Seia. This identical construction clearly reflects a localized building practice..

The only other baths in Arabia where non-ashlar vaulting is known to have been used are those at Osia and Rehovot-in-the-Negev. The baths at both these sites are described as being of "concrete", likely references to mortared rubble construction. It is not clear why this vaulting technique was used in a region where vaulting in baths were otherwise built of ashlars. Unfortunately, the publications of these baths do not provide any discussion of this vaulting technique or suggest why it was used.

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[821] Seigne 2002.
[822] Rababeh 2005; Bessac 2007.

Observations on Vaulting in Roman-style Baths in the Roman East

As was noted in the introduction to this chapter, the relative paucity of extant vaulting from baths makes it difficult to arrive at a definitive conclusion regarding the materials and techniques used in their construction. Nevertheless, some patterns do emerge from the available evidence. It is clear, for example, that ashlar vaulting was the preferred method of vault and dome construction in both Judea and Arabia. Out of the seventeen sites from these two provinces where evidence of vaulting survives from baths, at least twelve contain examples of ashlar vaulting. Some of the best examples of these ashlar vaults are those in the baths at Upper Herodium and the baths at Gerasa. Cut-stone vaulting seems also to have been the standard vaulting technique on Cyprus, where it is found at Salamis and in the baths at the Sanctuary of Apollo Hylates, near Kourion. Elsewhere in the Roman East, ashlar vaulting is rare, but it is found in northern Syria, at Barade. Roughly cut blocks of light-weight tufa are also used in the vaults of the Great Baths at Antiocheia ad Cragum and the Large Baths at Elaeussa Sebaste (both in Cilicia); however, these rough-cut blocks are set in mortar and are thus closer to mortared rubble construction than to ashlar.

The use of such mortared rubble vaulting is found in a number of regions throughout the Roman East. It is particularly common in Rough Cilicia, where vaults in Roman-style baths were often built of roughly cut stones set in mortar. In Flat Cilicia, mortared rubble vaulting often used locally available volcanic scoria to reduce the overall weight of the vaults. Black scoria was also universally used in the mortared rubble vaults in the baths of the Hauran region, most notably in the baths at Philippopolis and those at Bosra. Outside these areas, mortared rubble vaulting seems to have been used sporadically and is found at Dura Europos, Osia (modern Yotvata), and at Rehovot-in-the-Negev. Mortared rubble vaulting is also found in the thermal baths at Hammat

Gader, where roughly cut blocks of tufa are set in mortar at the top of an otherwise ashlar vault, likely as means to lighten its highest courses. As the crown of vaults rarely survive, it is possible that this technique of using mortared rubble above ashlar vaults was more common than the extant remains suggest.

In the regions covered by this study, brick vaulting seems to have been mostly limited to Flat Cilicia and northern Syria. In the region of Flat Cilicia, vaults with a brick intrados also often had a mortared rubble fill that in some cases included volcanic scoria, such as in the baths at Corycus, Tarsus, and Anazarbos. Brick vaulting is also found in neighboring Rough Cilicia, at the site of Anemurium. In northern Syria, brick vaulting exists at Apamea and at the site of Athis. Further east, it has also been found at Dura Europos. The only other site where brick vaulting is attested is the bathing suite at Herod's Third Palace at Jericho.

The least common method of constructing vaults was the use of vaulting tubes, which is only attested at three sites: Dura Europos, Pella, and likely at Scythopolis. The proximity of Pella and Scythopolis suggests that the use of vaulting tubes in this area may have been a local building practice. It is also likely that with future excavation, further examples of vaulting tubes will emerge from the Roman East.

It is clear from the survey of surviving vaults that there was regional variation in in techniques and materials used, but it remains to be discussed what factors influenced this choice. The size of the baths, for instance, does not seem to have been a factor in terms of determining what materials and techniques were used. In the Hauran region, for example, all baths, regardless of size, were constructed with vaults of mortared rubble using volcanic scoria. Further south in the provinces of Judea and Arabia, cut stone vaulting was used in the small baths found at Emmaus and on the North Ridge at Petra as well as in monumental baths in the Decapolis, such as those at Jerash. It is also clear that vaulting practices did not correspond to Roman provincial boundaries. While the baths in the provinces of Syria and Cilicia were constructed with a variety of vaulting techniques and materials, the baths of the Hauran region, which was divided between two provinces (Syria and Arabia), universally had vaults of mortared rubble.

Unsurprisingly, local geology and the availability of construction materials seem to have been the largest factors in determining which vaulting technique was used, but another major factor was pre-existing local building practices. At the beginning of this chapter, pre-Roman vaulting techniques such as mudbrick and cut-stone vaulting were detailed. The widespread use of ashlar vaulting in Roman-style baths suggests that there was continuity between pre-Roman ashlar vaulting and its use in Roman-style baths, but in actuality these pre-Roman vaulting traditions likely had little direct effect on the methods used in baths. This limited direct influence largely stems from the fact that the pre-Roman ashlar vaults of the Near East were limited to fortifications, subterranean rooms, and other structures that relied on earth or some other solid mass to resist their lateral thrusts.[823] The vaults of Roman-style baths, on the other hand, were often much larger than earlier Hellenistic vaults and, as free-standing buildings, could not rely on solid masses to resist their lateral thrusts. Instead, they were designed to transfer the lateral trusts downwards through their abutment walls. The vaulting of these baths therefore required much more complex centering and a better understanding of structures' internal forces than had previously existed in the Near East. These structural differences meant that the vaulting skills developed in the pre-Roman East had little application in the construction of vaults in Roman-

[823] Waelkens 1989, 78; Netzer 2006, 317.

style baths, and thus there was likely little direct influence on the vaulting practices in these structures.

One exception where there seems to have been a continuation of pre-Roman vaulting techniques for the construction of baths is found at Dura Europos, where the vaults of Bath M7 were built with bricks laid at a pitched angle.[824] This placement of bricks is a clear use of pitched brick vaulting, a technique widely used in Mesopotamia and Parthia long before the Roman presence at Dura Europos.[825] This use of pitched brick vaulting therefore seems to be one of the only examples of pre-Roman vaulting techniques having a direct influence on the construction of Roman-style baths.

Although pre-Roman methods of vault construction in the Near East did not have much of a direct effect on the vaulting of Roman-style baths in the region, local building industries and deeply-rooted building traditions of using specific materials, such as stone or ceramic, likely did have an indirect effect on the types of vaulting employed in these structures. In regions where strong traditions of stone construction or the production of ceramic building materials did exist, the builders of Roman-style baths were able to employ highly skilled local laborers and could rely on well-established supply systems when building vaults. In many cases, the administrative and cultural shift seen after the advent of Roman control was not enough to dislodge these deeply entrenched building practices. Easily available resources, such as clay and building stone, continued to be a major factor in dictating which building material (and by extension building method) was most economical.

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[824] Brown 1936a, 86.
[825] Kawami 1982, 64.

One such local building industry that influenced the vaulting methods used in Roman baths was the production of ceramic brick and tile. Many regions of the Roman East did not have a well-developed ceramic building material industry before the advent of Roman control. In pre-Roman Judea, for example, there is little evidence for the large-scale manufacture of ceramic building materials, and ceramic roof tiles do not seem to have been used in any of Herod's building projects or even Hasmonaean structures.[826] Further east, there is evidence of Nabataean brick and tile production at Petra before its annexation in 106 CE; however, this industry does not seem to have been very large, with the manufactured brick and tile being used only for the construction of hypocausts and the roofing of important buildings.[827]

In many of these cases, the absence of a large-scale ceramic building material industry was the result of insufficient local resources. Brick and tile production required large amounts of clay, water, and fuel, all of which are scarce in certain arid regions of the Near East. For example, although Petra was a ceramic production center and likely had a small brick and tile industry, the region's limited clay supply prevented fired ceramic bricks from being a common building material.[828]

The construction of brick vaults, particularly for monumental baths, required large quantities of bricks and thus necessitated economical access to this material, whether through local production or trade. The vaults in the central block of the Baths of Caracalla, for instance, are estimated to have required 228,000 m3 of bessales, 15,000 sesquepedales, and 48,000 bipedales.[829] Although this bathing complex was far larger than any of the baths investigated in

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[826] Netzer 2006, 317.
[827] Harvey 2018, 603-604.
[828] Rababeh 2005, 48.
[829] DeLaine 1997, 126, table 11.

this study, these figures give some idea of the amount of brick that would have been required for vaulting. Sourcing such quantities of brick at a reasonable cost was not possible in regions where there was not already a pre-existing large-scale ceramic building material industry or sufficient clay, water, and fuel resources.

One of the only regions covered in this study that seems to have had a pre-Roman tradition of producing large amounts of ceramic building materials was Flat Cilicia. In addition to fuel for the kilns, the alluvial plains of this region provided copious amounts of water and clay perfectly suited for brick and tile production.[830] These raw materials appear to have supported the large-scale manufacture of ceramic roof tiles starting in the Hellenistic period. Although no tile kiln sites have been identified, fabric analysis of tiles from Beirut reveal that a substantial amount of the site's ceramic roof tiles were sourced from Flat Cilicia, particularly during the Seleucid and Late Hellenistic periods when these Cilician roof tiles were the most common tiles used at the site (fabrics BER2.1 and BER2.2).[831] This trade in roof tiles to Beirut and other sites along the Levantine coast evidently led to the development of a largescale tile production center in Flat Cilicia, possibly spurred on by the growth of the Seleucid Empire.[832]

Despite the existing tile industry, the production and use of fired brick in Flat Cilicia does not seem to have occurred until the Roman period.[833] When local production of brick did begin in this region, it was able to rely upon the infrastructure and supply system already set up for the manufacture of roof tiles. Marcello Spanu has suggested that the kilns used to produce the bricks

[830] Spanu 2003, 21.
[831] Mills 2013, 55-62, 84
[832] Mills 2013, 104.
[833] Spanu 2003, 22.

for the earliest baths in the region were likely the same as those used for tile.[834] The production of brick in Flat Cilicia could also rely on a local workforce of craftspeople skilled in making ceramic building material. The involvement of local Cilicians is supported by the fact that the bricks produced in this region do not conform to Roman standards of measurement but rather to local modules.[835] In addition to the supply system, the infrastructure set up for exporting tiles may also have been used for the exportation of bricks, allowing the brick industry to further benefit from the economics of scale.

Although this preexisting tile industry likely helped the initial establishment of brick production in Flat Cilicia, it was not the only factor that contributed to the prevalence of brick vaulting. In addition to an abundance of local recourses, social factors may also have promoted the use of brick. One theory suggests that the inhabitants of Flat Cilicia may have desired to emulate Roman construction methods or copy a new mode of land exploitation popular in Rome, in which land-owners invested in brickyards, resulting in an overabundance of cheap bricks.[836]

The extent to which these social factors contributed to the frequent use of brick vaulting in Flat Cilicia is not entirely clear. More obvious is the role played by the abundance and good quality of local clay resources and the limited amount of good building stones. While there was no local practice of brick vaulting, or even brick production, in this region prior to Roman control, the presence of a thriving roof tile industry likely also contributed to the common technique of brick vaulting in baths during the Roman period as it allowed for a continuity of the local ceramic building material industry.

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[834] Spanu 2010, 403.
[835] Spanu 2003, 23-24, fig. 6.
[836] Lancaster 2015, 67.

Another region of the Roman East where brick vaulting was common is northern Syria, including Apamea. Unfortunately, it is not clear whether or not there was a preexisting and large-scale ceramic building material industry before the advent of Roman control. Further research will hopefully clarify this lacuna in the study of building materials in the Roman East.

Just as the presence of a local ceramic building material industry could affect the type of vaulting used in Roman-style baths, so too could the presence of a deeply entrenched stone cutting industry. The builders of ashlar vaults in regions with a long tradition of ashlar construction could rely on the skill of local masons as well as the pre-existing infrastructure that supported the supply of stone. Skill in cutting stone was particularly important for ashlar vaults as each voussoir had to be carefully cut with the appropriate angles in order for the vault to effectively distribute its weight. Accurate stone cutting was of even more importance in dry-stone masonry where no mortar was used between the blocks. In many cases, the industry surrounding cut stone construction was so entrenched in a particular region that it was difficult for new construction techniques to permeate and take hold. It is likely that in many regions of the Roman East, the stone cutting industry and those who profited from it may have wielded great political and economic power, enabling them to resist the formation of new industries.[837]

One such region in the Roman East where the Hellenistic preference for ashlar construction was maintained throughout the Roman period and was employed for the construction of vaults was the Decapolis region. The strength of this tradition is best seen in Gerasa (modern Jerash), where its impact is abundantly clear in the monumental ashlar remains still standing throughout the site as well as the many stone quarries surrounding the ancient city.[838] The continued

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[837] Lancaster 2015, 48.
[838] Abu-Jaber et al. 2009.

importance of this stone cutting industry is also reflected in the presence of a sixth century water-powered stone sawmill in the center of the ancient city.[839] It was this local stone dressing and building industry that produced the monumental ashlar vaults in Gerasa's West Baths and East Baths.[840]

There is theoretically no reason why the vaults of these two baths could not have been constructed using brick. The region had abundant clay resources, and the city of Gerasa was home to a large ceramics production center by the third century CE that even included the manufacture of brick for hypocausts systems.[841] Furthermore, the massive size of these vaults (at least 20 m in the case of the East Baths) likely would have benefited structurally if lighter material like brick was used. Nevertheless, despite the availability of clay for bricks and the structural benefits of brick vaulting, these massive vaults were constructed of carefully cut stone. The presence of local masons and the larger stone cutting and building industry evidently made it economically and perhaps politically more expedient to use stone vaulting rather than to develop the local ceramic building material industry into one large enough to supply the required bricks for vaulting.

An excellent parallel for the presence of local stone building industries affecting the vaulting of baths can be found at Hierapolis, in Phrygia, which along with several other regions in Asia Minor, such as Pamphylia, Pisidia, Galatia, and Phrygia, maintained its Hellenistic preference for ashlar construction.[842] This continuity of building methods resulted in the construction of the massive vaults in the baths of Hierapolis, which are some of the largest ashlar vaults in the

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[839] Seigne 2002.
[840] Dodge 1990, 114.
[841] Kehrberg 2009, 493, 509.
[842] Waelkens 1987, 98-100.

Roman world built without the use of mortar.[843] Just like in Gerasa, the importance of the local stone cutting industry at Hierapolis is further exemplified by evidence for a technologically advanced water-powered stone sawmill, in this case depicted on a third century sarcophagus lid found at the site.[844]

In the other cities of the Decapolis, where the vaults of baths are almost universally made of ashlars, stone dressing and construction seem to have also been important local industries. At Scythopolis, for example, quarrying, stone dressing, and ashlar construction are thought to have been major economic drivers in the city, with local crafts people contributing to the architectural decoration of their own city and possibly working in the wider region.[845] Elsewhere in the Decapolis, there is evidence for the organization of labor relating to the stone industry. At Gadara (modern Umm Qais), an inscription referring to a guild of builders (συντεχνία οἰκοδόμων) was chiseled into a decorative stone pedestal sometime after the last decades of the first century BCE or beginning of the first century CE.[846] Though less explicit, the mason marks carved into the flagstones of the first century CE forum at Hippos-Sussita hint at some system of organization and supervision of the craftspeople and workshops involved in supply of these basalt stones.[847] The mason marks found in the thermal baths at Hammat Gadar may also suggest the involvement of an organized stone quarry and dressing industry.[848] As was the case at Gerasa, this local preference for building with cut stone was likely an influential factor in the decision to construct bathing complexes with ashlar vaulting.

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[843] Farrington 1995, 89.
[844] Ritti et al. 2007.
[845] Tsafrir and Foerster 1997, 89-90.
[846] Batayneh et al. 1994, 379.
[847] Kowalewska and Eisenberg 2019, 111-16.
[848] Solar 1997, 41-45.

The influence of preexisting ashlar construction practices on the decision to construct vaults out of ashlars is also seen in other regions of the Roman East, such as Cyprus, southern Judea, and in the south of the province of Arabia. As discussed in the previous chapter, ashlar construction had a long tradition in all three of these regions. On the island of Cyprus, this tradition continued from prehistoric times through the Roman period.[849] Similarly, in ancient Palestine, there was also a long history of ashlar construction dating back to the Iron Age, and well-dressed stones were commonly used in Hasmonaean and Herodian building projects throughout the region.[850] In the province of Arabia, the indigenous Nabataeans were likewise skilled at ashlar construction.[851]

As was the case at Gerasa and in the wider Decapolis, each of these regions had enough local clay resources to support ceramic building material industries. In the case of Cyprus, this ability is evidenced by the manufacture of roof tiles in several locations on the island.[852] In Judea, during the Roman period, legionary brick and tile production centers existed at Jerusalem[853] and at Legio, in northern Israel.[854] Finally, at Petra, the Nabataeans developed a small-scale ceramic building material industry that seems to have continued through the Roman period.[855] None of these regions, however, had ceramic building material industries of comparable size to the one that existed in pre-Roman Flat Cilicia. Whereas the producers of roof tiles in Flat Cilicia were manufacturing this material on an industrial level and even exporting tiles to other sites along the

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[849] Wright 1992, 362-75.
[850] Netzer 2006, 313.
[851] Rababeh 2005, 84-92, 113-120.
[852] Rautman et al. 1999, 387-89; Gomez et al. 2002, 25, 32.
[853] Arubas and Goldfus 2005, 15; Goldfus and Arubas 2019, 190-91.
[854] Tepper 2007, 66.
[855] Harvey 2018.

Levantine coast, the production of ceramic building materials that would develop in many of the other regions of the Roman East was limited to local use.

Without a doubt, one of the primary reasons for this limited production of ceramic building material was the expense of manufacturing a product that required large amounts of clay, fuel, and water, all of which were scarce in these arid and semi-arid regions. It was these economic considerations that prevented the development of large-scale ceramic building material industries in pre-Roman Judea and Arabia, like the one that had developed in Flat Cilicia. It is likely that the absence of a local large-scale ceramic building material industry, coupled with the local familiarity and preference for ashlar construction, led to the construction of ashlar vaults and domes for economic and socio-political reasons. Thus, while not the only factor, the local building practices of these regions almost certainly did have an indirect effect on the types of vaulting employed in Roman-style baths.

This continuation of ashlar traditions is seen in other regions of the eastern Mediterranean not covered by this study. In addition to Hierapolis, mentioned above, other sites in Asia Minor maintained their Hellenistic preference for ashlar construction, most notably in Pisidia, Phrygia, and Galatia.[856] Elsewhere in the eastern Mediterranean, traditional ashlar construction was gradually replaced by imported building techniques, and ashlar vaulting was not used in the construction of Roman-style baths. In Greece, for example, where there was a long and celebrated history of ashlar construction, vaults (particularly those in Roman-style baths) were largely constructed of brick. This choice was partially the result of rich clay deposits, a local

[856] Waelkens 1987, 99-100.

practice of fired brick construction, and the foundation of colonies by Romans using Italian building methods.[857]

Returning to the regions covered by this study, a notable exception where a longstanding tradition of cut-stone construction did not result in the use of ashlar vaulting in Roman-style baths is the Hauran. The stone masons of this region are frequently mentioned in building inscriptions that attest to their skill.[858] This ability is also demonstrated by the innovative technique for constructing flat roofs entirely out of stone.[859] In the absence of sufficient timber resources, local builders relied on an innovative technique, previously described, consisting of a series of transverse arches acting as ceiling beams that supported long stone slabs, covering the gap between the arches and creating a flat roof. This technique was employed in houses, temples, and public buildings, but never in the hot rooms of Roman-style baths, which were always roofed with barrel vaults and domes. Interestingly, despite local familiarity with stone construction, these bath vaults were not constructed of cut stone, but rather of mortared rubble. The reason for this discontinuity was likely that basalt was not well-suited to vault construction, as this hard and dense rock was difficult to cut into precise voussoir stones and its weight increased the internal forces needing to be absorbed by the abutment walls. A different vaulting method was thus required. As this region lacked sufficient timber and clay resources, brick vaulting was not economical. Evidently, the construction of mortared rubble vaults proved to be most economical.

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[857] Vitti 2016, 348-64.
[858] e.g. Littmann et al. 1907-1921, 94 n. 159, 104 no. 177, 112-13 no. 197, 315 no. 685, 330 no. 714, 344 no. 738, 374 no. 783[1], 375-76 no. 783[5], 382-83 no. 786-786[1], 389 no. 787[8], 390-91 no. 787[10], 438-39 no. 800[7].
[859] Ward-Perkins 1981, 343.

Fortunately, the builders of these mortared rubble vaults were able to take advantage of local sources of light-weight volcanic scoria, which could be used in vaults to reduce the weight of the construction. In the Hauran, there is no evidence for a local precedent for this use of scoria before the Roman annexation of the region.[860] Nevertheless, this material quickly became the material of choice for vaults. In addition to the region's baths, the Hauran contains several other structures which have vaults built with scoria. At Bosra, the cryptoporticus supporting the porticus on the north side of the site's principle east-west street had vaults made of *opus caementicium* and scoria.[861] Another example is the "Palace" at Shaqqa (ancient Saccaea).[862]

The construction of these mortared rubble vaults required centering and framework, a difficult task in a region without many timber resources. The beams and boards used for these temporary supports, however, could be reused again and again, cutting down on the amount of timber needed.[863] Once constructed, these mortared rubble vaults proved to be very stable, as demonstrated by their survival to this day. Much of this stability is thanks in part to the use of volcanic scoria that reduced the overall weight of the vaults and thus decreased the associated internal forces that needed to be withstood.

It has been suggested that, in the Hauran, the inclusion of crushed volcanic stone in mortar increased its strength in the same fashion as pozzolana.[864] The argument follows that it was this ability to make mortar comparable to Roman concrete that led to mortared rubble vaults being the preferred method of vaulting in this region. This claim, however, is questionable. As already

[860] Ward-Perkins 1981, 343.
[861] Dentzer et al. 2002, 105.
[862] Ward-Perkins 1981, 343.
[863] Ulrich 2007, 173.
[864] Dodge 1990, 112-13.

discussed, a similar theory had existed for the widespread use of mortared rubble construction in Flat Cilicia.[865] Mortar analysis from this region, however, revealed that volcanic sand was not always used and thus could not have been a reason for the prevalence of mortared rubble construction.[866]

Regarding the use of volcanic material as an additive in the mortar used for vaulting in the Hauran, research by Lynne Lancaster found no known examples in this region (although her study was not exhaustive).[867] A smaller study analyzing the mortars from the site of Umm al-Jimal has suggested that volcanic materials were indeed used as aggregate in some of the site's mortars.[868] It remains unclear, however, how common this use of volcanic materials in mortar was in the wider region and whether or not volcanic ash was used in the mortar of bath vaults. While any possible use of volcanic material may have provided pozzolanic properties to the mortar, the widespread use of mortar in vaulting in the Hauran was more likely a result of needing to bond uncut stones together rather than a result of its perceived strength.

There are several other exceptions in the Roman East where the vaulting technique or material show a clear break with pre-Roman building practices. Though it is not possible to address all of these exceptions, it is worth providing a brief discussion about a few of them as they demonstrate that vaulting was not limited by preexisting building traditions. These exceptions also allow for a study of other factors that affected the choices made by builders of Roman-style baths.

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[865] Boëthius and Ward-Perkins 1970, 387; Waelkens 1987, 99.
[866] Burragato and Santarelli 2003.
[867] Lancaster 2015, 22, fig. 9A.
[868] Dunn and Rapp 2004, 154.

One such exception is the possible use of brick vaulting at Herod's Third Palace at Jericho. Here, excavation of the structure found evidence that the heated rooms of this bathing suite were once covered by vaults constructed with an intrados of radially set bricks supporting mortared rubble packing.[869] If indeed employed, this use of brick vaulting technique would be unique in this region, particularly for this time period. The excavators of the site posited that much of the construction was the work of a team of Roman builders that were brought from Italy specifically for the project.[870] The presence of these foreign builders at Jericho is not attested beyond the imported building techniques, but this movement of craftspeople from the West to the East is recorded elsewhere. There was, in fact, a long history of Roman builders active in the southern Levant, but frustratingly little of their work survives.[871] In the case of Jericho, it is likely that the possible use of brick for vaulting was the result of foreign builders employing western construction techniques with which they were familiar. The fact that brick vaulting did not spread elsewhere in Judea, speaks to the difficulty of introducing new construction techniques to a region with firmly entrenched building practices.

Further south, the small baths at Osia (modern Yotvata) and Rehovot-in-the-Negev contain vaults of mortared rubble rather than of the typical ashlar. The reason for this break with the regional norm is not entirely clear. One possible explanation for the use of mortared rubble vaulting at Osia is this bathing complex's association with the adjacent Roman fort, and the likelihood that non-local troops or even a military engineer were involved in its construction.[872]

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[869] Netzer 2001, 256-57, figs. 388-390.
[870] Netzer 2006, 57, 315.
[871] Roller 1998, 76-84.
[872] For a brief discussion on the role played by the Roman army and military engineers in disseminating non-local vaulting techniques to many regions of the Roman world, see Lancaster 2015, 201.

This reasoning, however, does not explain why, across the Wadi Arabah at the nearby site of Arieldela (modern ʻAyn Gharandal), the nearly identical garrison baths had vaults constructed of ashlars.[873]

Another example of vaulting techniques used in the Roman East that have no connection to pre-existing building practices is the use of vaulting tubes. This chapter has discussed their use in three baths: Dura Europos, Pella, and Scythopolis (modern Bet She'an). The fourth and thus far only other bathing facility where vaulting tubes have been found in the eastern Mediterranean is located at Pompeiopolis in Paphlagonia, south of the Black Sea. These small baths produced many fragments of heavily ribbed and conical vaulting tubes.[874] Although different in form than those found in the sites discussed here, these vaulting tubes functioned in the same way.

Outside these four baths, vaulting tubes are attested at only two other places in the eastern Mediterranean. As previously mentioned, one of these sites is the fifth to sixth century Church of the Annunciation in Nazareth.[875] Beyond their presence in this structure, however, very little other information is provided about these pipes. The only other find spot for vaulting tubes is the ancient harbor of Caesarea Maritima, where excavation uncovered two vaulting tubes not associated with any particular building.[876] It was not clear to the discoverers of these tubes whether they were used in a building on shore or fell into the harbor from a docked ship. In form, they do not resemble the vaulting tubes found elsewhere in the eastern provinces. They are

[873] Darby 2015a, 78; Darby and Darby 2015b, 464.
[874] Koch 2011, 65, pl. 5.3.
[875] Viaud 1910, 66-67.
[876] Vann 1993, 29, figs. 1-2.

smaller, more heavily ribbed, and have a cylindrical body with a sharp carination leading to a conical nozzle. Closer parallels are found in the western provinces.[877]

Vaulting tubes are far more common in the western Mediterranean than in the East.[878] While it is therefore worth considering why this vaulting technique appears sporadically in the eastern provinces, the fact that they mostly appear in baths is not unexpected. Elsewhere in the Roman world, such as North Africa, vaulting tubes were used in a variety of public and private buildings, but their most widespread use in public buildings was in baths.[879]

Regarding the means by which this vaulting technique spread to these sites, one possible explanation is the Roman military, which seems to have had a major role in the dissemination of vaulting tubes across the Roman world.[880] Indeed, their use at Dura Europos was most likely connected to the military presence at the site. Vexillations of the North African *Legio III Augusta* are attested in Syria and along the eastern frontier throughout the second century, and it is entirely possible that members of this legion or other units were responsible for introducing the technique of using vaulting tubes.[881]

It is possible that the military also played a role in the use of vaulting tubes in the baths at Pella and Scythopolis , but this possibility is more tenuous than it is for Dura Europos. The presence of vaulting tubes at these two sites combined with their later use at Nazareth points towards a localized building practice. To the south of Nazareth is the legionary base at Legio, which was a production center for ceramic building materials.[882] There is no evidence, however,

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[877] Lancaster 2015, fig. 68.
[878] Lancaster 2015, 101, fig. 66.
[879] Wilson 1992, 102.
[880] Lancaster 2015, 108-112.
[881] Pollard 2004, 143.
[882] Tepper 2007, 66.

that the legionary kilns produced vaulting tubes or that their use in this region was definitively connected to the presence of the military.

One major benefit of vaulting tubes was that this vaulting technique did not require centering, and thus their use sped up construction and eliminated the need for specialist carpenters.[883] This avoidance of centering was also a benefit of the pitched brick vaulting technique, described above (Figure 141).[884] The ability to construct vaulting without the use of centering was particularly advantageous in arid regions where appropriately sized timber was harder and more expensive to acquire. This being the case, it is somewhat surprising that vaulting tubes and pitched brick vaulting were not more common in the Roman East, particularly in the regions where timber was scarce (e.g. the Hauran or Arabia). The rarity of these vaulting techniques in the East and the construction of vaults using techniques that would have required centering and formwork suggests that the sourcing of timber was not, in fact, a major issue in these regions. One possible reason is that while expensive to initially source, the timber used for centering and formwork could be reused again and again.[885] A clear example of this reuse is found with the vaults of the substructures in the Longeas public baths, at Chassenon (Charente, France).[886] Insufficient resources may also have played a part, as both vaulting tubes and pitched brick vaulting required fast-drying gypsum mortar to gain strength fast enough to be built without centering. Another possible reason for the limited use of vaulting tubes in the east is the difficulty of introducing a new building technique into a region with preexisting and deeply entrenched building practices and supporting infrastructure. This difficulty has already been

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[883] Wilson 1992, 100; Lancaster 2015, 115-17.
[884] Van Beek 1987, 100.
[885] Ulrich 2007, 173.
[886] Coutelas and Hourcade 2016, 266-70.

discussed regarding the introduction of brick vaulting to regions with strong traditions of ashlar construction. The use and dissemination of vaulting tubes in North Africa is believed to have been partly reliant on the interpersonal relationships among patrons and suppliers (for example if the patron of a building project owned land on which vaulting tubes were produced).[887] As the use of vaulting tubes in the Roman East may have disrupted preexisting systems of production and supply, their adoption was severely limited.

Conclusions

This chapter has provided an overview of the different materials and techniques used in the construction of vaults throughout the Roman East. Although the evidence from baths in and of themselves is scant, several general observations can be made about the distribution of vaulting techniques throughout the region. Brick vaulting was primarily concentrated in Flat Cilicia and in northern Syria, while mortared rubble is most common in Rough Cilicia and the Hauran, and ashlar vaulting was the dominant vaulting technique in Cyprus, Judea, and Arabia. The survey of sites demonstrates, however, that provincial borders and the size of the baths did not influence the vaulting technique or material used. Rather, it was the availability of resources as well as preexisting building practices that were the major factors in determining the vaulting technique used. In only a few cases, however, were pre-Roman vaulting techniques applied to Roman baths, such as the use of pitched vaulting at Dura Europos. Instead, it was the local familiarity with building materials combined with established construction industries and the associated production and supply infrastructure that determined what vaulting techniques were used in

[887] Lancaster 2015, 117-18.

Roman-style baths. The relative popularity of brick vaulting in Flat Cilicia, of example, was not only the result of abundant clay resources but also of the preexisting Hellenistic tile industry in the region, which provided established kiln sites, skilled laborers, and supply systems upon which the production of brick for vaulting could be established. Likewise, in regions of the Roman East, like the Decapolis, where there was a deeply rooted tradition of ashlar construction and an absence of a large-scale ceramic building material industry, it was far more economical and perhaps politically expedient to utilize the preexisting ashlar building industry than to attempt to introduce a new vaulting technique, such as the use of brick.

Chapter 5 Heating Systems

Introduction

This chapter focuses on the construction of heating systems in the Roman-style baths – that is the hypocaust and associated wall-heating systems. After a general description of their typical design, an overview of their development, and a brief history of heating systems in the Near East, examples of these systems from bathing complexes of this region will be presented. As this chapter will demonstrate, although these heating systems generally followed the standard pan-Mediterranean design, many different techniques and materials were used for their construction, resulting in a great deal of variation.

The heating apparatus was one of the most important elements of a Roman bathing facility and was integral to its operation, as it created the warm environment and waters that were not only considered relaxing and emblematic of luxury by the ancients but were also thought to be therapeutic.[888] While these heating systems were largely unseen by the bathers, their existence affected the entire architecture of bathing facilities. It was the fires that fueled these systems and the warm vapors they created that necessitated the construction of vaults in order to use water- and fire-resistant materials (as discussed in the previous chapter). In fact, the heating of these facilities played such an important role that the nomenclature used for the rooms of baths often

[888] Fagan 1999, 85-103.

describe the extent to which they were heated (*e.g. frigidarium*, *tepidarium*, *caldarium*, *sudatorium*).[889]

While heating systems are so characteristic of Roman-style baths that often their discovery during excavation is assumed to be indicative of this building type, it must be stated that not all Roman baths were built with heating systems and not all heating systems were built for baths. The major exception to the ubiquity of heating systems in Roman baths are thermal baths that take advantage of naturally occurring hot springs, and thus make any man-made heating system superfluous. These thermal complexes, such as those at Baiae, were extremely popular as health resorts and had a major influence on the development of heating systems.[890] Conversely, while heating systems were constructed for private baths in elite homes, they could also be built to heat other rooms (such as dining rooms) and are thus not always indicative of a bathing facility.

The typical Roman heating system comprised several components, the most characteristic of which was the hypocaust (Figure 178.2). Derived from the Greek ὑπό "beneath" and καυστός "burnt", the hypocaust was a system by which the hot gasses of an adjacent furnace were fed through an underfloor cavity that heated the floor and by extension the interior of the room. While the earliest hypocausts often had little more than a single underfloor channel for this hot air, the design that was most often used in the Roman period saw the entire floor raised on a series of pillars (often labelled *pilae*), which allowed the gasses to spread evenly under the floor and created a more equally distributed heat. The heat was generated by a furnace, or *praefurnium* (pl. *praefrunia*), which was located in a separate room adjacent to the rooms to be heated (Figure 178.1). A horizontal flue connected the *praefurnium* to the hypocaust, and a metal boiler often

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[889] Nielsen 1990, 153-61.
[890] Yegül 2010, 49-51.

sat above the furnace, which supplied hot water to the immersion pools of the heated rooms. An alternative to the metal boiler was a device call a *testudo alvei*, which allowed for the hot waters of a pool to be directly heated by the furnace. The *testudo alvei* was a concave metal device that functioned by extending a portion of a heated pool horizontally over the *praefurnium,* allowing the water heated in the *testudo alvei* to freely circulate throughout the rest of the pool.

In addition to the hypocaust, many heated rooms also contained wall-heating systems that functioned by creating a void along the surfaces of the walls that connected to the hypocaust (Figure 178.3). Hot air from the hypocaust rose through these voids and contributed to the heating of the room. As these wall-heating systems increased the surface area that was heated, the result was a more efficient system and warmer room.

One of the most important elements of the entire heating apparatus was the exhaust or flue system, which carried the draft and ensured that the hot gasses from the *praefurnium* entered and circulated throughout the system (Figure 178.4). Given the often-poor preservation of wall-heating systems, there is some debate regarding how the flue system connected with the hypocaust or wall-heating system.[891] In some cases, these flues may have connected the top of the wall-heating system to the exterior, ensuring a flow of hot air through the walls. In other cases, these flues may have bypassed the wall-heating system and connected directly to the hypocaust. In these systems, hot air would circulate in the walls via simple convection currents.

While the standard design of these systems is clear from the countless examples found through archaeological excavation, a description of the hypocaust's construction is also provided by the architect Vitruvius in his *De Architectura*:

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[891] Yegül et al. 2003, 171.

suspensurae caldariorum ita sunt faciendae ut primum sesquipedalibus tegulis solum sternatur inclinatum ad hypocausim, uti pila cum mittatur non possit intro resistere sed rursus redeat ad praefurnium ipsa per se. ita flamma facilius pervagabitur sub suspensione. supraque laterculis bessalibus pilae struantur ita dispositae uti bipedales tegulae possint supra esse conlocatae. altitudinem autem pilae habeant pedes duo eaeque struantur argilla cum capillo subacta, supraque conlocentur tegulae bipedales quae sustineant pavimentum (5.10.2)

> The floors of the hot baths are to be made thusly: first, the ground is paved with tiles measuring a foot and a half square sloping towards the furnace, so that if a ball is thrown into it, it does not remain at rest, but automatically rolls towards the furnace. In this way the heat will more easily flow under the floor. Upon this, piers of bricks 2/3 of a foot in diameter are raised, at such a distance that tiles measuring two feet in diameter can form their covering. The piers should be two feet in height, and should be laid in clay mixed with hair, on which the above-mentioned two feet tiles are placed, which carry the pavement. (translation by author)

As evident in Vitruvius' description, ceramic bricks were the preferred material used in hypocaust construction. The preference for this material resulted from its ability to withstand greater temperatures than most building stone. Nevertheless, in rare cases stone was used for the floor, *pilae* (the pillars), and roofing slabs of the hypocaust.[892]

While the hypocaust that Vitruvius describes (i.e. a raised floor supported by a series of regularly spaced pillars) is surprisingly standard across the Roman world, there was also a wide variety of methods used to construct these systems. In addition to stone and brick (which also varied in size and shape), ceramic cylinders were used in a few hypocausts throughout the Mediterranean world.[893] Although, the vast majority of *pilae* were simple pillars, many *pilae* were also built with a wider top (much like a column capital) to broaden the area of the supporting surface. In a few cases, however, the *pilae* were connected to adjacent pillars with arches, the result being a series of parallel rows of arcades.[894] *Pilae* could also be bunched

[892] Yegül 1992, 357; Adam 1994, 268.
[893] Yegül 1992, 357; Adam 1994, 267; Bouet 1999, 174-78.
[894] Yegül 1992, 357.

together or extended into broad pillars to provide extra support. This technique was particularly common under heated pools to help support the weight of the installation above.

Wall-heating systems were similarly built using a variety of materials and techniques.[895] By far the most common method for wall-heating was to use rectangular ceramic tubes known as *tubuli* (also referred to as box-flues or flue-tiles), which were stacked on top of each other in columns (Figure 179-b). These heating pipes had vents cut into their sides to allow for the lateral flow of air between adjacent columns of pipes. Another method of creating wall-heating systems was through the use of so-call *tegulae mammatae*, which were flat tiles with conical clay projections on one side (Figure 179-a). When these tiles were hung vertically against walls (typically using iron nails or clamps), these projections acted as spacers and created the gap through which the hot air from the hypocaust could circulate. A third technique was the use terracotta spacers or spacer bobbins, which were ceramic cylindrical spacers typically hollow or with a hole drilled through their lengths (Figure 179-d). These spacers were placed between vertically hung flat tiles and the wall to ensure a continuous gap. An iron nail placed through the hole of the spacer held the system in place. Yet another method was using ceramic spacer pins, which were nail- or chisel-shaped ceramic pegs (Figure 179-c). With their pointed ends set into the masonry wall, these pins acted as both spacers and the supports for vertically hung flat tiles. All four of these techniques are found widely in the Roman world and were at times used concurrently in the same region and even in the same structure.

The standard Roman hypocaust system which was described by Vitruvius and found throughout the Roman world was the result of a long developmental process. Before the

[895] Yegül 1992, 363-65, fig. 455; Adam 1994, 268-70.

widespread use of the hypocaust, baths are thought to have relied on portable braziers for their heat.[896] The introduction of the hypocaust, however, resulted in several improvements in comfort for the bathers. First, whereas braziers produced gases and smoke that had to be exhausted through openings in the ceiling that also allowed heat to escape, the hypocaust system contained all these dangerous gases safely under the floor and behind the walls. It produced heat without smoke. Second, a hypocaust heated a room far more evenly than a brazier, which could only radiate heat from its position. It is for this reason that Vitruvius recommended using round braziers in round rooms so that they more evenly distribute their heat (*De Arch*. 5.10.5). When combined with wall-heating systems, hypocausts produced a more comfortable and even heat, an advantage clearly recognized by the Romans and mentioned by Seneca the Younger (*Ep*. 90.25).

Despite its proliferation and ubiquitous use during the Roman era, the hypocaust (like so many other "Roman" technologies) was not invented by the Romans, but rather was developed from a pre-existing design. Nevertheless, Pliny the Elder ascribed the invention of the hypocaust to Sergius Orata, who had used a similar system to heat pools for the cultivation of oysters (*Nat. Hist*., IX.168). While scholars had generally accepted this origin story, archaeology has now shown that the invention of the hypocaust took place long before Sergius Orata's time (the late first century CE).[897]

The earliest known example of a hypocaust system from a Greek-style bathing facility comes from the late fourth century BCE baths at Gela, on Sicily.[898] These early Greek hypocausts, however, were often simple channels under the floor and did not resemble the pillared systems

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[896] Adam 1994, 264.
[897] Fagan 1996, 56.
[898] Lucore 2013, 151-53.

described by Vitruvius and ubiquitously found in Roman-style baths. The earliest known example of these full-floor and pillared hypocaust systems comes from Fregellae in Latium. This heating system predates 125 BCE, placing it well before the life of Sergius Orata, the fabled inventor of the hypocaust.[899]

Although Vitruvius makes no mention wall-heating systems in his discussions on baths, these systems did exist during his time, and elsewhere in his writing he provides a detailed description on how to construct a void within a wall to protect it from dampness (*De Arch*. 7.4.1-2). One of the few ancient authors to refer to wall-heating systems is Seneca the Younger, who makes it clear that by his time hypocausts with wall-heating systems were also being used in dining rooms (*Prov*. 4.9). He also gives some indication on when wall-heating was invented stating:

> *Quaedam nostra demum prodisse memoria scimus, ut speculariorum usum perlucente testa clarum transmittentium lumen, ut suspensuras balneorum et inpressos parietibus tubos, per quos circumfunderetur calor, qui ima simul ac summa foveret aequaliter* (*Ep*. 90.25).

> We know that certain devices have come to light only within our own memory – such as the use of windows which admit the clear light through transparent tiles, and such as the vaulted baths, with pipes let into the walls for the purpose of diffusing the heat which maintains an even temperature in the lowest as well as in their highest spaces. (translation by author)

The evidence from archaeology, however, suggests that the development of wall-heating goes back much further than Seneca's own memory.

The exact date of the invention of wall-heating is somewhat difficult to pin down, as it seems to have slowly developed from the hypocaust flue or exhaust pipes set into the walls of heated rooms. For example, one of the earliest possible instances of wall-heating is found at the second century BCE baths at Gortyn in Arcadia, which contained a heated room with large flues leading

[899] Tsiolis 2013, 95.

up from the hypocaust. Although these flues were primarily designed as the hypocaust exhaust, they may have also contributed to heating the room, even if only in a small way.[900] Another possible predecessor to wall-heating systems comes from the baths at Fregellae in Latium, which predate 125 BCE. Here, excavators uncovered fragments of long ceramic tubes that acted as the hypocaust flue and may have also heated the walls.[901] If these pipes were indeed designed to heat the walls of the room, they represent the earliest known use of pipes for wall-heating.[902] One of the earliest known examples of an unmistakable wall-heating system was found in the Hellenistic baths at Taposiris Magna in Egypt. These baths contained a heating wall formed by flat roof tiles set vertically at a distance from the wall, thus creating a hollow void through which hot air from the underfloor heating system passed.[903] This wall-heating system has been dated to between the end of the second and middle of the first century BCE. Back in Italy, baths in Pompeii (such as those in the Forum Baths and Stabian Baths) were being outfitted with wall-heating systems by the beginning of first century BCE.[904] Over the course of the following century, such wall-heating systems became a standard component of the heating of baths and spread throughout the Roman world.

The introduction of hypocaust systems to the eastern Mediterranean pre-date Roman hegemony in the region, as they have been found in several Hellenistic Greek baths in the region. The late second century BCE private baths at Tel Anafa, for example, had an early hypocaust system that consisted of a subfloor channel for hot air under the heated rooms.[905] Two Hellenistic

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[900] DeLaine 1989, 113.
[901] Tsiolis 2013, 95, fig. 11.
[902] Yegül 2013, 79.
[903] Fournet and Redon 2013, 246-52.
[904] Adam 1994, 270.
[905] Herbert 1994, 67.

baths uncovered on Cyprus also had heating systems. The *balaneion* at Amathus was outfitted with a furnace during a major renovation in the second century BCE.[906] In the same fashion, excavators of the undated Hellenistic baths at Kition reportedly found a hypocaust system; however, the absence of a final publication has prevented a detailed understanding of this structure.[907] Furthermore, despite the previously held assumption that the Hellenistic baths of Egypt were minimally heated, new evidence has shown that even these bathing facilities contained technologically advanced heating systems, which were comparable to those found in contemporary baths elsewhere in the eastern Mediterranean.[908]

As Roman power and cultural dominance grew in the East, the pilastered and full-floor hypocaust systems quickly replaced the simpler systems commonly found in Hellenistic Greek baths. In fact, some of the best examples of early "Roman-style" hypocaust systems found outside Italy come from the Herodian baths built at the end of the first century BCE in the Levant. Many of these baths contained a hypocaust in the fashion described by Vitruvius as well as wall-heating systems. Herod is credited with building eleven baths with such heating systems in his palaces, all seemingly constructed between c. 35 and 15 BCE.[909] The earliest of these baths was found at Herod's First Palace at Jericho. Here, excavation uncovered a hypocaust very much in the Roman style, built almost completely of brick and having *tubuli* for wall-heating.[910] This heating system represents a complete break with earlier systems found in Hasmonean baths in the region.[911]

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906 Christodoulou 2014, 84-85.
907 Christodoulou 2014, 85-86.
908 Fournet and Redon 2013, 239.
909 Netzer 1999, 45.
910 Pritchard 1958, 10-12, pl. 7.
911 Netzer 1999, 49.

As Roman-style baths and associated heating systems spread throughout the East, local builders and craftspeople were faced with the challenge of not only constructing these complex systems, but also sourcing and producing the ceramic building material needed for their operation. As this chapter will demonstrate, the result was a multiplicity of innovative solutions, some of which were quick to be replaced, while others even outlived Roman-style baths themselves. Despite the vast variety of building techniques and materials used, however, the general concept and design of the hypocaust remained very similar to the system described by Vitruvius and found in Roman-style baths across the empire.

Examples of Heating Systems from Roman-style Baths in the Roman East

In the following sections, examples of heating systems from Roman-style baths are presented in geographical order by site. As outlined in the Introduction, these sites are organized by Roman province as they roughly existed under Hadrian (i.e. Cilicia, Cyprus, Syria, Judea, Arabia). As heating systems are not always visible in unexcavated baths, it is not possible to discuss the heating systems of all known bathing complexes from the Roman East. Furthermore, not all elements of the standard Roman heating system remain equally represented in the archaeological record. Unfortunately, *praefurnia* are not always located or excavated, and when they are, poor preservation or a poor understanding of their significance often results in these furnaces not being described in detail in published reports. Similarly, wall-heating systems rarely survive intact in the archaeological record. Hypocausts, on the other hand, are often the best-preserved element of these heating systems, thanks in large part to their position under floor level and the fact they are sometimes purposefully filled in during remodeling. This generally good state of preservation, combined with the widespread familiarity with hypocausts as characteristic of Roman baths, has led to a disproportionate focus on these underfloor heating systems in publications. As a result of this preservation bias and focus in scholarship, the following analysis is also weighted towards the construction of hypocausts, but these features are also used to infer information about parts of the heating systems less well preserved. As with the case studies on wall and vault construction, there are so many known examples of hypocaust systems throughout the Roman East that it is not possible to discuss all of them in this chapter. The following examples, therefore, aim to provide a representative sample while also reflecting the wide range of techniques and materials used in their construction throughout the region.

The Heating Systems of Roman-style Baths in Cilicia

Although Cilicia is home to many impressive Roman-style baths, few have been excavated to the extent that their hypocausts and *praefurnia* have been exposed and fully documented. As a result, information on the construction materials and techniques used in the heating systems of these bathing complexes is limited. As the following discussions will show, much of the data available comes only from visible remains and small probes within the structures.

Iotape

The site of Iotape, on the western edge of Rough Cilicia, is home to two possible bathing complexes, but only one of these baths (Building 5B) (Figure 11) has produced evidence of a hypocaust. A small sondage excavated in the corner of one of its vaulted halls revealed parts of a hypocaust system comprising pillars of circular bricks (25 cm in diameter) in the center of the room and rectangular pillars of rectangular bricks measuring 34 cm by 17 cm by 6 cm, placed along the walls of the hypocaust.[912] No image of this installation or further information of the

[912] Huber 1967, 40.

heating system is provided. These baths measure 567 m^2 and likely date to the reign of Trajan, as suggested by an inscribed lintel block that bears a dedicatory inscription to the emperor.[913]

Selinus

To the south of Iotape is the site of Selinus, located at the mouth of the Hacimusa River. Although at least two known baths are located at this site, only one of these structures, the so-called River Bath (Figure 144), has a heating system that is visible thanks entirely to erosion by the adjacent Hacimusa River. This erosion has sheered away the northern half of the baths, leaving a near-perfect cross-section of the structure, the visible remains of which measure only 79 m^2. Little of the hypocaust survives, which has been described both as comprising rectangular brick *pilae* [914]and circular brick *pilae* as evidenced from their imprint on the hypocaust floor.[915] My own personal examination of the structure confirmed this evidence for circular *pilae* as well as rectangular brick against the walls, similar to the construction of the hypocaust in the baths at Iotape. In the easternmost room, a 10 cm gap between the raised hypocaust floor and the walls is evidence of the wall-heating system that once existed, though nothing beyond this gap seems to remain.[916] Under an interior door, a small passageway was cut through the walls to allow hot air to travel between the heated rooms, while vertical grooves in the walls may have acted as flues for the exhaust.[917] These baths are undated, but their arrangement and lack of apses has been compared to the late first/second century CE Central Baths at Patara.[918]

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[913] Huber 1967, 41.
[914] Huber 1967, 33.
[915] Hoff 2013, 151.
[916] Huber 1967, 33; Hoff 2013, 151, fig. 12.9.
[917] Hoff 2013, 151, fig. 12.8.
[918] Hoff 2013, 151.

Anemurium

Further along the coast is the site of Anemurium, which is located near the southernmost point of Rough Cilicia and home to several well-preserved bathing complexes. One of the best preserved of these baths is the structure known as Bath II 7 A, which covers an area of roughly 500 m^2 (Figure 21). The heated rooms of these baths were built atop hypocausts comprising *pilae* of circular tiles (25 cm in diameter), while basins in several rooms were built over pillars of rectangular brick.[919] Excavation uncovered between 35 and 40 *pilae* surviving to an average height of 1.20 m, as well as two large tunnels cut through the walls to allow for the circulation of air between rooms.[920] Images of the hypocaust also reveal that masonry walls were not lined or covered by ceramic tile and that the circular *pilae* of the hypocaust rested upon one or two stacked square tiles that act as a base.[921] Nothing of the wall-heating system or the *praefurnium* is recorded or was clearly visible during my own personal observation of the structure. Excavation of the hypocaust of these baths has dated its construction to sometime before 200 CE.[922]

Investigation of a second bathing facility at Anemurium (Bath III 2 B) also uncovered the remains of the structure's heating system (Figure 23). The hypocaust of these baths comprised *pilae* of circular bricks (25 cm in diameter), with rectangular *pilae* along the walls.[923] None of these *pilae* remained standing above five courses; however, the tile floor they supported could be reconstructed at a height of 1.22 m above the level of the hypocaust floor.[924] Nothing of the wall-

[919] Huber 1967, 7.
[920] Smith 1968, 177.
[921] Smith 1968, 181.
[922] Akok et al. 1980, 203.
[923] Huber 1967, 10; Russell 1975, 123, figs. 2, 8.
[924] Russell 1975, 123.

heating system or the *praefurnium* is recorded. These baths measure roughly 957 m^2 and were likely constructed sometime in the third century CE and fell out of use in the mid-fourth century CE.[925]

The third baths at Anemurium that produced a hypocaust system are the Small Baths (III 15), which measure roughly 330 m^2 (Figure 180). The excavation of this structure reveals it was built around 500 CE and was abandoned shortly afterward.[926] Images of this heating system reveal that the *pilae* were built of circular bricks that rested on square bricks forming a base, while pillars composed entirely of square bricks were placed along the walls.[927] These pillars (the highest of which was found standing 1.0 m tall) were placed on a well-built floor of limestone slabs and once supported a no longer extant tile and mortar floor.[928] Along the walls of the heated rooms there is a series of vertical grooves that once held ceramic pipes to channel away the flue gases of the heating system.

Elaeussa Sebaste

Further examples of heating systems come from the three Roman-style baths at the ancient city of Elaeussa Sebaste, located east of Anemurium and on the eastern edge of Rough Cilicia. The site's Large Baths (Figure 27) remain unexcavated, and as a result this structure has not been firmly dated; however, it is thought to have been built no earlier than the second century CE.[929] The thermal block of this structure measures around 1000 m^2; however, this measurement does not include its associated palaestra or any remains no longer visible. In total, these baths likely

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925 Russell 1980, 264.
926 Russell 1980, 267.
927 Russell 1980, figs. 7-8.
928 Russell 1975, 125-26.
929 Spanu 1999, 103.

once covered an area over 2000 m^2. The fact that these baths have not been properly excavated has also prevented any understanding of the structure's hypocaust or *praefrunium*. The only evidence of the heating system comes from the five vertical channels set into the walls of a vaulted hall. These channels once held ceramic pipes (16 cm in diameter) and are thought to have been used for the evacuation of gasses from the hypocaust.[930]

Elsewhere at the site, the Reticulate Baths (Figure 30) also contain similar vertical channels that are set into its walls and extend through the vault covering the rooms. These channels are likewise thought to have acted as exhaust for the heating system.[931] As these baths are also unexcavated, no details of the structure's hypocaust or furnace are available. An examination of the standing remains of these baths, which measure roughly 215 m^2, has led to the conclusion that they date to between the end of the first century CE and the middle of the second century.[932]

The third baths at Elaeussa Sebaste are the Harbor Baths, which cover roughly 420 m^2 and are located next to the now silted up harbor (Figure 33). Initially constructed between the mid-first century BCE and the mid-first century CE, it is thought that this structure did not function as baths until its second phase, which predates a major renovation of the bathing complex in the mid-second century.[933] These baths have been carefully excavated, and as a result a great deal of information exists about their heating system. Several *praefurnia* were uncovered during the excavation of the baths, but their construction has not yet been published.[934] The heating system of this structure's second phase (its earliest phase as a bathing facility) is not well preserved as a

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[930] Spanu 1999, 97-98, fig. 37.
[931] Spanu 1999, 112.
[932] Spanu 1999, 113.
[933] Borgia and Spanu 2003, 299-310.
[934] Borgia and Spanu 2003, 304, n. 159.

result of subsequent renovations, but excavation nevertheless uncovered some of its extant remains. Significantly, it was discovered that this early phase used *pilae* built of square bricks that correspond to the size of the typical Roman *bessalis* (19-20 cm by 19-20 cm and 3-4 cm thick), which makes these brick a very rare example from Cilicia of a brick that conformed to standard Roman sizes.[935] Given that the masonry of this phase was partially constructed of *opus reticulatum*, this use of the Roman foot almost certainly was a result of Italian (or Italian trained) builders who evidently played a large role in this facility's construction. The hypocausts of the structure's third phase (the second phase of the baths) were all fairly similar in construction. The floors of the hypocaust were of grey mortar.[936] The *pilae* were constructed of two sizes of circular bricks (16-18 cm and 22 cm in diameter, and 5 cm thick) used together in no recognizable order.[937] In addition to these circular *pilae*, square bricks (measuring 20 cm by 20 cm and 3.5 cm thick) were used either whole or cut in half to form pillars along the walls.[938] Square bricks were also used at the top of the circular *pilae*.[939] Although much of the raised floor no longer remains extant, in places where it is preserved it is built of large tiles measuring 55 cm by 55 cm and 4-5 cm thick.[940] In the hypocaust, rectangular channels built of bricks (25 cm by 25 cm, and 4 cm thick) allowed for air to circular between adjoining rooms.[941] The wall-heating system of the Harbor Baths primarily comprised rectangular *tubuli*. These pipes (measuring 29 cm by 24.5 cm by 11 cm, and with walls 2 cm thick) were installed against many of the walls in

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[935] Borgia and Spanu 2003, 304.
[936] Borgia and Spanu 2003, 267.
[937] Borgia and Spanu 2003, 286, 289, 309, 321, figs. 200, 216, 217, 239, 245, 256.
[938] Borgia and Spanu 2003, 286, fig. 239.
[939] Borgia and Spanu 2003, fig. 245.
[940] Borgia and Spanu 2003, 323, 329, fig. 245.
[941] Borgia and Spanu 2003, 273.

the heated rooms, and in some cases were found still *in situ* during excavation (Figure 181).[942] In addition to these *tubuli* the excavators also found terracotta spacers, suggesting this technique was also employed.[943] The excellent preservation of this wall-heating system in places allowed for a much better understanding of its function than is typically possible for Roman-style baths. As reconstructed by the excavators, the columns of *tubuli* used in these baths were closed at the top and not connected to the exhaust system, which instead connected directly to the hypocaust.[944] The result, therefore, was a closed wall-heating system that relied entirely on convection currents and not on the draft of the entire system for air flow.

Although the initial bath complex may have been built with the direct involvement of Roman or Italian craftspeople (as evidenced in part by the use of *opus reticulatum*), elements of the heating system suggest that local craftspeople may have played a larger role in the subsequent renovations to the complex. The fact that several of the bricks used in the heating system (such as the large covering slabs placed above the *pilae*) differed in size from the Roman standard, led the excavators to conclude that they were likely produced by local workshops using local standards of measure.[945] The production of fired bricks based on local measures has been recorded an many other sites in Cilicia.[946] As discussed in the previous two chapters, Flat Cilicia had a longstanding tradition of manufacturing ceramic roof tiles, and this familiarity with ceramic building materials helped local industries transition to the production of bricks that supported the use of this material in walls and vaults.

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[942] Borgia and Spanu 2003, 309, 329, figs. 215, 246.
[943] Borgia and Spanu 2003, 267, 286, 330.
[944] Borgia and Spanu 2003, 329-30, fig 260.
[945] Borgia and Spanu 2003, 329.
[946] Spanu 2003, 23-22, fig. 6.

Küçük Bernaz

East of Elaeussa Sebaste and on the coast of the Gulf of Alexandretta (İskenderun), the site of Küçük Bernaz is home to two Roman-style baths that have produced some evidence of their heating systems. As both baths have not been excavated, the available information is limited to the visible remains. Furthermore, no firm date is available for their construction, but they are believed to have been built in the fourth or fifth century.[947]

During the architectural survey of the Larger Baths (measuring roughly 325 m^2) (Figure 39), a circular hypocaust brick was recorded on the surface, suggesting that its unexcavated hypocaust system comprised circular *pilae*. This brick measured 21 cm in diameter and 3.5 cm thick, while its fabric, which contained basalt inclusions, indicated that it was produced locally.[948] Beyond this brick, the only other information about the heating system comes from the flue vents embedded into the masonry of the walls, one of which contained cylindrical ceramic pipe (Figure 182).[949]

Evidence for the site's Smaller Baths is equally scarce. The visible remains of this structure measures roughly 160 m^2 (Figure 41). In its vicinity, archaeologists found three incomplete circular hypocaust bricks, again indicating that the hypocaust system contained circular *pilae*. These bricks had an estimated diameter of between 20 cm and 25 cm and a thickness of 4 cm to 4.5 cm.[950] The survey report does not make clear if these bricks are of local fabric. The walls of the Smaller Baths also contained several flue holes that served as exhaust for the heating

[947] Tobin 2004, 53-55.
[948] Tobin 2004, 51.
[949] Tobin 2004, 42, 51, figs. 37-39.
[950] Tobin 2004, 51.

system.[951] Other than these bricks and the presence of the flues, no other information about the heating apparatus will be available until a proper excavation is conducted.

Conclusions

The limited excavation of Roman-style baths in Cilicia hinders a comprehensive understanding of the materials and techniques used in the construction of heating systems in this region. Furthermore, any consideration of the effect that size had on the materials and techniques used for heating systems in this region is complicated by the lack of information regarding the hypocausts of the largest baths in Cilicia (such as the Great Baths at Antiocheia ad Cragum and the Large Baths at Elaeussa Sebaste). Nevertheless, a few general observations can be made about the materials and techniques used in the heating systems of the baths of this region.

Unfortunately, very little is known about the construction of *praefurnia* in Cilicia. There does, however, seem to be a common regional hypocaust design, in which *pilae* in the center of the room were built of circular bricks, and the *pilae* against the walls were formed by rectangular bricks, which could sit flush against the wall. *Pilae* of rectangular bricks were found against walls in baths at Iotape, Selinus, Anemurium, and Elaeussa Sebaste. *Pilae* made from circular bricks, meanwhile, are found in every hypocaust system where information is available. Even at baths that have not been excavated, such as at Küçük Bernaz, the presence of circular hypocaust bricks on the surface indicate their use in the hypocausts. The one exception to this trend is the use of square *pilae* in the earliest bath phase of the Harbor Baths at Elaeussa Sebaste. Nevertheless, the otherwise similar design of the hypocausts of this region is remarkable.

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[951] Tobin 2004, 34, 37, fig. 58.

There is also some continuity in the size of the circular bricks used in these systems, regardless of size or date of the baths. Circular bricks measuring 25 cm in diameter were used at Iotape, Küçük Bernaz, and at two baths in Anemurium, while the circular bricks of a slightly smaller size (22 cm) were used in the Harbor Baths at Elaeussa Sebaste. Significantly, this measure does not conform to the size of a *bessalis* (2/3 of a Roman foot, or 19.7 cm), which was the standard Roman brick used for *pilae* construction. As with the dimensions of the covering tile used in the raised hypocaust floor at the Harbor Baths in Elaeussa Sebaste (55 cm by 55 cm), this deviation from the Roman standard, suggests that these circular bricks were produced by local workshops using local standards of measurement. Similar deviations from Roman standard brick sizes have been noted of bricks used throughout Flat Cilicia.[952] In fact, one of the only examples of bricks that conform to Roman standard sizes are the square *bessales* that come from the earliest phase of the Harbor Baths in Elaeussa Sebaste.[953] While these early brick suggest a degree of Roman influence, Marcello Spanu, who has published a great deal on the baths and the building materials of Roman Cilicia, has posited that the earliest hypocaust bricks in Cilicia may have been produced at tile kilns that were in operation long before the advent of Roman control and the introduction of Roman-style baths.[954]

Unsurprisingly, wall-heating systems rarely survive in Cilicia as these installations are some of the first elements of the heating apparatus to fall into ruin. The best evidence for these systems in Cilicia comes from the Harbor Baths at Elaeussa Sebaste, where both *tubuli* and terracotta spacers have been found. As *tubuli* are ubiquitous throughout the Roman world, their use here is

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[952] Spanu 2003, 23-22, fig. 6.
[953] Borgia and Spanu 2003, 304.
[954] Spanu 2010, 403.

not unexpected; however, the use of terracotta spacers is. This technique for creating wall-heating systems is considerably more rare than the use of *tubuli* and is not commonly found in the eastern Mediterranean. The closest parallel for their use is at Amorium, in Phrygia.[955] The Harbor Baths at Elaeussa Sebaste have also provided a rare understanding of how the flue system connected to the heating system, suggesting that the flues did not attach to the wall-heating system but rather directly to the hypocaust.[956] It is not clear whether or not this design can be extrapolated to the other baths in the region where flue holes are clearly visible in the walls, such as Selinus, Anemurium, and Küçük Bernaz.

The Heating Systems of Roman-style Baths on Cyprus

The Roman-style baths on Cyprus have been excavated to a greater degree than those in Cilicia; however, they are not as well preserved. More problematic is the fact that none of the known 16 Roman-style baths have a final publication and the initial reports and subsequent studies do not always provide sufficient detail about the heating systems. As result, the information presented below is based on both the limited data available in publications as well as what was visible during my own personal visits to the sites.

Salamis

The ancient city of Salamis on the eastern coast of Cyprus is home to the largest bathing complex on the island, covering an area roughly 7360 m^2 (including its palaestra) (Figure 43). Excavation of this bath-gymnasium complex has revealed several phases of its construction. The Roman baths were first built under Augustus, and subsequently underwent renovations during

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[955] Koçyiğit 2006.
[956] Borgia and Spanu 2003, 329-30, fig 260.

the reigns of Trajan and Hadrian, as well as a restoration under Constantius.[957] Although completely excavated, the heating system of this massive bath complex, is not described in detail. The baths were heated by two large *praefurnia* that were located on the north and south of the building and were connected to the hypocaust via brick-built channels.[958] The hypocaust itself is not described, but excavation reports mention circular bricks, presumably alluding to the use of circular *pilae*.[959] The wall-heating system comprises rectangular *tubuli* as well as ceramic pipes that are described as being used "in the manner of *tubuli*", suggesting they may have served a heating role in addition to their role elsewhere in the structure to carry the exhaust from the hypocaust.[960]

Amathus

Much more detail is available for the heating system in the small (roughly 143 m^2) Roman-style baths at Amathus, on the island's southern coast. This well-preserved structure dates to the first or second century CE and is located on the eastern edge of the city's agora (Figure 45).[961] Its *praefurnium*, which was reached by a short flight of steps, was constructed of fired brick.[962] Adjacent to the *praefurnium* was the *caldarium* that was heated by a hypocaust comprising *pilae* of square bricks.[963] The hypocaust of the *tepidarium* has not been exposed. The *caldarium* also contained a hot water immersion pool (known as an *alveus*) that the excavators suggest was heated by means of a bronze apparatus (known as a *testudo alvei*), which worked by extending

957 Christodoulou 2014, 90.
958 Karageorghis 1967, 350; Christodoulou 2014, 91.
959 Karageorghis 1969b, 548.
960 Karageorghis 1966, 381; Christodoulou 2014, 91.
961 Christodoulou 2014, 97.
962 Karageorghis 1989, 828.
963 Aupert 2000, 42; Christodoulou 2014, 87.

the pool over the *praefurnium*).[964] The wall-heating system of the baths comprised ceramic tiles held in place vertically with ceramic spacer pins.[965] The walls of the heated rooms also contained vertical channels that acted as flues for the exhaust.[966]

Kourion

West of Amathus are the well-preserved baths at the Sanctuary of Apollo Hylates, near Kourion (Figure 47). An inscription found in the vicinity of the baths dates its construction to 101/102 CE.[967] Excavation of the structure, which covers an area of approximately 250 m^2, resulted in a detailed understanding of the heating system. The *praefurnium* was partially rock-hewn with the rest built of locally produced fired brick (Figure 48).[968] The hypocaust, which extends under the baths' three heated rooms was described in detail by the structure's excavators.[969] The floors of the hypocaust were built of bricks measuring 62 cm by 62 cm, 50 cm by 50 cm, and 50 cm by 25 cm. The walls of the hypocaust were lined with similar brick that served to protect the masonry from the intense heat. The *pilae* were of square bricks measuring 21 cm by 21 cm, and 3-4 cm thick. These *pilae* bricks are roughly equivalent to the standard *bessales*, the bricks measuring 2/3 of a Roman foot recommended by Vitruvius for this use. Above the *pilae* were placed bricks measuring 62 cm by 31 cm, which supported the raised floor comprising square bricks 31 cm by 31 cm. The wall-heating system was created via the use of a unique form of ceramic spacer pin. Rather than the nail-like spacer pins with a single groove used elsewhere on Cyprus and in Asia Minor, those used in the baths at the Sanctuary of Apollo

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[964] Karageorghis 1989, 828; Aupert 2000, 42; Christodoulou 2014, 8.
[965] Christodoulou 2014, 87.
[966] Karageorghis 1989, 828.
[967] Mitford 1971, no. 110, 214-15; Christodoulou 2010, 289.
[968] McFadden 1950, 16.
[969] McFadden 1950, 16-17, pl. 5; Scranton 1967, 59, figs. 59.

Hylates were larger, rectangular in profile, and contained two grooves (Figure 183).[970] These spacer pins, which were labelled "peg-tiles" by their excavator, functioned in the same way as the smaller versions found elsewhere, with the exception that their additional groove, located about midway along their length, served to support vertical tiles installed flush against the masonry walls. In this way, these unique spacer pins served to create a hollow void between the vertically hung tiles against the masonry walls and those hung vertically at distance from the walls. Flues cut into the walls of the heated rooms carried the draft of the heating system and allowed exhaust to escape.[971]

To the southeast of the Sanctuary of Apollo Hylates is the ancient city of Kourion, which is home to several Roman-style baths including a large (over 3000 m^2) complex on the city's acropolis, which was built in several stages starting at the beginning of the first century CE (Figure 49).[972] This bathing complex was heated by two *praefurnia* that were built of small rectangular bricks and located on the southeastern and northwestern edges of the structure.[973] The hypocausts of this baths comprise *pilae* of both square and circular brick (Figure 50).[974] The relationship between these two types is not entirely clear. Several of the walls in the heated rooms also contained *tubuli* systems.[975] During my own personal examination of these *in situ tubuli*, it was clear that they contained both a spigot and a socket end, likely a design to ensure a tighter fit. These *tubuli* are similar in form to those noted in the baths at Ayios Georgios of Peyeia, discussed below.

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[970] Scranton 1967, 60-61, figs. 60c, 61.
[971] Scranton 1967, 59.
[972] Herscher 1998, 344; Christodoulou 2014, 88.
[973] Karageorghis 1989, 829.
[974] Herscher 1998, fig. 29.
[975] Karageorghis 1989, 829; Christodoulou 2014, 88.

Paphos

On the western coast of Cyprus is the ancient city of Paphos, which is home to two known bathing suites in domestic complexes. The private baths in the House of Orpheus measure only 176 m^2 and are poorly preserved, but excavation has dated this facility to the late second to early third century CE (Figure 184).[976] The *praefurnium* of these baths remains unexcavated; however, the hypocaust was fully exposed revealing *pilae* built of circular bricks.[977] During my own personal observation of the structure, large ceramic tiles were visible lining the masonry walls to protect them from the heat of the hypocaust. Though no longer extant, excavation uncovered collapsed remains of the wall-heating system, which was created with ceramic spacer pins with a single groove (Figure 185) and ceramic tiles with holes or their corners cut to help the pins hold them in place.[978]

Nearby the House of Orpheus is the much larger Villa of Theseus, which was built at end of third century CE and reconstructed after its destruction by an earthquake in the fourth century.[979] In the southeast corner of this complex is a large bathing establishment (416 m^2), which may have been for public use given its size (Figure 186). Excavation of these baths found evidence for a bronze water tank that would have been placed above the *praefurnium*.[980] During my own personal observation of this structure, it was evident that square bricks were used to pave the hypocaust floor, while arched *pilae* were built under an immersion pool (a design likely intended

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[976] Christodoulou 2014, 92.
[977] Christodoulou 2014, 92.
[978] Christodoulou 2014, 92-93, figs. 15-16.
[979] Christodoulou 2014, 93.
[980] Christodoulou 2014, 93.

to better support the weight of the water). The rest of the hypocaust comprised *pilae* built of circular bricks.[981] Nothing of the wall-heating system remains extant.

Ayios Georgios of Peyeia

Further north on the island's western coast, archaeological investigation at the site of Ayios Georgios of Peyeia on Cape Drepanon uncovered a small (approximately 150 m^2) bathing complex dating to the fifth century CE (Figure 154).[982] Excavation of this structure revealed that its *praefunium*, built of brick, has semi-circular niches above it that likely once held a metal water tank, while the hypocaust was built with *pilae* of circular bricks. During my own personal visit to these baths, it was clear that the *tubuli* used in these baths had a spigot and socket end just like those used in the Acropolis Baths at Kourion.

Conclusions

Despite the absence of detailed excavation reports, the Roman-style baths of Cyprus do allow for a few general comments on their heating systems. The *praefurnia* of these baths are generally not well described beyond that they are brick-built. Several of these furnaces, however, provide enough evidence to infer that metal water tanks (and at Amathus a *testudo alvei*) once existed above the *praefurnia*, even though nothing of the actual tanks remain extant.

Both circular and square hypocaust bricks were found in Cypriot baths. While circular *pilae* were used in the bath-gymnasium at Salamis, the baths at Paphos, and the baths at Ayios Georgios of Peyeia, square *pilae* were employed in the baths at Amathus and the baths at the Sanctuary of Apollo Hylates. Both square and circular *pilae* were used together in the Acropolis

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[981] Christodoulou 2014, 93.
[982] Christodoulou 2014, 94.

Baths at Kourion. On the basis of this distribution, it seems that the use of square bricks for *pilae* construction on Cyprus was limited to the southern coast of the island. Unfortunately, brick measurements are only provided for those from the baths at the Sanctuary of Apollo Hylates, and thus it is difficult to consider regional types or the use of local measures as was done for Cilicia. Notably, however, the square *pilae* bricks from the baths at the Sanctuary of Apollo Hylates correspond to the typical Roman *bessales* (roughly 2/3 of a Roman foot), while the other bricks used in the facility measuring 31 cm and 62 cm are slightly larger than modules of the Roman foot (i.e. the *pes monetalis* - 0.296 m).

Two types of wall-heating systems are attested on Cyprus. *Tubuli* are attested at the bath-gymnasium at Salamis, the Acropolis Baths at Kourion, and the baths at Ayios Georgios of Peyeia. In the cases of the last two, the *tubuli* used were unlike other known *tubuli* in the Roman East, in that they had spigot and socket ends. This unique form may represent an island specific type. Ceramic spacer pins were found in the baths at Amathus, in the House of Orpheus at Paphos, and at the Sanctuary of Apollo Hylates. This sample size is too small to arrive at definitive conclusions; however, the fact that spacer pins were not used in the bath-gymnasium at Salamis and in the large Acropolis Baths at Kourion may suggest that this technique was limited to smaller baths.

The Heating Systems of Roman-style Baths in Syria

The province of Syria is home to a large number of Roman-style baths, not all of which are excavated or fully published. As was the case for the discussion on masonry techniques, the following discussion will not attempt to discuss all known examples of heating systems in the province, but will focus on the best published and preserved examples while also providing as representative a sample as possible, with examples drawn from across the province. The examples selected below largely overlap with the sites discussed in the previous chapters.

Antioch

At the ancient metropolis of Antioch, early excavations in the 1930s by Princeton uncovered the heating systems of several Roman-style baths. One of these bathing facilities was Bath A, which covered an area of roughly 800 m^2 (Figure 51). The excavators of this complex dated it to the second half of the fourth century CE.[983] There is relatively little information about this structure's heating apparatus, although the excavation report mentions a few details.[984] The baths were heated by a small *praefurnium*, and a second furnace may have also existed. The floor of the hypocaust was built of ceramic tiles and several *pilae* were found extant, but not described. The plan of the baths, however, appears to depict these *pilae* as being built of circular bricks upon a square brick as a base.[985] No other information is provided.

East of Bath A, excavators uncovered a small (ca. 150 m^2) undated bathing facility (Bath B) that may have been part of a private residence (Figure 52). Although no *praefurnium* was found, Bath B produced the remains of its hypocaust and evidence for a wall-heating system.[986] The floor of the hypocaust was constructed of ceramic bricks, some of which contained a stamp reading CKYPOY. The *pilae* resting on this floor were 67 cm tall and built primarily of circular bricks (with diameters of 26 cm) on a single square brick as a base and with several square bricks on top as caps. These pillars supported a floor built of larger ceramic bricks. The *pilae* along the

[983] Fisher 1934b, 6-7.
[984] Fisher 1934b, 5.
[985] Fisher 1934b, pl. III.
[986] Fisher 1934c, 8-9, figs. 2, 7.

edge of the hypocaust were constructed of circular bricks built into the wall to ensure proper spacing between pillars. *Tubuli* were also found within the tumble of the hypocaust, suggesting the use of this technique for wall-heating.

The largest bathing complex excavated at Antioch was the monumental Bath C (ca. 2600 m^2) (Figure 53), which was heavily despoiled to the point that even *pilae* from the hypocaust were removed for use elsewhere. It was initially thought that these baths were built in the second half of the fourth century CE overtop the ruins of early second century baths.[987] A re-dating of this structure, however, has suggested that the initial baths were constructed in the early or mid-third century and then underwent major renovations in the fourth century.[988] The excavators of these baths uncovered two heating systems built on top of each other. The earlier system comprised a hypocaust possibly 1.40 m high that was built of circular *pilae* bricks resting on a square brick as a base.[989] This hypocaust was purposefully filled in to create the foundation for the later structure. Traces of a *tubulus* wall-heating system was also found associated with this earlier phase.[990] Much more survived of the second phase of the baths, despite the largescale removal of its building material. The *praefurnia* associated with this phase were built of brick[991] and had brick vaulting.[992] The hypocausts were connected to each other by means of brick flues, at least one of which was found in an excellent state of preservation (Figure 187).[993] The floors of the hypocaust were paved with bricks measuring 35 cm by 35 cm, above which the *pilae* (standing 1

[987] Fisher 1934a, 31.
[988] Yegül 1992, 326; 2000, 150, n. 9.
[989] Fisher 1934a, 25-26, figs. 13-14.
[990] Fisher 1934a, 25.
[991] The brick of one of these *praefurnia* measured 34 cm by 34 cm by 4.5 cm thick, while those used in the others ranged in size from 35 cm by 35 cm to 37.5 cm by 37.5 cm, with thicknesses of 3 to 3.5 cm.
[992] Fisher 1934a, 27-8, fig. 20
[993] Fisher 1934a, 28, fig. 22.

m tall) were built of circular bricks (32 cm in diameter and 4 cm thick) and rested on one to three square bricks as a base.[994] Nothing of the wall-heating system remains *in situ*; however, the discovery of *tubuli* in the hypocaust debris suggests that this technique was employed, while the remains of the walls have vertical flues that likely carried the exhaust of the entire system as mentioned above.[995]

Although the three discussed Antiochene baths are not fully described and differ greatly in size, their heating systems display similar techniques of construction. For example, while the sizes of bricks differ, the *pilae* of all three baths were built with circular bricks resting on a square brick as a base. *Tubuli* were also used in Bath B and in the two known phases of Bath C. Unfortunately, the absence of more information prevents further comparison regarding the construction of the *praefurnia* or other elements of the baths' heating systems.

Apamea

At the ancient city of Apamea, south of Antioch, excavation uncovered the remains of two Roman-style baths, one of which is the so-called Northeast Quarter Baths, which covers an area of about 425 m^2 (Figure 55). Located at the city's northern gate, these baths were initially constructed in the second century CE and subsequently underwent several renovations in the following centuries.[996] The original second century CE heating system was completely replaced in these later renovations and does not survive in the archaeological record. Excavation did uncover the later *praefurnium*, which dates to the fourth century CE and was constructed entirely of brick, including its vaulted chamber, which was built of brick laid edgewise in mortar. Much

[994] Fisher 1934a, 26-27, fig. 19.
[995] Fisher 1934a, 28.
[996] Paridaens and Vannesse 2014, 335; Vannesse 2015, 102.

of the hypocausts that remain visible today date to major renovations of the sixth century, which saw the construction of *pilae* built of both square and circular bricks and a brick *praefurnium*.[997] It is not clear if use of both square and circular hypocaust bricks was a result of reusing bricks from the earlier phases.

South of the Northeast Quarter Baths are the Baths of L. Julius Agrippa (Figure 57), which were constructed shortly after the devastating earthquake of 115 CE.[998] Roughly 800 m^2 of these baths have been uncovered, but it may have once been as large as 2500 m^2.[999] Only partially excavated, this bathing facility is described as having a brick hypocaust and *tubuli* system.[1000] Nothing else about the heating apparatus of these baths is recorded.

Zeugma

Northeast of Antioch, on the western bank of the Euphrates is the site of Zeugma, now covered by the reservoir of the Birecik Dam. Excavations at the site have located or partially uncovered numerous Roman-style baths.[1001] Only one of these baths, however, has been fully excavated and published. This structure, found during the construction of the dam, measures roughly 200 m^2 and is thought to date to the early third century CE (Figure 59).[1002] The excavation of these baths uncovered a well-preserved heating system.[1003] *Praefurnia* were located on the northern and southern edge of the facility; however, neither were described in detail. These furnaces were connected to the hypocaust system via long horizontal flue channels

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[997] Paridaens and Vannesse 2014, 343, figs. 22, 24.
[998] Balty 1988, 91-92.
[999] Fournet 2012b, 233.
[1000] Vannesse 2015, 98.
[1001] Aylward 2013, n. 150.
[1002] Ergeç and Önal 1998, 429-30.
[1003] Ergeç and Önal 1998, 420-21.

built of thin bricks.[1004] In one of the heated rooms, the hypocaust contained 25 extant *pilae* (16 of which were circular, and nine were square) that measured 80 cm in height (Figure 188). The circular *pilae* were built of circular bricks (30 cm in diameter) with square bricks as bases and caps.[1005] These *pilae* supported large ceramic bricks measuring 60 cm by 60 cm. A second circular heated room contained circular *pilae* resting on square bricks (Figure 188).[1006] Excavation also uncovered elements of the wall-heating system in the form of *tubuli*.[1007]

The diameter of the circular bricks (30 cm) and the dimensions of the covering bricks (60 cm by 60 cm) from the hypocaust correspond well to the Roman foot, suggesting that this unit of measure may have been used for their production. This possible use of the Roman foot is not surprising, as numerous tile stamps found in the site's environs indicate that the Roman military was producing ceramic building material in the region.[1008] These military kilns may have been the source of the hypocaust bricks used in these baths or may have influenced local production of the material.

Athis (modern Dibsi Faraj)

The site of Athis was located east of Aleppo on the right bank of the Euphrates River and was flooded after the construction of the Tabqa Dam and the creation of its reservoir. Excavations at the site before its flooding uncovered the remains of three Roman-style baths. One of these baths was a bathing suite located in the so-called *principia*, which post-dates the Diocletianic fortifications and covers an area of 500 m^2 (Figure 60). Not much detail exists about

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[1004] Ergeç and Önal 1998, fig. 5.
[1005] Ergeç and Önal 1998, figs. 3, 4.
[1006] Ergeç and Önal 1998, fig. 6.
[1007] Ergeç and Önal 1998, fig. 23.
[1008] Wagner 1977, 525-26, fig. 2; Kennedy 1998, 133-35.

the heating system of these baths other than then the fact that they were heated by three *praefurnia*, they contained a “deep” hypocaust system that appears to be built of circular *pilae* bricks, and they had a wall-heating system of *tubuli* (Figure 61).[1009] Relatively little is known about the other two extramural baths. The published report only mentions that, in the heating system from the fourth century CE public baths (600 m^2), brick was used to protect the limestone masonry from heat damage.[1010]

Dura Europos

The ancient city of Dura Europos, located on the western bank of the Euphrates River, is home to four known Roman-style baths, three of which (Baths E3, C3, and M7) display similar construction methods and techniques that extended to their heating systems. Bath E3 covers an area of approximately 625 m^2 and is dated to between 210 and 215 CE (Figure 64).[1011] Unlike some of the other Roman-style baths in Syria, its heating system is described in detail by its excavators.[1012] These baths are heated by two *praefurnia*, both of which were roofed by *bipedales*. One of these furnaces had a brick-vaulted flue leading to the hypocaust and a semicircular opening that likely once held a *testudo alvei* that served to heat the water of an immersion pool. The floor of the hypocaust comprised square ceramic bricks 37-39 cm by 37-39 cm, which supported the *pilae*. These pillars were constructed with a base of two square bricks 30-34 cm by 30-34 cm, a column of nine circular bricks 24-26 cm in diameter and 4-5 cm thick, and two square capping bricks 41-44 cm by 41-44 cm and 4-5 cm thick. The mortar joints

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[1009] Harper and Wilkinson 1975, 329, pl. 6a.
[1010] Harper and Wilkinson 1975, 329.
[1011] Brown 1936a, 104.
[1012] Brown 1936a, 93-4, pls. XV.3 and XVI.1.

between these bricks were 2-3 cm thick. Along the walls, the pillars were of whole and half bricks (of the type measuring 30-34 cm by 30-34 cm). The *pilae* were placed 58-60 cm apart and supported square bricks 58-60 cm by 58-60 cm (*bipedales*), above which was a layer of "concrete" 18 cm thick. Flues cut into the walls connected the hypocaust systems of each room. Nearly all walls of the heated rooms were covered with *tubuli* (Figure 189).[1013]

At roughly 900 m^2, Bath C3 was the largest of the baths at Dura Europos and, like Bath E3, is dated to between 210 and 215 CE (Figure 63).[1014] The heating system of these baths is also described in detail in the preliminary excavation report.[1015] Bath C3 had three rooms (Rooms II, III, and C) that were heated by two *praefrurnia*, which were largely undescribed other than that their flues were roofed by corbeling with *bipedales* placed on top. The floor of the hypocaust was paved with square bricks 37-39 cm by 37-38 cm. The *pilae* comprised a base of two square bricks 30-34 cm by 30-34 cm, eighteen circular bricks 30-32 cm in diameter (notably larger than in the other baths), and two square capping bricks (the first 30-34 cm by 30-34 cm, and the second 40-42 cm by 40-42 cm). Just like in Bath E3, the hypocaust pillars were set 58-60 cm apart and supported square bricks 58-60 cm by 58-60 cm. Above these *bipedales* was a layer of "concrete" 16 cm thick. The *tubuli* used in Bath C3 were of the same size as those used in Bath E3.[1016]

Bath M7 (roughly 375 m^2) has often been grouped with Baths E3 and C3 because of its similar construction methods, and like these other two baths has been dated to between 210 and

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[1013] These *tubuli* measured 35-37 cm by 21-23 cm by 15-17 cm and had walls 2-3 cm thick.
[1014] Brown 1936a, 104.
[1015] Brown 1936a, 99, pls. XVI.2-.3.
[1016] The *tubuli* used in Bath C3 measured 35-37 cm by 21-23 cm by 15-17 cm and had walls 2-3 cm thick.

215 CE (Figure 65).[1017] Unlike the other two baths, however, Bath M7 has two distinct heating systems, one of which is peculiar in design. Heated by a brick-built *praefurnium*, the heating apparatus of Room I did not use a typical hypocaust of raised pillars, but rather a long barrel vault that ran the length of the room under the floor.[1018] As the excavators of these baths noted, this system would have heated the floor unevenly, as the center of the room's floor (along the apex of the underfloor vault) would have been hottest, with the heat gradually diminishing towards the side walls where the subfloor vault was thickest. This form of heating apparatus seems to have been unique in the Roman East. The hypocaust systems of the other heated rooms in Bath M7 (Rooms II, III, and C) are more traditional in their construction, which is fortunately described in detail.[1019] These rooms were heated by two *praefurnia*, the construction materials and techniques of which are not described but are likely of fired brick. The hypocaust floors were paved with square bricks measuring 30-34 cm by 30-34 cm. The *pilae* comprised two or three square bricks 30-34 cm by 30-34 cm as a base, a column of circular bricks 24-26 cm in diameter and 4-5 cm thick, and one to three square bricks 37-39 cm by 37-39 cm as a cap. The mortar joins were 4-5 cm thick. Along the walls, whole or half square bricks of the 30-34 cm type were used as pillars. The *pilae* were set 58-60 cm apart and supported square bricks 58-60 cm by 58-60 cm. Above these *bipedales* was a layer of "concrete" 18 cm thick. *Tubuli* were installed against all the walls of Rooms II, III, and C.[1020] A vertical flue vent was placed in the middle of the north wall of Room II.

[1017] Brown 1936a, 104.
[1018] Brown 1936a, 86, pl. IV.
[1019] Brown 1936a, 87-88, pls. XV.1-XV.2.
[1020] These *tubuli* measured 35-37 cm by 21-23 cm by 15-17 cm and had walls 2-3 cm thick.

The fourth bath structure found at Dura Europos (Bath F3) differs significantly from the others at the site in terms of its construction materials and techniques (Figure 67). These baths (measuring roughly 300 m^2) were initially dated to the third quarter of the first century CE, but they have been re-dated after a reexamination of the construction materials and techniques to between 165 and 216 CE.[1021] The heating apparatus of Bath F3 is described in its preliminary excavation report.[1022] Heat was supplied by two *praefurnia*. The hypocaust floor was constructed of square bricks 36-38 cm by 36-38 cm and 4.5-5 cm thick that were laid over a layer of ash plaster. These floors sloped towards the *praefurnia*, precisely as Vitruvius recommends.[1023] The edges of the hypocaust system were covered by walls of half bricks to protect the masonry from heat damage. The *pilae* were 1.30 m high and were built of square bricks 26-27 cm by 26-27 cm and 4.5-5 cm thick, with thick mortar joints. Occasionally, one, two, or three capping bricks 36-38 cm by 36-38 cm and 4.5-5 cm thick were placed above the pillars, which were spaced 58-60 cm apart to carry square bricks 58-60 cm by 58-60 cm and 5-6 cm thick. Above these *bipedales* was a layer of gypsum mortar 8-11 cm thick. The wall-heating system used *tubuli* that measured 26 cm by 16 cm by 17 cm, with walls 2.5 cm thick. The walls of the baths also contained ceramic flue pipes that carried the exhaust and draft of the entire system.[1024]

An overview of the heating systems found in the baths of Dura Europos reveals that they are all similar in terms of their construction (see Table 2). This similarity is especially true in the case of Baths E3, C3, and M7 (with the exception of the unique system under Room I in Bath

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[1021] Pollard 2004, 142.
[1022] Brown 1936b, 52-53.
[1023] Vitruvius recommends that the floor be laid in such a way, *uti pila cum mittatur non possit intro resistere sed rursus redeat ad praefurnium ipsa per se* "so that if a ball is thrown into it, it does not remain at rest, but automatically rolls towards the furnace" (*De Arch*. 5.10.2).
[1024] Brown 1936b, 52-53.

M7). These three baths largely used the same sizes of bricks (although some variation did exist) and were also built with circular *pilae*. Bath F3 used comparable bricks of slightly different sizes and had only *pilae* of square brick. Several of these bricks roughly adhere to modules of the Roman foot.[1025]

Table 2: Brick sizes used in the baths at Dura Europos (according to Brown 1936a; 1936b).

	Bath E3	**Bath C3**	**Bath M7**	**Bath F3**
Praefurnia	Uncertain, "*bipedales*"	Uncertain, "*bipedales*"	Uncertain	Uncertain
Hypocaust Floor	Square bricks: 37-39 cm^2	Square bricks: 37-39 cm^2	Square bricks: 30-34 cm^2	Square bricks: 36-38 cm^2, 4.5-5 cm thick
Hypocaust walls	None/not described	None/not described	None/not described	"halved bricks"
***Pilae* bases**	Square bricks: 30-34 cm^2	Square bricks: 30-34 cm^2	Square bricks: 30-34 cm^2	None
***Pilae* columns**	circular bricks: 24-26 cm in diameter, 4-5 cm thick	circular bricks: 30-32 cm in diameter	circular bricks: 24-26 cm in diameter, 4-5 cm thick	Square bricks: 26-27 cm^2, 4.5-5 cm thick
***Pilae* caps**	Square bricks: 41-44 cm^2, 4-5 cm thick	Square bricks: 30-34 cm^2 and 40-42 cm^2, 4-5 cm thick	Square bricks: 37-39 cm^2	Square bricks: 36-38 cm^2, 4.5-5 cm thick
***Pilae* along walls**	Whole or half square bricks: 30-34 cm^2	None/not described	Whole or half square bricks: 30-34 cm^2	None/not described
Covering bricks above *pilae*	"*bipedales*": 58-60 cm^2	"*bipedales*": 58-60 cm^2	"*bipedales*": 58-60 cm^2	"*bipedales*": 58-60 cm^2, 5-6 cm thick
Tubuli	35-37 cm by 21-23 cm by 15-17 cm, walls 2-3 cm thick	35-37 cm by 21-23 cm by 15-17 cm, walls 2-3 cm thick	35-37 cm by 21-23 cm by 15-17 cm, walls 2-3 cm thick	26 cm by 16 cm by 17 cm, walls 2.5 cm thick

[1025] Pollard 2004, 135, n. 8.

While all the baths had wall-heating systems of *tubuli*, Baths E3, C3, and M7 seem to have used a similar size of *tubulus* that was slightly larger than those used in Bath F3. The original excavators of the Dura Europos baths were certainly correct in their assessment that Baths E3, C3, and M7 display similar construction techniques; however, the heating system of Bath F3 still adheres to the materials and techniques used throughout the Roman East.

Baalbek

On the western side of Syria, excavation in the ancient city of Baalbek uncovered a large bathing complex (ca. 5000 m^2), which was likely initially constructed in the second century CE (Figure 70).[1026] The heating system of these baths has not been thoroughly assessed, largely because of its poor preservation. Nevertheless, images of the hypocaust system show that it was constructed of *pilae* using square bricks (Figure 190).[1027] Nothing else of the heating apparatus is recorded.

Beirut

To the west of Baalbek, excavation in the city center of Beirut uncovered a large bathing complex that retained poorly preserved elements of its hypocaust system. Roughly 1700 m^2 of these baths have been uncovered, but this complex may have once been as large as 8000 m^2 (Figure 71).[1028] The excavation of this structure has demonstrated that it underwent multiple renovations as well as reconstructions, and its complete phasing has yet to be finalized.[1029] The *praefurnia* of these baths are not described in detail, and the rest of the heating system is heavily

[1026] Brünenberg 2009, 191.
[1027] Brünenberg 2009, 198, figs. 4, 8; 2014, fig. 10.
[1028] Fournet 2012b, 233.
[1029] Thorpe 1998, 70-71, 75-78.

damaged. The hypocaust floor of one heated room (Room 2) was constructed using circular *pilae* bricks, although it is unclear if these bricks were reused from *pilae* of an earlier phase.[1030] The floor of another hypocaust, which has tentatively been dated to the fifth century CE, was paved with "*pedales*" (*i.e.* brick measuring one Roman foot square) with imperial stamps of INIMA~ or INIBAΓPA.[1031] The *pilae* found in these baths were constructed of circular bricks with bases of square bricks.[1032] Excavation also uncovered several *pilae* buttressed by brick or pottery embedded in mortar, likely an attempt to repair or stabilize failing pillars.[1033] The excavation reports make no mention of wall-heating systems for these baths, other than to state that no such systems were found associated with the earliest phase of the structure, the date of which remains uncertain.[1034]

Sha'arah

Further south, in the volcanic Hauran region, the site of Sha'arah is home to a public bathing facility that has been dated by excavation to between the end of the second century and the start of the third century CE (Figure 72).[1035] The footprint of these baths stretches over roughly 950 m^2. Its heating system was largely removed after its thermal function ceased; however, excavation did uncover a few surviving elements. The *praefurnium*, built of brick, was found to have been built with a base above it to receive a metal boiler that supplied hot water to a heated immersion pool.[1036] The hypocaust floor was paved with brick measuring 40 cm by 33 cm that

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[1030] Butcher and Thorpe 1997, fig. 10; Thorpe 1998, 71, fig. 20.
[1031] Butcher and Thorpe 1997, 304.
[1032] Butcher and Thorpe 1997, fig. 10; Thorpe 1998, fig. 22.
[1033] Butcher and Thorpe 1997, 304.
[1034] Thorpe 1998, 69
[1035] Fournet 2010, 317.
[1036] Fournet 2008a, 161, 164, fig. 11.

were laid on a bed of mortar and small basalt stones.[1037] Nothing of the *pilae* remains *in situ*, as they seem to have been purposefully removed. Excavation did, however, find large quantities of fragmented *pilae* bricks (of unspecified size and shape), *tubulus* fragments and a reused *bipedalis* that almost certainly was originally used in the raised floor.[1038] The presence of these *tubulus* fragments indicates their use in the wall-heating systems that covered the walls of the heated rooms. All the heated rooms also contained vertical flue vents that carried the exhaust and draft of the system.[1039]

Philippopolis (modern Shahba)

The monumental bathing complex at ancient Philippopolis covers an area of around 5500 m^2 and was built during the reign of Philip (241-245 CE) (Figure 74). As these baths have not been excavated, very little is known about the heating system, particularly the hypocaust. Nothing of the wall-heating system survives; however, traces of the fixtures that once held in place the *tubuli* attest to the use of this technique.[1040] The massive walls of this structure may also display evidence for the baths' exhaust system. Early explorers of these baths noted the presence of vertical channels in the walls, which they assumed to be for water pipes.[1041] Alternatively, these grooves may have held ceramic pipes for the flues of the heating system.

Selaema (modern Salim)

The Roman-style baths located in the town of Selaema (modern Salim), which is south of ancient Philippopolis, are now used as a residence (Figure 76). On account of its continued

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[1037] Fournet 2008a, 164.
[1038] Fournet 2008a, 164.
[1039] Fournet 2008a, 160-61, fig. 10.
[1040] Fournet 2012b, 204.
[1041] Butler 1903, 385.

occupation, this structure has not been excavated; however, it has tentatively been dated to the late first century CE, making it possibly the earliest known Roman-baths in southern Syria.[1042] The extant remains of this structure measures approximately 200 m^2, and as it has not been excavated, not much is known about heating system of these baths. Fortunately, the hypocaust bricks removed from the structure by the great-great-grandparents of the current inhabitants were still available for study by the investigators of these baths (Figure 191).[1043] The square bricks retrieved from this sample had a diagonal cross made with fingers that ran from corner to corner and measured 40 cm by 40 cm and 3.5 cm thick. The circular bricks likewise had crosses on their upper surface made by fingers, and they measured 22 cm in diameter with a thickness of 4 cm. These finger grooves likely helped the bricks grip the mortar. Examination of the interior walls of the heated rooms noted 15 cm projections of the masonry that are thought to give the depth of the wall-heating system, which the investigators assumed was built of *tubuli*.[1044] Vertical flue vents for the heating system were still extant in the walls, and inside one of these vents a ceramic tube is still visible.[1045]

Kanatha (modern Qanawat)

To the southwest of Selaema is the site of Kanatha (modern Qanawat), home to a medium sized Roman-style bathing facility, the visible remains of which occupy an area of over 300 m^2 (Figure 78). Excavation of these baths has suggested they were initially constructed in the first half of the second century CE.[1046] Very little of the construction of the *praefurnium* is recorded

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[1042] Fournet 2010, 331.
[1043] Fournet 2010, 327.
[1044] Fournet 2010, 327.
[1045] Fournet 2010, 326, fig. 14.
[1046] Peuser 2000, 229.

other than the fact that it led to the hypocaust via a brick-vaulted flue.[1047] The walls of the hypocaust were lined with large bricks (47-50 cm long) to protect the masonry from the heat, while at least one heated room (Room A) had two distinct floors on which the *pilae* stood: a lower floor predominantly made of square bricks (27 cm by 27 cm and 3.5 cm thick), and an upper floor built at a later date with bricks of different sizes (e.g. 57 cm by 57 cm; 27 cm by 27 cm; 38 cm by 38 cm).[1048] Unfortunately, the construction of the *pilae* was not described in detail, nor were any brick measures given. The *pilae*, some of which were completely preserved, were only described as being both circular and square; however, the published plan of the baths suggests that many of the *pilae* in the center of the room were circular, while short walls of square bricks projected from the walls of the heated rooms.[1049] The baths' wall-heating system was constructed with *tubuli*, some of which were still preserved *in situ* against the walls.[1050] The walls of the heated rooms also contained vertical channels that carried the exhaust of the heating system. In one of these flue vents, a ceramic tube with a diameter of 12 cm is still preserved.[1051]

Seia (modern Sīʿ)

Southwest of Kanatha , the sanctuary site of Seia (modern Sīʿ) was home to a possible bathing facility that was never excavated (Figure 80). These baths, measuring 437 m^2 and roughly dated to the Roman period, were described as having ceramic pipes embedded within the walls.[1052] It is possible that these pipes once formed the flues for the heating system. Having not

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[1047] Peuser 2000, 227.
[1048] Peuser 2000, 224.
[1049] Peuser 2000, 224, 226, fig. 1, pl. 45a.
[1050] In Room C, the *tubuli* measured 33 x 17 x 12 cm (Peuser 2000, 226), while in Room D, they measured 33 x 19 x 13 cm (Peuser 2000, 227).
[1051] Peuser 2000, 226.
[1052] Butler 1919, 399.

been excavated, this theory remains unproven, and nothing further of the facility's heating system is known.

Conclusions

The published detail on the materials and construction techniques used in the heating systems of Roman-style baths of Syria varies widely between sites. While sites such as Dura Europos and Kanatha (modern Qanawat) are described in great detail, others such as Beirut or Baalbek are not. Nevertheless, it is still possible to observe some general patterns of construction.

The construction of *praefurnia* is rarely described beyond the fact that they are often built of brick. Evidence for a *testudo alvei* was found in Bath E3 at Dura Europos, and evidence for a metal boiler was found at Sha'arah. It is certain that all other baths also once had similar water heaters above the *praefurnium*. As is typical, the hypocaust floors of all baths (where it is described) were paved with ceramic bricks. In the case of the baths at Beirut, the floor was paved with circular *pilae* bricks that may have been reused. Regarding the construction of *pilae*, almost all of the baths described above used circular brick, with the exception of the Northeast Quarter Baths at Apamea, the baths at Zeugma, Bath F3 at Dura Europos, and the baths at Baalbek, where square brick *pilae* were found. In the baths discussed from Antioch, Zeugma, Dura Europos, and Beirut, circular *pilae* also had bases or caps of square bricks. In a few cases, the *pilae* along the walls were of different construction than those in the center of the hypocaust. In Baths E3 and M7 at Dura Europos, these *pilae* were entirely of whole or halved square bricks rather than circular brick, while at Kanatha the pillars along the edge were in fact short walls of square brick that projected perpendicularly from the edges.

The dimensions of bricks used in hypocausts are unfortunately not always provided, making it difficult to observe types or patterns of use. In the case of circular *pilae* bricks, it is notable that the hypocaust systems at Antioch and Dura Europos each use two distinct sizes of circular bricks that are comparable between the sites.[1053] Elsewhere, at Selaema (modern Salim), the circular bricks are smaller in size (22 cm in diameter). Square bricks display an even greater range of variation, both within a given site (such as at Dura Europos) and between sites. A much more detailed study will be necessary in order to identify patterns of use and typologies of this material. In the cases where hypocaust bricks seemingly adhere to Roman units of measure (for example at Dura Europos and Zeugma), there may have been greater involvement of nonlocal craftspeople, such as those attached to the Roman military. For much of this region, however, the range of sizes suggests that no single measuring system was used. Further investigation will be needed to determine if this variation reflects the use of local systems of measurement.

Tubuli were the only wall-heating technique mentioned in excavation reports, and thus it seems this method was the dominant choice. These heating pipes, however, are not described in enough detail to comment on regional variation or to consider a typology. Judging from the limited descriptions and the published images, it seems likely that all of these *tubuli* were of the standard slab-made technique. As to be expected, vertical channels were described in almost all the baths in Syria discussed above. In a few cases, ceramic pipes were still present in these flue vents.

This corpus of baths is not ideally suited to inform a comprehensive understanding of the extent to which the size of the baths affected the construction of the heating system. The site of Antioch is best suited for such an analysis; however, the small sample size and the limited information on the heating apparatus of Bath A limits what can be observed. In general, the

[1053] For Antioch: a small size of 26 cm in diameter and a large size of 32 cm in diameter. For Dura Europos: a small size of 24-26 cm in diameter and a large size of 30-32 cm in diameter.

Antiochene baths suggest that size was not a major factor affecting the construction of the heating system, as all three baths were built using similar materials. One possible difference is in the height of the hypocaust systems. Whereas the hypocausts of Bath B were 0.67 m tall, in the much larger Bath C, the pilae were preserved up to 1 m tall and the hypocaust may have been up to 1.4 m in height. In the Hauran to the south, a similar comparison of baths sizes is hindered by the fact that the largest baths in this area, such as the one at Philippopolis and those at Bosra (to be discussed below), have not been fully excavated, and thus very little is known about how their heating systems differ from the smaller baths in the region.

The Heating Systems of Roman-style Baths in Judea

Compared to the previously discussed regions, there are far more detailed descriptions of the heating systems of baths in the province of Judea; however, the availability of information still depends on the level of preservation and the extent of excavation. This region is also significant, because, through its Herodian period baths, it is home to some of the earliest heating systems comprising full-floor hypocausts and wall-heating in the Roman East. These facilities, therefore, present an interesting view of how the builders of these early baths grappled with constructing these complex heating systems. Judea is also home to several thermal baths, such as the complex at Hammat Gadar. Although these well preserved and published baths were discussed in detail in previous chapters, they will not be discussed below as this bathing facility had no hypocaust and was instead heated naturally through adjacent hot springs.

Hippos-Sussita

The Decapolis city of Hippos-Sussita, is located to the east of the Sea of Galilee and is home to at least three known Roman baths; however, only one of these baths (the Southern Bathhouse) has been extensively excavated (Figure 81). Extending over an area of at least 1050 m^2 along the city's southern wall, this bathing facility was constructed sometime in the second century CE.[1054] Excavation of this structure uncovered three separate *praefurnia*.[1055] These furnaces were covered by basalt arches and were built of basalt and limestone blocks. Holes in the masonry walls adjacent to these *praefurnia* suggest that water tanks originally sat above them and fed hot water via pipes to the heated rooms. Unlike the *praefurnia*, the hypocausts that existed in the facility's four heated rooms were largely constructed of brick.[1056] The floors of the hypocaust were paved by square bricks of different sizes (20 cm square, 26 cm square, and 30 cm square) laid over a levelling of cement and plaster. Despite basalt's ability to withstand high heat (as evidenced by its use in the construction of the *praefurnia*) the basalt walls of the hypocaust were lined with brick.[1057] The hypocaust *pilae* stood to a height of 1.25 m and display a wide range of variation. Both circular and square bricks were used in their construction, and in one image, circular bricks are visibly placed on a square brick as a base (Figure 192).[1058] Where extra support was needed (such as under pools), large rectangular piers of irregular sizes were constructed of square bricks. In a few other cases, arched piers were found.[1059] The type of hypocaust pillar varied by room, with rectangular pillars found in Hall 3, circular *pilae* in Hall 5, and a mixture of techniques in Halls 1 and 6. The excavators of these baths suggested this mixture of techniques was the result of repair to the system. The fact that the hypocaust of Hall 3 was filled in during a renovation suggests that the technique of using large rectangular hypocaust pillars may have been early in date, although this possibility is not fully explored by the

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[1054] Kowalewska 2019b, 274.
[1055] Kowalewska 2019b, 265, 268, fig. 5.
[1056] (Kowalewska 2019a, 171-72; 2019b, 268-69.
[1057] Kowalewska 2019a, fig. 4.46.
[1058] Kowalewska 2019b, figs. 8, 10.
[1059] Kowalewska 2019b, fig. 9.

excavators.[1060] The *pilae* were placed with gaps of 30 cm between them, and they supported large covering bricks measuring 50 cm square and 6 cm thick. The wall-heating system of the baths was constructed from slab-made *tubuli* that ranged in size between 24 cm by 17 cm by 12 cm and 30 cm by 20 cm by 14 cm (Figure 193).[1061] Nothing is mentioned of vertical flue vents in the walls of these baths; however, it is certain that they did contain an exhaust system of some kind.

Gadara (modern Umm Qais)

South of Hippos-Sussita is the ancient Decapolis city of Gadara (modern Umm Qais). Although this site is home to several Roman-style baths, only one has been extensively excavated and fully published. The so-called Byzantine Baths (Figure 85), which extend over 2300 m^2, were initially constructed in the early fourth century CE and subsequently underwent repair after a devastating and undated earthquake.[1062] Very little of the heating system from the initial phase remains, but that which does is notable. Curiously, the first phase of the Byzantine Baths saw the construction of the hypocaust almost entirely out of basalt monoliths. This heat-resistant material was used for both the *pilae* (Figure 194), the slabs of the *suspensura*, and the flues from the *praefurnia*.[1063] Although stone *pilae* are found in early Herodian baths, this later use of this material is relatively rare and suggests that this locally available stone was cheaper and easier to acquire and use than brick. As noted in the previous chapters, deeply entrenched stone cutting industries may have also played a part in selecting the material to be used. Only one

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[1060] Kowalewska 2019b, 272.
[1061] Kowalewska 2019b, 269, fig. 10.
[1062] Holm-Nielsen et al. 1986, 220.
[1063] Holm-Nielson et al. 1986, 220, 225-26; Nielson et al. 1993, 133, pl. 9.B.

praefurnium from this initial phase was excavated. It was constructed of both brick and basalt, and there is clear evidence for a boiler that had once been placed in front of the *praefurnium* vault as indicated by the traces it left on the stone.[1064] In total, these baths had about ten *praefurnia*, many of which seem to have had an associated boiler or *testudo alvei*.[1065] After being partially destroyed by an undated earthquake, the heating system was rebuilt, retaining much of the earlier hypocaust system but with brick being used for many of the repairs.[1066] For example, the hypocaust floor of this phase was paved with square bricks measuring 25 cm by 25 cm. In other places, the basalt pillars of the first phase were used to pave the hypocaust floor. The *pilae* of this phase were largely built entirely of square bricks (measuring 25 cm by 25 cm), although in some cases, bricks were simply stacked on preexisting basalt pillars as a repair or to raise them. Ceramic bricks were also used to line the walls of the hypocaust as a protection against excessive heat. Several of the heated rooms had wall-heating systems of *tubuli*, many of which were 43 cm high, 25 cm wide, and 14.5 cm deep.[1067] One *tubulus* collected from these baths measures 26 cm by 16.5 cm by 14.5 cm and appears to have been slab-made.[1068] *Tubuli* collected from elsewhere at Gadara were also found to be slab-made, suggesting this manufacturing technique was commonly used here.[1069] The heated rooms also contained vertical flue vents cut into the walls to carry the exhaust of the entire heating system.[1070]

[1064] Nielson et al. 1993, 123.
[1065] Holm-Nielson et al. 1986, 226; Nielson et al. 1993, 123, 133.
[1066] Nielson et al. 1993, 124, 137-38.
[1067] Holm-Nielson et al. 1986, 220, 224-25; Nielson et al. 1993, 122, pl. 9.C-10.A.
[1068] Nielson et al. 1993, 191, 265, no. 294.
[1069] Vriezen and Mulder 1997, 330, fig. 12.
[1070] Nielson et al. 1993, 122.

Pella

Much less information is available about the heating system of the Roman-style baths at Pella, south of Gadara. Located in a wadi valley overlooking the east bank of the Jordan River, only about 200 m^2 of this site's bathing complex has been uncovered (Figure 87). The baths, which were initially constructed in the first century CE, are located in an area with an extremely high water table, and thus excavation was not able to reach the level of the hypocaust.[1071] Evidence of this heating system, however, comes from an excavated water channel that was partially built of reused circular hypocaust bricks.[1072] The presence of these distinctive bricks indicate that the baths very likely had at one point a hypocaust of circular *pilae*. Unfortunately, this is the only information about the heating system that could be gleaned from the facility's partial excavation.

Scythopolis (modern Bet She'an)

Located west of the Jordan River and only 12 km northwest of Pella, the ancient Decapolis city of Scythopolis (modern Bet She'an) is home to several Roman-style baths that still preserve elements of their heating systems. The large Eastern Baths occupied an area no less than 4900 m^2 on the eastern edge of the city center (Figure 89). This structure is not fully exposed, and its dating is not entirely clear. It has been suggested that it was initially constructed in the first century CE and was thoroughly rebuilt in the second century.[1073] Elsewhere, it is dated to the second century CE with renovations taking place in the late fourth century.[1074] Regardless of

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[1071] Smith and Day 1989, 18.
[1072] Smith and Day 1989, 12, 14.
[1073] Tsafrir and Foerster 1997, 98.
[1074] Mazor and Bar-Nathan 1998, 12

date, excavation of this bathing complex did not uncover much of its heating system. From its initial phase, both a hypocaust system and *tubuli* were found associated with the structure's *caldarium*, but neither have been described.[1075] Excavation also uncovered a limestone-built "furnace" from the structure's later phase; however, no additional information is provided.[1076] Nothing of the heating system was visible during my own personal observation of the structure, as the hypocaust seems to have been largely unexcavated or subsequently filled in.

Scythopolis was also home to the monumental Westerns Baths, located to the west of the Eastern Baths (Figure 91). Extending over 8500 m^2, the Western Baths were constructed in the late fourth to early fifth century CE overtop earlier second century CE baths.[1077] Once again, frustratingly little is published on this facility's heating system. The baths were heated by nine *praefurnia* (some of which were latter blocked), and had a hypocaust comprising pillars and brick piers as well as a wall-heating system of *tubuli*.[1078] Nothing further is described; however, a published image of the hypocaust shows *pilae* of circular brick on square brick bases, and large rectangular piers of brick along the edges of the heated room.[1079] These square bases were covered by the application of excessive mortar during modern conservation of the structure.[1080] The *tubuli* still visible from the Western Baths appear to be slab-made.[1081]

A third bathing facility at Scythopolis was located south of the city center, between the theater and the amphitheater. The so-called South Bathhouse was in use between the third and

[1075] Mazor and Bar-Nathan 1998, 13.
[1076] Mazor and Bar-Nathan 1998, 14.
[1077] Mazor 1999, 295.
[1078] Mazor 1999, 297.
[1079] Mazor 1999, fig. 5.
[1080] Mazor and Bar-Nathan 1998, fig. 24.
[1081] Kowalewska 2019a, fig. 3.62.

fifth centuries and occupies an area of approximately 264.5 m^2 (Figure 93).[1082] Unlike the monumental baths already discussed, there is much more information about the heating system of these smaller baths. The *praefurnium* had a ceramic tile floor and an arch leading to the hypocaust.[1083] The hypocaust is relatively well-preserved and comprises both circular and square *pilae* that were found standing to a height of 35-40 cm.[1084] Several different sizes of square bricks were recovered from this system, including those measuring 25 cm by 25 cm, 23 cm by 23 cm, and 30 cm by 30 cm. The circular bricks were 20 cm in diameter and 5 cm thick. Rectangular piers were constructed against the walls of the hypocaust. The *pilae* supported covering slabs, measuring 55 cm by 55 cm and 4 cm thick. Above these large bricks was a 10 cm layer of cement and flagstone pavers. The excavators of these baths also found the remains of a wall-heating system of rectangular *tubuli* with cross sections of 16-18 cm by 25 cm.[1085] The height of these heating pipes is not recorded.

Ramat Hanadiv

To the west of Scythopolis is the site of Ramat Hanadiv, where excavation uncovered the remains of a small (125 m^2) Roman-style bathing facility dating to the Herodian period (Figure 95). This bathing facility was heated by an ashlar-built *praefurnium* that had a packed earth floor and likely held a bronze boiler for heating water (Figure 96).[1086] The hypocaust floor was built of rough stones covered by a 2-3 cm thick layer of dark grey plaster.[1087] The *pilae* were stone monoliths of soft chalk (80 cm high and an average of 25 cm in diameter), with their tops and

[1082] Peleg 2004, 55.
[1083] Peleg 2004, 62, figs. 20-21.
[1084] Peleg 2004, 63, figs. 18, 22.
[1085] Peleg 2004, 64, fig. 19.
[1086] Hirschfeld 2000, 324-26, figs. 216-19.
[1087] Hirschfeld 2000, 320.

bottoms carved into broad capitals and bases (Figure 195).[1088] Above these *pilae* were placed ceramic rooftiles, measuring 40 cm by 60 cm and 3 cm thick.[1089] The builders of these baths likely chose to use these rooftiles because the local ceramic kilns were unfamiliar with the process of manufacturing the large bricks that were typically used in the *suspensura*. Their use is an excellent example of local innovation by using familiar materials to construct unfamiliar designs. Rooftiles were used in a similar fashion in the *suspensura* of a heated room in an elite house at Zantur, Petra.[1090] The excavators of the baths at Ramat Hanadiv also found the remains of a wall-heating system along the north and west walls of the heated room that comprised *tubuli* measuring 7 cm by 10 cm in cross-section and with walls 1 cm thick.[1091] No flue channels or pipes seem to have been found in the baths, but the excavators suggest that the *tubuli* system doubled as the exhaust system by being attached to chimneys at the top of the wall.[1092]

Jericho

The site of Jericho, southwest of Ramat Hanadiv, was selected by Herod the Great for the location of his Winter Palaces. While all of these palaces were constructed with private baths in the Roman-style, only two will be discussed here. The North Wing of Herod's Third Palace (Figure 97), well-known for its use of *opus reticulatum*, was dated by its excavator to either 15 or 14 BCE, on the basis of its construction technique and wall paintings.[1093] Unfortunately, the heating system of this 234.5 m^2 bathing facility was largely dismantled in antiquity, and almost nothing remained to be found during excavation. The hypocaust floor was covered in a plaster

[1088] Hirschfeld 2000, 320, figs. 200, 202, 213.
[1089] Hirschfeld 2000, 320-21, figs. 202, 203.
[1090] Kolb and Keller 2000, 361; Hamari 2017, 93.
[1091] Hirschfeld 2000, 322, figs. 206-209.
[1092] Hirschfeld 2000, 323.
[1093] Netzer 2001, 339-40.

containing many sherds of ceramic.[1094] The partial remains of a *pila* comprising square bricks with a hole through their center and measuring 21 cm by 21 cm and 4 cm thick as well as a ceramic cylinder with a diameter of 20 cm were also found (Figure 196).[1095] The excavators suggested that the hole in the center of the bricks was there to allow mortar to "form a solid rod for reinforcement". Regarding the ceramic cylinder, although the excavators of the baths believed it to be in secondary use, its placement and diameter (20 cm) suggest that it is more likely a purpose-built *pila*. Similar ceramic cylinders were used as *pilae* in several baths both in Judea and elsewhere in the Roman world.[1096] It is possible that the square bricks formed the base (and perhaps the caps) of these ceramic cylinder *pilae*. The excavation report for the Jericho baths also states that "flue pipe" were found in a dump associated with the baths, suggesting that it may have once contained a wall-heating system of *tubuli*.[1097]

West of the Herod's Third Palace is his Second Palace at Jericho. This structure, which has been dated to around 25 BCE, contained a small (167.5 m^2) Roman-style bathing suite (Figure 197).[1098] The *praefurnium* of these baths, like the rest of the structure, is poorly preserved. The furnace is bounded by a row of small stones, and there is no mention of the use of brick in the final report.[1099] All of the hypocaust's *pilae*, with the exception of the two closest to the *praefurnium*, were of stone (Figure 198).[1100] These monoliths stood 80 cm high, were 20 cm by 20 cm in cross section, with a broader top of 30 cm by 30 cm. The two *pilae* closest to the *praefurnium* were constructed of circular bricks. It is possible that these brick pillars were

[1094] Netzer 2001, 256.
[1095] Netzer 2001, 256, ill. 385.
[1096] Gordon 2007, 76-78.
[1097] Netzer 2001, 256.
[1098] Netzer 2001, 339.
[1099] Netzer 2001, 214, ills. 301, 308.
[1100] Netzer 2001, 213, ill. 307, pl. 8.

purposefully placed there, where they would receive the greatest amount of heat, or it is possible that they replaced original stone *pilae* that had failed because of the intense heat coming from the *praefurnium*. Regardless of the reason, the *pilae* of the hypocaust supported large covering bricks, measuring 50 cm by 50 cm. Every wall of the heated room is thought to have been covered by rectangular *tubuli*.[1101]

Cypros

Overlooking Herod's palaces at Jericho from the southwest, the site of Cypros is home to two more Herodian baths in the Roman style, one at the summit of the towering hill (Figure 99), and the other on its shoulder (Figure 100). Both are dated generally to the Herodian period (37 BCE – 4 CE) by the excavators.[1102] The upper baths on the summit comprised a three-room bathing suite covering approximately 50 m^2. These baths have suffered extensive damage from subsidence down the slope, resulting in the poor preservation of the heating apparatus. Nevertheless, several elements of the system were uncovered by the excavators.[1103] The hypocaust floor was paved with ceramic tiles, while two types of *pilae* were found. The majority were monoliths of local sandstone with a diameter of 20 cm and a broader cap measuring 25 cm by 25 cm (Figure 199).[1104] Less common were *pilae* of circular brick. Both types stood to a height of 65 cm. This heated room also once contained a wall-heating system of *tubuli*, little evidence of which remains.[1105]

[1101] Netzer 2001, 214.
[1102] Netzer and Damati 2004, 278.
[1103] Netzer and Damati 2004, 254-55.
[1104] Netzer and Damati 2004, ills. 294, 295.
[1105] Netzer and Damati 2004, 253, ill. 297.

The lower baths on the hill's shoulder are approximately 192 m^2 large and were heated by two *praefurnia*.[1106] These baths had two heated rooms from different phases. The larger of the two had a hypocaust floor of ceramic bricks (measuring 60 cm by 60 cm) and *pilae* of stone monoliths 52 cm high.[1107] The *pilae* supported covering bricks that measured 60 cm by 60 cm. The excavators also found fragments and mortar impressions of rectangular *tubuli*, measuring 34 cm high, 16 cm wide, 10 cm deep, and with walls 0.8 cm thick.[1108] At some point a second heated room was added to the baths. This circular room was heated with a hypocaust system comprising *pilae* of circular bricks and square bricks (which were broken and reused floor tiles).[1109] These *pilae* supported ceramic covering bricks measuring 57 cm by 57 cm. The *tubuli* that were found associated with this room were of a different size and more circular in cross section than those found in the other heated room of the baths.

Jerusalem

The city of Jerusalem was home to a number of Roman-style baths, but only one will be discussed here. This structure (Figure 200), located in the old city, covered an area of approximately 1800 m^2 and was probably built in the second century CE, after which it underwent subsequent renovations.[1110] The *praefurnia* of these baths were not discovered, but they were likely located to the west of the heated rooms. The hypocaust floor of these baths was constructed using fired brick, with the floors in one room comprising square bricks 22 cm by 22 cm.[1111] In the hypocaust of another room, the floor was paved with circular hypocaust bricks

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[1106] Netzer and Damati 2004, 270-71.
[1107] Netzer and Damati 2004, 269-70, ill. 320.
[1108] Netzer and Damati 2004, 270, ill. 321.
[1109] Netzer and Damati 2004, 270, ills. 322, 323.
[1110] Mazar 2011, 80-81.
[1111] Mazar 2011, 63.

with stamps of the Tenth Legion, which was based in the city (Figure 201).[1112] The presence of these tiles in the floor not only reveals that the military kilns were supplying building materials for construction of these baths, but also that these baths likely once had *pilae* of circular brick. These circular *pilae* were replaced with the square and arched pillars found during excavation.[1113] Although the exact construction of these pillars varies between rooms, they were largely constructed of square and rectangular bricks. In one case, the *pilae* measured 47 cm by 47 cm and were built of square bricks (23 cm by 23 cm) and rectangular bricks half that size (23 cm by 11 cm).[1114] The floors above these pillars were constructed of fired bricks of different sizes including large *bipedales*.[1115] The excavation of these baths produced two different types of *tubuli* that were used in the wall-heating systems (Figure 202). Slab-made *tubuli*, measuring 24 cm by 20 cm by 12 cm were associated with an earlier phase of these baths.[1116] In the northern *caldarium* of the baths, wheel-made *tubuli* were found, which measure 10 cm by 8 cm in cross section and were believed to date to a later phase of construction.[1117]

Herodium

Herodian period baths in the Roman style have also been found at the site of Herodium, south of Jerusalem. One of the four baths at Herodium is located in the mountain-top citadel that overlooks the site and surrounding countryside (Figure 101). Dating to the late first century BCE, this bathing suite is over 135 m^2 in size and includes a large hypocausted room. The floor of this hypocaust was paved with ceramic bricks of various sizes, including those measuring 58 cm by

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[1112] Mazar 2011, 53, fig. 2.77.
[1113] Mazar 2011, 53, 60, 64, figs. 2.73-76.
[1114] Mazar 2011, 53.
[1115] Mazar 2011, 54.
[1116] Reuven 2011, 123, fig. 4.1; Mazar 2011, figs. 2.89-90.
[1117] Reuven 2011, 123-24, fig. 4.1.

58 cm, 42 cm by 42 cm, and 28.5 cm by 27 cm, and with thicknesses ranging from 3 to 5 cm.[1118] The *pilae* comprised stone monoliths that stood 60 cm to 65 cm tall, had diameters of 25 cm, and broad tops that were 28 cm to 35 cm wide (Figure 203).[1119] Within the fill of the hypocaust circular brick with diameters of 18 cm were also found, suggesting that brick *pilae* were also used in the underfloor heating system.[1120] The *suspensura* supported by these *pilae* comprised brick of different sizes. The excavators also noted that the walls of the heated room had vertical flue channels (Figure 102), which they claimed were designed to work with *tegulae mammatae* for the heating of the room.[1121] No further details of these *tegulae mammatae* are provided, and it seems more likely that these grooves held exhaust flue pipes. It would be very surprising if this wall-heating technique was in fact used at Herodium, as it is not attested at any other site in the wider region.

Ein Yael

To the west of Jerusalem, excavation uncovered two small bathing suites belonging to a villa complex. This complex and its associated baths were likely constructed at the end of the second century CE and remained occupied until the mid-third century (Figure 103).[1122] Although both baths produced heating systems, neither is described in great detail. Excavation of the upper baths (measuring approximately 10 m^2) revealed a *praefurnium*, a hypocaust system comprising arches of brick, rectangular *tubuli*, and flue vent in one of its walls.[1123] The *tubuli* used in these

[1118] Corbo 1989, 50, pl. 81.
[1119] Corbo 1989, 49, pl. 83.
[1120] Corbo 1989, 50.
[1121] Corbo 1989, 50, pls. 81, 82.
[1122] Edelstein 1990, 40.
[1123] Edelstein 1990, 38; 1993, 118.

baths were wheel-made.[1124] Much less information is provided about the lower baths, which cover an area of about 30 m^2. The heating system of this facility included a hypocaust floor of ceramic brick and rectangular *tubuli*.[1125] Again, these *tubuli* were made on a potter's wheel.[1126] No other details are provided.

Emmaus

To the west of Jerusalem, the site of Emmaus is home to one of the best preserved Roman-style baths in Judea (Figure 104). Covering an area of 105 m^2, these baths were built sometime between the turn of the second century and the beginning of the fourth century.[1127] No *praefurnium* was found during the excavation of the structure; however, a brick-built flue found connecting to the hypocaust likely led to it.[1128] The floor of the hypocaust system was of ceramic brick.[1129] Rather than simple pillars, the *pilae* were constructed as a series of parallel rows of continuous arches[1130]. The excavator of these baths suggested that this design may have been intended to provide stability against earthquakes; however, if this was the case, one would expect this technique to have been widespread across this earthquake-prone region. Alternatively, this hypocaust design may have been used to decrease the size of covering brick needed in the *suspensurae*. With the space between the *pilae* columns bridged along one axis, the builders of the baths did not require the very large bricks that were difficult to produce and transport. The

[1124] Kowalewska 2019a, fig. 3.91.
[1125] Edelstein 1990, 40; 1993, 119.
[1126] Kowalewska 2019a, fig.3.93.
[1127] Gichon 1979, 109.
[1128] Gichon 1979, 106.
[1129] Gichon 1979, 105, fig. 1.4.
[1130] Gichon 1979, 107, fig. 2, pl. 13.A.

excavation of these baths also found fragmented and complete *tubuli in situ* against the walls of one of the heated rooms (Figure 204).[1131]

Masada

Excavation at the site of Masada, south of Jerusalem and on the western shore of the Dead Sea, uncovered a relatively well-preserved heating system in the so-called Large Baths (sometimes known as the Independent Bath) (Figure 106). These baths (measuring 239 m^2) are thought to have been constructed between 30 and 20 BCE and underwent subsequent alterations until their abandonment after the Trajanic period.[1132] The heating system of this facility is described in great detail in the final reports of the excavation.[1133] The material used to construct the *praefurnium* is not specifically mentioned; however, it is believed that it once held a metal boiler (rather than a *testudo alvei*) that provided hot water to the *caldarium* through pipes. The floor of the hypocaust was partially constructed of square bricks measuring 40 cm by 40 cm and 3.5 cm thick (Figure 205). While complete bricks of this type were used for part of the floor, broken bricks were used to pave the rest. Two different types of *pilae* were used in the hypocaust. About half of the pillars were limestone monoliths, which varied in size (15-20 cm) and cross-section (square and rectangular). Some of these blocks were carved to have a broad top, similar in form to a capital. The other half of the *pilae* were built of circular brick, measuring 16 cm in diameter and 4.5-5 cm thick, and were coated in a lime plaster. These brick pillars were always topped by one or more square bricks measuring 26 cm by 26 cm. The *pilae* supported large covering bricks, measuring 57 cm by 57 cm and 3.5 cm thick. The *caldarium*

[1131] Gichon 1979, 106, fig. 1.6, pl. 13.B.
[1132] Foerster 1995, 205.
[1133] Netzer 1991, 89-93; Foerster 1995, 198-200.

also contained a wall-heating system of rectangular *tubuli* that covered all four walls (Figure 8 & Figure 206). These heating pipes measured 30.5-33 cm by 18 cm by 9 cm, and it is estimated that about 1700 of these pipes would have been required for the baths. Behind the *tubuli*, four flue channels (measuring 10 cm deep and wide) carried the draft and exhaust of the heating system. While flue channels in other baths of the region were typically vertical grooves in the masonry, the flues of the Large Bath at Masada zig-zagged up the walls, often following the contours of the stone used in the masonry (Figure 205).

Conclusions

The Roman-style baths discussed above display a wide variety of construction techniques and materials used in their heating system. As with the other regions covered in this study, any observations are complicated by the small sample size and the typically limited amount of data available. For example, even where *praefurnia* are identified and excavated, very little is often recorded about their construction. Notable exceptions to the general rule of brick-built *praefurnia* are the *praefurnia* built of basalt at Hippos-Sussita, and the limestone *praefurnium* at Ramat Hanadiv. While basalt can withstand thermal shock fairly well, it is surprising that friable limestone was used in this way at Ramat Hanadiv. Similarly, while hypocaust floors are commonly built of ceramic brick in both the Roman East and the wider Roman World (as well as in the design recommended by Vitruvius), in the baths as Ramat Hanadiv and in the Third Palace at Jericho, they were of plaster. The decision to use materials other than brick in heating systems may have in part been influenced by the rarity of ceramic building materials in this region before the Roman period. As has been mentioned in previous chapters, Herodian building projects and Hasmonean structures do not even seem to use ceramic roof tiles.[1134]

The substitution of stone for brick construction is also seen in *pilae*. Although a number of different techniques were used to construct hypocaust pillars, the use of stone monoliths is perhaps most surprising given their poor suitability to withstand thermal stress and thus their liability to fail.[1135] Nevertheless, such stone *pilae* were commonly used in Herodian-period baths, with over half of the excavated hypocaust systems from these baths being built at least partially with them.[1136] The use of basalt *pilae* in the baths at Gadara (modern Umm Qais) dates much later; however, basalt is also much more resistant to thermal stress than the types of stone used for the earlier Herodian *pilae*. Typically, stone *pilae* were limited to the earliest baths in the region and were gradually replaced with pillars of brick, although even here diversity abounds. Unlike the previously discussed regions of the Roman East where circular bricks were dominant in *pilae* construction, *pilae* of square bricks were far more common in the province of Judea and were found in the baths at Hippos-Sussita, Gadara, Scythopolis, and Emmaus, among others.[1137] In this region, square-brick *pilae* seem to appear around the late first century and gradually replace circular-brick *pilae* as the dominant form over the course of the second century CE.[1138] Along with these square pillars, a few hypocausts were constructed as a series of parallel rows of continuous arches, such as those at Hippos-Sussita, Jerusalem, Ein Yael, and Emmaus.[1139] The cluster of these arched hypocausts around Jerusalem, suggests that this technique may have been

[1134] Netzer 2006, 317.
[1135] Nielsen 1990, 14.
[1136] Netzer 1999, table 1; Gordon 2007, 75-6, table 4.
[1137] Kowalewska 2019a, table 5.14.
[1138] Gordon 2007, 74-75.
[1139] As will be discussed below, these arches are also found in the baths at Mamshit in the Negev Desert.

a localized practice. Elsewhere in the empire, in the province of Mauretania Tingitana (modern Morocco), the construction of arched *pilae* was also a regional practice and is thought to represent the presence of itinerant teams of specialist builders who used this technique.[1140] It is possible that the concentration of arched hypocausts around Jerusalem may likewise reflect the existence of similar teams of itinerant builders using specific building techniques.

One of the least common methods of creating *pilae* was though the use of ceramic cylinders, such as the one found in the North Wing of Herod's Third Palace at Jericho. Similar cylinder *pilae* have been found at a number of other Herodian and first century CE baths surrounding and to the east of Jerusalem, and they are also attested at several sites elsewhere in the wider Roman world.[1141]

With the exception of Gadara where basalt slabs were used in the first phase of the baths, the suspended floors of hypocausts in this region were primarily comprised of large ceramic brick or tile. Unfortunately, these large covering bricks are very prone to breaking and are rarely found complete. Many of the large covering bricks placed over the *pilae* were of comparable size to the Roman *bipedalis* (59 cm by 59 cm), such as those in the Large Bath at Masada or the lower baths at Cyrpos. In other cases, smaller bricks (ca. 50 cm by 50 cm) were used, as was the case in the Herod's Second Palace at Jericho and possibly in the Southern Bathhouse at Hippos-Sussita. Such smaller sized covering bricks would have been easier to produce and transport than their larger counterparts. The difficultly in producing such large ceramic bricks was also likely the driving factor in the use of rooftiles in the suspended hypocaust floor of the baths at Ramat Hanadiv.

[1140] Thébert 2003, 471.
[1141] Gordon 2007, 76-75.

It is fortunate that many of the excavation reports on the baths included in this chapter provide measurements for the bricks used in heating systems. While only a small sample of the known baths in Judea, the bricks used in these structures reveal that there was no strict standardization of this material between sites, and in some case within a given site. While it is possible to draw comparisons between some bricks and the standard Roman types, there are just as many bricks that do not conform to these measures. This pattern also holds true for other baths in this region not included in this study.[1142] Shrinkage during firing can account for some of this variation, but in other cases it is likely a result of local practices that varied between localized production centers and possibly changed over time. In the context of this variation, it is still surprising the extent to which hypocaust construction remained somewhat standardized at the most basic level (i.e. comprising parallel rows of pillars supporting, in almost all cases, ceramic bricks or tiles).

The use of *tubuli* also seems to have been a standard feature of the heating systems in Judea.[1143] No other wall-heating technique is known to have been used.[1144] Despite the ubiquity of *tubuli*, these heating pipes varied in terms of their manufacture. Slab-made *tubuli*, for example, were used in baths at Hippos-Sussita, Gadara, Scythopolis, and Jerusalem, while wheel-made *tubuli* are attested in the baths at Jerusalem and Ein Yael. Beyond the baths discussed above, both slab- and wheel-made *tubuli* are prevalent throughout this region, with both appearing in Herodian and later baths.[1145]

[1142] Kowalewska 2019a, 236, table 5.14.
[1143] Gordon 2007, 79-81; Kowalewska 2019a, 239.
[1144] The single possible exception comes from the upper Baths at Herodium, where the use of *tegulae mammatae* was suggested. This suggestion, however, seems to have been a misinterpretation of flue vents.
[1145] Kowalewska 2019a, 238, 249, table 5.16.

Given the small sample size and the emergence of large public baths after the smaller Herodian-period baths, it is difficult to draw conclusions on the extent to which size and date were factors affecting the construction materials and techniques used. The most obvious trend is the shift from stone to ceramic in *pilae* construction and possibly the gradual shift from circular to square hypocaust brick. In general, there is far less ceramic building material used in the earlier baths of this region, likely a result of an underdeveloped industry at the time of the introduction of Roman-style baths. The extent to which the size of a bathing structure played a role is similarly unclear, other than the need of larger baths to have more *praefurnia* that their smaller counterparts.

Above all, the heating-systems of the Roman-style baths in Judea display a great deal of variety in both construction material and technique. This variety is not seen to nearly the same extent in the materials and techniques used for the vaulting and masonry of the baths of this region, which primarily use ashlar construction. Nevertheless, this variation suggests that the production and installation of the hypocaust materials was decentralized and subject to evolution over time.

The Heating Systems of Roman-style Baths in Arabia

Perhaps the best example of just how committed ancient builders were to constructing Roman-style baths comes from the province of Arabia. Given the heat of this arid region and the lack of water, fuel, and clay for brick production, it is perhaps surprising that the construction and operation of Roman-style baths was either desired by the locals or feasible. Nevertheless, this region has produced numerous examples of hypocaust systems built of ceramic building materials to the technological standard of those elsewhere in the Roman world. The following examples are only a sample of the heating systems found in this region, but they demonstrate the ability of the local building industry to construct Roman heating system even before the annexation of the Nabataean Kingdom by Rome in 106 CE.

Bosra

The city of Bosra, located in the Hauran, is home to several Roman-style baths, but unfortunately none of these structures have well excavated or recorded heating systems. One of these bathing complexes is the monumental South Baths (Figure 108), which stretch over 8000 m^2, but were initially built on a much smaller scale in the second half of the second century CE.[1146] The only thing recorded of this facility's heating system are the numerous vertical flue channels cut into the massive ashlar walls.[1147] More recent scholarship has not elucidated any additional information about the baths' heating apparatus; however, it has identified earlier baths that were located just to the west of the South Baths and may have been replaced by it. This structure, dated to the late first or early second century CE, used both *tubuli* and circular hypocaust bricks.[1148]

The Central Baths is possibly the largest bathing complex in Bosra, occupying roughly 9000 m^2 (Figure 110).[1149] The initial construction of this complex took place in the second century CE; however, the baths underwent several major renovations throughout its use.[1150] As with the South Baths, very little is known about the heating system of the Central Baths. Publications of this structure mention the existence of a boiler above the *praefurnia*, the existence of a hypocaust system, and the presence of *in situ tubuli*, but little else (Figure 178).[1151] The massive walls of

[1146] Broise and Fournet 2007, 221-24.
[1147] Butler 1919, 260, 263-64.
[1148] Broise and Fournet 2007, 221.
[1149] Fournet 2012b, 197.
[1150] Fournet 2007, 246; 2008b, 124.
[1151] Fournet 2007, 245; 2008b, 119.

this structure also contain vertical grooves that likely once held flue pipes for the evacuation of hot gases from the hypocaust.[1152]

The third baths at Bosra are the so-called North Baths (or Baths of the Roman Camp) (Figure 112 & Figure 113). The exact size of this complex, which has been dated tentatively to the first half of the second century CE, is unclear, but its visible remains stretch over an area of 2000 m^2.[1153] The only element of the heating system that is visible are the vertical grooves in the building's masonry that served as flue vents.[1154]

Gerasa (modern Jerash)

Southwest of Bosra is the ancient Decapolis city of Gerasa (modern Jerash), which was likewise home to a number of Roman-style baths.[1155] The largest of these baths was the East Baths (Figure 114), a monumental complex stretching over 15000 m^2 (although roughly half of this area was taken up by its palaestra). The dating of the East Baths is uncertain, but its initial construction does not predate the second half of the second century CE, after which it was enlarged to current size at the end of the second or the start of the third century CE.[1156] Although excavation has taken place in the unheated halls, almost nothing is known about heating system of these baths. The walls of the massive structure, however, contain vertical channels that likely once held exhaust flue pipes leading up from the hypocaust.

The second largest bathing facility at Gerasa was the West Baths, which covers an area of about 4200 m^2 (Figure 116). The absence of excavation within this structure has prevented a

[1152] Butler 1919, 264.
[1153] Fournet 2012b, 208-209.
[1154] Butler 1919, 264, Fournet 2012b, 208.
[1155] Lepaon 2008.
[1156] Lepaon 2008, 65, fig. 12.

clear understanding of both its date and its heating system. As with the East Baths, the walls of this structure contain vertical flue channels, hinting at the presence of a hypocaust below.[1157]

South of the West baths is the recently excavated Central Baths, located at the intersection of the city's *cardo* and the south *decumanus* (Figure 118). This bathing facility covers an area over 500 m^2 and was initially constructed in the late third century CE, after which it underwent several repairs and renovations.[1158] Fortunately, unlike the East Baths and West Baths, the heating system of this facility has been excavated and published in detail.[1159] The bottle-shaped *praefurnium* of these baths had a packed clay floor and was entirely built of brick, except for its stocking hole made from two leaning stones (Figure 207).[1160] The floors and walls of the hypocaust system were lined with ceramic bricks of unspecified sizes, while the hypocausts of each heated room were connected via brick arches under the walls.[1161] Two types of *pilae* were found. In the center of the hypocausts, tall columns of circular brick were placed on square bricks as base, while pillars of square bricks were placed along the edges of the rooms (Figure 208).[1162] In terms of the wall-heating system, the excavators of these baths uncovered rectangular *tubuli* both fragmented in the fill and *in situ* against the walls. They also found numerous vertical grooves in the walls for flue vents. Several of the circular hypocaust bricks from these baths had potter's marks drawn on their faces.[1163] Although not proven, it is possible that these bricks were

[1157] Fisher 1938b, 23.
[1158] Blanke 2015, 86, 93.
[1159] Barnes et al. 2006, 300-305; Blanke et al. 2007, 178-80; Blanke 2015, 87-90.
[1160] Blanke 2015, figs. 4-5.
[1161] Blanke 2015, fig. 2.
[1162] Barnes et al. 2006, figs. 12, 14; Blanke 2015, figs. 2-3.
[1163] Barnes et al. 2006, 306, fig. 17.

produced locally. Excavation of the Gerasa hippodrome has uncovered a sixth century CE pottery workshop that produced a wide range of material, including square hypocaust bricks.[1164]

Birketein

Roughly 2 km north of Gerasa is another bathing facility, located at the sanctuary site of Birketein (Figure 120). This structure is about 670 m^2 large and has been dated to the second and third centuries CE.[1165] Excavation of these baths uncovered a well-preserved hypocaust system, that unfortunately, has since been heavily disturbed (Figure 121).[1166] The *praefurnia* of the structure were not fully exposed, but the discovery of a raised platform above one furnace suggests that it once held a water boiler. The floor of the hypocaust was paved with square bricks, while the walls were lined with vertical bricks of the same type to protect them from heat damage (Figure 122).[1167] The *pilae* were constructed of circular bricks placed on a square brick as a base, while larger pillars of square bricks were found in two large alcoves where additional support was needed to carry the weight of pools.[1168] There is no discussion of a wall-heating system; however, one is almost certain to have existed. There is plenty of evidence, on the other hand, for the flue system, as vertical channels were found in the walls of all the heated rooms (Figure 122).[1169]

[1164] Kehrberg 2009, 509, fig. 10.
[1165] Lachat et al. 2015, 46.
[1166] Lachat et al. 2015, 48-55.
[1167] Lachat et al. 2015, figs. 5, 10.
[1168] Lachat et al. 2015, figs. 5-6, 8.
[1169] Lachat et al. 2015, figs. 5, 9-10.

Betthorus (modern Lejjun)

South of Gerasa, the legionary fort at Betthorus (modern Lejjun) contains baths (223 m^2) that were built after the initial construction of the fort in c. 300 CE, but before the earthquake of 363 CE (Figure 123).[1170] These garrison baths were only partially excavated. The *praefurnium* was not located, and the floors of two rooms (Rooms D and E), which had flue vents and were thus likely hypocausted, were not reached. Excavation in a third room (Room C), however, uncovered the partial remains of a hypocaust system. The hypocaust seems to have existed only in the western half of this room, as evidenced by a floor of rooftiles that still preserved the mortar of the circular *pilae*, but not the bricks themselves.[1171] The excavators were able to determine, however, that the *pilae* stood about 75 cm high and comprised circular bricks measuring 18 cm in diameter and 5 cm thick. Excavation of the baths also uncovered the fragmented remains of many cylindrical pipes that were likely used for the flue vents, some of which were of the typical waterpipe form with a spigot and a socket end.[1172] Several rectangular wheel-made *tubuli* were found elsewhere in the fort, apparently having been removed from the baths and collected for reuse.[1173]

Petra

In the ancient city of Petra, many of the excavated baths have also produced elements of their heating systems. The largest baths thus far uncovered in Petra are those immediately west of the so-called Great Temple, which stretch over 1477.5 m^2 (Figure 125). The dating of this structure

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[1170] de Vries and Lain 2006, 221.
[1171] de Vries and Lain 2006, 215-16.
[1172] Parker 2006, 361, figs. 16.80-.81.
[1173] Groot et al. 2006, 171-73; Parker 2006, 361, figs. 16.76-.79.

is somewhat unclear, but excavation has suggested that it was initially constructed around the time of the Roman annexation of Petra in 106 CE.[1174] Interestingly, the baths' heating system contains several different techniques for hypocaust construction, possibly suggesting multiple phases or renovation. For example, the hypocaust in the largest heated room (Room U) comprised two different types of *pilae* (Figure 209).[1175] Long rectangular pillars of square brick, which terminated in arches, were used in alcoves of this room, possibly to provide extra support to pools. In the center of the room, the *pilae* were built with columns of circular bricks (22 cm in diameter) that were placed on two or three square bricks as bases. The hypocaust floor was paved with *sesquipedales* (bricks measuring roughly 45 cm square) and the raised floor was built with *bipedales*. Elsewhere, a circular heated room (Room O) contained a hypocaust with stone *pilae*.[1176] Two types of *tubuli* are recorded from these baths: "tubular and squared".[1177] Upon personal examination, the *tubuli* from these baths (that had been discarded on site) appeared to be wheel-made.

Overlooking the downtown center of Petra from the east is a small (225 m^2) bathing facility on the summit of Jebal Khubthah (Figure 127), which excavation suggests was built around the end of the first and start of the second centuries CE, but underwent several phases of construction and use.[1178] Several rock-cut *praefurnia* were uncovered during excavation of this facility, which likely date to different phases of the baths.[1179] The *pilae*, which differed between heated rooms, were placed directly on prepared bedrock. In the largest heated room (labelled the

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[1174] Power 2017, 188.
[1175] Power 2017, 195, fig. 9.9.
[1176] Power 2017, 192, 194.
[1177] Power 2017, 193.
[1178] Tholbecq et al. 2015, 31; Fournet and Paridaens 2016, 99.
[1179] Fournet and Paridaens 2015, 47-48, 52-54, figs. 30-31.

caldarium), thin walls of brick lined the masonry walls, possibly for protection against the heat.[1180] Here, the *pilae* were built with two types of circular bricks, both with diameters of ca. 20 cm, but with different thicknesses (ca. 2 cm and ca. 6.5 cm).[1181] It is thought that the thicker bricks may have come from an earlier phase. In some places, the circular *pilae* were placed closely together, likely to increase support of the heated pools or their walls. In a second heated room, the *pilae* were of square bricks (measuring roughly 18 cm square).[1182] The raised floor was built of large tiles (identified as *bipedales*).[1183] The discovery of a flat roof tile (*tegula*) with its side flanges chipped away is possible evidence that such tiles were also used in the raised floor, as was the case at Ramat Hanadiv and in another hypocaust at Petra.[1184] The wall-heating system of these baths comprised wheel-made *tubuli*.[1185] A vertical channel with an *in situ* ceramic pipe (10 cm in diameter) was found in the corner of the *caldarium*, but curiously in this instance does not seem to connect to the hypocaust, and so may not be a part of the baths' exhaust system.[1186]

On Petra's North Ridge, recent excavation uncovered a small bathing facility in a possible domestic complex (Figure 170). This small bathing suite measured at least 35 m^2, though it may have extended beyond the excavation area. It is thought that these baths date to the first century CE.[1187] The *praefurnium* was not located, and all that remains of the heating system is the ruins of a small hypocaust system and the rubble found in its fill (Figure 210). The floor of the hypocaust was built of complete and broken bricks of various sizes. The *pilae* display several

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[1180] Fournet and Paridaens 2016, 85, 89, fig. 13.
[1181] Fournet and Paridaens 2016, 90, figs. 9-13, 21.
[1182] Fournet and Paridaens 2015, 47, figs. 23-25.
[1183] Fournet and Paridaens 2016, 94, fig. 21.
[1184] Fournet and Paridaens 2015, fig. 23. For the use of *tegulae* in hypocausts at Zantur, in Petra, see Kolb and Keller 2000, 361; Hamari 2017, 93.
[1185] Fournet and Paridaens 2015, 46 figs. 23-4; 2016, fig. 21.
[1186] Fournet and Paridaens 2015, 56, fig. 33.
[1187] Parker and Perry (forthcoming).

different construction techniques. The majority were constructed of small rectangular bricks (20 cm by 10 cm by 2 cm) placed side to side in alternating courses so that they form *pilae* measuring 20 cm square. A few other *pilae* were of circular bricks of two sizes (20 cm in diameter and 6-7 cm thick, and roughly 17 cm in diameter). On one of the fallen circular *pilae* a square capping brick (27 cm by 27 cm by 4 cm) was found. A cut stone block placed in the corner of the hypocaust, may have also been used at a pillar. The raised floor of the hypocaust does not survive, but the spacing of the *pilae* indicate that they were covered by large bricks 60 cm by 60 cm (comparable to a *bipedalis*). In the fill of the hypocaust, numerous fragments of wheel-made *tubuli* were found.

Sabrah

Roughly 6.5 km south of Petra, is the site of Sabrah where the ruins of an unexcavated bathing facility have recently been identified and tentatively dated to the turn of the first and second centuries CE (Figure 129).[1188] The remains of the baths (including its courtyard) cover an area of about 756 m^2. Despite the absence of excavation, erosion of the structure by an adjacent wadi has revealed several elements of its heating system (Figure 211).[1189] The floor of the hypocaust was comprised of square bricks (measuring 26 cm by 26 cm, and 3.5 cm thick). Two types of *pilae* were observed: *pilae* of circular bricks (with diameters of 22 cm and thicknesses of ca. 7 cm) and square *pilae* of square bricks (26 cm by 26 cm, and 3.5 cm thick) combined with small rectangular bricks half their size (26 cm by 13 cm, and 3.5 cm thick). The *pilae* are roughly 95 cm tall and supported a floor of large bricks, mortar, and sandstone slabs. Fragments of *tubuli*

[1188] Fournet and Tholbecq 2015, 42.
[1189] Fournet and Tholbecq 2015, 39-41, fig. 6.

were also recorded at the site. While not fully described or illustrated, the descriptions of these heating pipes as being thin-walled and rounded, strongly suggests that they were wheel-made.[1190]

Hauarra (modern Humayma)

Approximately 80 km to the south of Petra is the settlement of Hauarra (modern Humayma), where excavation uncovered a bathing facility (roughly 450 m^2 in size), which was associated with a nearby Roman fort (Figure 130). These baths were constructed sometime in the second century CE (likely contemporaneously with the fort) and underwent multiple phases of renovation, enlargement, and reduction before falling out of use, possibly as late as the Umayyad period (seventh to eighth centuries CE).[1191] The earliest heating system found by excavation comprised *pilae* of circular bricks (19-21.5 cm in diameter, and 3-4.7 cm thick) resting on a square brick (30.4-31 cm square, and 2.6-3.4 thick) as a base.[1192] Small rectangular bricks (21-21.5 cm by 14.5-15.5 cm by 2.4-3 cm) and smaller square bricks (19.5-21.6 cm square and 2.5-3.5 cm thick) were also associated with this early system. All of the bricks seem to conform roughly to standard measurements for Roman bricks (i.e. of *pedales* and *bessales*) and had a similar fabric with straw-temper. Although not found *in situ*, slab-made *tubuli* were uncovered in the fill of this system and are believed to have been used in conjunction with it.[1193] This early hypocaust system was filled in and built over during one of the renovations to this structure.

Secondary phases of the heating system are represented by material either found in the fill or in secondary use. For example, the large number of fragmented wheel-made *tubuli* found

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[1190] Fournet and Tholbecq 2015, 39, n. 8.
[1191] Reeves et al. 2017, 109, table 1.
[1192] Oleson 1990, 299, fig. 8, pl. 3.1; Reeves and Harvey 2016, 467-71, fig. 9, table 3; Reeves et al. 2017, 114, 121, fig. 16.
[1193] Harvey 2013, 53-61.

through excavation likely post-date the slab-made *tubuli* (Figure 212).[1194] Circular bricks (19.1-21.3 cm in diameter, and 2.7-3.7 cm thick) reused in the floor of the hypocaust of the last phase are distinct in form and fabric from those found in the earlier hypocaust, and thus they likely date somewhere between the two systems.[1195]

The heating system of the final phase is represented by a *praefurnium* and two well-preserved hypocaust systems in the southern half of a reduced bathing structure. The *praefunium* was constructed of reused sandstone blocks, clay, and bricks in grey mortar, which were set inside an earlier furnace that was built partially of sandstone blocks and brick (22 cm square) laid in mortar.[1196] The hypocausts of both rooms were characterized by a heterogeneous assortment of bricks, many showing signs of reuse (such as the circular bricks mentioned above). The *pilae* in the easternmost of these rooms (Room A) were built of square bricks (21 cm square).[1197] Along the walls of this hypocaust, thin brick walls were built to protect the stone from heat damage.[1198] A probe through the undisturbed floor of Room D (to the west of Room A) revealed a near-perfectly preserved hypocaust dating to the fourth century CE or later and comprising a mixture of different bricks (Figure 213).[1199] The square *pilae* of this room were built of rectangular bricks (22-24.5 cm by 11-12 cm by 2.5-4.2 cm) laid side by side and capped by square brick (22 cm square, and 2.4-3 cm thick). These *pilae* supported large covering bricks (50-55 cm square and 3.2-5.6 cm thick) that formed the bottommost layer of the raised floor. This room also had a thin wall of rectangular and square bricks built against the hypocaust walls.

[1194] Harvey 2013, 61-72.
[1195] Oleson 2010, 228; Reeves and Harvey 2016, 452, fig. 12; Reeves et al. 2017, 122.
[1196] Oleson 2010, 228-29.
[1197] Oleson 2010, 228, fig. 4.52; Reeves et al. 2017, 121.
[1198] Reeves and Harvey 2016, fig. 6.
[1199] Reeves and Harvey 2016, 471, fig. 11; Reeves et al. 2017, 122, fig. 17.

In Room A, wheel-made *tubuli* of a different type than those already mentioned above were found *in situ*,[1200] while both Rooms A and D had vertical channels that once held cylindrical flue pipes.[1201]

Wadi Ramm

South of Hauarra, a bathing suite in the Roman style was found at the site of Wadi Ramm (Figure 214). This small (150 m^2) bathing facility was part of what appears to be an elite residential complex, located close to a Nabataean temple. Partly on the basis of its heating system, these baths have been dated to the late first century BCE.[1202] Although the facility's *praefurnium* was not found, a small probe in one of the heated rooms revealed a hypocaust system built of sandstone *pilae* and covering slabs (Figure 215).[1203] The *pilae* were square in cross-section and had capitals formed by one or more separate blocks of sandstone. It seems likely that part of the hypocaust, in either this room or another was partially built of brick, as fragments of circular hypocaust bricks (19 cm in diameter and 6 cm thick) and small rectangular bricks (21 cm by 10 cm by 2 cm) were also found in the fill of the baths.[1204] The baths had a wall-heating system of wheel-made *tubuli*, which measured roughly 29 cm high, 14 cm wide and 10 cm deep (Figure 216).[1205] The walls of these baths also contained vertical channels for flue vents that led up from the hypocaust and carried away the exhaust.[1206]

[1200] Harvey 2013, 75-82.
[1201] Oleson 2010, 228; Harvey 2013, 85-87.
[1202] Dudley and Reeves 1997, 98-9; Reeves and Harvey 2016, 455.
[1203] Dudley and Reeves 1997, 96-7, pls. 10-11; 2007, 405-406, fig. 3.
[1204] Dudley and Reeves 1997, 99; Reeves and Harvey 2016, 452, fig. 8, table 2.
[1205] Dudley and Reeves 1997, 94-95; Reeves and Harvey 2016, 452, fig. 8, table 2.
[1206] Dudley and Reeves 1997, 94; 2007, 405, fig. 3.

Tamara (modern En Hazeva)

Northwest of Petra and roughly 25 km south of the Dead Sea is the site of Tamara (modern En Hazeva), which is located on the northwestern edge of the Wadi Arabah. Adjacent to an associated late Roman fort was a bathing complex built at the end of the third century CE and measuring roughly 230 m^2 (Figure 174). Although completely excavated, these baths remain unpublished.[1207] Its hypocaust comprised long rectangular *pilae* of square brick, while imprints of heating pipe remain visible against the walls.[1208] Upon my own personal examination of these mortar impressions, they appeared to have been made by cylindrical pipes, rather than rectangular *tubuli* (Figure 217).

Arieldela (modern 'Ayn Gharandal)

To the south of Tamara, on the eastern edge of the Wadi Arabah, is the site of Arieldela (modern 'Ayn Gharandal). Dominated by a Late Roman *castellum*, this site is also home to partially excavated baths that cover an area of at least 84 m^2 (Figure 131). These baths were likely built at the same time as the adjacent fort, which dates to the Tetrarchic period.[1209] Although not yet fully published, the entire heating system of these baths have been excavated, including its *praefurnium* and evidence for a *testudo alveus* feeding into an immersion pool.[1210] The hypocaust was entirely brick built and comprised bricks of several difference sizes (Figure 218).[1211] The *pilae* were built of square bricks (averaging 18.2 cm by 18.2 cm and 2.4 cm thick), capped by slightly larger square bricks (averaging 23.5 cm by 21.7 cm and 2.8 cm thick). These

[1207] Darby 2015a, 68-72; Kowalewska 2019a, 133-36.
[1208] Kowalewska 2019a, figs. 3.112 and 3.113.
[1209] Darby 2015b, 471-84.
[1210] Corbett et al. 2016, 676, fig. 25.
[1211] Harvey 2019, 162-70, figs. 3-8.

pillars supported square covering bricks that measured roughly 53 cm by 53 cm and 3 cm thick). The wall-heating system of these baths is particularly interesting. In the *caldarium*, a heterogeneous assortment of wheel-made *tubuli* were used alongside cylindrical pipes with spigot and socket ends (Figure 219). An examination of the wheel-made *tubuli* identified no less than five different types (distinguished by size, shape, and fabric), suggesting extensive renovation to the system and possibly multiple suppliers of the material.[1212] In the *tepidarium*, the wall-heating system was built almost entirely of the cylindrical pipes typically associated with hydraulic installations (with spigot and socket ends) (Figure 220).[1213] It is likely that the use of these cylindrical pipes resulted from a lack of proper heating pipe (i.e. rectangular *tubuli*). Evidently, the proper and more efficient *tubuli* were prioritized for the warmer *caldarium*. Some of the cylindrical pipes may have also been used in the vertical flue channels that were present in the walls of the heated rooms, particularly in the corners.[1214]

Osia (modern Yotvata)

Southwest of Arieldela and on the western edge of the Wadi Arabah, a similar Late Roman *castellum* and garrison bathhouse exists at Osia (modern Yotvata) (Figure 133). Excavation of these baths did not fully uncover the structure, but its exposed remains stretch over 135 m^2. Like the baths at Arieldela, this facility is considered to be contemporary with the adjacent fort, which was constructed under the Tetrarchs.[1215] The baths at Osia are very poorly preserved, and the heating system is no exception. Little remains of the *praefurnium* other than its hard-packed clay

[1212] Harvey 2019, 170-78, figs. 9-19.
[1213] Harvey 2019, 170; (Forthcoming).
[1214] Darby and Darby 2015b, fig. 3.
[1215] Davies and Magness 2014, 356.

floor and a platform that likely held a water boiler.[1216] The stoking hole into the hypocaust was brick-lined and was likely covered by a brick vault.[1217] Excavators found two rooms that were heated by a hypocaust, which was found heavily disturbed. The *pilae* were constructed of circular bricks, and there is evidence that stone blocks were also used (Figure 221).[1218] *Tubuli* were used in the wall-heating system. An image of an *in situ tubulus* shows a thin-walled pipe with rounded corners, suggesting the heating pipes were wheel-made (Figure 222).[1219]

Oboda (modern Avdat)

To the north of Osia in the Negev Desert, well-preserved Roman-style baths have also been found at the site of Oboda (modern Avdat) (Figure 134). These baths measure roughly 305 m^2, and while initially constructed in the fourth century CE, the structure underwent major renovations sometime after an early fifth century earthquake.[1220] The heating system, although fully exposed, is not published in great detail.[1221] Excavation uncovered two *praefurnia*, neither of which were well-preserved, other than their brick-lined channels leading to the hypocaust. The *pilae* of the two heated rooms were built of square bricks; however, large rectangular pillars of brick were also built along the walls, which helped support immersion pools and perhaps channel hot air to the wall-heating system, little of which survives. During my own personal examination of the baths, it was clear that cylindrical pipes were used in place of rectangular *tubuli* along the walls (Figure 223). Vertical channels for flue vents were also present in the walls of the heated rooms.

[1216] Darby 2015a, 82.
[1217] Davies and Magness 2015, 48.
[1218] Meshel 1989, 235, pls. 32.A-32.C.
[1219] Meshel 1989, 235, pl. 32.D.
[1220] Erickson-Gini 2014, 97.
[1221] Negev 1997, 173-76, fig. 26, ph. 276-79.

Mamshit / Mampsis

Roman-style baths were also uncovered northeast of Oboda, at Mamshit (Figure 137). The dating of these baths (measuring ca. 208 m^2) is fairly uncertain. Its excavators suggest that it was initially built in the Late Nabataean period and continued to be used during the late Roman and Byzantine periods.[1222] The heating system was fully exposed and has been published.[1223] Its *praefurnium* and the flue leading into the hypocaust were built of bricks laid in mortar. Many of the *pilae* were square, with several measuring 35 cm by 40 cm. Along some of the walls of the hypocaust, the *pilae* were more rectangular and projected from the edges into the center of the room. These *pilae* were arched; however, the "arches" that survive are actually crudely built false arches (Figure 224).[1224] The wall-heating system does not survive and there is little description of it other than the existence of mortar impressions of pipes measuring 10 cm in diameter.[1225] This diameter is much smaller than any known rectangular *tubulus*, and given the used of cylindrical pipes at Oboda, Tamara (modern En Hazeva), and Arieldela (modern ʻAyn Gharandal), it seems likely that the pipes that formed these impressions were also cylindrical pipes. Within the walls of the heated rooms, vertical channels were installed for flue vents.

Rehovot-in-the-Negev

To the west of Mamshit and northwest of Oboda, Roman-style baths were also built at Rehovot-in-the-Negev (Figure 139). Measuring 91 m^2, these baths were never excavated, and thus are not securely dated. On the basis of surface pottery finds, however, early visitors to the

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[1222] Negev 1988, 181.
[1223] Negev 1988, 172-77, ph. 180-86.
[1224] Negev 1988, plan 38.
[1225] Negev 1988, 176.

baths suggested a date in the Byzantine period, which has been generally accepted by later scholars.[1226] Unfortunately, this structure was destroyed during the construction of a British police station at the site in the British Mandate period, and little remains of it today.[1227] The only descriptions of the heating system of these baths, therefore, come from the early visitors to the site and as a result provide little detail. Alois Musil, for example, described what seems to be a hypocaust using stone *pilae*, which stood 70 cm tall.[1228] During their visit to the site, Woolley and Lawrence recorded the existence of channels in the walls, likely to carry away the exhaust of hypocaust.[1229] Given the poor preservation of these baths, it is not possible to glean more information about the structure or confirm the existence of a stone hypocaust, which is somewhat surprising given the assumed late date of the baths.

Conclusion

While there is lot of data about the material and techniques used in the construction of heating systems from the province of Arabia, the majority comes from the region around Petra. Unfortunately, a lack of excavation has resulted in almost nothing being known about the heating systems of the largest baths built in this region (those at Bosra and Jerash). It is therefore difficult when assessing this larger corpus to consider the extent to which size was a factor in influencing what materials and techniques were used in heating systems.

There is likewise a general absence of data regarding the construction of *praefurnia*. Two well published *praefurnia* come from the Central Baths at Gerasa (modern Jerash) and the baths

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[1226] Woolley and Lawrence 1915, 117; Rosenthal-Heginbottom 1988, 20, ill. 28.
[1227] Tali Erickson-Gini, personal communication, Dec. 2019.
[1228] Musil 1908, 80-81, figs. 48-49.
[1229] Woolley and Lawrence 1915, 116.

at Hauarra (modern Humayma). In both cases, the furnaces were primarily built of brick, but stone and packed clay was also used. The *praefurnium* of the baths at Arieldela (modern ‘Ayn Gharandal) is remarkably well preserved and should hopefully provide important information when it is fully published.

As was seen in Judea, there is also a great deal of variation in the materials and techniques used for the construction of *pilae* in this region. Local stone (which was commonly used in Herodian period baths) was used for hypocaust pillars in the baths at Wadi Ramm, the baths near the so-called Great Temple in Petra, as well as possibly in the Petra’s North Ridge baths and the baths at Rehovot-in-the-Negev. Just as was the case in the early Herodian baths, this use of stone may have resulted from a lack of brick or an unfamiliarity with using ceramic building materials, particularly in the early Nabataean baths at Wadi Ramm.

Several baths discussed above, including those at Sabrah, on Petra’s North Ridge, at Hauarra, and possibly those at Wadi Ramm, used small rectangular bricks to create square *pilae*. This was also the case in the small private baths found in Wadi Musa, just outside Petra.[1230] With the exception of their use at Hauarra, all other examples come from early Nabataean baths, suggesting that this was a localized technique. Significantly, these rectangular bricks typically measured ca. 20 cm by ca. 10 cm and thus created square *pilae* measuring ca. 20 cm by 20 cm. These dimensions are approximately 2/3 a Roman foot, or equal to the standard size of brick (called a *bessalis*) used in *pilae* construction throughout Roman world.[1231] These dimensions are even recommended by Vitruvius (*De Arch.* 5.10.2).[1232] The use of these bricks, therefore,

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[1230] ‘Amr et al. 1997, fig. 13; Reeves and Harvey 2016, 463.
[1231] Adam 1994, 266-67; Reeves and Harvey 2016, 463.
[1232] “*supraque laterculis bessalibus pilae struantur*”, “Above (this floor) piers of bricks 2/3 of a foot in diameter are raised” (translation by author).

suggests that the builders of these Nabataean baths were using Roman units of measurement long before the annexation of the territory by Rome in 106 CE.

The use of circular brick in the construction of *pilae* was common throughout the region, except for in the Negev Desert. In many cases (such as in the Central Baths at Gerasa, in the baths at Birketein, and in those at Hauarra) the circular bricks were placed on square bricks as bases. In other cases, such as in the baths on Jebal Khubthah in Petra, they were not. By comparison, square *pilae* built entirely out of square bricks are lesson common, but appear in several baths, including those at Petra, Hauarra, Arieldela, Oboda, and Mamshit. In the baths at Mamshit and those next to the so-called Great Temple at Petra, these square *pilae* supported arches, similar to those seen in Judea.

In terms of sub-regional patterns, this small sample size suggests that *pilae* of rectangular brick are most common around Petra and to its south, while *pilae* built of circular bricks are not commonly found in the Negev Desert. It is also possible to see a few changing practices over time. The use of stone *pilae*, as was the case in Judea, is mostly limited to earlier baths such as those at Wadi Ramm and those on Petra's North Ridge, although stone is possibly also used in the much later hypocaust at Rehovot-in-the-Negev. With the exception of the post-fourth century hypocaust at Hauarra, the use of rectangular brick also seems to have been an earlier technique, apparently limited to baths built in or around the first century CE. It is not entirely clear if there is a general shift in this region from circular to square brick as has been suggested for Judea by some scholars.[1233] Although a hypocaust of circular *pilae* was replaced by one of square pillars at Hauarra, this pattern does not hold true elsewhere. For example, circular bricks were used in the

[1233] Gordon 2007, 74-75.

hypocausts of the late third century Central Baths at Gerasa and the early fourth century baths at Betthorus (modern Lejjun), while square bricks were used in the *pilae* of the much earlier baths at Sabrah, dated to the turn of the first and second centuries CE.

Regarding the size of bricks used in these heating systems, there is a great deal of variability similar to what is seen elsewhere in the Roman East. Nevertheless, a few interesting observations can be made, including the possible use of Roman measures in bricks produced for Nabataean baths built in the first century CE, before the annexation of the territory in 106 CE. As has already been discussed, the small rectangular bricks used in the *pilae* of several first century CE baths correspond well to standard Roman measures for hypocaust construction. The circular hypocaust bricks used in these early Nabataean baths, such as those at Wadi Ramm, Petra, and Sabrah, also measure precisely (or approximately) 20 cm in diameter, which corresponds to 2/3 of a Roman foot. In addition, the fact that the *pilae* in the baths on Petra's North Ridge were spaced 60 cm (2 Roman feet) apart further supports the likelihood that the manufacturers of these hypocaust bricks were using Roman units of measurement. It should be noted, however, that not all the brick used in these early baths closely followed Roman standard dimensions, and it is possible that this apparent use of the Roman foot may have simply resulted from the use of a local measure that was coincidentally similar to the Roman one. Nevertheless, if these bricks do represent the use of the Roman foot, it speaks to the spread of Roman construction techniques beyond its borders.

Roman measures are also found in the bricks of the earliest hypocaust at the Hauarra baths. As this facility was built for and possibly by the Roman garrison and the nearby fort, this use of Roman measures is not surprising. Conversely, the ceramic building material of subsequent phases of the Hauarra baths (as well as the material in the Tetrarchic period baths at Arieldela) show much less correlation to Roman standards. While a much larger and more detailed study is needed to confirm this apparent pattern, it seems there is a general movement away from using the Roman foot in the production of brick in this region.

In this region (or at least in the south) the wheel-made *tubulus* was the preferred method of creating wall-heating systems.[1234] These heating pipes are found in nearly all baths south of Betthorus (modern Lejjun), regardless of size or date. They have been uncovered in early Nabataean baths, such as those at Wadi Ramm and Petra, as well as garrison baths from the early fourth century, such as at those as Betthorus and Arieldela. These *tubuli* were produced on a potter's wheel in a similar fashion to the wheel-made *tubuli* in Judea and are thus evidence of a regional manufacturing practice dating to as early as the introduction of the Roman-style baths to the area. Significantly, wheel-made *tubuli* are not attested in any other region of the Roman world, and thus these pipes represent a regional production technique that likely reflects a greater familiarity with production on a potter's wheel than using slabs of clay. The only recorded example of slab-made *tubuli* in the regions comes from the first phases of the Hauarra baths, which were likely constructed by the soldiers of the nearby Trajanic fort. Being one of the earliest Roman garrisons in the territory, these soldiers understandably used production methods familiar to them.[1235] Significantly, however, in all subsequent phases of the Hauarra baths (and indeed all subsequent garrison baths in this region) the local wheel-made *tubulus* was preferred. This use of wheel-made *tubuli* in Roman garrison baths is a clear example of local influence on bath construction.

[1234] The use of wheel-made *tubuli* in this region was the subject of my MA thesis. For more (albeit somewhat dated) information, see Harvey 2013.
[1235] Harvey 2013, 72-75.

Another regional practice seems to be the use of cylindrical pipes in wall-heating systems. While cylindrical pipes of the type used typically used for water (i.e. with a spigot and socket end) were commonly used as flue pipes and placed in the vertical grooves that directed air for the hypocaust to the outside, at Arieldela, Tamara, Oboda, and Mamshit, these cylindrical pipes were also installed along the walls and served to heat the room. The fact that these pipes did not have the lateral vents that existed on purpose-made *tubuli* meant that the flow of hot air was restricted. As a result, the use of these cylindrical pipes created a less efficient wall-heating system.[1236] The most obvious reason for their use is that the builders of these baths did not have any or enough of the typical rectangular *tubuli*. This explanation, however, does not explain why the use of these cylindrical pipes seems to be localized around the Negev Desert and was not widely seen elsewhere in the Roman East where shortages of *tubuli* may have occurred. It is possible, therefore, that their use represents a local (and less efficient) alternative to the rectangular *tubulus*.

Observations on the Heating Systems of Roman-style Baths in the Roman East

Although the baths discussed above are only a fraction of the Roman-style baths from the Roman East where elements of the heating system are preserved, it is clear that a variety of techniques and different materials were used for their construction. Nevertheless, ceramic building materials were by far the most common, thanks to their ability to withstand high temperatures. It also bears repeating that, despite the techniques and materials used to construct these systems, they still largely adhere to the general design found throughout the Roman world.

[1236] Harvey (Forthcoming).

A perfect example of this variation is seen in the construction of the *pilae* designed to hold up the raised floor and create the void through which hot air circulated under the floor. The standard method of constructing these pillars was to stack ceramic brick in columns, often placing larger bricks at the tops and bottoms of these pillars to broaden their surface areas, functioning in a similar way to the bases and capitals of architectural columns. In a few cases, however, the brick pilae were connected to adjacent pillars with an arch, the result being a series of parallel rows of arches.[1237] Examples of these arched pillars come from Hippos-Sussita, Jerusalem, Emmaus, Ein Yael, and Mamshit. The purpose of this design seems to have been related to increasing the stability of the heating system. At least one scholar has suggested that these arches provided extra stability during earthquakes.[1238] While possible, this earthquake-resistant theory raises the question of why this technique was not more widespread in this earthquake prone region. It has also been suggested that this design was specifically used a at sites with slopping typology in order to stabilize the structure without hindering the flow of air.[1239] In addition, by eliminating the distance between *pilae* (at least along one axis) this arched design may have been better suited for projects that were unable to acquire sufficiently robust or a sufficient number of the large covering bricks needed to span the distance between *pilae*. The fact that these arches increased the stability of the hypocaust system is most apparent in systems where they were used alongside regular, pillared *pilae*. In these cases, the arched *pilae* were typically used under immersion pools where extra support was needed to carry the added weight

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[1237] Outside the study region, arched *pilae* have been found in a number of other baths throughout the empire (Yegül 1992, 357, 464, n. 13, fig. 451).
[1238] Gichon 1979, 107.
[1239] Reuven 2011, 122.

of the water. Examples of this use come from the baths in the Villa of Theseus at Paphos and in the baths next to the so-called Great Temple in Petra.

In other cases, the *pilae* were constructed not of brick, but rather of stone. Such hypocaust pillars were particularly common in early Herodian baths, such as Ramat Hanadiv, Jericho, Cypros, Herodium, and Masada. In total, over half of the known hypocaust systems from the Herodian period were built at least partially with *pilae* of local stone.[1240] Stone *pilae* were also found in a few of the Nabataean baths from the first century CE, such as those at Wadi Ramm and possibly on the Petra North Ridge, and provide evidence for the transfer of bath technology between these two regions.

Stone as a building material for hypocausts is very much inferior to ceramic brick, as the limestone and sandstone that was commonly used for these pillars degraded quickly when exposed to intense heat.[1241] The most likely explanation for this use of stone is the absence of a well-developed local ceramic building material industry when Roman-style baths were first introduced to the Levant.[1242] Overtime, stone *pilae* became less common as the ability to build brick *pilae* increased. In the lower baths at Cypros in Judea, for example, the first-phase heating system contained stone *pilae*, while the subsequent addition of a second heated room used hypocaust pillars built of brick.[1243]

While it may be tempting to assume the use of stone in hypocausts always predates the use of ceramic bricks, this is not the case. In the earliest Roman-style baths built in the Levant, which are believed to be the baths found at Herod's First Palace at Jericho, the initial hypocaust was

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[1240] Netzer 1999, table 1; Gordon 2007, 75-6, table 4.
[1241] Nielsen 1990, 14.
[1242] Small 1987, 62.
[1243] Netzer 2004, 269-70.

constructed with *pilae* of circular bricks that subsequently seem to have been replaced in some places with stone blocks.[1244] There are also examples of stone *pilae* from heating systems that date much later than the Herodian period, such as the fourth century CE phase heating system at Gadara (modern Umm Qais) and possibly the "Byzantine period" baths at Rehovot-in-the-Negev. While the basalt stone used at Gadara could withstand the high temperatures of the hypocaust, in other cases, the continued use of less heat resistant stone (i.e. limestone and sandstone) likely resulted from improvised construction or repair using whatever materials were available at the time.[1245] Indeed, the type of stone used for these hypocaust pillars was always locally available and typically also used in the walls and vaults of the baths. While this repair using stone was certainly not ideal, advances in heating technology may have made their use less problematic. Scholars have suggested that by the second century CE the heat demand of some hypocaust systems was no more than 100 degrees Celsius, which resulted in a wider range of materials used for *pilae* in the West.[1246] As this examination has demonstrated, however, brick-built *pilae* continued to dominate hypocaust construction in the Roman East after the first century CE. Thus, while late stone *pilae* do exist, there is clearly an increasing preference for the use brick over stone for hypocausts in the baths of the Roman East.

Another technique for constructing *pilae* was the use of specially designed ceramic cylinders. In this study, this technique was only seen at the baths in the North Wing of Herod's Third Palace at Jericho; however, it has also been found at other sites in the study region. Interestingly, much like stone *pilae*, its use seems to have been limited to ancient Palestine, particularly in

[1244] Pritchard 1958, 10-12, pls. 7-9.
[1245] Gordon 2007, 75.
[1246] Degbomont 1984, 99.

Jerusalem and the Judean desert, between the Herodian period and the late first century CE.[1247] Generally, these tubes had thick walls to help support the weight of the floor above, and often had holes cut in their side to allow air to pass through them, thereby preventing a large difference between their internal and external temperatures and the associated thermal stress.

Beyond Judea, ceramic cylinder *pilae* have been found at only a few other sites in the wider eastern Mediterranean, such as in the Small Bathhouse at Pergamon.[1248] Another example of their use comes from an undated Roman period baths at Parion, located on the Sea of Marmara.[1249] Similar ceramic cylinders were used for hypocaust supports in other regions of the Roman world, but they were never widely adopted. In southern Gaul, for example, the use of cylinders for *pilae* was also concentrated in a small area.[1250] The limited use of ceramic tubes for this purpose may have resulted from the fact that they were less resistant to collapse or were purpose-made and thus less adaptable for other uses in the heating system than bricks, which were more versatile and thus more easily sourced and replaced.[1251]

Returning to the use of brick in *pilae* construction, there is also variation in the shape of the brick. The most commonly used bricks were square and circular; however, rectangular bricks were also employed both in the *pilae* along the edges of hypocausts throughout the Roman East and in the stand-alone *pilae* in first century Nabataean baths in the region around Petra. In the study region, hypocaust *pilae* of circular bricks are much more common than those of square bricks. This is particularly the case in Cilicia, Cyprus, and Syria, although square bricks are still

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[1247] Gordon 2007, 76-77.
[1248] Radt 1999, 139-41, abb. 84.
[1249] Keleş and Çelikbaş 2014-2015, 284, fig. 9.
[1250] Bouet 1999, 174-78.
[1251] Adam 1994, 267.

used in these regions for pillars placed around the edges of the hypocaust as well as for the bases and caps of *pilae* that were otherwise made of circular bricks. Sites, where *pilae* are built entirely of square bricks, are found on the southern coast of Cyprus and a few specific baths such as the earliest phase of the Harbor Baths at Elaeussa Sebaste, Bath F3 at Dura Europos and the baths at Baalbek. In the provinces of Judea and Arabia, square brick *pilae* are comparatively much more common and are found in many hypocaust systems.

There has been very little scholarship regarding the functional difference between circular and square hypocaust bricks and the reasons why one type may have been preferred to the other. A study of hypocaust bricks in southern France has suggested that the circular bricks were inferior for transportation purposes, as their shape would have resulted in a loss of volume; however, their lack of corners made circular bricks more resistant to heat exposure.[1252] These conclusions are not entirely convincing. While it is certain that heat damaged square *pilae* often exhibit broken or damaged corners, such damage would not affect their ability to support the weight of the floor above. Furthermore, the loss of volume caused by the tight packing of circular bricks, compared to square ones, would have resulted in a reduced weight to be transported. If anything, this lighter load likely made circular bricks more appealing, as their transportation costs would have been lower. On the other hand, square bricks were more versatile and could be used for different purposes, such as lining the floors and walls of the hypocaust or use in the construction of other installations. Circular bricks, by comparison, were purposefully made and were not as easily adapted for other uses. As neither shape has a clear advantage over

[1252] Bouet 1999, 162.

the other, it is likely that their production largely depended on the preference or custom of the producers of the material and builders of the baths.

Concerning the sizes of bricks used in hypocaust systems, this study has provided only a very rudimentary examination of a topic that requires a great deal more study. On the basis of what evidence this investigation has presented, there were many different sizes of brick used in the hypocausts of the Roman East rather than a single standard. While some of this variation may have been caused by the natural shrinkage of ceramic bricks during their manufacture, there remains enough disparity between (and even within) sites to rule out the adherence to a uniform model. This variation suggests that the production of bricks in the Roman East was not centralized but was rather dependent on local (or perhaps regional) production centers.

If there were to have been standard dimensions for this material, one would expect the Roman foot (i.e. the *pes monetalis* - 0.296 m) to have been used. Roman bricks were standardized in the first century CE around this measure, with their names in literature describing their size (e.g. *pedalis* = 1 Roman foot, *bipedalis* = two feet, *bessalis* = 2/3 of a foot, etc.).[1253] Studies of ceramic brick used elsewhere in the Roman world have revealed that this material commonly varies in size (again, largely because of shrinkage during manufacture). In Roman Britain and in Gallia Narbonensis (southern France), however, bricks found in association with hypocausts generally conformed to Roman standard sizes.[1254]

A similar understanding of bricks used across the Roman East would require a much more detailed study and statistical analysis; however, there does not seem to be a widespread adherence to Roman standards in this region. Nevertheless, there are a few exceptions, such as

[1253] Adam 1994, 147-48, fig. 347.
[1254] Brodribb 1987, 34, 36, 142; Bouet 1999, 144-47, figs. 88-89.

the use of *pilae* bricks that corresponded to the typical Roman *bessalis* in the earliest phase of the Harbor Baths at Elaeussa Sebaste.[1255] In the province of Arabia, the small rectangular bricks used in many of the early Nabataean baths likewise seem to have been made based on the size of a Roman *bessalis*, which suggests that the builders of these baths were using Roman measures despite being outside the Roman Empire. Another example is the bricks from the first phase of the baths at Hauarra (modern Humayma), which is less surprising given that these bricks may have been produced by Roman soldiers. At other baths associated with the Roman military, there is less connection to the Roman foot. This is the case at Dura Europos, where some of the bricks from the baths conform to Roman measures, while others do not.[1256] Similarly, the square bricks used in the *pilae* of the garrison baths at Arieldela (modern ʻAyn Gharandal) conform to the Roman *bessalis* but the larger bricks at these baths do not correspond to their standard Roman counterparts, such as the *pedalis* and the *bipedalis*.[1257]

In other places of the Roman East, the Roman foot was clearly not used in the production of brick. For example, throughout the wider region the large covering slabs that rested over the *pilae* were often not nearly as large as Roman *bipedalis* (59.2 cm) that Vitruvius recommends for this use. The smaller size (sometimes as small as 50 cm square) of these covering bricks may be partly the result of the difficulty and cost of producing and transporting them.

In Cilicia, circular bricks with a diameter of 25 cm were used in the baths at Iotape, Küçük Bernaz, and Anemurium. This measure does not correspond to any know Roman brick size, but rather may reflect the use of a local system of measure. Marcello Spanu has argued that the vast

[1255] Borgia and Spanu 2003, 304.
[1256] Pollard 2004, 134-35, n. 8.
[1257] Harvey 2019, 162.

majority of square bricks produced in Cilicia were based on local measures.[1258] It is entirely possible that more detailed and comprehensive study of the sizes of brick used throughout the Roman East could definitively show a similar reliance on local systems of measure elsewhere in the region.

Variation in construction also likely existed for *praefurnia*; however, relatively little information exists on these furnaces. For many of the baths included in this study, the *praefurnia* were not found, poorly preserved, or not recorded in detail. Of those that were recorded and mentioned above, the majority were constructed of fired brick, although a few were entirely or partly built of stone. Such stone-built *praefurnia* include those in the Southern Bathhouse at Hippos-Sussita (built of basalt and limestone blocks), the Byzantine Baths at Gadara (partially built of basalt), the baths at Ramat Hanadiv (built of limestone ashlars), the bathing suite in Herod's Second Palace at Jericho (built of small stones), and the garrison baths at Hauarra (partially built of sandstone blocks). Notably all these examples come from Judea and Arabia. Furthermore, at Gadara, Ramat Hanadiv, and Herod's Second Palace at Jericho, stone was also used instead of brick for some or all of the *pilae* in the hypocaust. A few *praefurnia*, such as those from the baths at Sanctuary of Apollo Hylates near Kourion and on Jebal Khubthah at Petra, were partially built by cutting into the bedrock. The floors of the *praefurnia* discussed in this chapter were typically of brick, but in some cases, such as those at the baths at Ramat Hanadiv, the Central Baths at Gerasa, and the baths at Osia (modern Yotvata), the floors of the furnaces were of hard-packed earth or clay.

[1258] Spanu 2003, 23-2, fig. 6.

As is the case with *praefurnia*, the water heating devices that were often placed above these furnaces are poorly understood. As mentioned at the beginning of this chapter, these water heaters could be boiler tanks that fed hot water to the baths through pipes or so-called *testudo alvei* that extended the pools over the *praefurnia* and allowed for the direct heating of the pool water. As both these devices were typically made of bronze, they were removed and recycled once the baths fell out of use and thus almost never survive in the archaeological record. In a few cases, however, the impressions of these water heaters remained visible in the extant remains of the baths, allowing excavators to determine their earlier existence. While such water heaters likely existed in all of the baths discussed above, surviving evidence for them is so scant that it is not possible to comment on regional designs or distribution patterns other than that evidence for both boiler tanks and *testudo alvei* exist from the Roman East.[1259]

Regarding the construction of wall-heating systems, it is very clear that the *tubulus* was without question the preferred technique for constructing these systems. Elsewhere in the Roman world, it was not uncommon for multiple techniques for creating wall-heating systems to be employed in a given region. For example, in Roman Britain and Gallia Narbonensis (southern France), *tubuli*, *tegulae mammatae*, and spacer bobbins were widely used.[1260] This was not at all the case in the Roman East, where *tubuli* are found in every region and in nearly all baths. Indeed, there are only a few instances of other techniques being found. One such example is the apparent use of spacer bobbins in the Harbor Baths at Elaeussa Sebaste.[1261] The only other

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[1259] Evidence for boiler tanks has been found at the Villa of Theseus at Paphos, Ayios Georgios of Peyeia, Sha'arah, Hippos-Sussita, Gadara, Ramat Hanadiv, Masada, Birketein, and Osia. Baths that are thought to have contained a *testudo alvei* include Amathus, Bath E3 at Dura Europos, and Arieldela.
[1260] Brodribb 1987, 63-79; Bouet 1999, 13-83.
[1261] Borgia and Spanu 2003, 267, 286, 330.

known use of a technique other than *tubuli* is on Cyprus, where spacer pins have been found at a number of baths, including those at Amathus, Kourion, and Paphos.

Given the wide variety of techniques and materials used for constructing hypocaust *pilae*, it is somewhat surprising that nearly all the wall-heating systems of the Roman East were built of *tubuli*. There are several factors that likely affected the choice of construction techniques when building a wall-heating system. The size of the baths, for example, may have been a significant factor determining the choice between spacer pins and *tubuli* on Cyprus. Elsewhere in the eastern Mediterranean, spacer pins tend to be found in relatively smaller baths. In Lycia, where the use of spacer pins was common, most baths measure between 200 m^2 and 700 m^2, with only a few structures over 1000 m^2.[1262] Further west, excavation on Crete has also demonstrated that many of the island's Roman baths used spacer pins for wall-heating systems.[1263] Here too the baths are relatively small, although the Megali Porta baths at Gortyn, which used spacer pins, has been estimated to cover an area of about 3600 m^2.[1264] On Cyprus, spacer pins were not found in the island's largest known baths, the bath-gymnasium at Salamis (7360 m^2) and the Acropolis baths at Kourion (over 3000 m^2), where *tubuli* were employed. Instead, spacer pins were common in the smaller baths of Cyprus.

Cost was also likely a factor taken into consideration by builders of baths; however, what limited information is available suggests that *tubuli* may have been the most expensive of the techniques to produce. In Britain, *tubuli* are thought to have been produced by specialized workshops, as they likely took greater skill to produce than simple flat tiles and bricks.[1265] This

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[1262] Farrington and Coulton 1990, 67.
[1263] Kelly 2004-2005, 611-14; 2006, 240-43; 2013, 13.
[1264] Kelly 2006, 244-45; 2013, 137.
[1265] Scott 1971, 15; Warry 2006, 124-25.

increased price is reflected in Diocletian's *Price Edict*, which gives the maximum price for a *tubulus* as being 50% more than the cost of a *pedalis* brick (six *denarii* compared to four).[1266] Although Diocletian's *Price Edict* gives only a period-specific snapshot of maximum prices rather than actual ones, this relative pricing seems to reflect the increased time and specialization needed for *tubulus* manufacture. While there is no firm evidence for the cost of manufacturing spacer pins or spacer bobbins, spacer pins are believed to have been produced on Crete at amphora workshops, where they could theoretically have been mass-produced at a cheap cost by taking advantage of the existing ceramic industry.[1267] Lancaster has suggested that a similar relationship existed for the production of vaulting tubes in North Africa, where the increased production of transport amphoras resulted in a lower cost to produce vaulting tubes, thereby making them more economically viable.[1268] It is not clear, however, if the production of spacer pins on Cyprus was able to piggyback off of existing industries in a similar way.

While *tubuli* may have been relatively expensive to produce, they seem to have created more efficient wall-heating systems. While it would be reasonable to assume that the tubular form of these pipes limited the circulation of hot air, scholars believe the larger problem was the formation of turbulence in the wall-heating systems if the void was too narrow. Systems built with *tegulae mammatae* and spacer bobbins created narrower wall cavities that were more prone to this turbulence than those built of *tubuli* and spacer pins.[1269] Although builders of these baths may not have fully comprehended the physics of such convection currents, they likely understood that narrower voids created less efficient heating systems.

[1266] Erim and Reynolds 1973, 103, 108.
[1267] Kelly 2004-2005, 613-14; 2006, 245.
[1268] Lancaster 2012, 157-58.
[1269] Farrington 1995, 102; Adam 1994, 269.

A further factor than may have affected the decision of which wall-heating technique to use was status. It has been suggested that the supposed origin of the *tubulus* in Italy may have granted a level of prestige to *tubuli* systems, which in turn made them more popular.[1270] While it is not possible to know the extent to which this factor may have influenced the local building industries in the Roman East, it is conceivable that different levels of prestige may have been granted to different construction techniques.

While all the factors discussed above probably had some influence on what technique was used, the largest contributor was likely practice, specifically the continuity of previous practice – whereby a functional and accepted technique is not changed unless affected by outside influence. When Roman-style baths were introduced to regions in the Roman East, whichever wall-heating technique was introduced along with them (if proven successful) was likely to continue to be used. In the Levant, the earliest Roman-style baths are thought to have been those built at Herod's First Palace at Jericho, which used *tubuli*.[1271] It is almost certain that the first Roman-style baths to be introduced elsewhere in the Roman East likewise were built with *tubuli*, leading to the proliferation of this technique in the region.

While the *tubulus* was without a doubt ubiquitous in the Roman East, the form of these heating pipes varied quite a bit. In addition to their size, two very different production practices were used in their manufacture. Throughout much of the Roman East, and indeed the wider Roman world, *tubuli* were produced using slabs of clay. These slabs were either wrapped around a wooden form[1272] or placed in a wooden frame.[1273] In the provinces of Judea and Arabia,

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[1270] Farrington 1995, 102.
[1271] Pritchard 1958, 11.
[1272] Morgan 1979, 395-97.
[1273] Vriezen and Mulder 1997, 330, fig. 12.

however, *tubuli* were also wheel-thrown. These heating pipes were first formed into cylindrical pipes on a potter's wheel and then pressed by hand into their rectangular form before being fired.

These wheel-made *tubuli* functioned in the same way as slab-made *tubuli* and have been found widely throughout southern Judea and Arabia. The earliest examples of these innovative heating pipes seem to come from Herodian baths.[1274] Around this same time, the Nabataeans also appear to be producing wheel-made *tubuli*. These pipes were used in all their early heating systems, including the baths at Wadi Ramm, which may date to the late first century BCE.[1275]

The impetus for this innovative production technique was likely tied to the absence of a well-established ceramic building material industry in the Levant prior to the introduction of Roman-style baths. Unaccustomed to producing slab-made material, the local ceramic workshops looked for alternative ways of producing *tubuli*. The result was to manufacture these pipes on a potter's wheel, a technique with which they were much more familiar. A similar shift in production technique is seen with ceramic water pipes. While these pipes were commonly made from slabs of clay in other regions, Nabataean potters had begun producing cylindrical water pipes on the potter's wheel from as early as the first century BCE.[1276]

In addition to taking advantage of local preferences in manufacturing techniques, wheel-made *tubuli* had a few technical advantages over slab-made heating pipes. Being comparatively lighter, they were theoretically cheaper to transport, and it is likely that columns of installed *tubuli* were less likely to collapse. Indeed, in other regions where slab-made *tubuli* were installed, iron pins or clamps were often used to stabilize the wall-heating system.[1277] There is no

[1274] Kowalewska 2019a, 238.
[1275] Dudley and Reeves 1997, 94-5; Reeves and Harvey 2016, 452, fig. 8, table 2.
[1276] Bellwald 2007, 322-23.
[1277] Brodribb 1987, 77; Adam 1994, 269; Bouet 1999, 39.

evidence of such clamps being used in systems of wheel-made *tubuli*. Furthermore, their thin walls and lack of corners also meant that wheel-made *tubuli* were subjected to less thermal stress that those heating pipes made from slabs of clay and were therefore less likely to fracture and fail after installation.[1278] While these advantages may have made the wheel-made *tubulus* superior in some ways to the typical slab-made type, they were likely secondary to the preference for continuing local production practices.

Once adopted by the local building industry, the practice of making *tubuli* on a potter's wheel was very resilient. The endurance of this production technique is best seen along the *Limes Arabicus* where it persisted throughout the Roman period and continued to be used even in the heating systems of garrison bathhouses built at the end of the third or start of the fourth centuries, such as those at Betthorus (modern Lejjun), Arieldela (modern 'Ayn Gharandal), and Osia (modern Yovtava). The use of this local adaptation of a Roman technology by the Roman army may indicate that military itself adopted this manufacturing technique, but it is more likely the case that the imperial administration in this region contracted the supply of building material to local workshops.[1279] The production of wheel-made *tubuli* proved so resilient that this production technique outlived Roman-style baths and was used for the heating pipes found in Early Islamic baths, which developed from their Roman predecessors. For example, the heating pipes used in the eighth century CE baths at Qasr al-Hayr in Syria appear to have been produced on a potter's wheel.[1280]

[1278] Rice 2015, 330.
[1279] Harvey 2018.
[1280] Grabar et al. 1978, 1: 179-80; 2: 279, no. 28.

An interesting issue that is not often discussed in scholarship is the reuse of material in heating systems.[1281] Perhaps the clearest example of this reuse is the paving of hypocaust floors with circular bricks that once formed *pilae*, examples of which can be found in the baths at Hauarra, Beirut, and Jerusalem. While this reuse is most obvious with circular brick, it is certain that square and rectangular bricks were similarly dismantled and reused in subsequent phases. Such recycling of material may partly be the reason for the heterogeneity of materials found during excavation. In the baths at Hauarra, for example, the assortment of different bricks used in the hypocaust of the latest phases was thought to be the result of reuse.[1282] Similarly, the excavators of the baths on Jebal Khubthah at Petra suggested that irregularly sized circular bricks used in the *pilae* likely came from an earlier phase.[1283] *Tubuli*, being more fragile and thus more prone to breaking, were less likely to be reused. Nevertheless, evidence for the removal and reinstallation of these heating pipes in later phases has been found in the baths at Arieldela (modern ‘Ayn Gharandal).[1284]

In addition to reused material, several heating systems from Roman-style baths were partially built with ceramic building materials that were not originally intended for use in heating systems. At a few sites, for instance, cylindrical “water” pipes were used in wall-heating systems in place of *tubuli*, the best example of which is seen in the baths at Arieldela. Here, the wall-heating system of one of the heated rooms is built almost entirely out of cylindrical pipes of the type typically used for hydraulic installations (with spigot and socket ends for tight connections).[1285]

[1281] For a discussion on the reuse of construction materials by building industries in the Roman world, see Barker and Marano 2017.
[1282] Reeves et al. 2017, 122.
[1283] Fournet and Paridaens 2016, 90.
[1284] Harvey 2019, 179.
[1285] Harvey (Forthcoming).

Other examples of this use of cylindrical pipes for wall-heating systems comes from Tamara (modern En Hazeva), Oboda (modern Avdat) and Mamshit (Mampsis), in the Negev Desert. Further away, excavation of the bath-gymnasium complex at Salamis uncovered the remains of ceramic pipes that were described as being used "in the manner of *tubuli*".[1286] While somewhat unclear, this description may be a reference to a similar repurposing of cylindrical pipes for wall-heating. The use of these cylindrical pipe in place of purpose-made *tubuli* may have resulted from an insufficient supply of the rectangular heating pipe, as was clearly the case at Arieldela, where typical *tubuli* were prioritized for use in the hotter of the two heated rooms.[1287] Alternatively, the concentration of this practice in the Negev Desert may indicate that it was a localized custom by builders in this region.

Another example of repurposing material for heating systems is the use of rooftiles in the raised floor of hypocausts. This type of repurposing is seen at Ramat Hanadiv in Judea, where flat rooftiles (*tegulae*) formed the lowest course of the raised floor and rested directly over the *pilae*.[1288] Although not from a bathing facility, another example of this use of rooftiles in the *suspensura* comes from a heated room in an elite residence at Zantur in Petra.[1289] Elsewhere in Petra, the excavators of the baths on the summit of Jebal Khubthah found a *tegula* with its flanges removed, suggesting that this rooftile may also have been used in the hypocaust system.[1290] The repurposing of these tiles is likely tied to the difficulty in producing and sourcing the large bricks that traditionally covered the *pilae*. Using rooftiles was likely a cheaper

[1286] Christodoulou 2014, 91.
[1287] Harvey 2019, 170.
[1288] Hirschfeld 2000, 320-21, figs. 202, 203.
[1289] Kolb and Keller 2000, 361; Hamari 2017, 93.
[1290] Fournet and Paridaens 2015, fig. 23.

alternative. It is not clear, however, whether or not these tiles had been previously used for their intended purpose prior to their use in hypocausts.

The use of rooftiles instead of large covering bricks seems to be part of a larger phenomenon in Judea and Arabia in which alternative and sometimes innovative solutions were developed for building heating systems without bricks and other slab-made materials. Other examples include the installation of stone *pilae*, the use of stone in *praefurnia*, and the production of *tubuli* on a potter's wheel rather than from slabs of clay. All these practices were concentrated in Judea and Arabia and are likely related to the inexperience of the local building industries with brick production. It seems that prior to the introduction of Roman-style baths, local ceramic workshops were not accustomed to producing ceramic building materials.[1291] The result seems to have been an attempt to find alternative solutions for typically brick-built installations and materials produced with slabs of clay. As local familiarity with and capacity for producing this material increased, brick became more commonly used for *pilae*; however, the innovative practice of making wheel-made *tubuli* continued.

There is very little direct evidence for any influence the Roman military may have had in the construction of heating system. Perhaps unsurprisingly, the influence seems to vary between regions. In Jerusalem and its vicinity, the Roman army seems to have been a supplier of ceramic building material for the heating systems of baths. The use of hypocaust bricks with stamps of the Tenth Legion in baths at Jerusalem attests to this supply.[1292] Excavation of the *Legio* X *Fretensis* kilns and workshops in Jerusalem uncovered numerous examples of hypocaust bricks and slab-made *tubuli*, all of which were produced for use in heating systems in the surrounding

[1291] Small 1987, 62.
[1292] Mazar 2011, 53, 66, 80, fig. 2.77.

region.[1293] Indeed, it has been suggested that the baths in this region that used slab-made *tubuli* rather than wheel-made *tubuli* may have had connections to the Roman army.[1294] In contrast to this supply of hypocaust materials from their kilns at Jerusalem, there is evidence to suggest that the Roman army stationed along the *Limes Arabicus* to the east in the province of Arabia contracted the production of ceramic building material for their garrison baths to local workshops.[1295] The one exception in this region is the earliest phase of the garrison baths at Hauarra, which was likely constructed by the recently arrived troops garrisoning the new province. Their involvement in its construction is supported by the fact that the bricks from this first phase appear to correspond to Roman measures and the *tubuli* were produced from slabs of clay rather than the local wheel-made method.

As has been mentioned throughout this chapter, it is difficult to discern to extent to which the size of the baths was a factor in the materials and techniques used in the heating system. In large part, this uncertainty stems from the fact that few of the largest baths in this region have been fully excavated or published in enough detail to comment on their heating systems. Nevertheless, the evidence at hand, although limited, suggests that size may have played a role beyond determining the number of *praefurnia* required. The baths at Antioch, for example, suggest that larger heating systems had taller *pilae*, which were likely required to help circulate greater amounts of air across larger spaces. An analysis of *tubulus* and spacer pin use on Cyprus also suggests that *tubuli* were preferred in larger baths, possibly because of their perceived status or greater efficiency.

[1293] Rosenthal-Heginbottom 2005, 257, fig. 101; Goldfus and Arubas 2019, 190-91.
[1294] Kowalewska 2019a, 239.
[1295] Harvey 2018.

Conclusions

This chapter has demonstrated the wide range of techniques and materials that were used across the Roman East for the construction of heating systems in Roman-style baths. Despite this variation, this study has also demonstrated the extent to which these systems still retained the standard design of the hypocaust found throughout the Roman world. The reason for this variety is almost certainly related to the need to construct these heating systems using specialized materials, specifically ceramic building materials such as fired brick and *tubuli*, that were not produced in the region prior to the introduction of Roman-style baths.

Apart from along the Mediterranean coast, such bulky commodities could not be imported from abroad in large quantities at an economical cost, although this possibility has been suggested.[1296] The rough terrain and scarcity of navigable waterways in the Roman East made the long-distance trade of bulky goods both difficult and expensive. Inland sites likely relied primarily on locally produced materials, which were specially ordered for individual construction projects.[1297]

It was this decentralized and intermittent production that resulted in the wide variety of ceramic building materials used in heating systems, as individual local workshops across the Roman East worked to replicate the specialized material using local practices and techniques. Adding to this diversity was the production of materials by Roman military kilns using non-local techniques. The result was a mixture of square and circular brick, Roman and local measures, traditional techniques and innovative designs, all dependent on the region.

1296 Foerster 1995, 204.
1297 Butcher 2003, 200.

These production practices in turn affected usage, as the builders of baths in most cases were limited to whatever was produced by local workshops. If the closest tile kiln or ceramic workshop produced circular hypocaust bricks, that is the type of brick that was used. The effect of local production centers is clearly seen in the distribution patterns of wall-heating techniques used in the south of France where the use of *tubuli*, *tegulae mammatae*, and spacer bobbins is concentrated in discrete regions, clustered around production centers that fabricated the respective materials.[1298] A similar clustering of building materials is evident in the Roman East.

As this chapter also demonstrated, the absence of well-developed ceramic building material industries further contributed to the variation in building techniques used in heating systems. When not available, local building industries were able to find alternative techniques to using bricks and slab-made materials. These solutions included the use of stone pilae, wheel-made *tubuli*, and the repurposing of other materials for the construction of heating systems.

The variation in building techniques and materials used throughout the Roman East for heating systems was thus tied to the production techniques and practices of the local building industries. While nearly all Roman-style baths in this region contained heating systems comprising full-floor pillared hypocausts and wall-heating systems, the materials and techniques used for their construction were entirely dependent on the availability of the material from local workshops and the solutions developed by the local building industries.

[1298] Bouet 1999, figs. 11-14, 33, 40-42.

Chapter 6 Conclusion

The intent of the study presented here was to explore the extent to which provincial building industries across Rome's eastern provinces were involved in the construction of Roman-style baths by investigating the use of local building materials and techniques in these facilities. Emphasis was placed on examining how local communities deployed their own well-developed building traditions and worked within their specific environmental limitations to overcome the technical challenges that Roman-style baths presented. In addition to developing innovative solutions from their own building practices, these provincial building industries also imported western techniques when necessary.

These Roman-style baths are among the most visible attestations of the adoption of Roman cultural practices in the eastern provinces, and thus their study has provided tangible examples of how provincial communities responded to Roman imperialism. The wide geographic scope of this investigation has made it possible to examine regional as well as transregional patterns regarding the deployment of specific building materials and building practices; however, it has also presented challenges, as the study area incorporates over 250 known baths. It was thus necessary to limit this investigation to only a selection of baths, based largely on their accessibility (i.e. preservation, excavation, and publication). Consequently, the observations presented here are not comprehensive; they are, however, representative of widespread trends. Furthermore, to increase the feasibility of this study and control the amount of data collected, only three elements of construction were considered: masonry, vaulting, and heating systems.

After summarizing the patterns observed in each of the three case studies, it will be possible to consider the why these patterns existed and what were the primarily considerations that conditioned the choices made by the builders of Roman-style baths in the Roman East.

Masonry

It is in the materials and techniques used in the masonry of walls where the influence of local building industries on baths is most visible. Throughout the study region, locally available stone was the most widespread masonry material used for baths. Not only was stone suitable for bath construction, but it was also commonly used by preexisting building industries. The involvement of these preexisting industries and local masons is evident in the continued use of local masonry techniques (whether ashlar, sub-ashlar, or rubble/fieldstone construction) for the construction of bathing facilities.

Brick was also employed in the walls of baths, but its use was largely restricted to Flat Cilicia and northern Syria. Although brick masonry was introduced to Flat Cilicia during the Flavian period, several factors such as the availability of good clay, the absence of building stone, and a preexisting roof tile industry led to the establishment of a local brick industry that supported the widespread use of the material as well as the development of localized brick sizes and laying techniques distinct from those of Rome.[1299] The use of this Cilician brick masonry in the baths of Augusta Ciliciae, Anazarbos, and Küçük Bernaz is thus evidence for the involvement of local brick industries. Much less is known about the regional brick industries of northern Syria. During the period covered here, however, the use of brick masonry in this region was largely limited to

[1299] Spanu 2003, 22-24.

baths (and in particular their heated rooms),[1300] and thus does not seem to reflect local building practices.

A more complete break with preexisting masonry practices is the use of mortar as a bonding agent in ashlar construction.[1301] Its use, particularly in the heated rooms, likely served to increase insulation and strengthen the walls supporting vaults and is thus an example of local building practices (i.e. ashlar masonry) being adapted to accommodate the specific needs of Roman-style baths. By far the most explicit example of non-local masonry techniques used in bath construction is the use of *opus reticulatum* at Jericho and Elaeussa Sebaste, the use of which is considered strong evidence for the importation of Italian builders. Despite these exceptions, the overwhelming pattern in the masonry of Roman-style baths is the continued use of local materials and techniques, indicating that provincial building industries were involved in their construction and had the agency to employ familiar building practices.

Vaulting

In the Roman East, the construction of true vaults and domes in above ground structures was not common until the introduction of Roman-style baths. Although the vaulting of baths does not often remain extant, surviving examples reveal that a variety of materials and techniques were employed in their construction. While the materials used were largely dependent on available resources, the vaulting methods used in the baths of the Roman East included innovative techniques imported from the West as well as techniques influenced by local construction practices. Few regions of the Roman East had the available resources or a well-developed

[1300] For example: Bath C at Antioch and the baths at Palmyra.
[1301] Best seen in the baths at Sha'arah (Fournet 2008, 160).

ceramic building material industry to support the widespread construction of brick and concrete vaulting as was common in many regions of the West. One exception was Flat Cilicia, where a pre-Roman tile industry and good clays resources supported the construction of brick vaulting. In the volcanic region of eastern Flat Cilicia (also known as Black Cilicia), the builders of these vaults took advantage of the local geology and used light-weight scoria as *caementa* in the mortared rubble packing above the brick intrados of the vaults to reduce their weight. Brick vaults were also constructed in several baths of northern Syria, although much less is known about this region's brick industry. Of particular note is a brick vault from baths at Dura Europos (Bath M7), which displays an interesting mix of Roman and local building traditions and is a rare example of pre-Roman vaulting technique influencing vault construction in baths. Here, the builders of the vault used a Roman material (kiln-fired ceramic bricks) with a local and pre-Roman vaulting technique, known as "pitched vaulting".[1302]

Elsewhere in the Roman East, stone was the primary material used for vaulting. The use of this material resulted partly from the availability of resources (an abundance of local building stone and a comparative scarcity of good clay) and partly from preexisting building industries (which themselves were tied to the availability of resources). In the provinces of Judea and Arabia, deeply entrenched ashlar traditions led to the widespread construction of cut stone vaults and domes, perhaps best exemplified in those still standing at Gerasa (modern Jerash). The application of these masonry traditions to the construction of vaulting was likely encouraged by the economic and political expediency of using existing industries. A notable exception to this pattern can be found in the Hauran region of southern Syria, where a longstanding tradition of

[1302] Brown 1936a, 86.

basalt ashlar masonry did not translate to the widespread use of basalt blocks in the vaulting of the region's baths. Instead, the builders of these baths constructed vaults using locally sourced volcanic scoria embedded in mortar. They likely chose to use this non-local construction technique, despite their familiarity with basalt ashlar masonry, because basalt blocks were ill-suited to vault construction on account of their heaviness and difficulty to cut into voussoirs. Furthermore, the use of scoria helped reduce the weight of the vaults, thereby increasing their stability. Another imported vaulting technique was the use of vaulting tubes, which were used in only a few baths in the Roman East and failed to diffuse widely on account of the strength of other traditions.

Heating systems

Heating systems comprising hypocausts and wall-heating devices were characteristic elements of Roman-style baths and integral to their function. In addition to being a ubiquitous feature of baths across the Roman Empire, the design and construction of these heating systems were remarkably standardized, with ceramic building materials being the preferred material used on account of ceramic's ability to withstand high temperatures. This study found that, while the heating apparatus of baths in the Roman East generally adhered to the standard pan-Mediterranean design, the builders of baths also employed a range of construction techniques and materials when installing these systems. This variation is not only indicative of the decentralization of the brick industries producing building material for these heating systems, but it also demonstrates the agency that local builders had to adapt construction materials and techniques as situations demanded.

Unfortunately, a general lack of published detail on the *praefurnia* of baths (resulting from both poor preservation and poor understanding of them) has hindered a detailed study of the construction of these furnaces. Conversely, the hypocausts of baths are often the best-preserved component of the heating system on account of their position under floor level. This comparatively high level of preservation combined with the attention paid to hypocausts in publications and site presentations made it possible for this study to identify a great deal of variation in hypocaust construction, which could then be used to infer more information about parts of the heating systems less well preserved. One such example of this variation was in construction material. While ceramic building materials were widely used, some of the earliest Roman-style baths in Judea and Arabia were partially built with stone *pilae*, likely as a result of an undeveloped brick industry. This absence of established local industries also evidently led to the re-purposing of flat rooftiles (*tegulae*) in the early hypocausts of these regions.

Interestingly, the region of Judea was home to a considerable amount of variation in hypocaust construction. In addition to a seemingly localized practice of using arched *pilae* (in contrast to simple columns) in the area surrounding Jerusalem, the hypocausts of several Herodian period baths in this region contained *pilae* formed by ceramic cylindrical tubes. This concentration of diverse hypocaust construction methods may have been partly the result of the early introduction of Roman-style baths to this region; however, it is also possible that intensive excavation in the modern state of Israel, which has led to a much greater number of baths being found in this region than elsewhere, has resulted in a sampling bias.

For much of the Roman East, the variation of hypocaust construction is most evident in the shape of bricks used to construct the *pilae*, with regional patterns clearly visible. In Cilicia and Syria, *pilae* of circular bricks were the norm, with only a handful of baths having hypocaust supports built entirely of square bricks; on Cyprus, both styles existed, but *pilae* of entirely square bricks appear to have been limited to the southern coast; in Arabia, square brick pilae were almost as common as those of circular brick; and in Judea, *pilae* built entirely of square bricks appear to have been more popular than those of circular bricks. In what appears to be a localized practice, builders of some of the earliest baths around Petra also used small rectangular bricks to construct *pilae*. There does not seem to have been a clear advantage to using one type of brick over another, and thus the type of brick used likely depended on the local production practice.

While evidence such as brick stamps and the discovery of military brick kilns at Jerusalem clearly indicates that the Roman army was involved in the production of bricks for hypocausts, there is also evidence for local civilian production of this material. The study of brick size and the modules of measurement used in their manufacture offers a tantalizing opportunity to investigate local influences on brick production (and by extension bath construction). Unfortunately, a general paucity of brick studies in the wider Roman East has prevented a detailed analysis of the sizes of the bricks used in hypocausts; however, it is clear that brick sizes did vary within and between regions and the bricks used in hypocausts did not always adhere to the Roman standard. The variety of brick sizes used in Cilicia, for instance, points towards a decentralized brick production influenced by local standards of measure.

In contrast to the variation seen in hypocausts, wall-heating systems across the study region almost exclusively used *tubuli*. The exception to this uniformity was the use of spacer pins in a few small baths on Cyprus. Like the ceramic bricks, however, the sizes of *tubuli* varied between and even within baths. Of particular interest is an innovative technique for manufacturing *tubuli* on a potter’s wheel that is found only in parts of Judea and southern Arabia and likely resulted from the local industries’ preference for wheel-made over slab-made ceramic production.

Considerations Conditioning Building Materials and Techniques of Roman-style Baths

The observations and patterns outlined above speak to the range of building materials and techniques that were employed in the construction of Roman-style baths in the Roman East. Confronted with the structural and technical challenges posed by these structures, the builders of these facilities turned to both local and non-local construction methods. Moreover, these builders had to contend with environmental limitations such as the availability of necessary resources. Reflecting on these observations, it is possible to comment on some of the primarily considerations that conditioned the choices made by the builders of Roman-style baths in the Roman East.

Availability of Materials

It is evident from the observations made in this study that the availability of resources was a fundamental factor affecting the decisions of those building Roman-style baths in the eastern provinces. Across this region, local building industries had to contend with environmental limitations such as access to construction material. While the builders of baths often imported materials for decoration (such as marble and other ornamental stone) over great distances,[1303] the exorbitant costs of transporting bulky goods (especially overland) made the importation of other building materials economically unfeasible, except in specific circumstances.[1304] Thus, if provincial communities wished to build a bath, they had to do so using what materials were available to them.

[1303] For example, see Dodge 1988.

[1304] For discussions on the cost and logistics of transporting building materials in the Roman world, see DeLaine 1997, 98-100, 207-224; Russell 2013, 95-140; Russell 2016.

Fortunately, most of the Roman East was rich in building materials suitable for bath construction. In regions with abundant and good clay resources (such as Cilicia and evidently northern Syria), it was possible to construct baths with brick masonry and/or vaulting, in a similar fashion to the baths in the West. Elsewhere, the builders of baths could rely on the widespread availability of building stone, which was commonly employed for other building projects and was perfectly suitable for use in baths for wall and (in some cases) vault construction. While limestone was the local building stone for much of the Roman East, basalt was ubiquitously used in the Hauran region, micaceous slate was common in parts of Rough Cilicia, gypsum was employed at Dura Europos, and sandstone was the local building stone in the Jordanian desert as well as at several sites on the Mediterranean coast.

While local building materials were typically preferred for economic reasons, the builders of baths could and did use imported materials when feasible or necessary to do so. Transport by sea was the cheapest way to import building materials, and there are several examples of maritime trade networks of building materials in the eastern Mediterranean, including the importation of pozzolana from Italy for constructing harbors[1305] and the supply of ceramic roof tiles produced in Cilicia by sea to cities along the Levantine coast.[1306] The study presented here did not uncover any firm evidence that the building industries in the Roman East imported pozzolana for the construction of baths or that the baths along the Mediterranean coast used hypocausts bricks brought in by ship. Nevertheless, the infrastructure to support such importation of building materials did exist, and it is possible that those building baths may have taken advantage of them. One instance where there is evidence of building materials for baths being imported by sea is the

[1305] Hohlfelder and Oleson 2014, 223-26.
[1306] Butcher 2003, 200; Mills 2013, 115.

supply of volcanic scoria for vault construction in Flat Cilicia. This lightweight material was sourced in eastern Cilicia and transported by sea and river to several sites in the west, including Anazarbos, Hierapolis Castabala, Tarsus, and Elaeussa Sebaste.[1307]

Despite the exorbitant costs of overland transport in the ancient world, there is evidence that building materials for bath construction were transported overland when they were not locally available. For example, ceramic building materials (such as hypocaust bricks and *tubuli*) were necessary for the construction of heating systems, but not every site in the arid and semi-arid regions of the Roman East had access to sufficient amounts of clay, water, and fuel to support the local production of these materials. As a result, their manufacture was often limited to a few sites that could supply the construction of baths in neighboring communities.[1308] This system of supply existed in the region surrounding Petra, which was home to a brick industry that supplied hypocaust materials for the construction of baths in the its vicinity, including the one at Hauarra (modern Humayma), 80 km to the south.[1309] A similar regional trade in ceramic building products may have existed for inland communities in Syria.[1310] Thus, while the builders of Roman-style baths preferred and widely used locally sourced building materials, they also imported materials when it was feasible to do so or when necessary.

Local Building Traditions

As emphasized throughout this dissertation and reiterated at the beginning of this conclusion, another factor that strongly influenced the construction of Roman-style baths in the eastern

[1307] Spanu 2010, 408, fig. 12; Lancaster et al. 2010, 958, Lancaster 2015, 30.
[1308] This mode of brick production has been referred to as "nucleated brickyards", for a brief discussion of which, see Peacock 1979, 7.
[1309] Harvey 2018, 603-604.
[1310] Butcher 2003, 200.

provinces was the building practices of local industries. These local building traditions developed out of and were conditioned by locally available building materials, and thus the two were closely linked. Throughout the Roman East, local building industries applied their expertise and well-developed traditions to the construction of Roman-style baths and in some cases adapted them to overcome the technical challenges that these facilities presented.

With the exception of a few notable examples, Roman-style baths were built using local masonry techniques, such as ashlar, sub-ashlar, and rubble (or fieldstone) construction. As has been noted, the deeply entrenched ashlar traditions of Judea and Arabia also led to the widespread use of cut stone in the construction of freestanding vaults. A similar local influence on vault construction in baths can be seen in the use of pitched brick vaulting in Bath M7 at Dura Europos. In Flat Cilicia, the transition of pre-Roman tile industries to the manufacture of bricks supported the extensive use of fired bricks in the walls and vaults of the region's Roman-style baths. The pre-Roman establishment of these ceramic building material industries and the continuity of production traditions is reflected in the use of local units of measure for brick production in the Roman period.[1311]

Conversely, the lack of a local building industry could lead to innovative solutions for adapting local construction and production techniques to new problems. For instance, the absence of well-developed brick industries in Judea and Arabia, at the time that Roman-style baths were introduced, forced the builders of early bathing complexes to look for alternative materials when constructing heating systems. One solution was to fall back on the availability of and familiarity with building stone and build hypocausts with stone *pilae*. The absence of

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[1311] Spanu 2003, 23-24, n. 98, fig. 6; Spanu 2015, 177, fig. 6.

adequate supplies of large covering bricks for hypocausts also led those installing these systems to repurpose ceramic roof tiles, which would have been more familiar and accessible to them. Another effect of the unfamiliarity with brick production in Judea and Arabia seems to have been the development of the wheel-made *tubulus*. Rather than manufacturing these heating pipes from slabs of clay as was typical elsewhere in the Roman world, local producers turned to their expertise in pottery production and began throwing them on a potter's wheel, in a similar fashion to the local manufacture of water pipes. Local building practices thus had a large influence on the construction of Roman-style baths throughout the East, and in many cases these practices led to innovative solutions for adapting local techniques and materials to the construction of these facilities.

In addition to the impracticability of importing entire work teams from the West for all baths built in the Roman East, there were several economic, social, political advantages of using local building industries for the construction of baths. Significantly, the existing local industries in much of the Roman East were skilled and accustomed to working with stone for public architecture and were thus entirely capable of building much of the bathing structure. Furthermore, the infrastructure that supported these local building industries, such as production and supply systems, was already in place and did not require change or additional investment. In some cases, it may also have been politically difficult to replace these preexisting and deeply entrenched industries, because of the political power that the guilds or owners of quarries and workshops enjoyed. In such cases, it was not only economically – but also socially – more expedient to use existing building industries and their associated craftspeople than to introduce new building techniques

In addition to using the local building techniques described above, the builders of baths in the Roman East regularly imported construction techniques from the West, often doing so when faced with the technical challenges of engineering that Roman-style baths presented, such as vaulting. One such imported building technique was the use of mortared rubble construction, which was used both for the fill of stone- and brick-faced walls and for vaulting. While used sporadically throughout the study region, mortared rubble vaulting seems to have been particularly prevalent in parts of Cilicia,[1312] northern Syria, and the Hauran region, where it was commonly (but possibly not always) used as packing above an intrados of stone or brick.[1313] In eastern Flat Cilicia and in the Hauran, the use of mortared rubble vaulting may have been connected to a desire to take advantage of the locally available volcanic scoria, which could be used as *caementa*, thus reducing the weight of the vaults. Another vaulting technique imported from the West was the use of vaulting tubes, which were used in baths at Dura Europos, Pella, and Scythopolis (modern Bet She'an) but failed to spread more widely in the Roman East.

The use of *opus reticulatum* in the baths at Jericho and Elaeussa Sebaste is another example of an imported building technique. Unlike the vaulting methods discussed above, however, this Italian masonry technique was not imported by local building industries to overcome specific structural challenges. Instead, its use reflects the importation of non-local builders for the construction of these baths.

[1312] Earlier studies ascribed the popularity of mortared rubble vaulting in Cilicia to the use of volcanic sand with pozzolanic properties (Boëthius and Ward-Perkins 1970, 387; Waelkens 1987, 99); however, this theory has been called into question as volcanic sand was only available in certain areas and there is no evidence for its importation (Spanu 2010, 407).

[1313] It is not entirely clear what material, if any, was used for the intrados of mortared rubble vaults in the Hauran region. It is possible that the mortared rubble was laid over wooden boarding until cured.

Size of Baths

The study presented here was not designed with the specific intent of identifying patterns of construction as they related to the size of baths. Furthermore, this examination is complicated by the fact that many of the largest baths in the Roman East have not been fully excavated or published in great detail. Nevertheless, it is possible to discuss some general observations on the extent to which the size of these facilities may have conditioned the decisions made by their builders. Generally, the materials and masonry techniques of the walls reflected the availability of resources and local masonry practices; however, it was observed that large ashlar construction was more common for larger baths, which was likely a reflection of the resources and manpower available. Conversely, the size of the baths had no apparent effect on the vaulting technique, which instead generally followed regional practices. Similarly, the size of the bathing facility did not have any major influence on the construction of the heating systems, other than expected modifications, such as a greater number of *praefurnia* and the increased height of the hypocaust system to allow for more air to circulate. The only observable pattern was the absence of spacer pins from the largest baths on Cyprus, which instead used *tubuli* (although *tubuli* were also used in small baths on the island).

Vehicles of Transmission

The use of these non-local building techniques in the Roman East brings into question the methods by which building techniques were spread in the ancient world. It is quite clear that Roman-style baths played an important role in the transfer of construction techniques and technology in the Roman world.[1314] The technical complexity of the heating systems and the structural challenges of building freestanding vaults required specialized materials and building techniques that did not exist in all regions of the eastern Mediterranean prior to the Roman period. The introduction of Roman-style baths to the Roman East thus also required the introduction of new building techniques and materials.

There were many ways by which building techniques could spread in the Roman world, including written sources, the Roman military, elite social networks, trade networks, and the movement of specialists.[1315] In terms of the building techniques used for bath construction in the Roman East, it is likely that most (if not all these) vehicles of transmission played varying roles, with the effects of some more clear than others.

The Role of the Roman Army

Among these agents of transmission, the Roman military is commonly cited as playing an important role in the diffusion of both Roman-style baths and building technology throughout the Mediterranean world.[1316] In the Roman East, the army has been credited with the introduction of Roman baths and bathing culture to Cilicia[1317] as well as to frontier regions such as the city of Dura Europos on the Euphrates and the Lajat region (Trachonitis) in the northern Hauran (modern day southern Syria).[1318] It is very likely that the non-local building techniques that were required for constructing these facilities were introduced to these regions and their local building

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[1314] Waelkens 1989, 87; Lancaster 2015, 193-95.
[1315] For discussions of these agents of transmission, see Greene 1992, 102-104; Hohlfelder and Oleson 2014, 227-33; Lancaster 2015, 199-202.
[1316] For a brief discussion on the role of the Roman army in the diffusion of vaulting technology, see Lancaster 2015, 201.
[1317] Hoff 2013, 145-46.
[1318] Fournet 2012a, 332.

industries alongside the baths themselves. For example, it was most likely the Roman military that was responsible for introducing vaulting tubes to Dura Europos.[1319] Similarly, direct military involvement in the initial construction of the garrison baths at Hauarra (modern Humayma) is the likely explanation for the use of slab-made *tubuli* in a region that otherwise university produced *tubuli* on the potter's wheel.[1320]

Even after the introduction of Roman baths, the Roman army could continue to influence the construction of these facilities through the production of material such as brick and *tubuli*. Many of the baths in the vicinity of Jerusalem, for example, used ceramic building materials produced in the Roman standard by the military kilns operated by the Tenth Legion at Jerusalem.[1321] The fact that the bricks used in the baths at Zeugma adhere to the standard Roman sizes may have resulted from a similar military production of the material, which is also suggested by the presence of legionary tile stamps on the material in the region.[1322]

While the presence of the military may have been influential in the introduction of non-local building techniques and their continued use in certain regions of the Roman East, this study has also demonstrated how garrison baths, particularly those in Arabia, were themselves influenced by local building traditions. These Roman-style baths, which were built to accommodate Roman troops, were constructed out of ashlars in the local fashion, and many even have had vaults of cut stone reflecting local ashlar traditions. The heating systems of these baths also display local influences, such as the use of wheel-made *tubuli*, and there is evidence to suggest that – in complete contrast to the military kilns at Jerusalem – Nabataean industries centered in Petra were

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[1319] Pollard 2004, 142.
[1320] Harvey 2013, 72-75.
[1321] Mazar 2011, 53, 66, 80, fig. 2.77; Goldfus and Arubas 2019, 190-91.
[1322] Wagner 1977, 525-26, fig. 2; Kennedy 1998, 133-35.

supplying these military baths with ceramic building material.[1323] Thus, while the Roman army did influence the construction of baths in the Roman East through the introduction of bathing traditions and building technology in some regions, the military may not have been the dominant influential force throughout the entirety of the Roman East.

The Role of Trade Networks

Trade networks may have also facilitated the transfer of building techniques for Roman-style baths in the eastern provinces. Throughout the study region, the wall heating systems of these bathing facilities almost exclusively used *tubuli*, with the only known exceptions being the use of spacer pins in several baths on Cyprus. As this island was an important link in the maritime trade networks of the eastern Mediterranean, it is entirely possible that this wall heating technique was introduced to Cyprus via its trade connections. Spacer pins were common in the Roman-style baths of Lycia[1324] and further to the west on Crete,[1325] and thus they may have been brought to Cyprus from these regions.

Trade was also likely responsible for the use of volcanic scoria in the Reticulate Baths at Elaeussa Sebaste. Unlike at other sites in the region, such as at Anazarbos, Hierapolis Castabala, and Tarsus, where this lightweight material was used for the entire vaults of bathing structures, scoria was used in such small quantities in the Reticulate Baths at Elaeussa Sebaste that it unlikely had any structural effect on the vaulting. This material therefore seems unlikely to have

[1323] Harvey 2018.
[1324] Farrington and Coulton 1990.
[1325] Kelly 2004-2005, 611-14; 2006, 240-43; 2013, 137.

been specifically imported for use in the baths and may instead have been transported as secondary cargo (perhaps as packing) on ships arriving from the East.[1326]

The Role of the Movement of Specialists

The movement of specialist builders was another mode by which the transmission of new building techniques took place in the ancient world. In the Roman East, the movements of builders from Italy to Rome's client kingdoms resulted in the use of *opus reticulatum* in the construction of baths at Jericho and Elaeussa Sebaste. While this Italian masonry technique was not adopted by the local building industries, it is entirely possible that the Italian builders also introduced other non-local building techniques relating to bath construction, such as the use of ceramic brick for hypocausts. Some of the earliest bricks used in the Harbor Baths in Elaeussa Sebaste conform to Roman standard brick sizes.[1327] This similarity to the Roman standard (which is in stark contrast to most bricks used in Cilicia) may suggest a more direct influence from non-local builders.

Other more localized itinerant builders were also among those whose movement likely contributed to the dissemination of construction techniques across the Roman East. From Miletus there is epigraphic evidence that builders could be mobile and move between cities for work.[1328] In Roman Britain, there is even evidence for the existence of builders specializing in bath construction, who travelled from one project to another.[1329] Similarities in hypocaust design and construction found in Morocco has also led to the suggestion that itinerant teams of specialists

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[1326] Lancaster et al. 2010, 958, fig. 3.
[1327] Borgia and Spanu 2003, 304.
[1328] Zuiderhoek 2016, 34.
[1329] Lancaster 2015, 148, 200.

were responsible for the spread of techniques and the establishment of regional patterns of construction.[1330] Similar "bath specialists" may very well have existed in the Roman East, especially in the years and decades immediately following the introduction of the Roman-style baths, when familiarity with constructing these facilities was not locally available. Such itinerant builders may have therefore played a critical role in the dissemination of building techniques required for these baths.

The movement of architects also likely played a role in the transmission of building techniques. Even small baths required the expertise of architects familiar with the design and construction of vaulting as well as thermal and hydraulic engineering. It is clear from Pliny's correspondence with Trajan that such architects existed throughout the Roman Empire, but they could also be brought in from Rome or other imperial centers for projects when necessary (Plin. *Ep.* 10.40). These skilled architects would likely have been familiar with a range of specialized building techniques and may also have had access to written sources such as construction manuals or plans.[1331] In North Africa, evidence for the involvement of such non-local architects in bath construction includes the use of both Roman and local units of measure in the bath plan, the blend of local and non-local masonry techniques, and the design of baths ill-suited for their environments (such as the construction of outdoor pools in colder climates).[1332]

[1330] Thébert 2003, 471.
[1331] For discussions of these manuals, see Greene 1992, 103; Taylor 2003, 27-36; Hohlfelder and Oleson 2014, 230-32.
[1332] Thébert 2003, 471-72.

Building Yards as Sites of Innovation

As discussed in Chapter 2, the construction of Roman-style baths required a large assemblage of specialized builders and craftspeople as well as the involvement of skilled architects familiar with the construction of vaults as well as hydraulic and thermal engineering. The mixture of local building industries and craftspeople, itinerant specialists, and skilled architects created diverse building yards where innovative building techniques could take shape through experimentation. Such “mixed building yards” are thought to have been instrumental in the spread of building techniques in North Africa[1333] as well as in Cilicia.[1334] Elsewhere in the Roman East, the building yards of Roman-style baths would have been equally significant, not only for the exchange of ideas, but also for the bending of techniques and innovation of new solutions for building these complex facilities using what resources were locally available.

Chronological Patterns

The study presented here was not specifically designed to examine chronological pattens of bath construction across the Roman East. Furthermore, the fact that Roman-style baths were introduced to different regions of the study area at different times complicates a transregional chronologic study of these structures (Table 1). Nevertheless, it is worth briefly examining if there was any discernable pattern of change in the construction of baths over the period of focus for this study (i.e. late first century BCE to early fifth century CE).

Generally, while the design and social function of Roman-style baths did evolve over the Roman and late Roman periods (as briefly discussed in Chapter 2), there does not seem to be a

[1333] Thébert 2003, 472.
[1334] Spanu 2010, 9-10, 20.

similar overarching evolution in the building materials and techniques used to constructing these baths. Although small regional patterns of development are evident in a few cases, the materials and techniques used in many of the earliest baths in the region continued to be employed throughout the Roman period and, in some cases, even into Late Antiquity and beyond. For example, ashlar masonry for both wall and vault construction remained the primary construction technique for baths in Judea and Arabia throughout the period studied here. Similarly, the use of scoria in the vaults of baths in the Hauran region is attested in the earliest known baths from this region (those at Salaema, tentatively dated to the late first century CE), and the use of this lightweight material in vaults continued throughout antiquity into the early Islamic period. Although the widespread regional variation of heating systems hinders the identification of diachronic changes, the transregional and continued use of *tubuli* is another example of the continuity of bath construction techniques. In fact, as will be discussed below, the innovative practice of producing wheel-made *tubuli* (which are found in early Herodian and Nabataean baths) continued into the Islamic period for the construction of hammams.

In terms of discernable changes over time, the often-discussed use of *opus reticulatum* in the baths at Jericho and Elaeussa Sebaste can be tied to the direct involvement of Italian builders in some of the earliest baths in the Roman East as well as the chronological range of this building technique, which developed over the first century BCE and first century CE and fell out of use in the second century CE.[1335] This study has also repeatedly referenced the early use of brick alternatives (such as stone *pilae* and roof tiles) in the construction of hypocausts in Judea and Arabia that resulted from an underdeveloped brick industry. As the production of bricks in these

[1335] Adam 1994, 132-33.

regions developed, the use of these alternative materials decreased. Another apparent change is the gradual shift from circular to square *pilae* bricks in Judea from the first to second century CE.[1336] While the findings of this study did not directly confirm or refute this possible evolution of brick shape, it is clear that circular hypocaust bricks continued to be used in this region throughout the study period, as demonstrated by their use at the late fourth to early fifth century Western Baths, at Scythopolis. Other, localized developments, such as the construction of arched *pilae* in the vicinity of the Jerusalem (ca. second century CE) and the use of vaulting tubes at Dura Europos (late second to early third centuries CE) as well as Pella and Scythopolis (unclear, likely post-second century), do not seem to have been picked up and become common building techniques. Thus, based on the examples discussed in this study, the construction materials and techniques used in the baths of the Roman East appear to have been fairly consistent, without major change over time. Additional study of Roman-style baths in this region, however, will likely elucidate addition information and may identify chronological patterns not recognized here.

Future Directions and Research

During the course of this study, a number of important topics came to light that would benefit from further study. One such topic is the study of ceramic building materials that were used in the construction of heating systems. Marcello Spanu's work on ceramic bricks in Cilicia has demonstrated the usefulness of this material in elucidating information about local building industries even without the identification and excavation of kiln sites. My own work on this topic

[1336] Gordon 2007, 74-75.

along with M. Barbara Reeves for the region of south Arabia has similarly shown the utility of their study.[1337] Nevertheless, these building materials are often ignored, the result being a poor understanding of the production, distribution, and use of this material. Greater attention to ceramic building materials should help further reveal regional patterns of construction and will also help uncover what, in many cases, are unknown local industries.

Another subject worthy of increased investigation is the use of volcanic scoria in the Hauran. Although widely reported, there has been no known comprehensive treatment of this regional construction technique. The use of this material in Flat Cilicia is similarly understudied, but there have been some more general treatments of its use in this region beyond excavation and site reports.[1338] Increased examination of this building practice in both regions (and especially in the Hauran) may reveal how the use of this material in the two regions compare.

The modular planning of Roman-style baths is another area that has not been sufficiently explored and may have the potential to elucidate previously unrecognized influences in their planning and construction. In the Roman East, the analysis of modular planning has revealed the care that was taken in the construction of Roman military structures.[1339] A similar application on the construction of baths may reveal the units of measure used in its planning and more detail about the design of these structures.

There is also need for a better understanding of the logistics of overland transportation in the arid regions of the Roman East, which suffer from an absence of navigable waterways. Scholarship on this matter is often focused on caravan trade, but the transportation of low-value

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[1337] Reeves and Harvey 2016; Harvey 2018.
[1338] Spanu 2010, 408; Lancaster et al. 2010.
[1339] Oleson 2017.

goods, such as building materials, over short distances is much less studied. It is clear from the study presented here, that regional trade in these materials, particularly ceramic building materials, did exist, but little is known about the organization and logistics of this trade.

Less related to the construction of baths, but nevertheless important, is the quantification of fuel and water required for the operation of baths in the Roman East. Quantification studies for fuel have typically been carried out on baths in the West and have thus assumed the use of wood or charcoal, whereas similar studies on water use seem to be nearly nonexistent. Future studies quantifying the amount of fuel and water required by baths in the Roman East (using appropriate fuels, attested in the archaeological record) would greatly increase our understanding of the resource intensity of these structures.

Connected to this resource intensity is the larger effect that the environment had on conditioning the evolution of baths and bathing. The scarcity of fresh water in much of the Roman East served to increase the significance of this life-giving resource to those living in the region. This importance is reflected in the ablution and ritual bathing practices that existed in the region prior to the Roman period and still exist today. While the introduction and spread of Roman-style baths certainly signified acculturation and the adoption of new practices in the region, they were also part of a larger history of baths and bathing in the region.[1340] In fact, there is evidence that pre-existing ritual bathing customs facilitated the adoption of Roman bathing technology, such as the presence of both *miqva'ot* and hypocausted rooms in Herodian baths and the fact that some of the earliest Roman-style baths in the Nabataean Kingdom were located next to sanctuaries, suggesting they were used for ritual bathing. Further study of these local bathing

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[1340] For a very brief discussion of the place Roman baths in the longer history of bathing in the Mediterranean world, see Maréchal 2018.

traditions may clarify the adoption and spread of Roman-style baths and bathing in the Roman East.

The Construction of Roman-Style Baths in the Context of Roman Imperialism

The examination of the constriction of Roman-style baths presented here covers only a small element of the archaeology and history of the Roman East. Nevertheless, it has allowed for a better understanding of the cultural implications of Roman imperialism and the operation of empire in the region. More than simple hygienic facilities or architectural ornaments of urban landscapes, Roman-style baths are one of the most visible attestations of the widespread adoption of Roman practices in these eastern provinces.

Much of the previous scholarship on the Roman East, including the larger synthetic studies, has focused on defining the process of acculturation that took place in the region during the Roman period. For Fergus Millar, the Roman East was largely Greek in character, with provincial communities largely assimilating fully into the Roman world.[1341] Rejecting this view as disregarding the agency of provincials, Warwick Ball's deeper focus on the material culture and architecture of the region gave rise to the argument that the visible elements of Roman and Hellenistic culture was nothing more than a "veneer" that covered the continuity of preexisting cultures.[1342] Subsequent scholarship, such as that of Kevin Butcher[1343] and Maurice Sartre,[1344] has sought to highlight the complexity of imperialism in the Roman East and the dynamic

[1341] Millar 1993.
[1342] Ball 2000, especially 246-396.
[1343] Butcher 2003.
[1344] Sartre 2005.

relationships that formed between the provinces and center that led to the creation of mixed identities and hybridized cultures.

While comparatively limited in its scope, the study presented here has used the detailed examination of bath construction in this region to demonstrate the agency that local building industries and communities maintained while under imperial control, even when constructing buildings often seen as representative of Roman cultural dominance. Through the use of local materials and building techniques, including the innovative adaptation of these techniques to overcome the structural and technical challenges posed by these structures, provincial builders succeeded in creating monumental baths every bit as impressive as those of the West. While the use of these local materials and techniques may have been a point of pride for these provincial builders, all the materials and techniques discussed in this study were ultimately covered by marble veneering, mosaics, and painted plaster in order to display the artistic and architectural visual language of the pan-Mediterranean. Much like Warwick Ball's "veneer" of Roman architecture that hid the underlying diversity of the East, this decoration covered the regional differences in construction materials and techniques. These baths, however, were more than a superficial ornamentation of the provincial landscape. Instead, their ubiquity reflects a widespread acculturation of Roman customs by the provincial communities that built them.

As discussed in Chapter 2, Roman-style baths were used by individuals and cities as tools for negotiating their status and standing within a changing Mediterranean world. For cities, they were a means of competing with neighboring communities, while provincials used these facilities to act out their *urbanitas* and integrate themselves into the wider Roman society. This provincial-driven adoption is reflected in the widespread involvement of local building industries in the construction of baths and their agency to adapt their own building methods to bath construction.

Instances of state-sponsored bath construction in the Roman East did exist, such as imperial benefaction and baths for garrisoned troops. While such baths may have helped introduce new building techniques to the region, they were not tools for the enforcement of Roman bathing culture or Roman construction techniques on the local communities. Imperial benefaction was not very common and was almost always limited to major urban centers where bathing culture already existed, while baths built for troops were generally not constructed for public use (they may, however, have helped introduce bathing culture to certain regions of the Roman East). These monumental urban baths and those expressly built for the military display a surprising level of local influence in their construction, further underlining the hands-off approach the imperial administration took to the proliferation of this Roman custom. Indeed, the priorities of the imperial administration are clearly seen in Pliny's correspondence with Trajan, who assented to the construction of baths in the city of Prusa, so long as the project did not adversely affect the taxes of the settlement (Plin. *Ep.* 10.22-23).

The Architectural Heritage of Roman-Style Baths in the Middle East

The practice of communal hot water bathing that was introduced by Rome did not simply disappear along with Roman hegemony in the region. Roman-style baths evolved along with bathing customs and transitioned almost seamlessly into the early Islamic hammam.[1345] This seamless transition extended to the continued use of many of the building techniques and

[1345] For this transition, see Yegül 1992, 339-49; Charpentier 1995, Yegül 2010, 206-212; Maréchal 2020, 223-24.

materials used in Roman-style baths, although new techniques were also introduced or developed. Examples of this continuity in building techniques included the use of high-quality lime mortar,[1346] ashlar and mortared rubble vaulting,[1347] and hypocaust bricks that roughly conform to Roman measures.[1348]

Innovative techniques such as the manufacture of *tubuli* on a potter's wheel also continued, and wheel-made *tubuli* have been found in several early Islamic hammams. Although not recognized by their excavators as wheel-made, published images of *tubuli* from the Umayyad hammam at Qasr Mushash[1349] and the mid eighth century hammam at Qasr al-Hayr East[1350] clearly show the rilling and oval shape indicative of this production technique. Furthermore, the *tubuli* from the last phase of the baths at Hauarra (modern Humayma) are wheel-made, and it has been posited that this last phase dates to the early Islamic period.[1351]

The architectural heritage of the Roman-style baths in the Middle East extends beyond the construction of hammams. This influence is particularly visible in the construction of freestanding vaults throughout the region.[1352] In addition to those in hammams, the vaulting of churches and mosques often followed the same regional patterns of construction techniques that were seen Roman-style baths. For example, brick, which was first used as a vaulting material in Flat Cilicia for baths, continued to be used in the vaulting of this region long after the Roman

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[1346] Almagro 1995, 273.
[1347] Almagro 1995, 274.
[1348] Arce 2008, 506; Arce 2015, 149-50, 154.
[1349] Bartl et al. 2013, 187, fig. 10.
[1350] Grabar et al. 1978, 1: 179-80; 2: 279, no. 28.
[1351] Reeves 1996, 239-48; Harvey 2013, 75-84, figs. 2.15-2.20.
[1352] It is of course the case that these baths were not the only structures in the Roman East to use freestanding vaults. Throughout the Roman period vaults were regularly constructed in tombs as well as in the passageways of theaters and circuses, to name a few examples. These structures, however, did not present the same structural challenges that baths did, and thus they do not often display the innovative vaulting techniques found in baths, such as the use of vaulting tubes and lightweight, mortared rubble construction using scoria (Lancaster 2015, 193).

period, as demonstrated by its use in the twelfth century Church of T'oros I at Anavarza (Anazarbos).[1353] Brick vaulting also continued to develop and spread in northern Syria, where it is found in numerous religious and secular late antique structures, such as in the monumental cisterns of Resafa, which were built in the early sixth century CE.[1354] In addition, fired brick became more commonly used in the masonry of walls in the late antique period in northern Syria. During the Roman period, brick masonry had largely been limited to the walls of baths (and in particular their heated rooms, such as in the baths at Palmyra and Bath C at Antioch), likely because of this material's ability to withstand high temperatures and decrease risk of fire damage. In later centuries, fired brick was increasingly used in other building projects throughout the region, such as at Androna, at Qasr Ibn Wardan, and along the Euphrates.[1355] In many cases brick was used alongside stone in *opus vittatum* (or *opus listatum*) construction, which is characterized by rows of brick alternating with rows of stone blocks.

On Cyprus, where the limited surviving evidence suggests baths were built with cut stone vaults, the earliest vaulted churches on the island likewise used this vaulting material and technique.[1356] Somewhat tangentially related, it has been suggested that the bath-gymnasium at Salamis may have played an important role in the historical development of the flying buttress.[1357] During the first half of the seventh century CE, what may have been structural damage to the central vault, forced architects to design and construct external arched buttresses, which are among the earliest known examples of such construction.

[1353] Edwards 1983, 129.
[1354] Hof 2018.
[1355] Butcher 2003, 175.
[1356] Stewart 2010, passim.
[1357] Stewart 2014, 1-11.

In the Hauran, the use of volcanic scoria for creating light-weight vaults continued in the construction of hammams, churches, and mosques. At Umm el-Jimal (in northern Jordan), for example, vaults of mortared rubble using scoria have been identified in the Double Church[1358] and the West Church,[1359] both of which date to the late Roman or early Byzantine period. This vaulting technique was also used at Hammam al-Sarah,[1360] which possibly dates to the eighth century, and the mosque at the associated site of Qasr al-Hallabat.[1361]

Finally, in the regions of Judea and Arabia, ashlar vaulting continued to be used into the Islamic period; however, the introduction of new vaulting techniques during this period that were influenced by Sasanian building practices also led to the development of new hybridized vaulting methods.[1362] Unlike cut-stone vaulting, the use of vaulting tubes, such as at Scythopolis and Pella, did not continue. The only other known use of this imported vaulting technique in the study region comes from the fifth to sixth century Church of the Annunciation in Nazareth.[1363]

While the formal legacy of Roman-style baths thus lived on through the Islamic hammam (and later through the Turkish baths that are still in use today), these baths also had an important impact on the broader architectural heritage of the region through the introduction and development of vaulting techniques that continued to be used in religious and secular buildings for many centuries.

[1358] Butler 1919, 182.
[1359] Butler 1919, 187; Al-Bashaireh 2016.
[1360] Butler 1919, xxi-xxii, 79; Arce 2015, 156.
[1361] Butler 1919, 76; Arce 2015, 146.
[1362] Almagro 1995, 274; Arce 2008, 519-24.
[1363] Viaud 1910, 66-67.

Figures

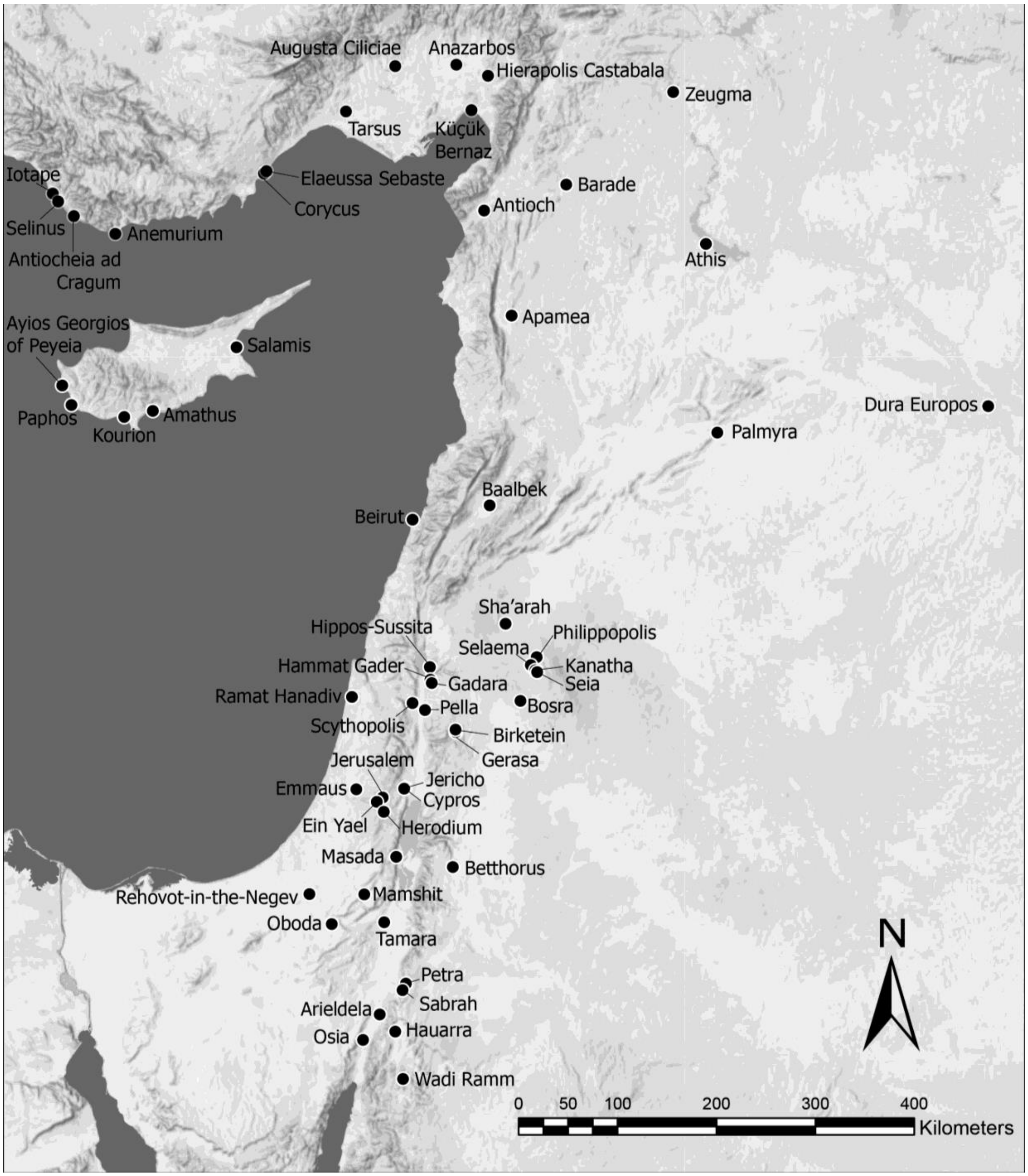

Figure 1: Map of the Roman East (map by author).

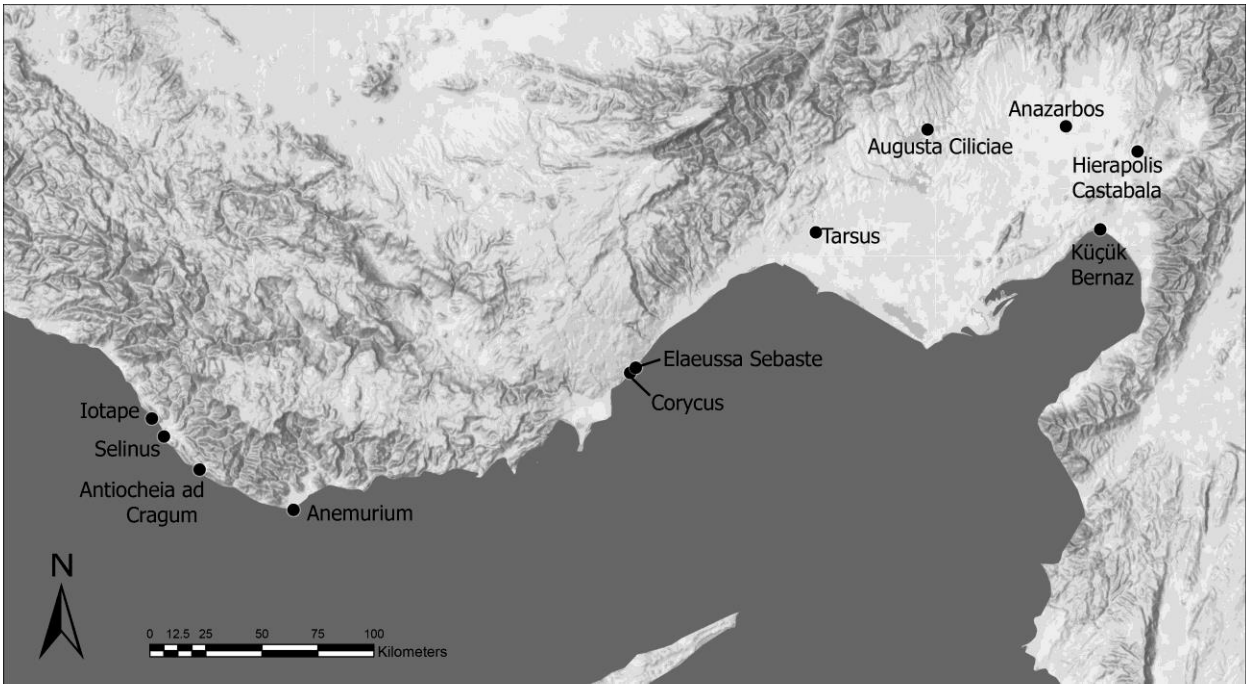

Figure 2: Map of Cilicia (map by author).

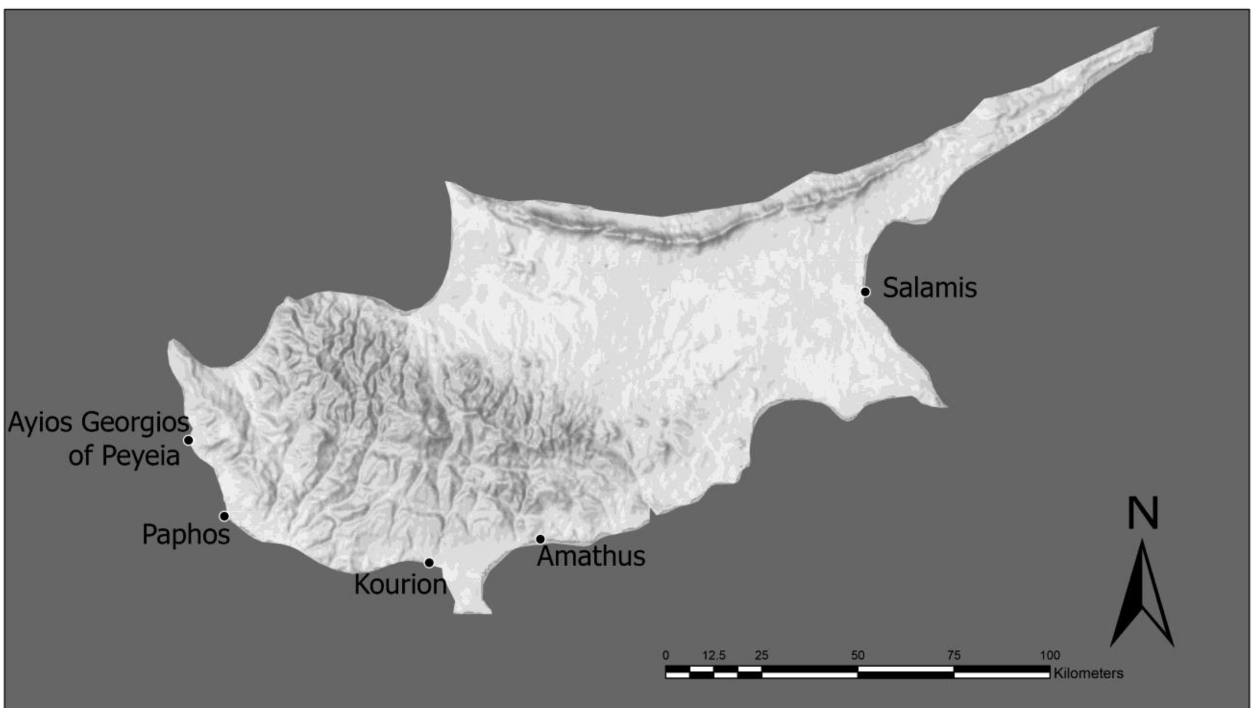

Figure 3: Map of Cyprus (map by author).

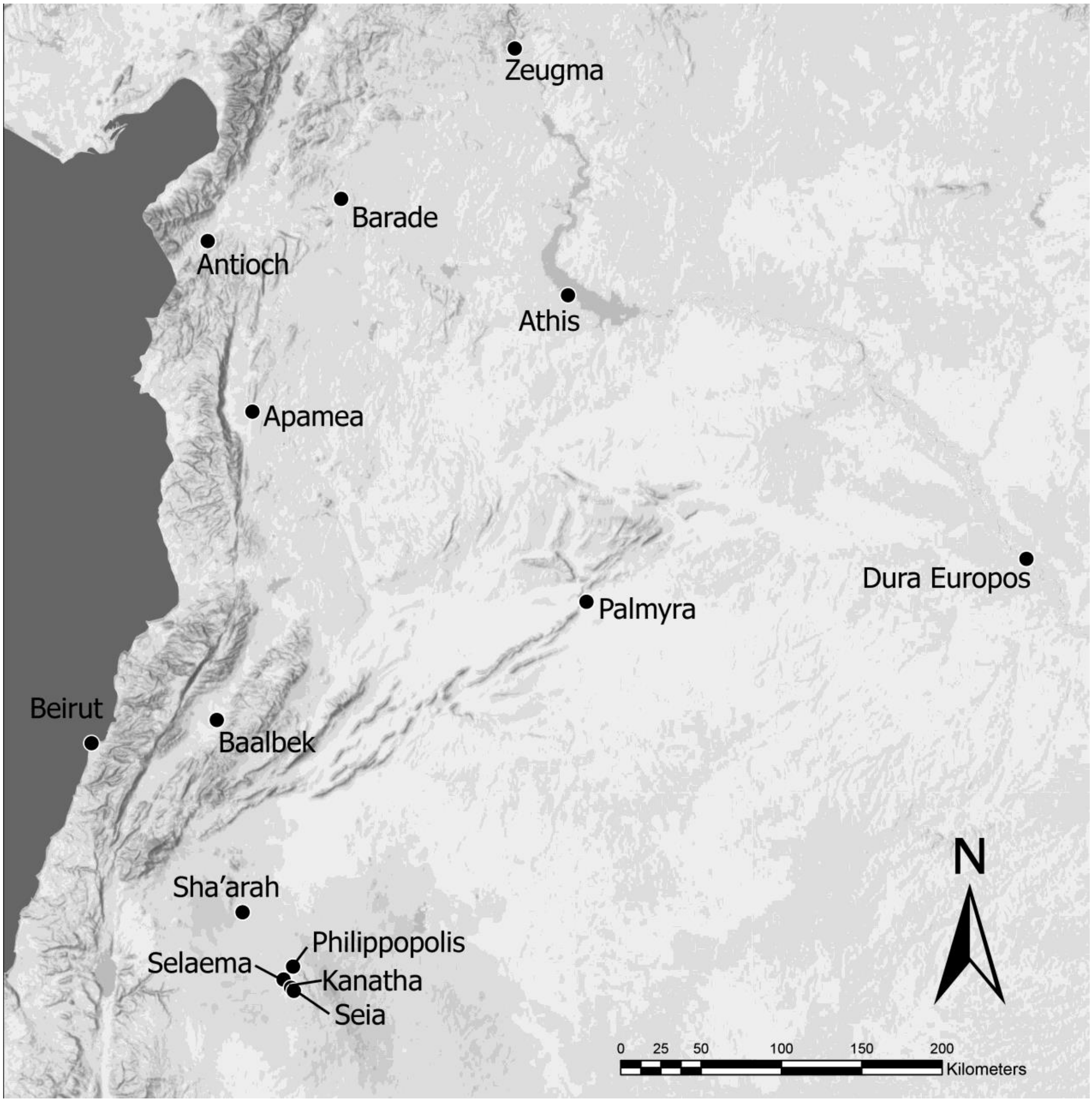

Figure 4: Map of Syria (map by author).

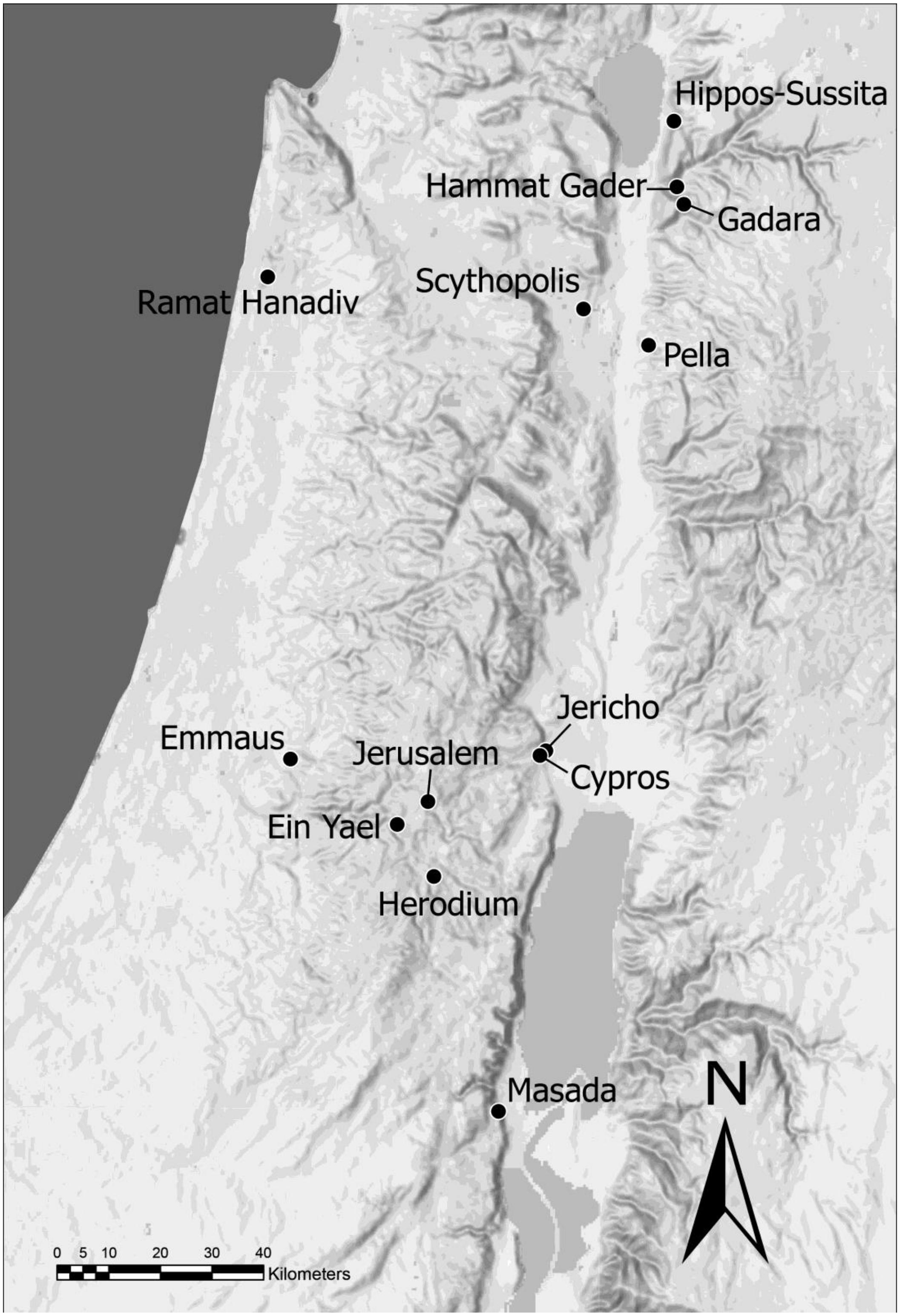

Figure 5: Map of Judea (map by author).

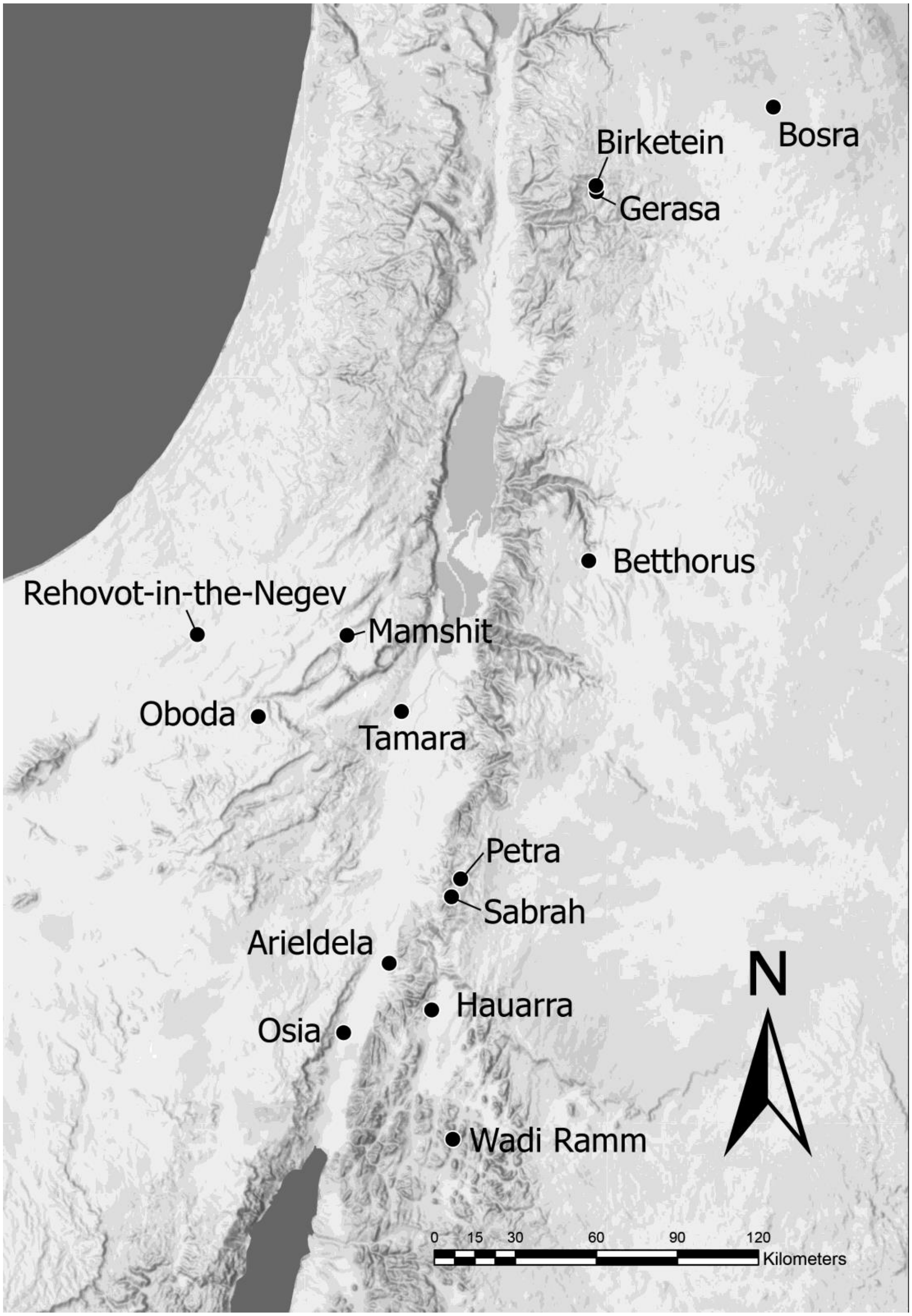

Figure 6: Map of Arabia (map by author).

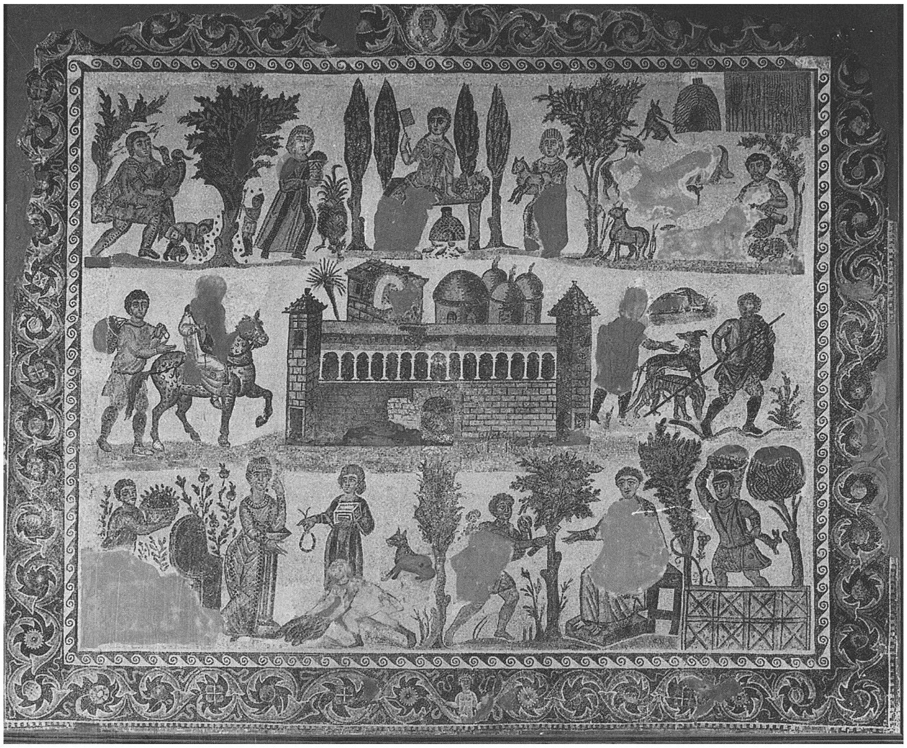

Figure 7: Late fourth century mosaic of Dominus Julius, Museé du Bardo, Tunis (Dunbabin 1999, fig. 122).

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Figure 9: Mosaic depicting construction of Tower of Babel, from synagogue at Huqoq (in the eastern Lower Galilee) (Magness et al. 2018, fig. 48).

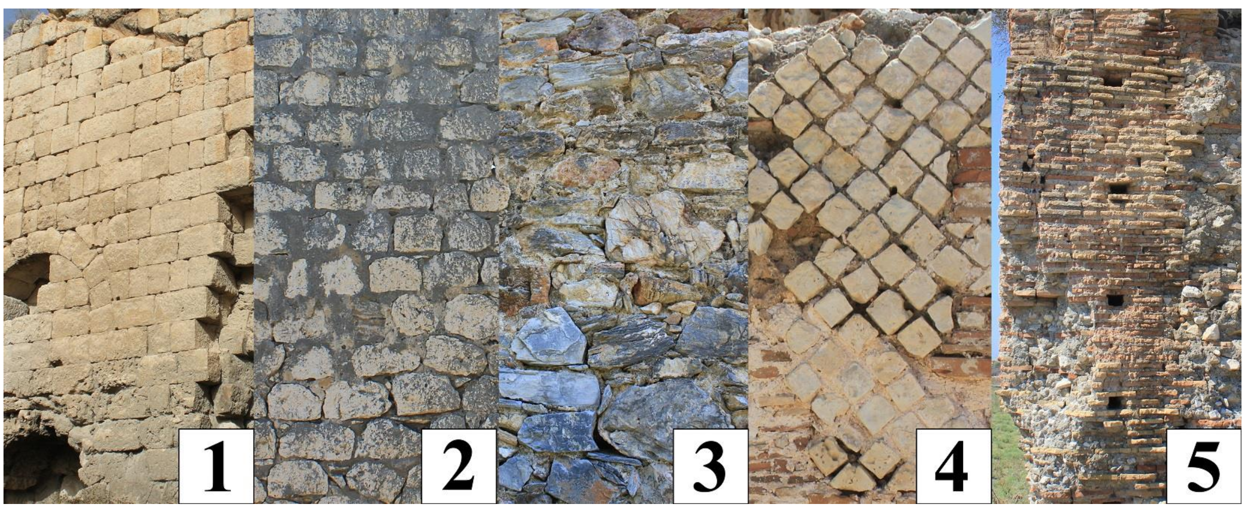

Figure 10: Examples of masonry techniques. 1 – ashlar; 2 – sub-ashlar; 3 – rubble; 4 – *opus reticulatum*; 5 – brick (photos by author).

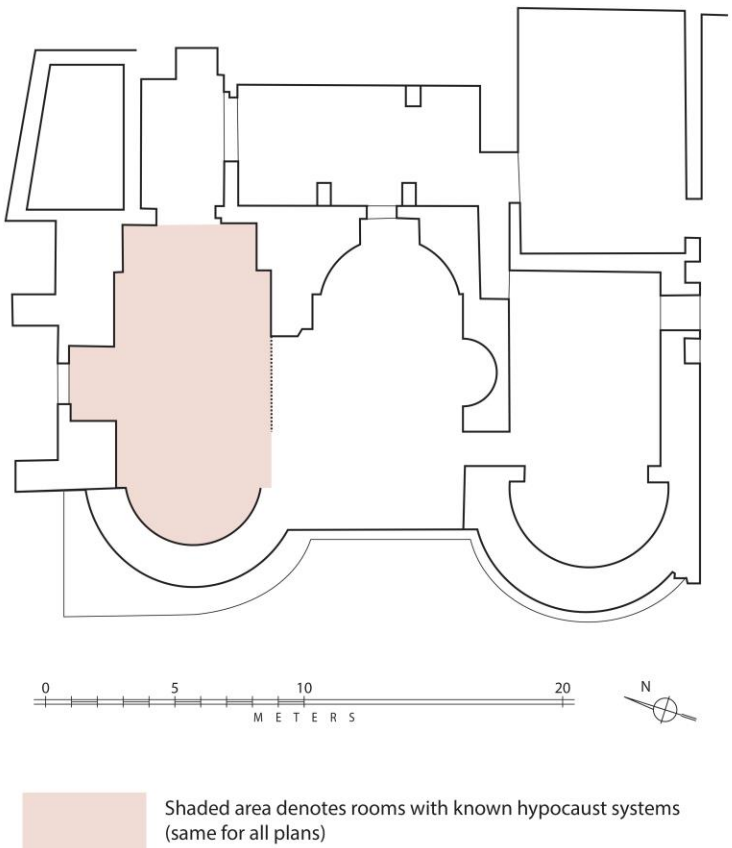

Figure 11: Plan of baths (5 B) at Iotape (after Huber 1967, fig. 29).

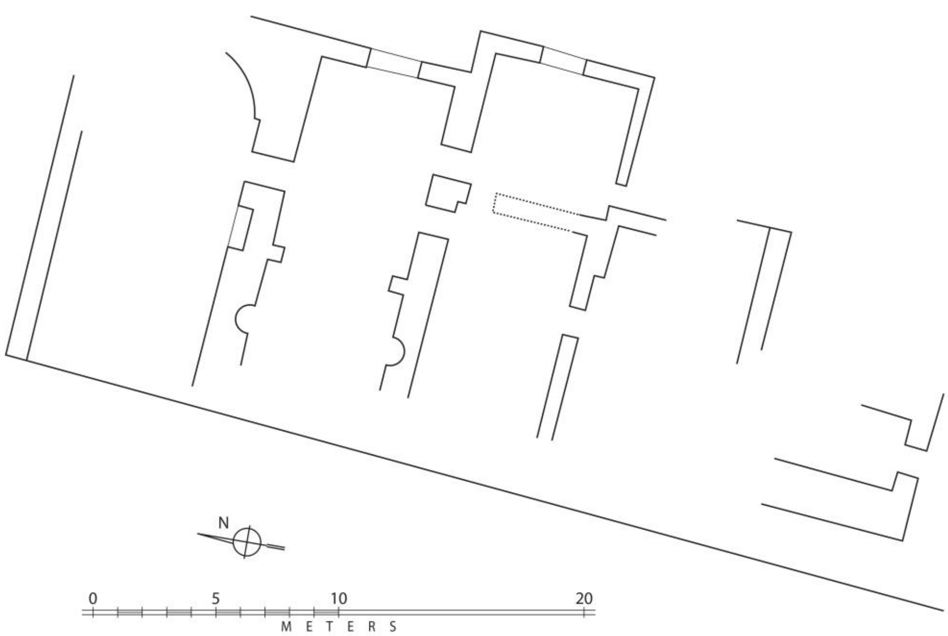

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Figure 13: Interior of baths ("Building 6") at Iotape, facing east, showing masonry of rough-cut limestone and vaulting of lime-tufa above (photo by author).

Figure 14: Interior of baths ("Building 6") at Iotape, facing south, showing masonry of rough-cut limestone and vaulting of lime-tufa above (photo by author).

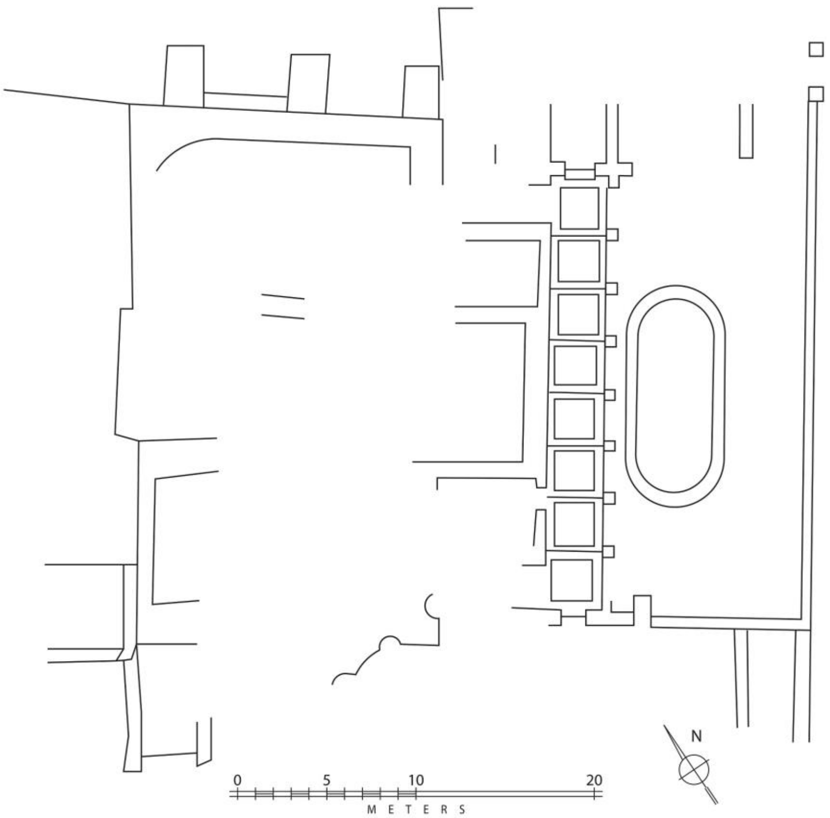

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Figure 17: View of vaulting in Room 8 of Great Baths at Antiocheia ad Cragum, showing sub-ashlar masonry of wall and lime-tufa blocks of vaulting (photo by author).

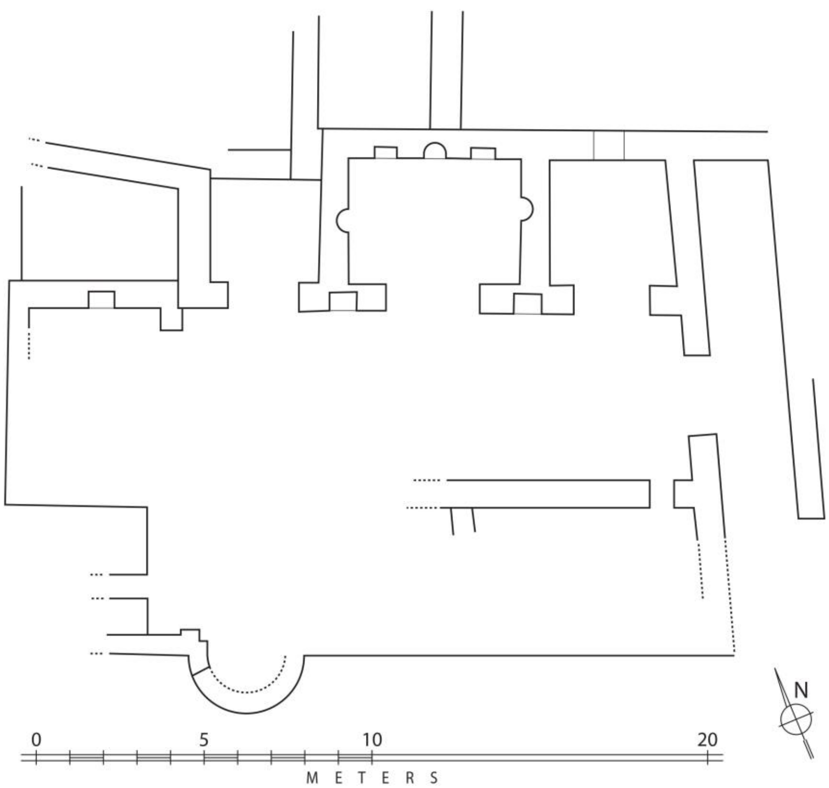

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Figure 19: Partial view of Extramural Baths at Antiocheia ad Cragum, showing sub-ashlar masonry of micaceous slate (photo by author).

Figure 20: Partial view of Extramural Baths at Antiocheia ad Cragum, showing sub-ashlar masonry of the walls and partially preserved vault of radially laid uncut stone (photo by author).

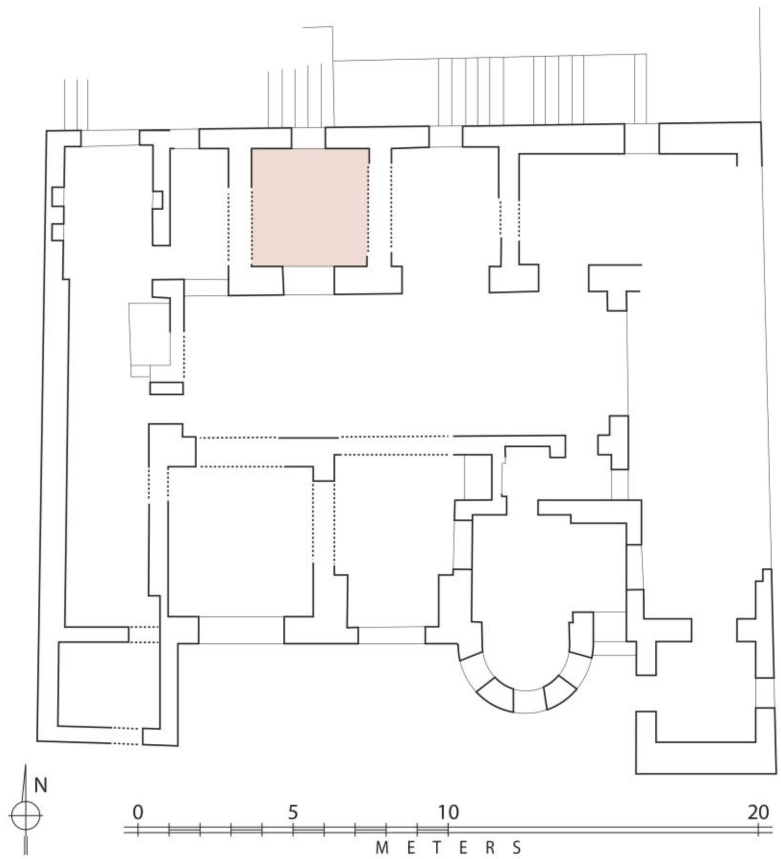

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Figure 22: View of Bath II 7 A at Anemurium, from northeast, showing use of irregular sub-ashlar blocks of quarried limestone (photo by author).

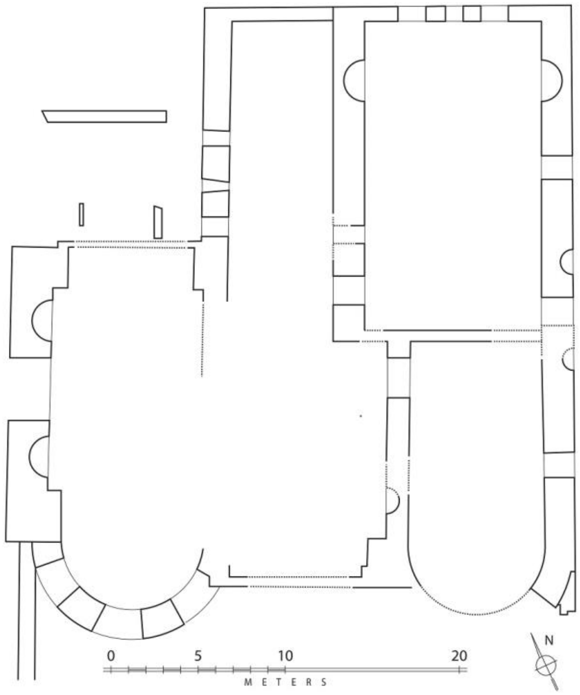

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Figure 24: View of interior of Bath III 2 B at Anemurium, showing the use of roughly dressed quarried limestone in walls and mortared rubble packing above brick *intrados* that still preserves impressions of the vertically placed bricks, now fallen away (photo by author).

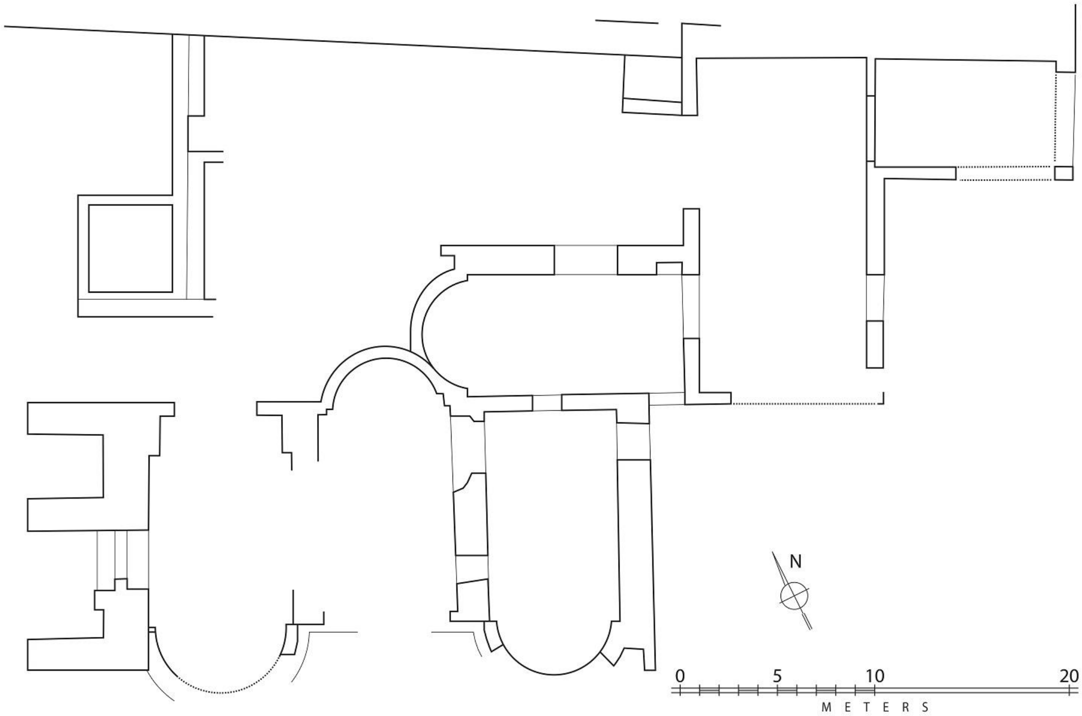

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Figure 29: Detailed view of the Large Baths at Elaeussa Sebaste, showing sub-ashlar masonry, mortared rubble core, and tufa blocks in remains of vault (photo by author).

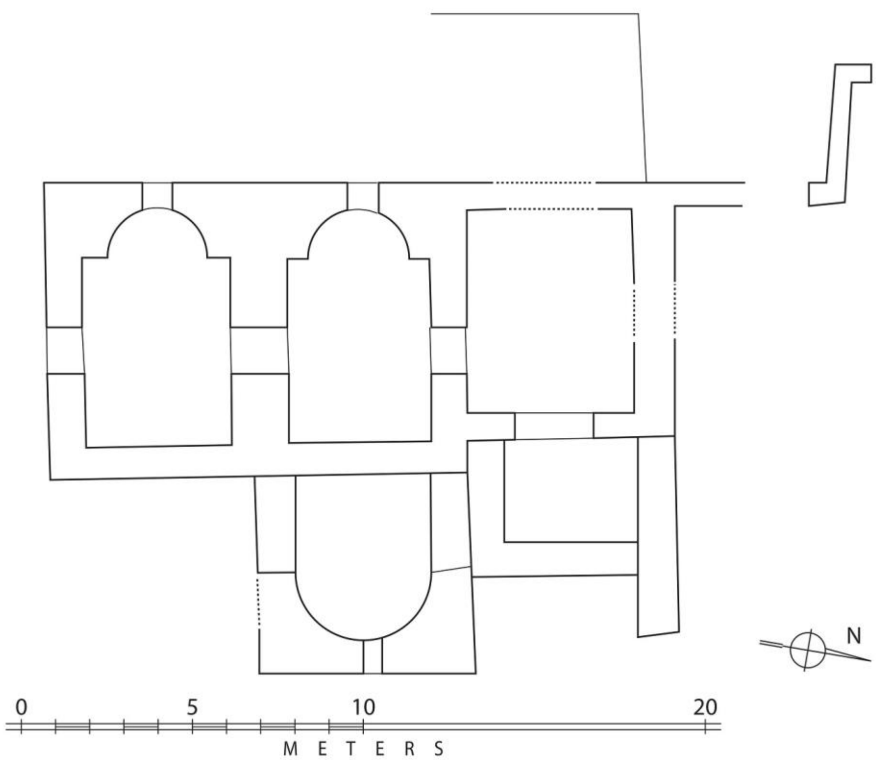

Figure 30: Plan of the Reticulate Baths at Elaeussa Sebaste (after Spanu 1999, fig. 44).

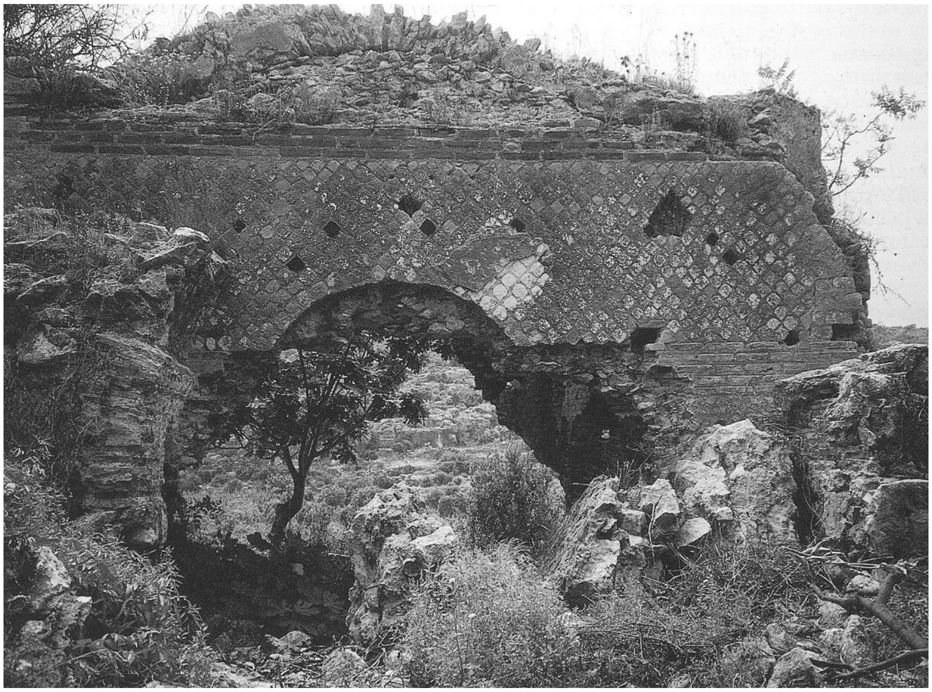

Figure 31: Exterior of Reticulate Baths at Elaeussa Sebaste, showing use of *opus reticulatum* (Spanu 1999, fig. 56).

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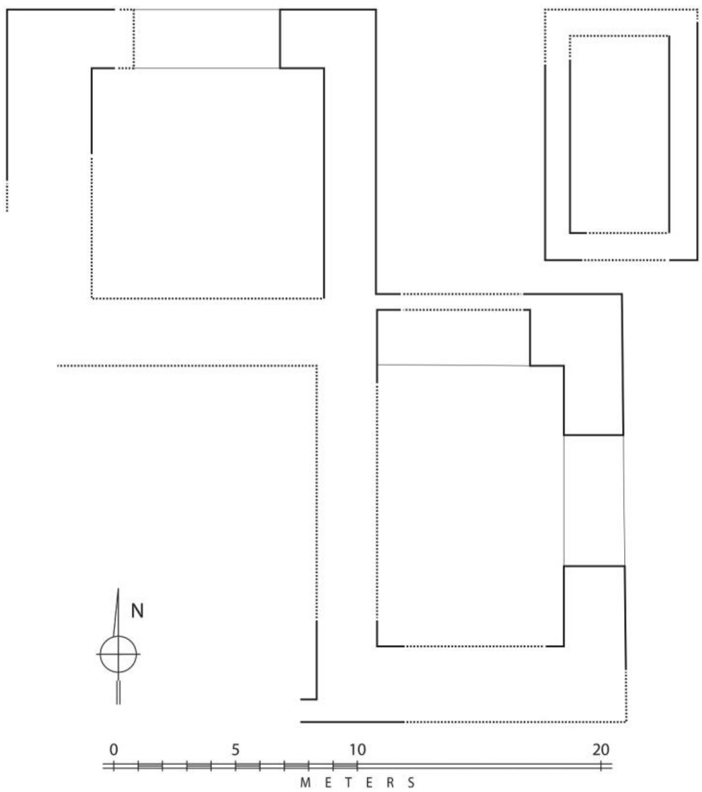

Figure 35: Plan of the baths at Augusta Ciliciae (after Gough 1956, fig 3).

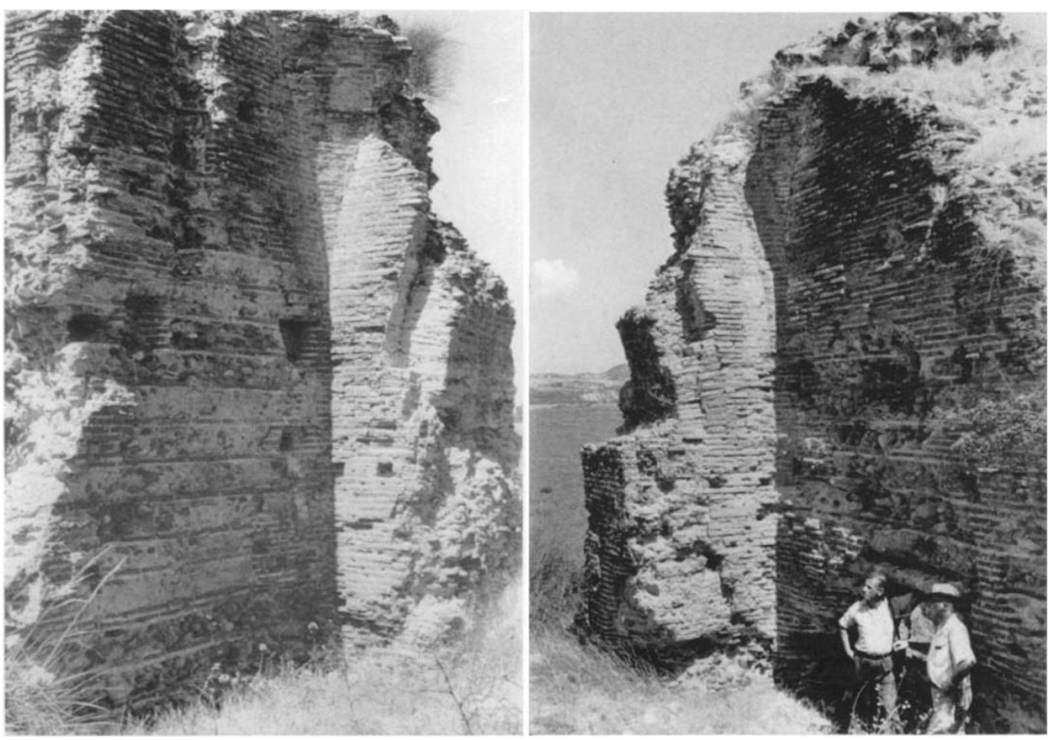

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Figure 38: View of the Southern Baths at Anazarbos, showing use of brick-faced mortared rubble masonry (photo by author).

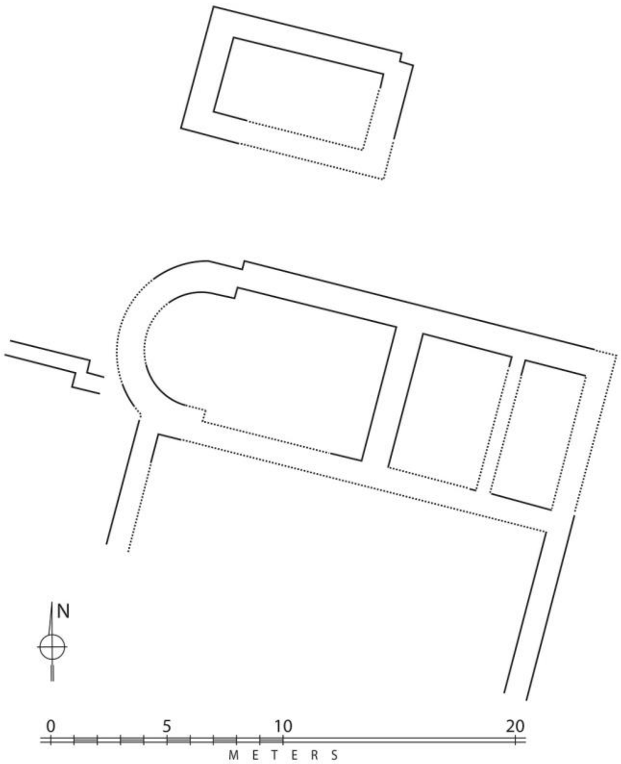

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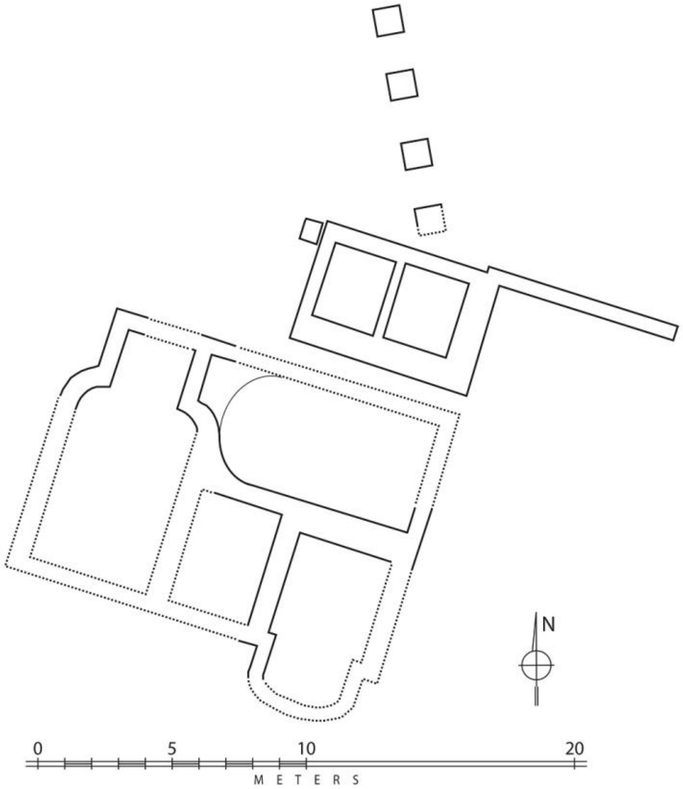
Figure 40: View of north wall of the Larger Baths at Küçük Bernaz, showing use of carefully shaped polygonal basalt stones (Tobin 2004, fig. 56).



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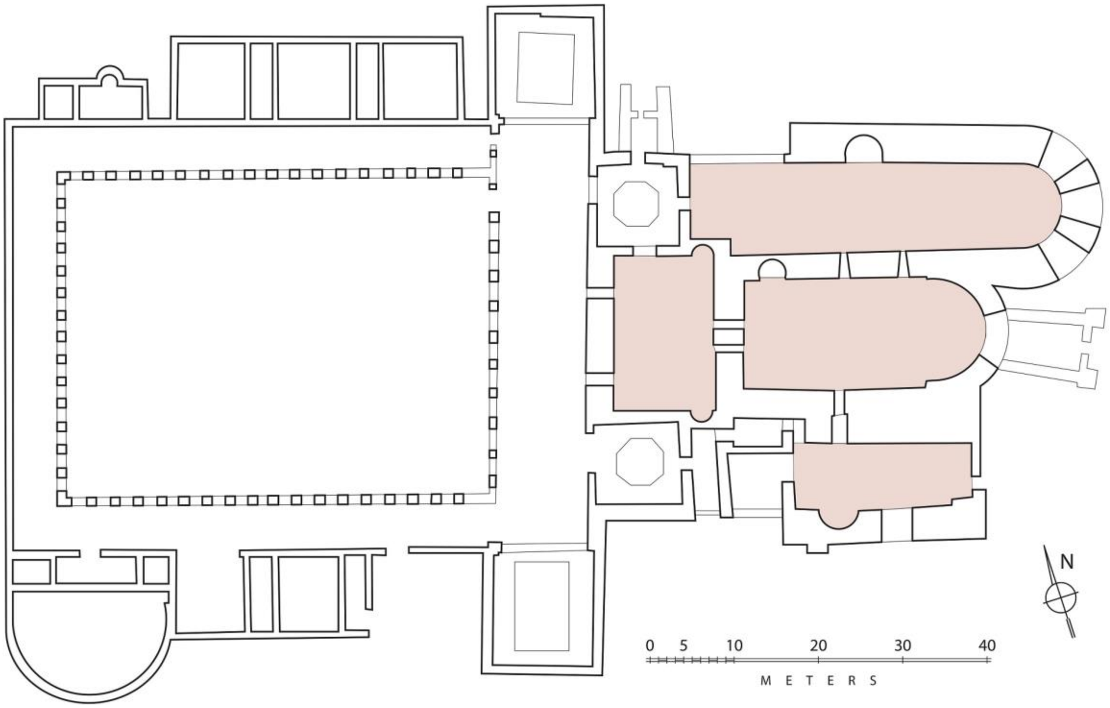

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Figure 44: Interior of the central *caldarium* of the bath-gymnasium complex at Salamis, showing ashlar masonry and collapsed blocks from the vault. View from the west (Karageorghis 1967, fig. 156).

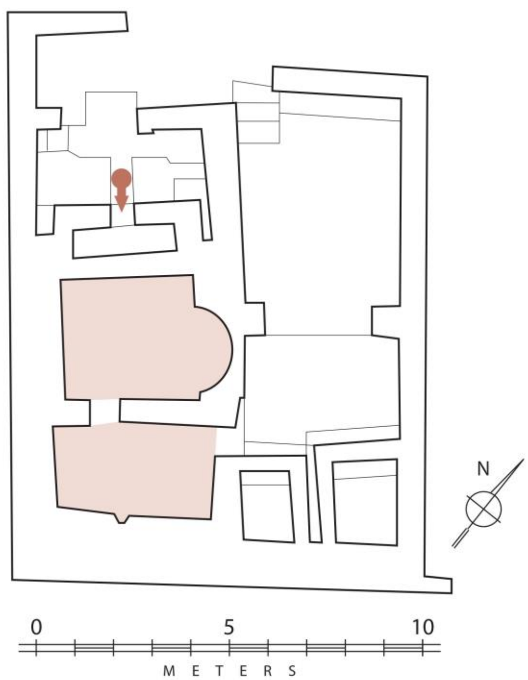
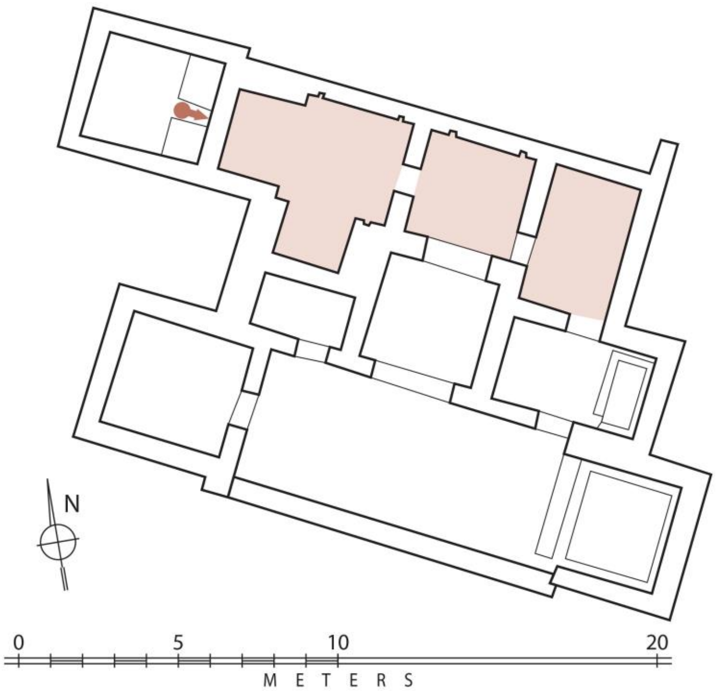


Figure 45: Plan of the baths at Amathus (after Christodoulou 2014, fig. 6).

Figure 46: View of the baths at Amathus, from northwest (photo by author).



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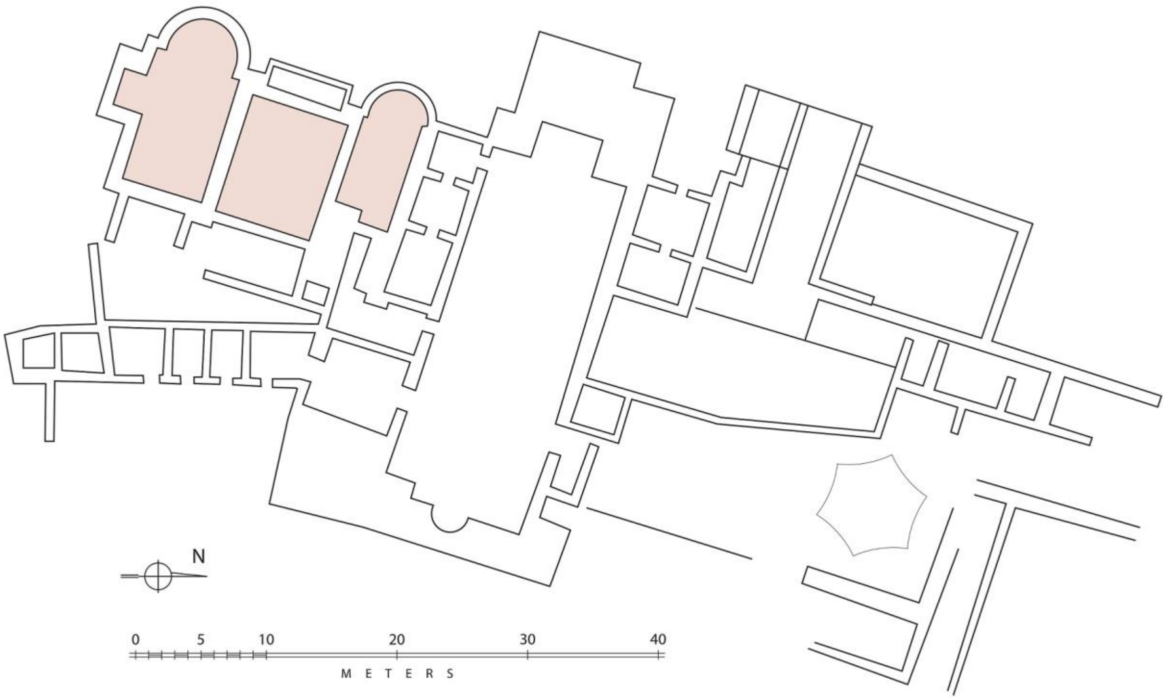

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Figure 50: View of the Acropolis Baths at Kourion, showing pseudo-isodomic ashlar construction (photo by author).

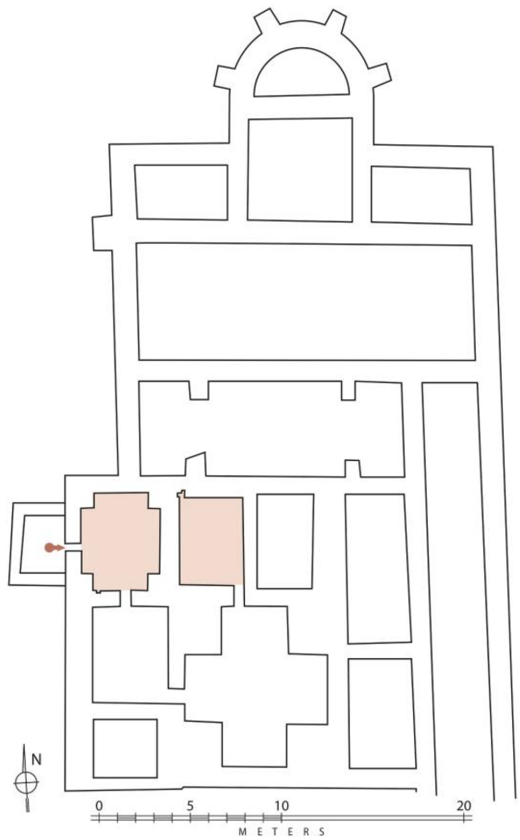


Figure 51: Plan of Bath A at Antioch (after Fisher 1934b).

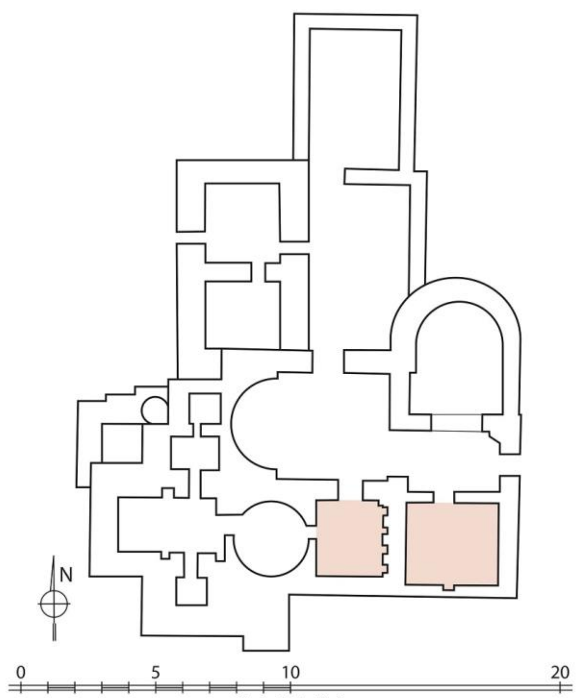
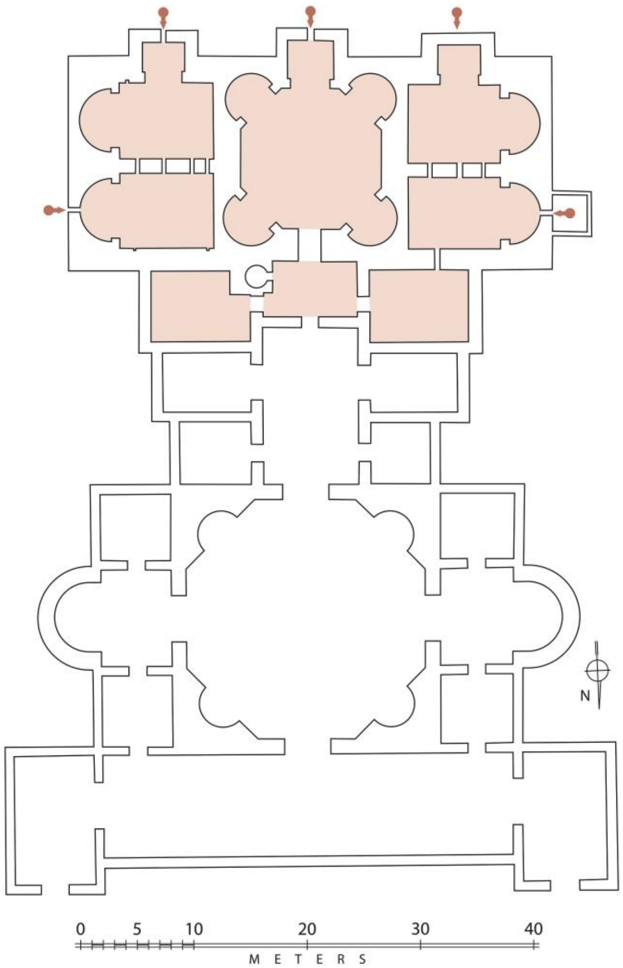


Figure 52: Plan of Bath B at Antioch (after Fisher 1934c, fig.7).



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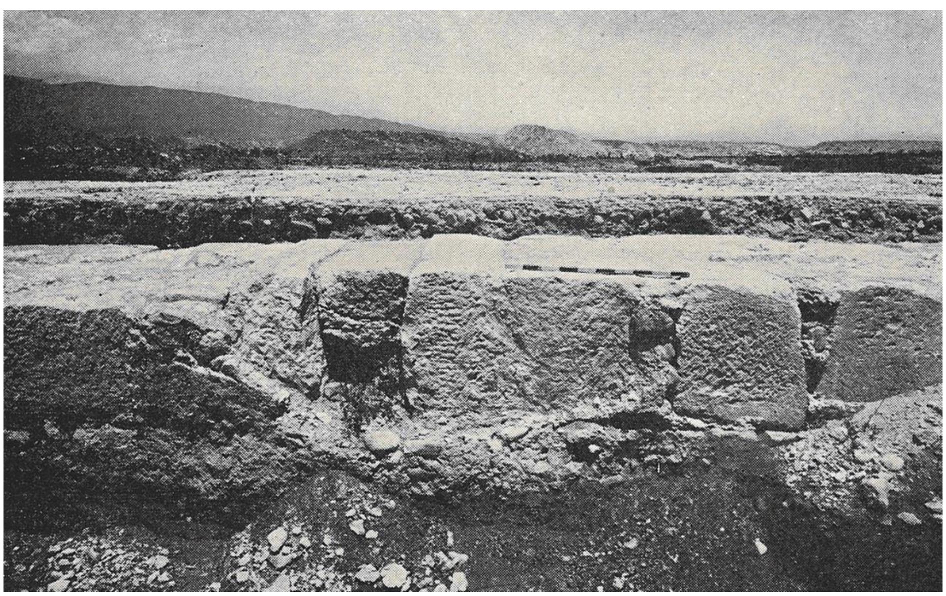

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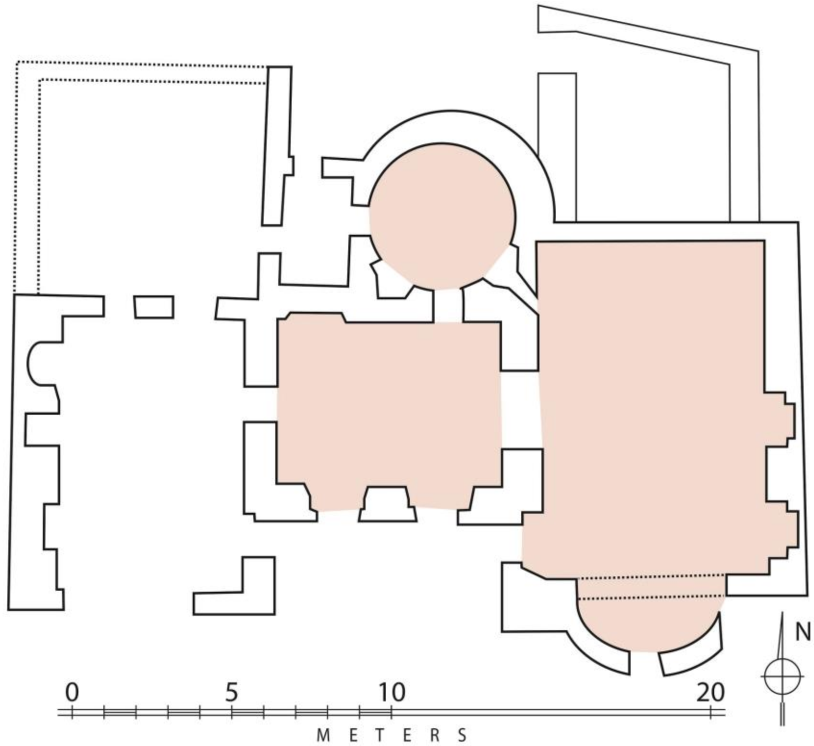

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Figure 56: View of Northeast Quarter Baths at Apamea, showing brick masonry and vaulting (Paridaens and Vannesse 2014, fig. 5).

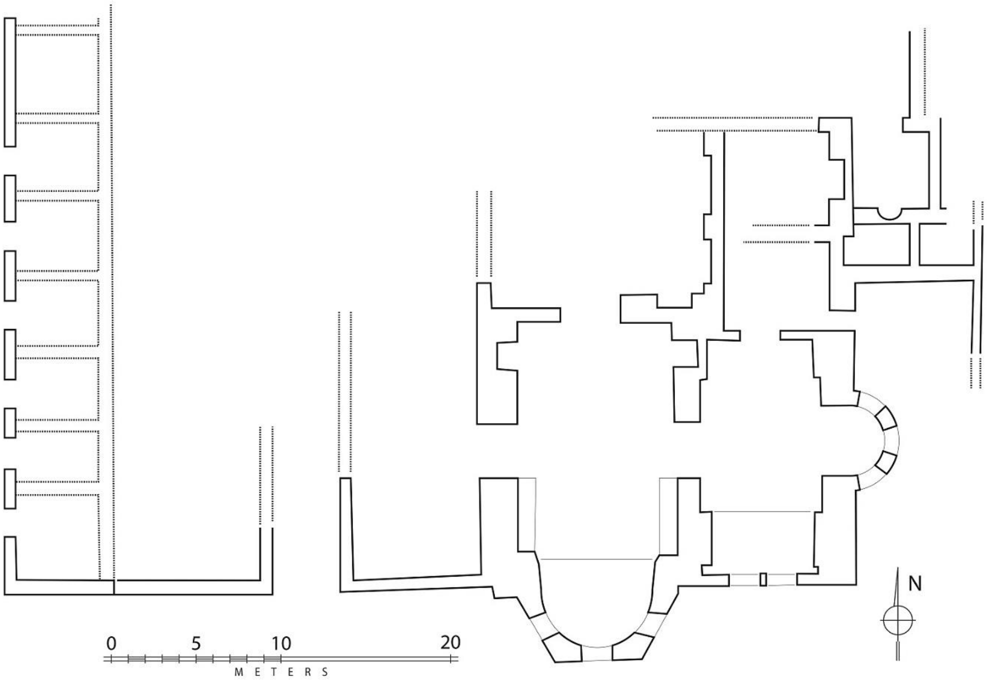

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Figure 58: View of the Baths of L. Julius Agrippa at Apamea, showing limestone construction of back wall of eastern portico (Vannesse 2015, fig. 2).

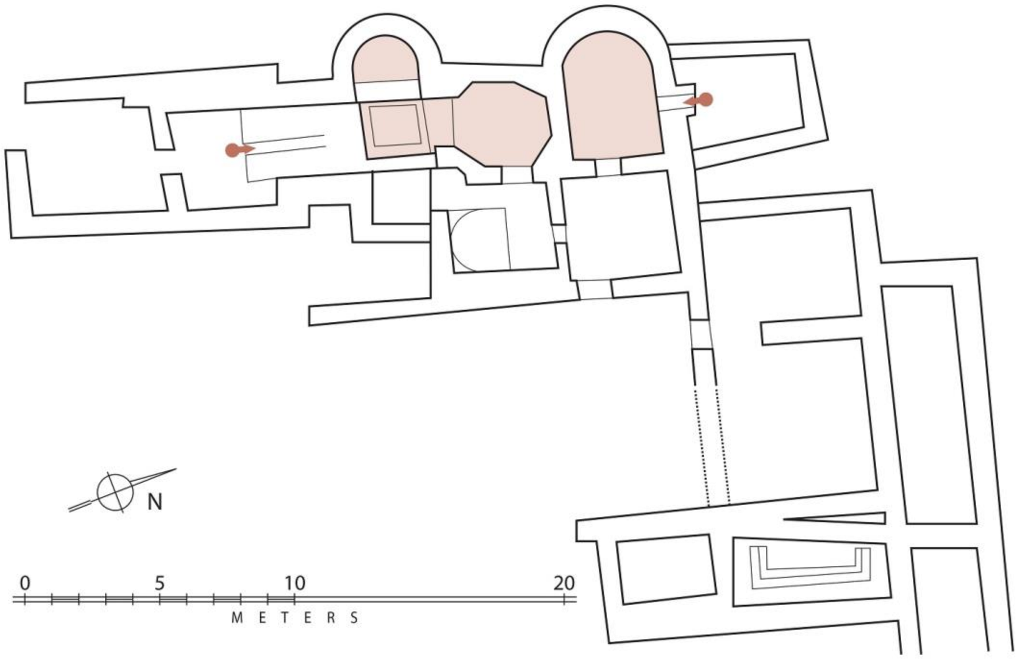

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Figure 61: The *caldarium* of the baths in the *principia* at Athis, from southwest (Harper and Wilkinson 1975, pl. 6a).

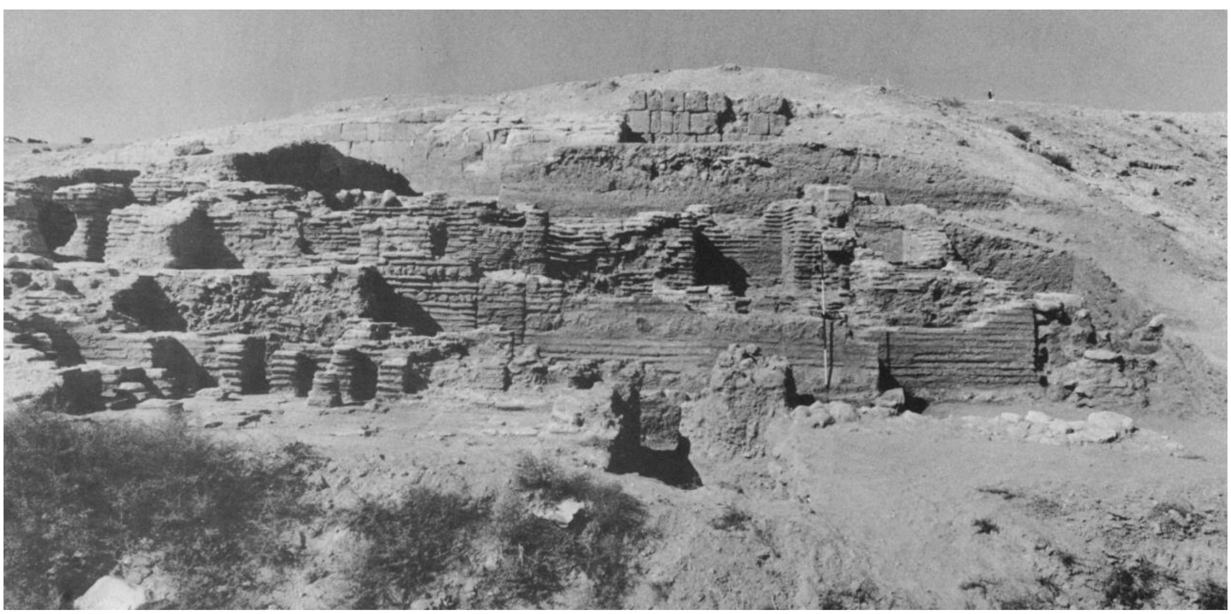

Figure 62: Hot rooms of later extramural baths at Athis, from north (Harper and Wilkinson 1975, pl. 7a).

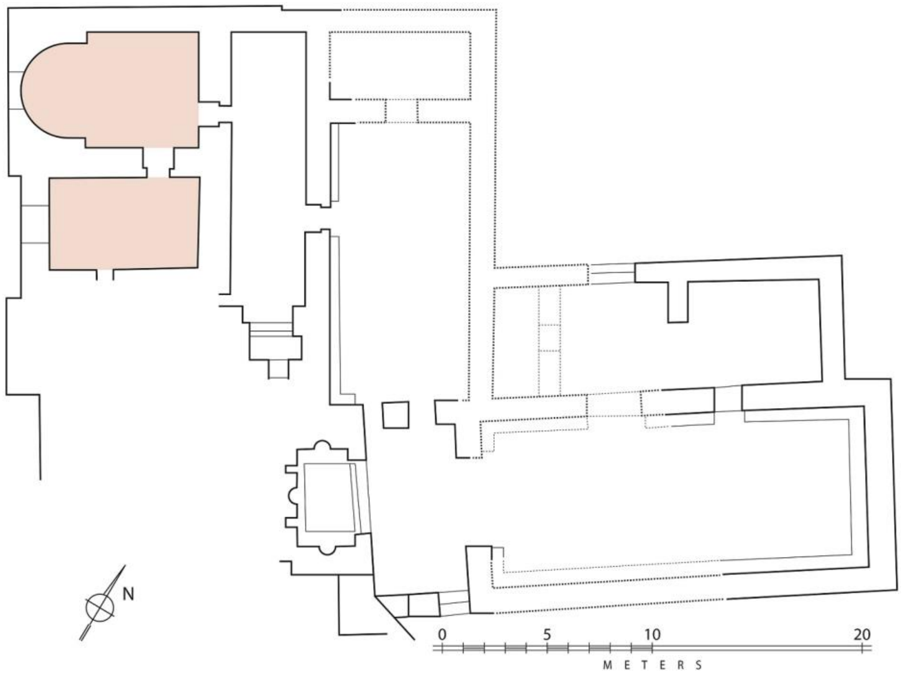

Figure 63: Plan of Bath C3 at Dura Europos (after Rostovtzeff et al. 1936, pl. 4).

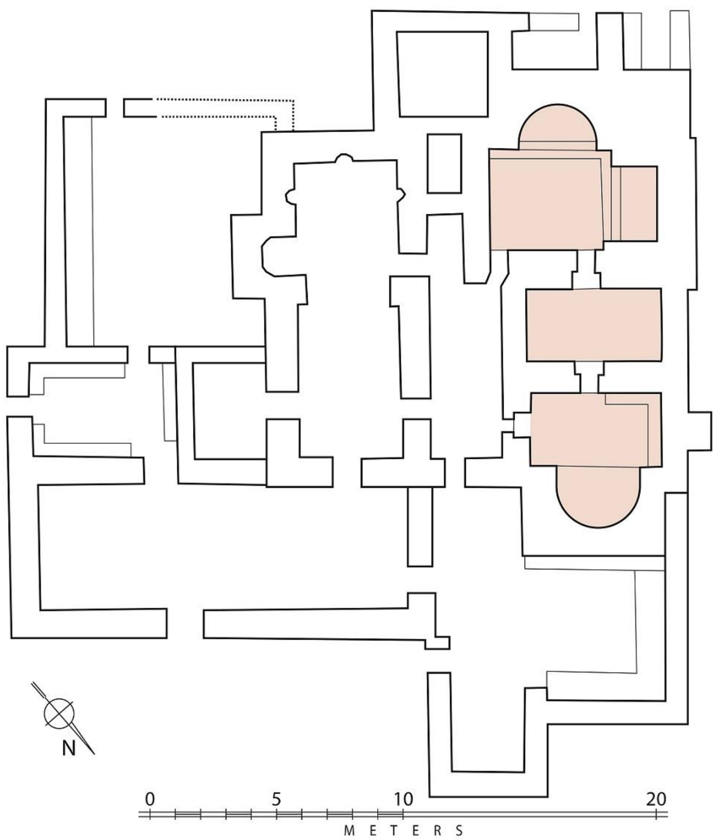

Figure 64: Plan of Bath E3 at Dura Europos (after Rostovtzeff et al. 1936, pl. 4).

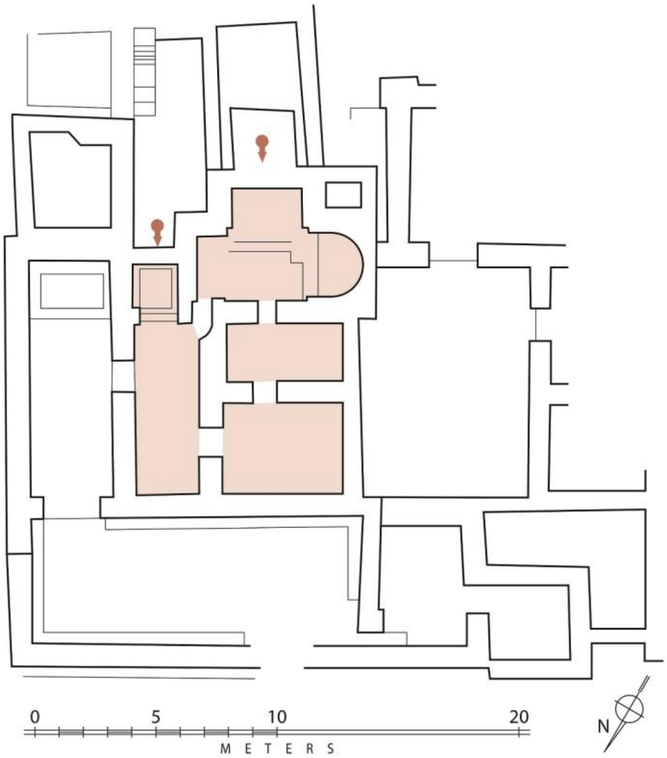

Figure 65: Plan of Bath M7 at Dura Europos (after Rostovtzeff et al. 1936, pl. 4).

Figure 66: Brick masonry of Bath E3 at Dura Europos (Rostovtzeff et al. 1936, pl. 16.1).

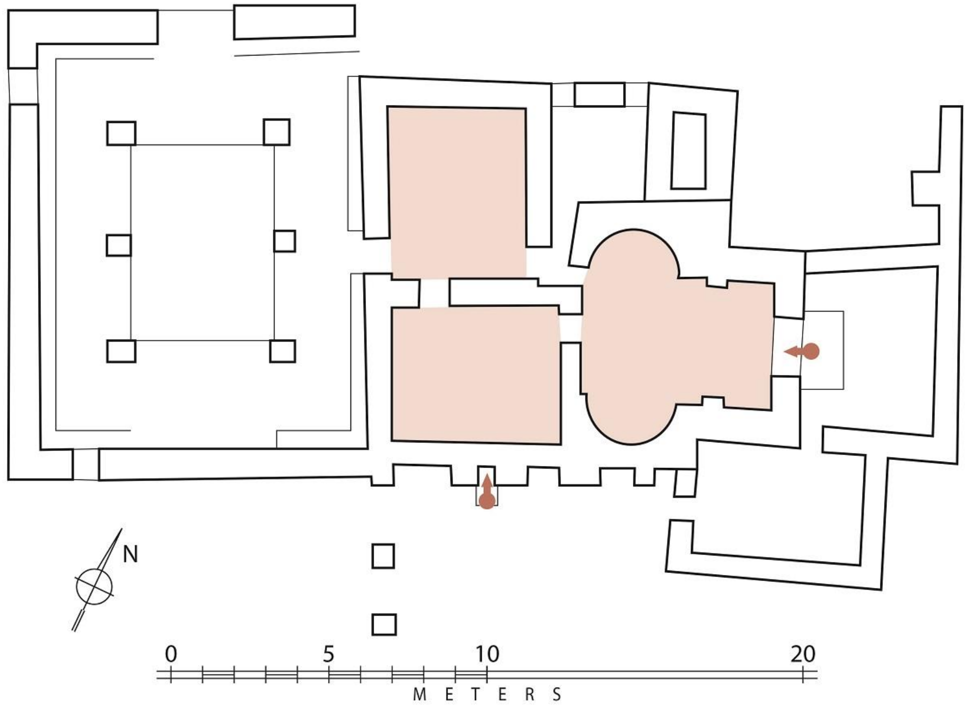

Figure 67: Plan of Bath F3 at Dura Europos (after Rostovtzeff et al. 1936, pl. 3).

Figure 68: View of Bath F3 at Dura Europos, with entrance to heated block to the right, showing sub-ashlar masonry of poorly cut blocks of gypsum (Vannesse 2015, 10).

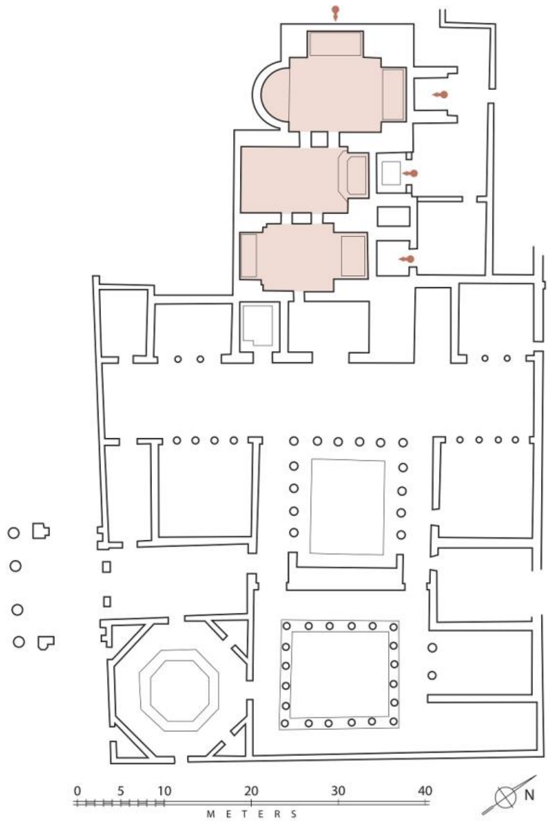

Figure 69: Plan of the Baths of Diocletian at Palmyra (after Fournet 2012b, fig. 20).

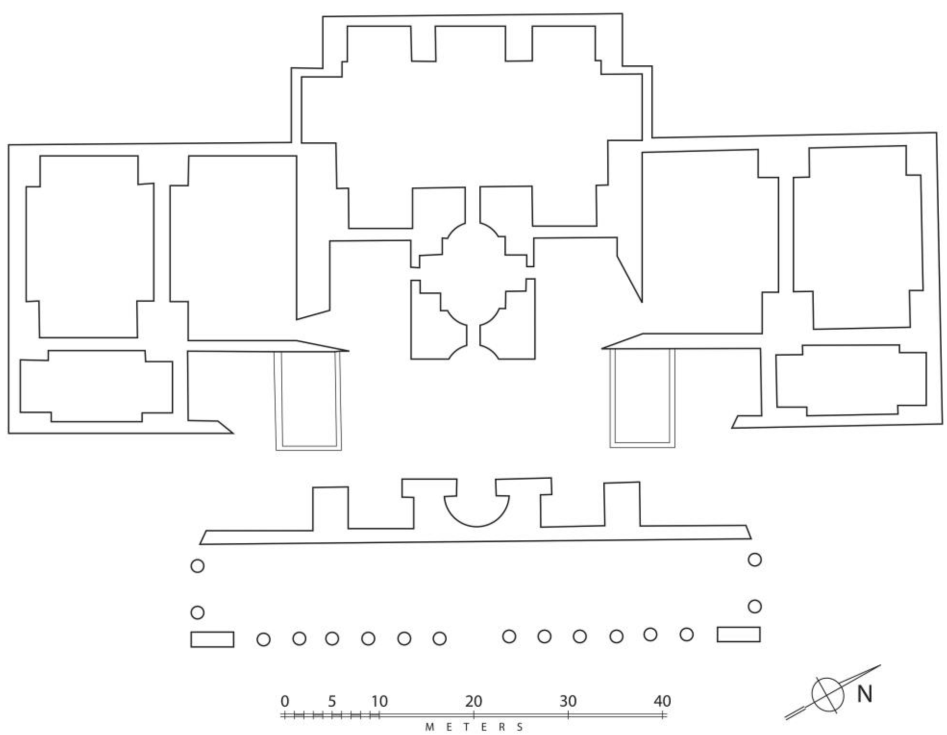

Figure 70: Plan of baths at Baalbek, in their First Phase (after Brünenberg 2014, fig 9).

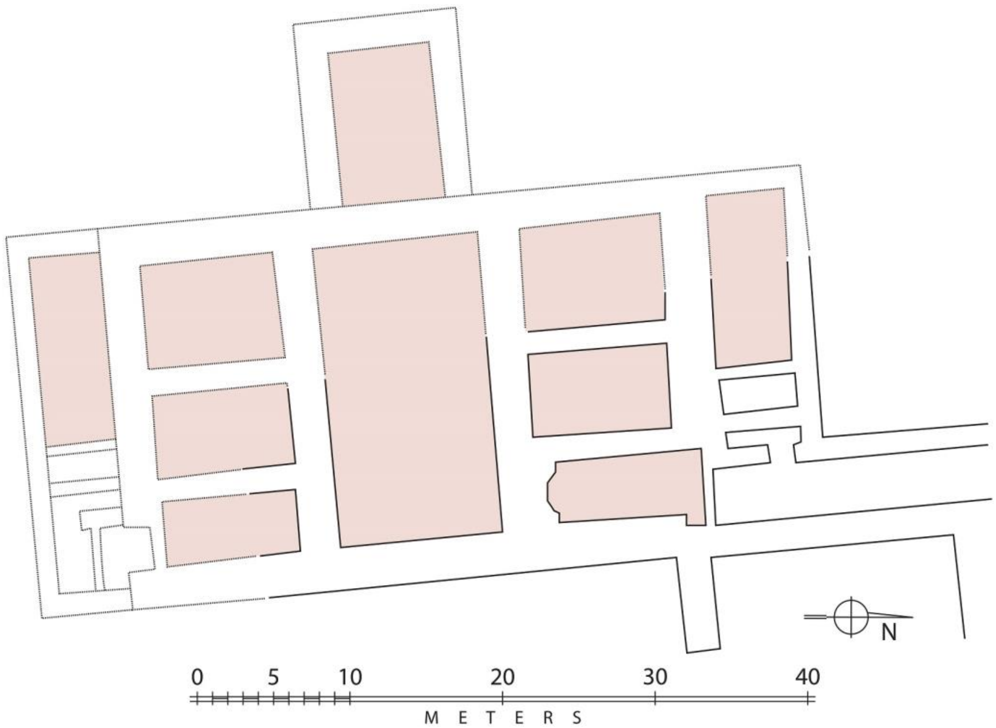

Figure 71: Plan of baths at Beirut, in the Imperial Phase (after Thorpe 1998, fig. 13).

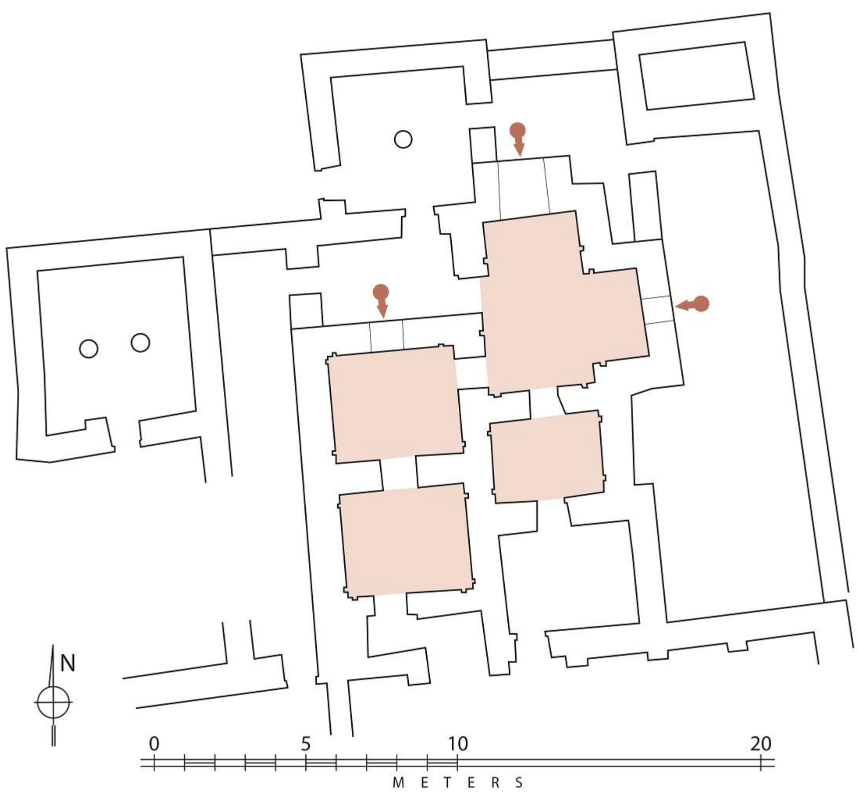

Figure 72: Plan of baths at Sha'arah (after Fournet 2008a, fig 7).

Figure 73: Interior of *caldarium* in the baths at Sha'arah before excavation, showing basalt ashlar construction (Fournet 2008a, fig. 9).

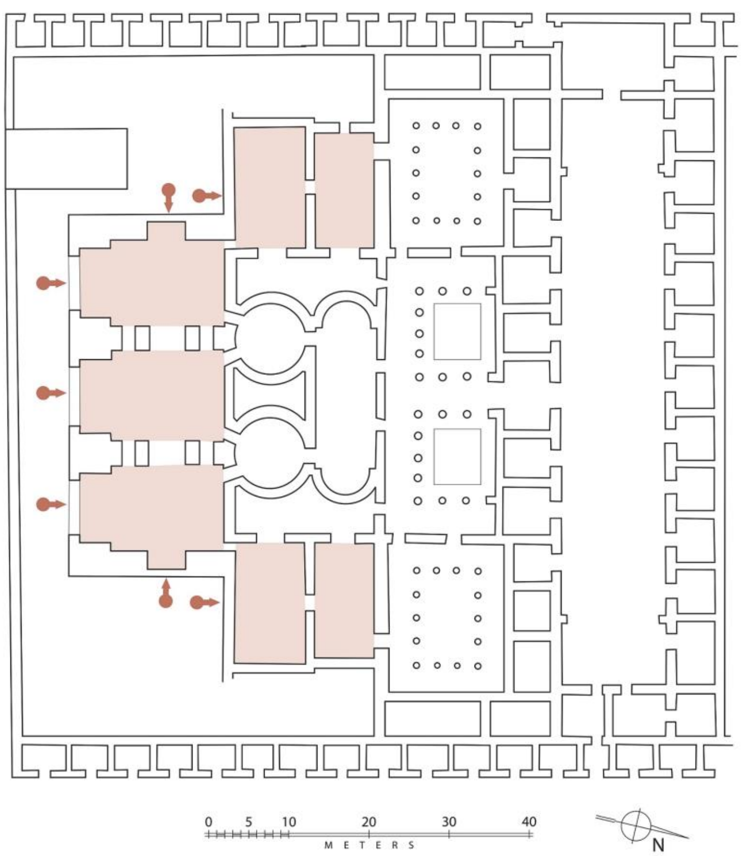

Figure 74: Plan of the baths at Philippopolis (modern Shahba) (after Fournet 2012b, fig. 11).

Figure 75: View of the baths at Philippopolis (modern Shahba), from west, showing basalt ashlar masonry and remains of scoria vaulting above (after Fournet 2012b, fig. 12).

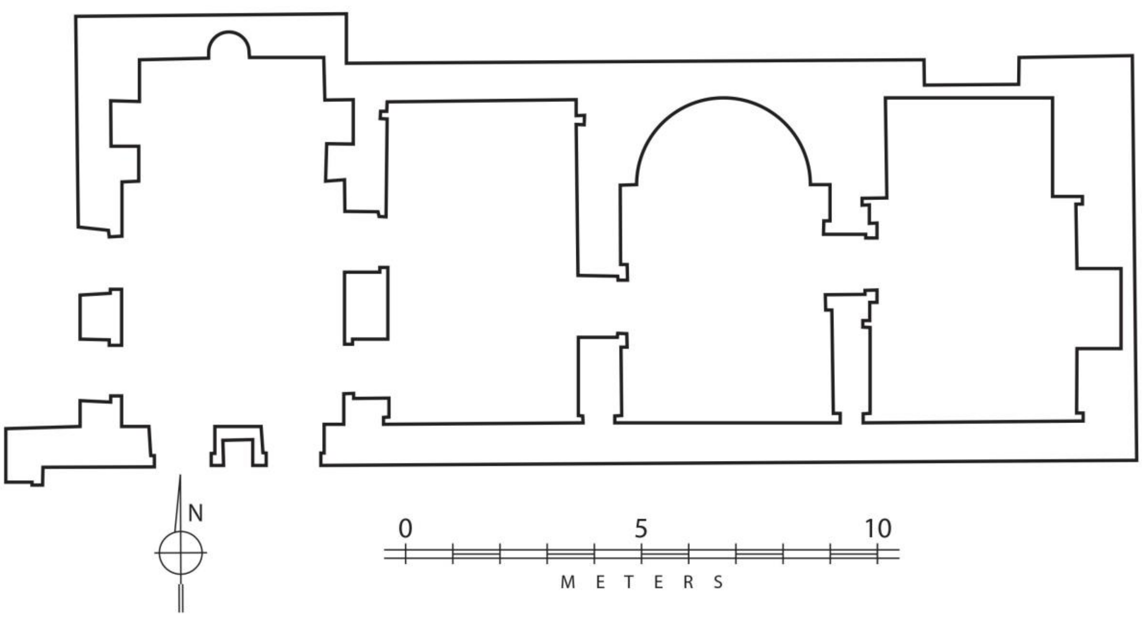

Figure 76: Plan of the baths at Selaema (modern Salim) (after Fournet 2010, fig 6).

Figure 77: Southern façade of the baths at Selaema (modern Salim), showing basalt ashlar masonry (after Fournet 2010, fig 2).

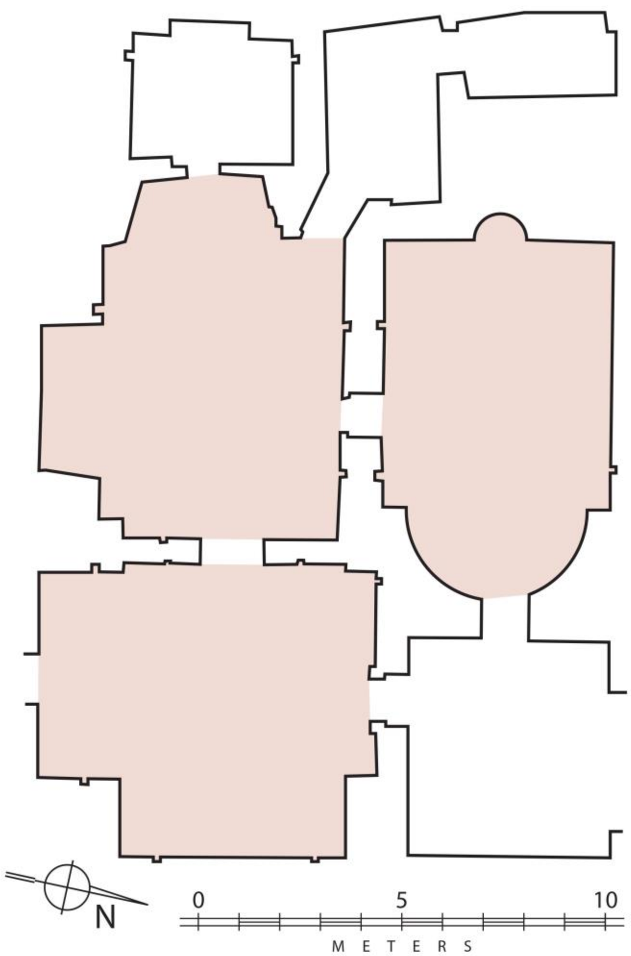

Figure 78: Plan of the baths at Kanatha (modern Qanawat) (after Peuser 2000, fig. 1).

Figure 79: View of southern wall of the baths at Kanatha (modern Qanawat), showing basalt ashlar masonry (Peuser 2000, pl. 45c).

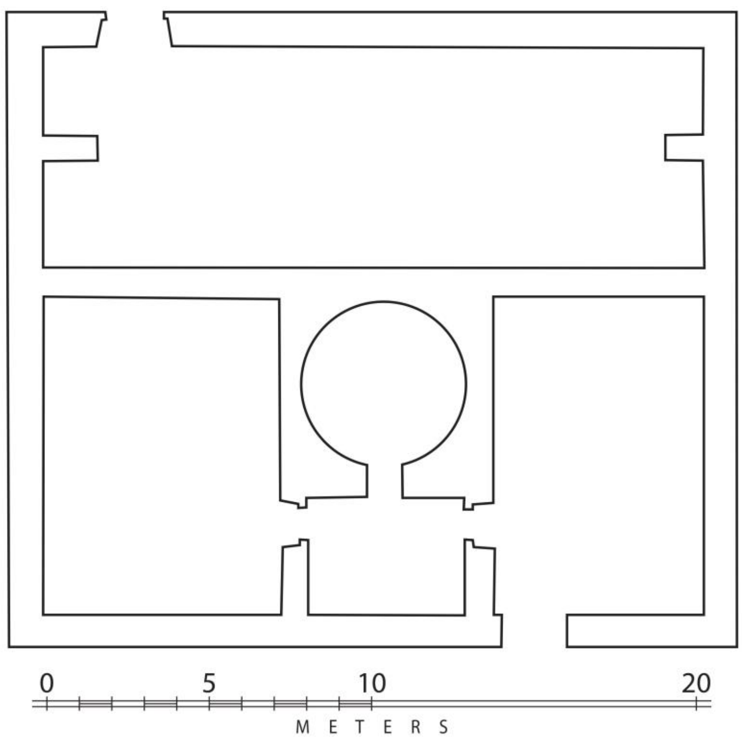

Figure 80: Plan of the baths at Seia (modern Sīʿ) (after Butler 1919, ill. 345).

Figure 81: Plan of the Southern Bathhouse at Hippos-Sussita (after Kowalewska 2019a, fig. 4.26).

Figure 82: Interior view of heated room in the Southern Bathhouse at Hippos-Sussita, showing use of basalt ashlars in foundations (most visible in bottom left of image) and limestone ashlars set in isodomic courses alternating between headers and stretchers (photo by author).

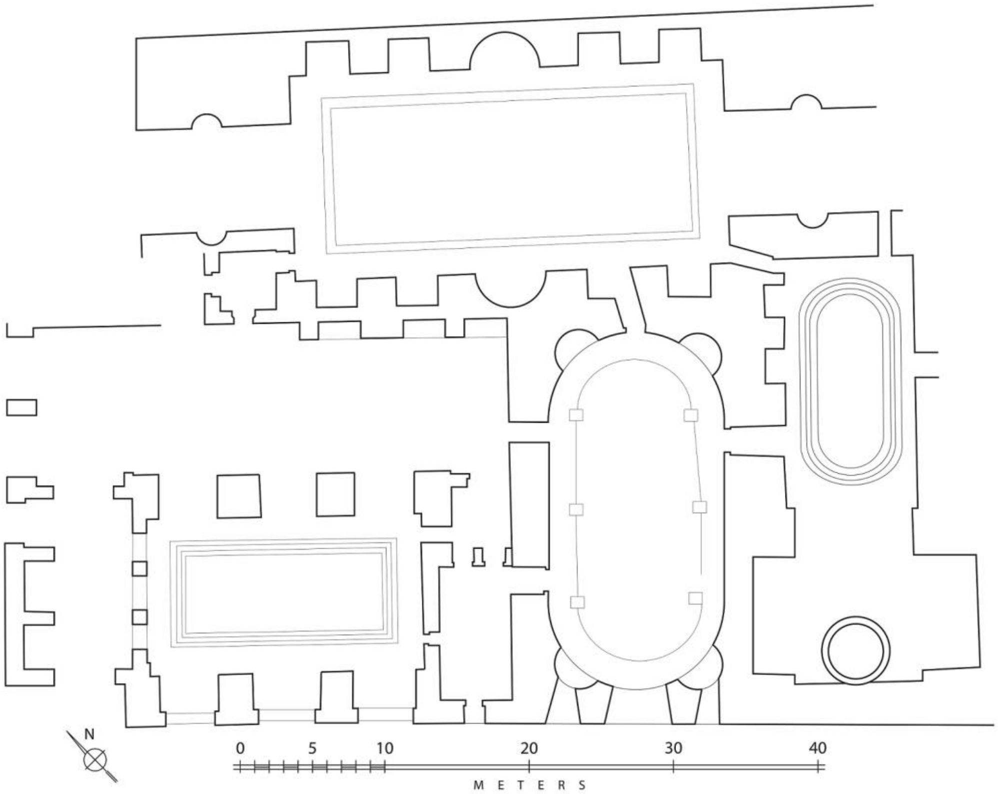

Figure 83: Plan of the baths at Hammat Gader (after Hirschfeld and Solar 1981, fig. 2).

Figure 84: Interior view of the baths at Hammat Gader, showing use of both basalt and limestone ashlar construction (photo by author).

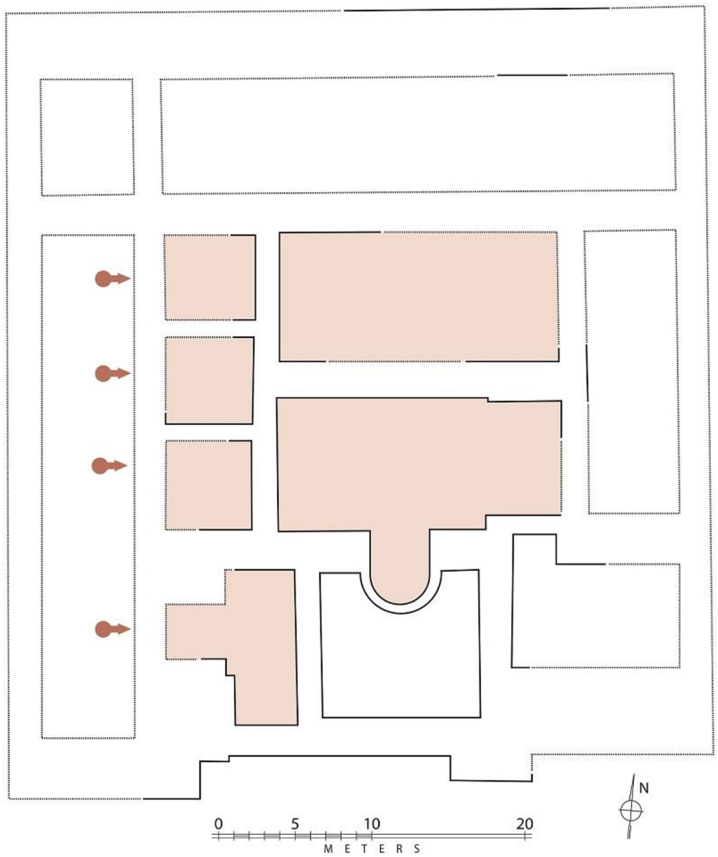

Figure 85: Plan of the Byzantine Baths at Gadara (modern Umm Qais) (after Holm-Nielson et al. 1986, fig. 1).

Figure 86: Close-up view of the masonry of the Byzantine Baths at Gadara (modern Umm Qais), showing use of basalt ashlars under limestone ashlars (photo by author).

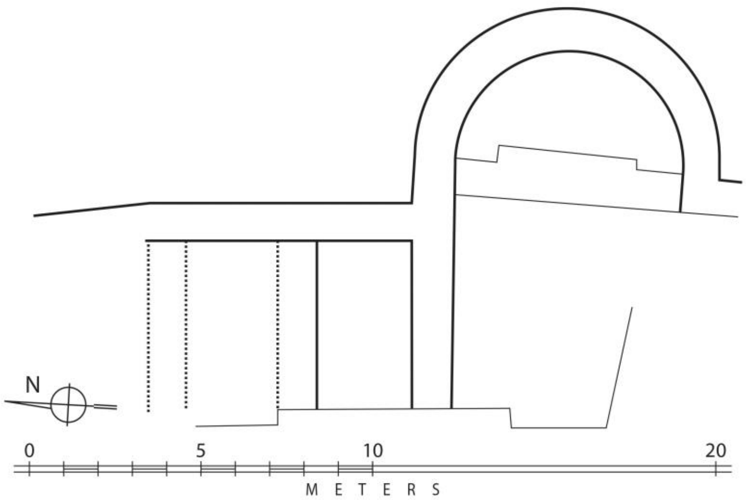

Figure 87: Plan of the baths at Pella (after Smith and Day 1989, fig. 3).

Figure 88: Interior view of the exedra in the baths at Pella, showing the limestone ashlar masonry and high water table (Smith et al. 1992, pl. 85).

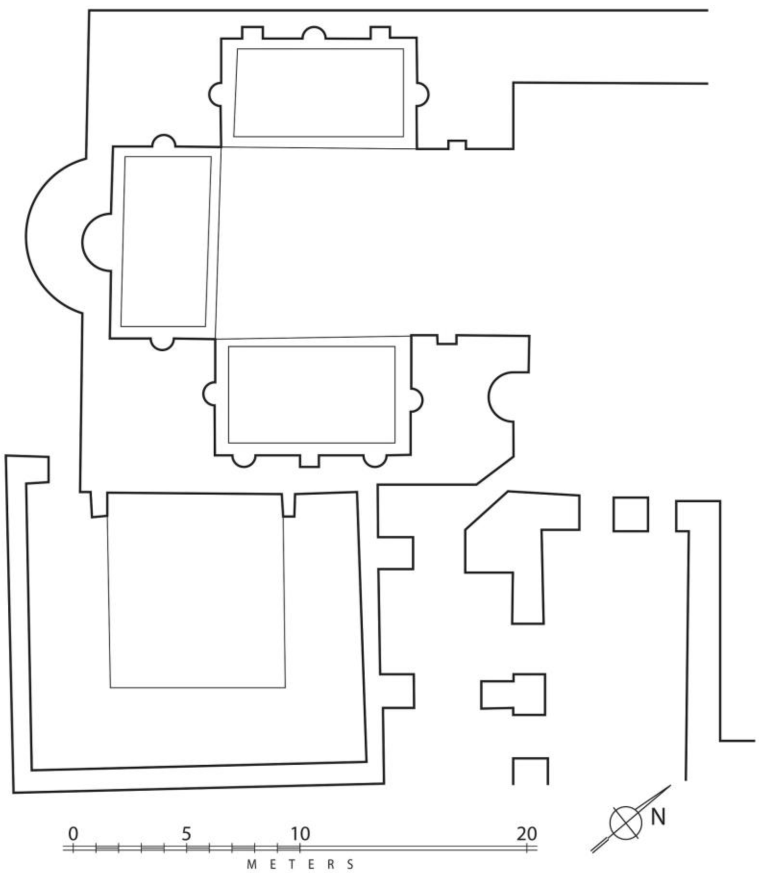

Figure 89: Plan of the Eastern Bath at Scythopolis (modern Bet She'an) (after Mazor 1999, fig. 7).

Figure 90: View of the Eastern Bath at Scythopolis (modern Bet She'an), from northeast, showing ashlar construction. The theater is visible in the background (photo by author).

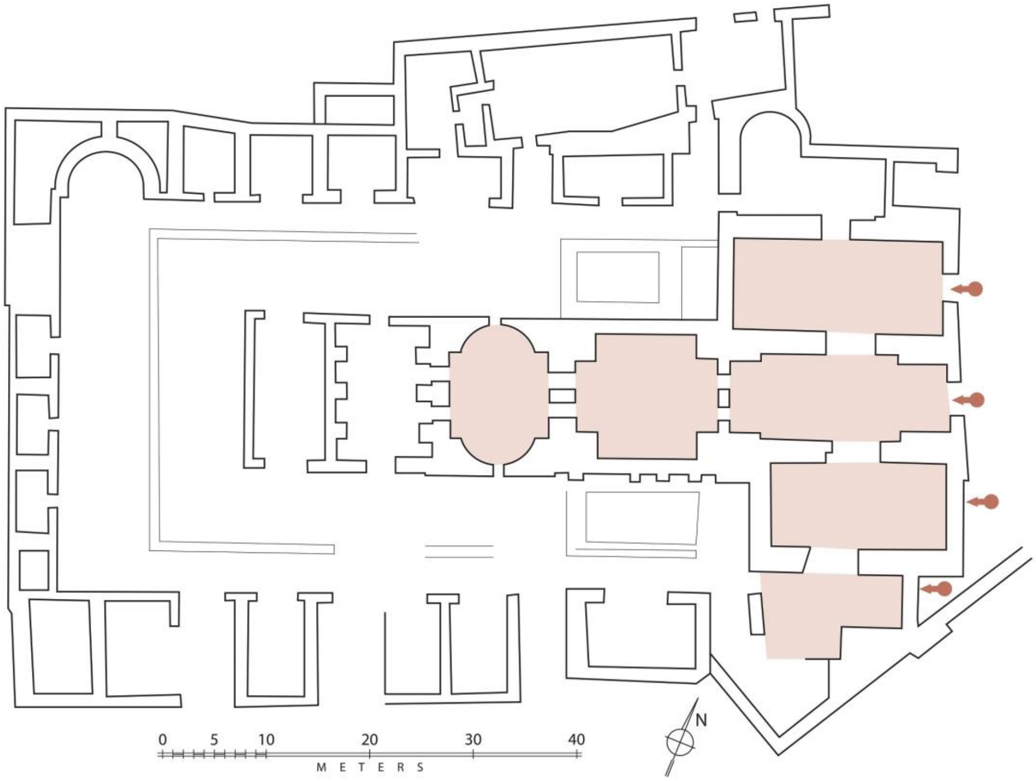

Figure 91: Plan of the Western Bath at Scythopolis (modern Bet She'an) (after Mazor 1999, fig. 3).

Figure 92: Interior view of the Western Bath at Scythopolis (modern Bet She'an), showing use of basalt and limestone ashlar masonry in a reconstructed wall (only the bottom two courses are original) (photo by author).

Figure 93: Plan of the South Bathhouse at Scythopolis (modern Bet She'an) (after Peleg 2004, plan 1).

Figure 94: View of South Bathhouse at Scythopolis (modern Bet She'an), showing sub-ashlar and rubble masonry (Peleg 2004, fig. 16).

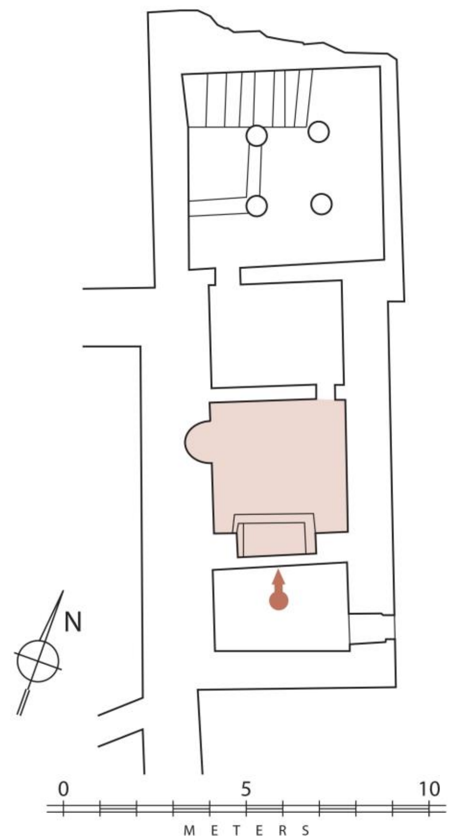

Figure 95: Plan of the baths at Ramat Hanadiv (after Hirschfeld 2000, fig. 180).

Figure 96: View of the *praefurnium* stoke hole in the baths at Ramat Hanadiv, showing limestone ashlar construction of the walls (photo by author).

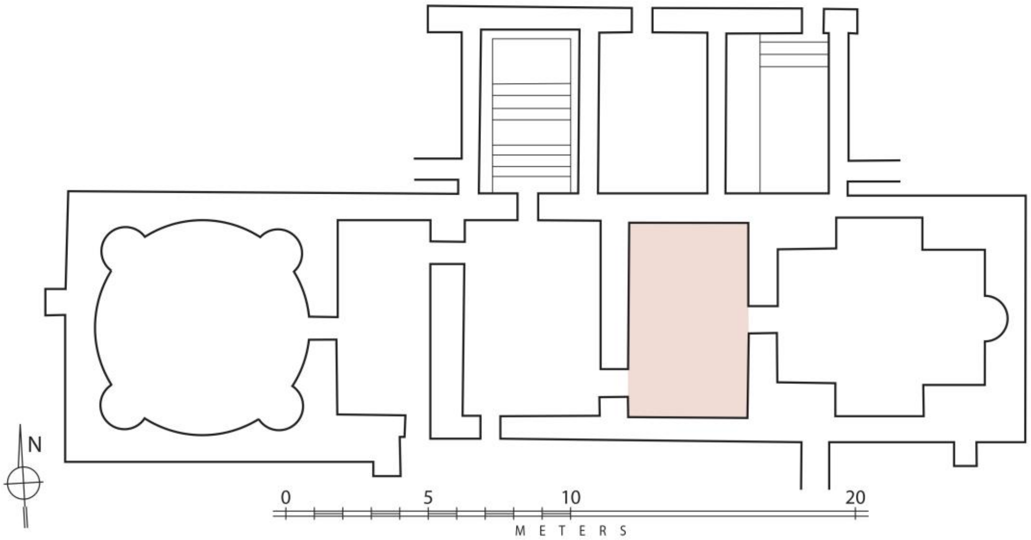

Figure 97: Plan of the bathing suite in the North Wing of Herod’s Third Palace at Jericho (after Netzer 2001, plan 34).

Figure 98: *Opus reticulatum* in the bathing suite in the North Wing of Herod’s Third Palace at Jericho (Netzer 2001, ill. 391).

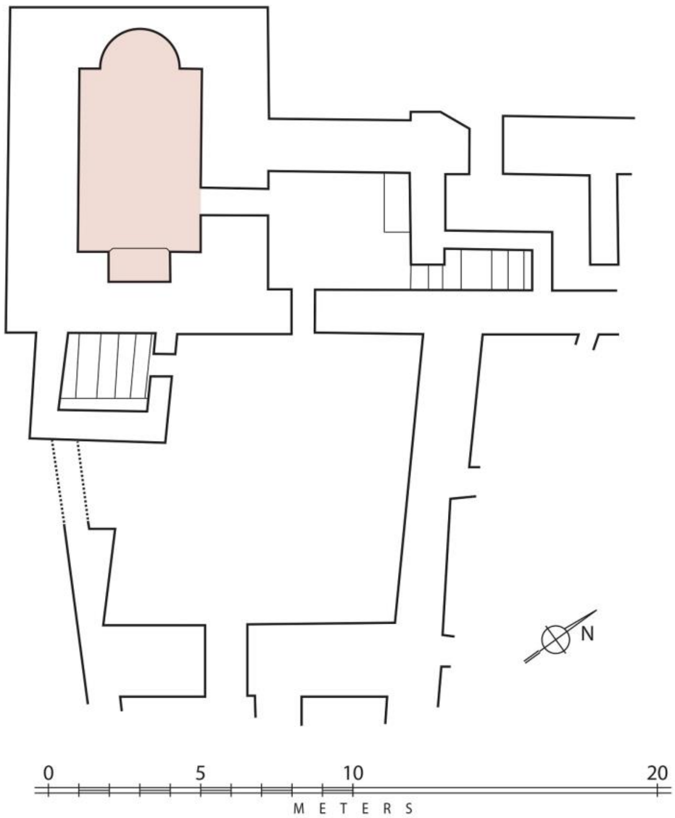

Figure 99: Plan of the baths at the summit at Cypros (after Netzer and Damati 2004, ill. 330).

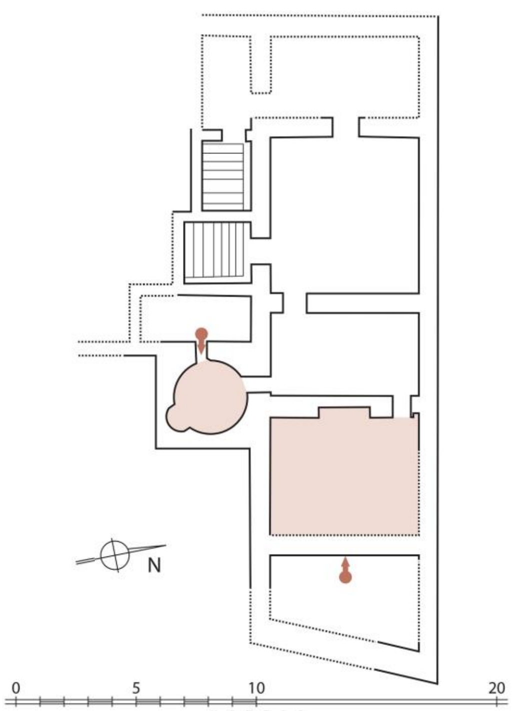

Figure 100: Plan of the baths on the shoulder at Cypros (after Netzer and Damati 2004, ill. 330).

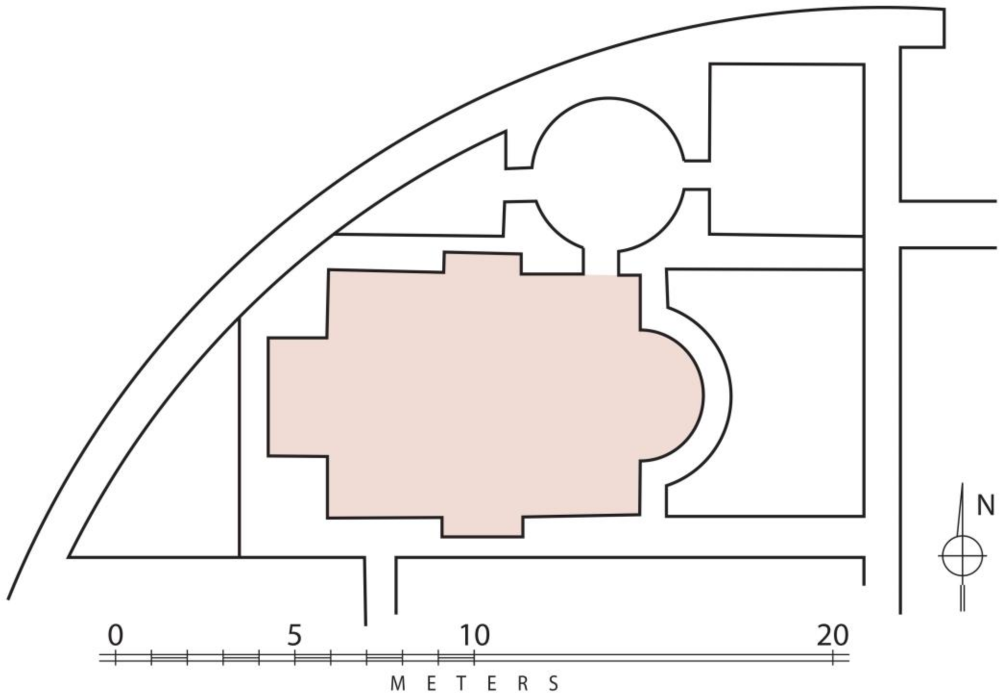

Figure 101: Plan of the upper baths at Herodium (after Corbo 1989, pl. 3).

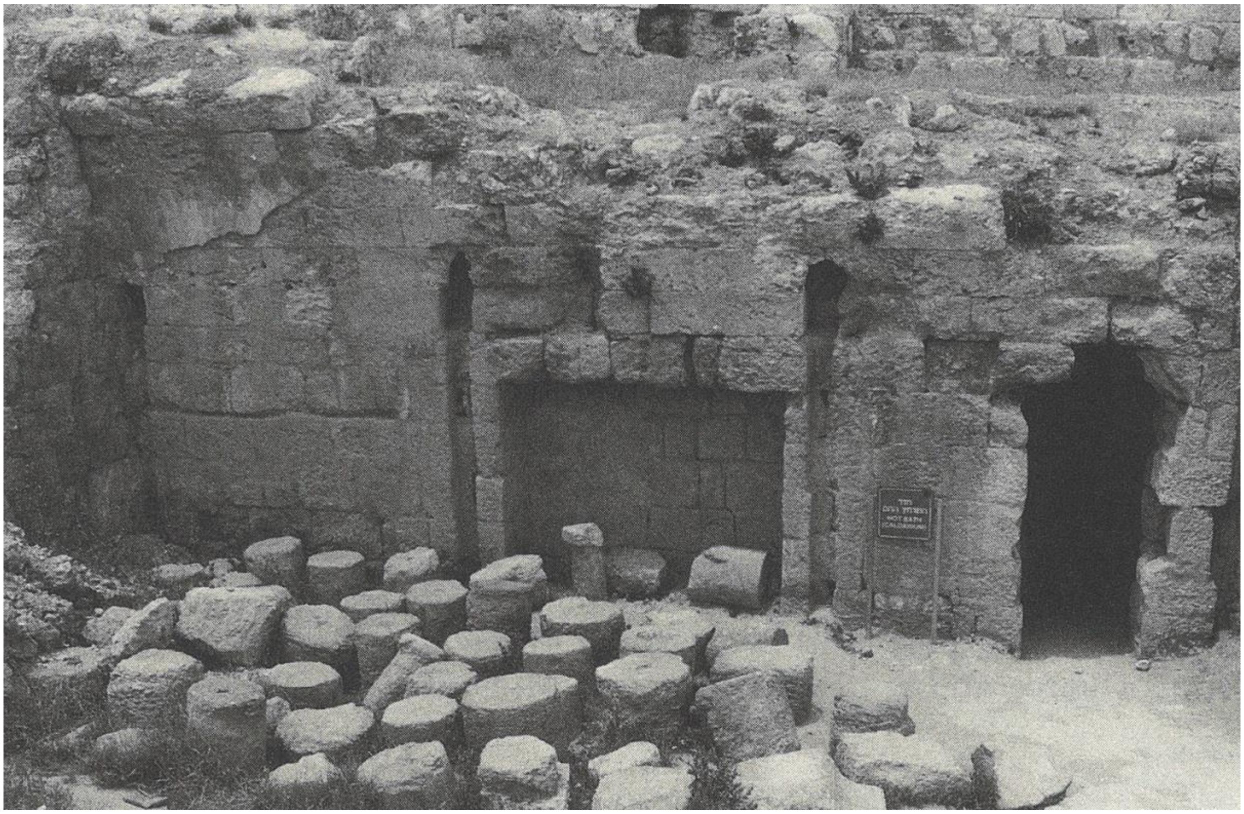

Figure 102: View of the *caldarium* of the upper baths at Herodium, showing ashlar masonry and the bottom courses of the ashlar vault on the left-hand side of the photo (Netzer 1999, fig. 7).

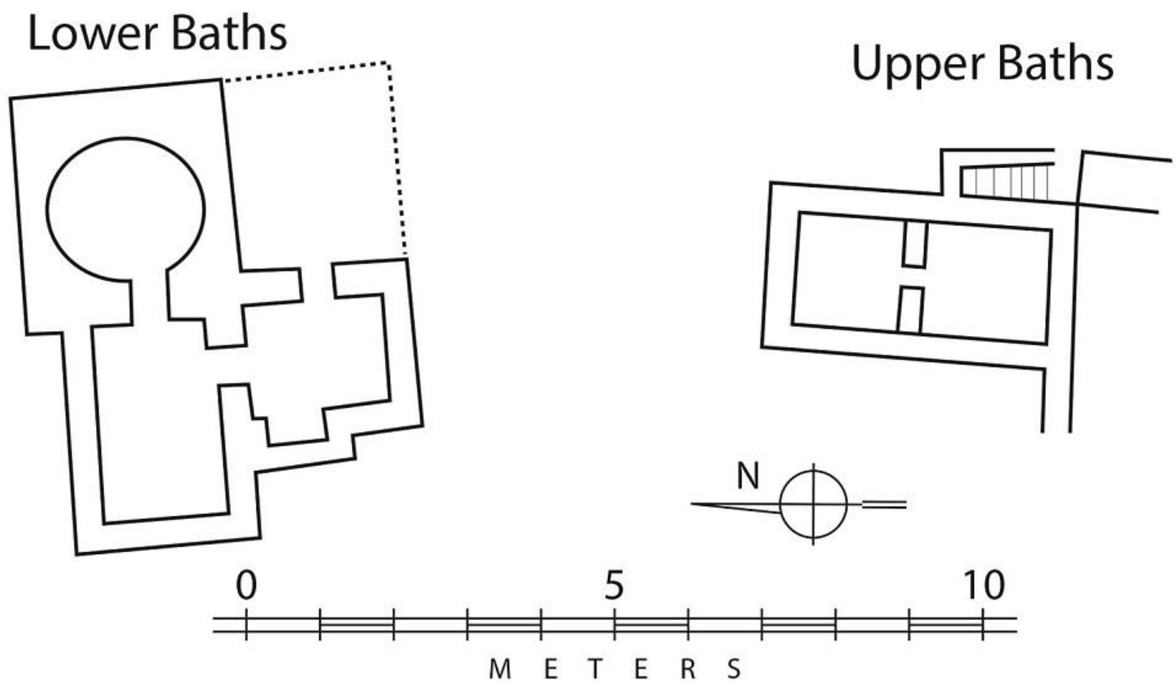

Figure 103: Plan of the two baths at Ein Yael (after Edelstein 1993, 115).

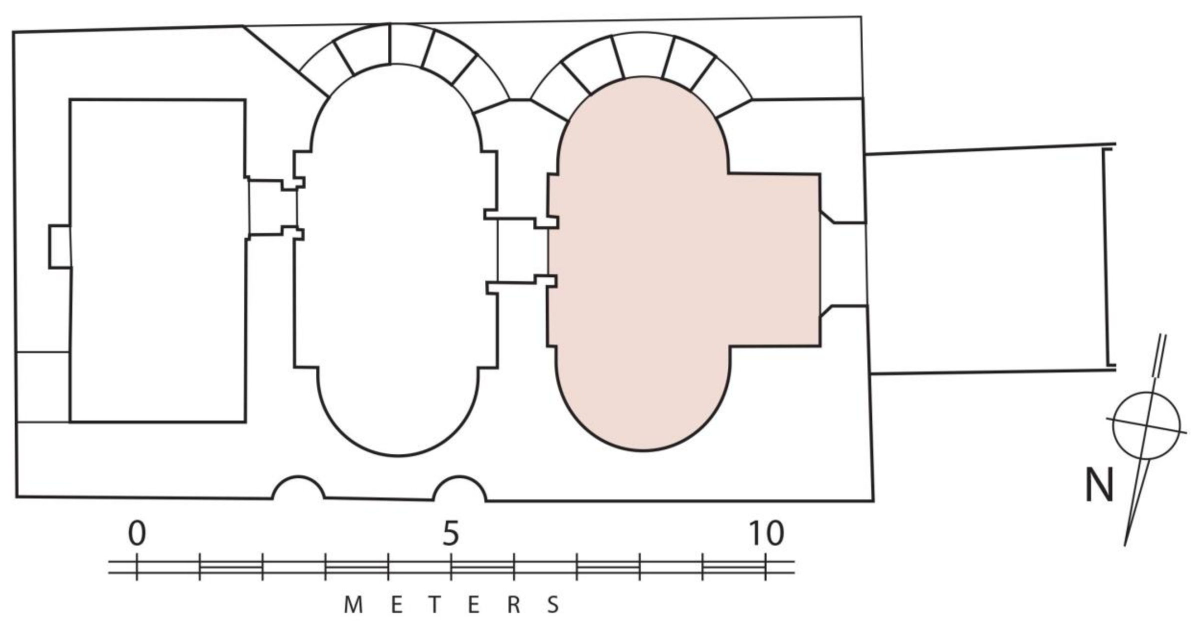

Figure 104: Plan of the baths at Emmaus (after Gichon 1979, fig. 1).

Figure 105: Interior view of Room 4 in the baths at Emmaus, showing ashlar masonry and ashlar vaulting (Gichon 1979, pl. 12a).

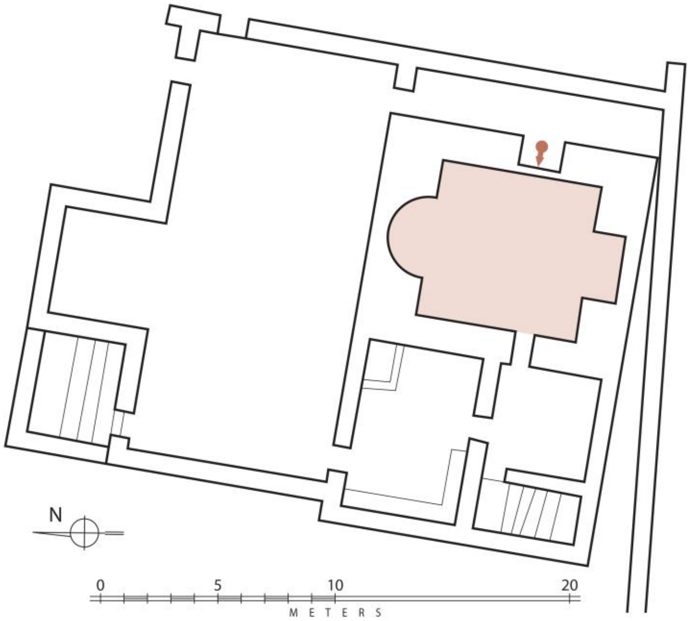

Figure 106: Plan of the Large Baths at Masada (after Netzer 1991, plan 5).

Figure 107: View of thermal block of the Large Baths at Masada, from the north, showing masonry of roughly worked local dolomite with small cobbles as chinking stones (masonry beneath black line is original) (photo by author).

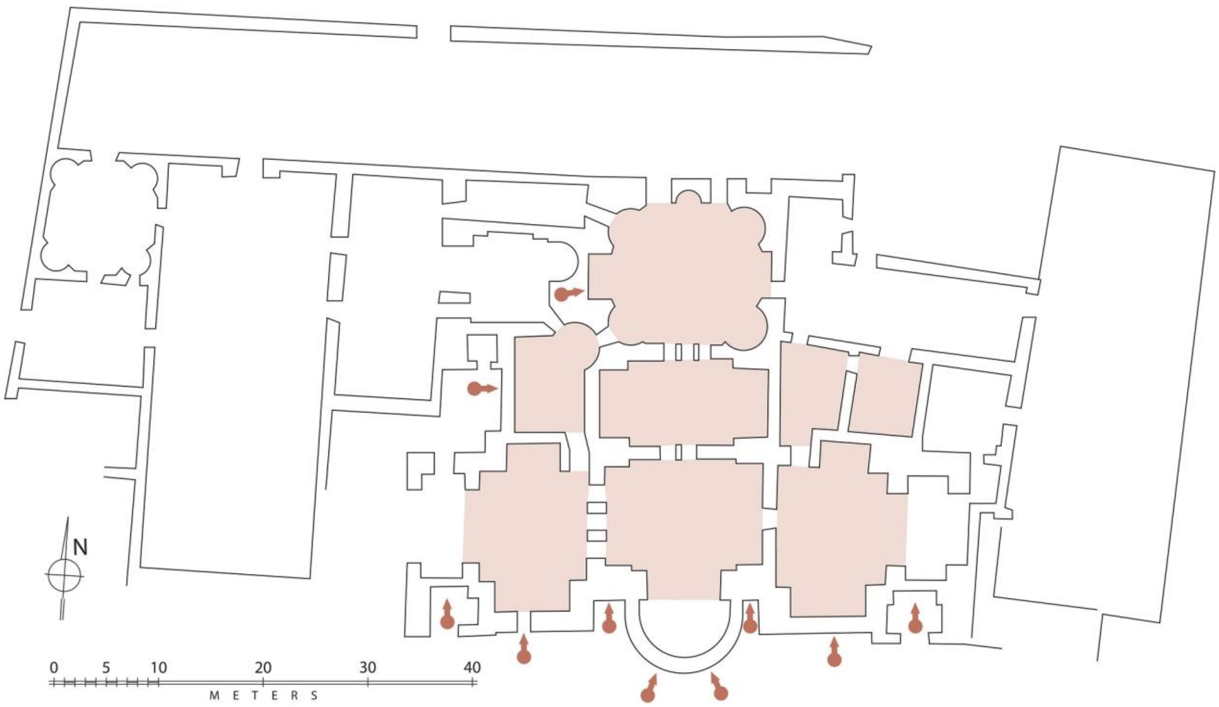

Figure 108: Plan of the South Baths at Bosra (after Fournet 2012b, fig. 6).

Figure 109: Interior view of the *frigidarium* of the South Baths at Bosra, showing basalt ashlar masonry and mortared rubble vaulting using scoria for *caementa* (photo by author).

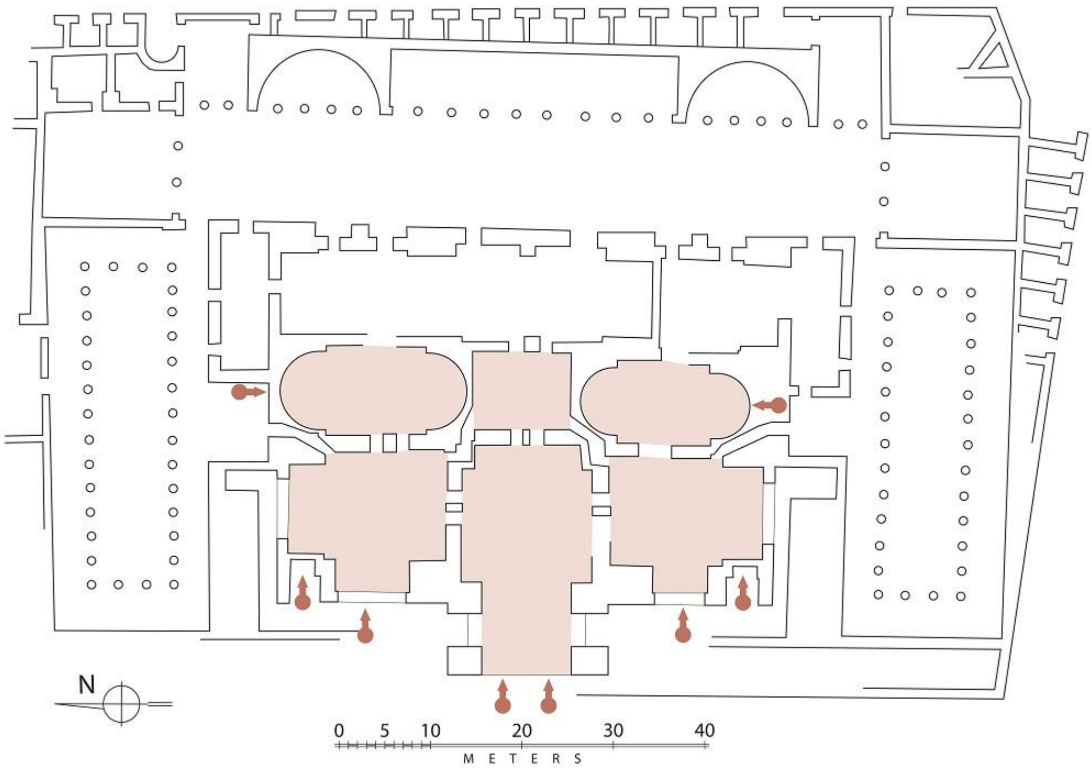

Figure 110: Plan of the Central Baths at Bosra (after Fournet 2012b, fig. 9).

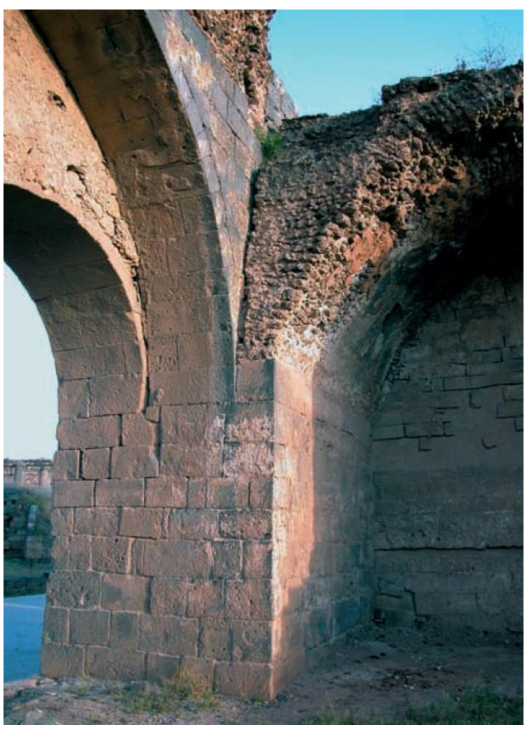

Figure 111: View of the masonry in the *frigidarium* of the Central Baths at Bosra, showing basalt ashlar masonry in walls and use of scoria in the mortared rubble construction of the vaults (Fournet 2007, 243).

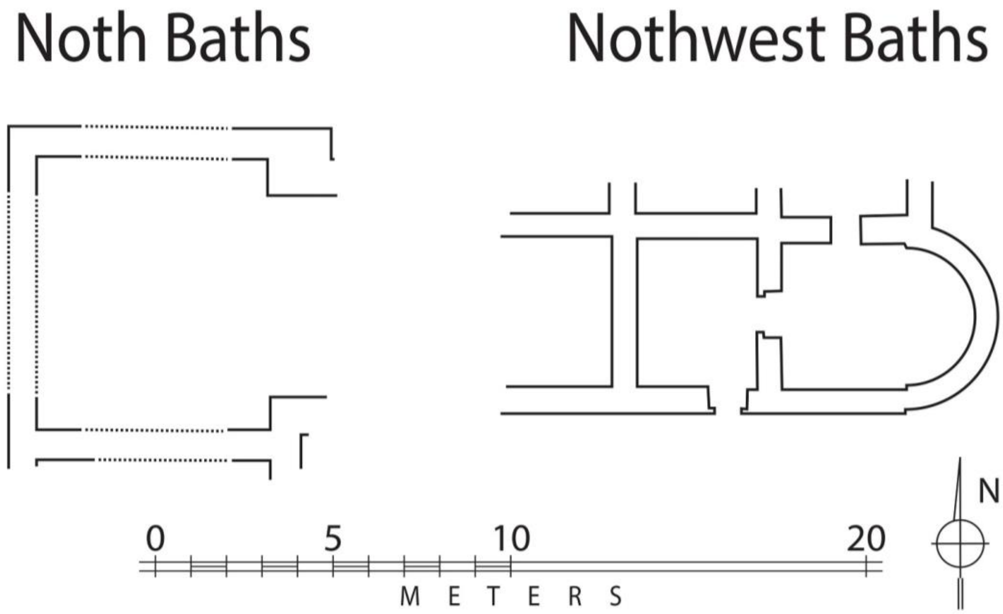

Figure 112: Plans of the North Baths and Northwest Baths at Bosra (after Butler 1919, ills. 232-33).

Figure 113: View of the North Baths at Bosra (Fournet 2012b, fig. 13).

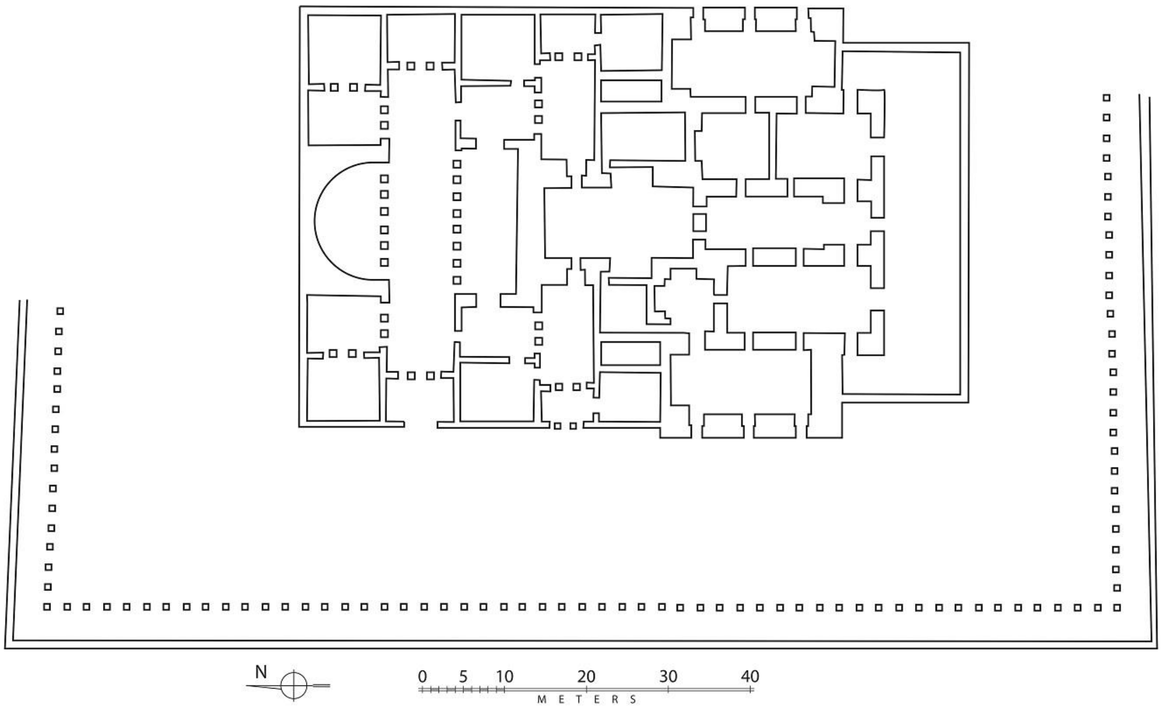

Figure 114: Plan of the East Baths at Gerasa (modern Jerash) (after Lepaon 2008, fig. 11).

Figure 115: View of the East Baths at Gerasa (modern Jerash), from northwest, showing ashlar masonry (photo by author).

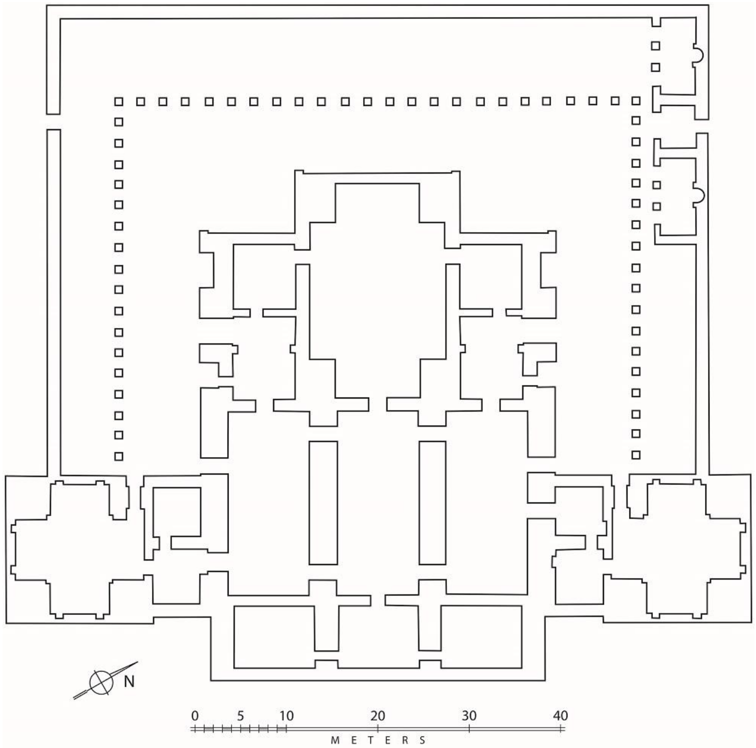

Figure 116: Plan of the West Baths at Gerasa (modern Jerash) (after Lepaon 2008, fig. 5).

Figure 117: View of the West Baths at Gerasa (modern Jerash), from north, showing ashlar masonry (photo by author).

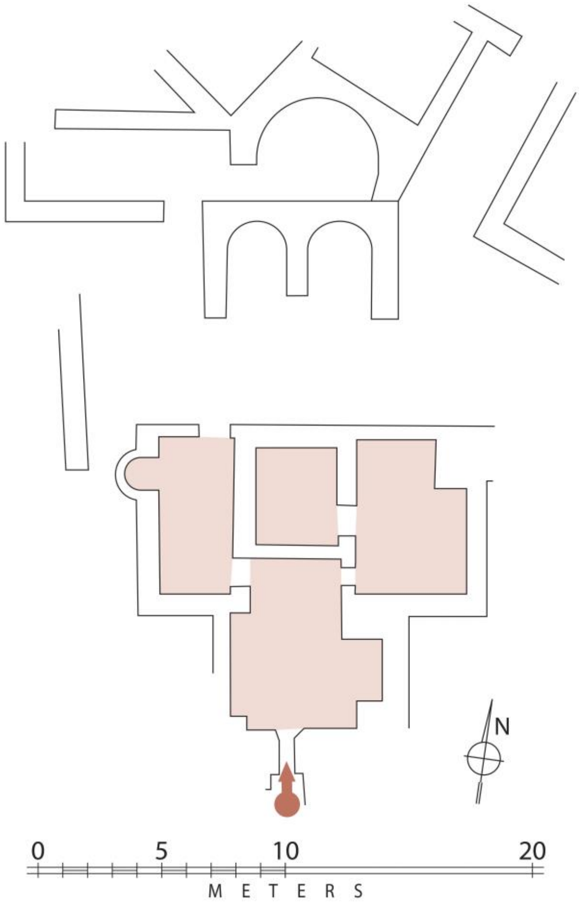

Figure 118: Plan of the Central Baths at Gerasa (modern Jerash) (after Blanke 2015, fig. 1).

Figure 119: View of the western entrance hallway of the Central Baths at Gerasa (modern Jerash), showing the use of limestone ashlars (Blanke 2015, fig. 10).

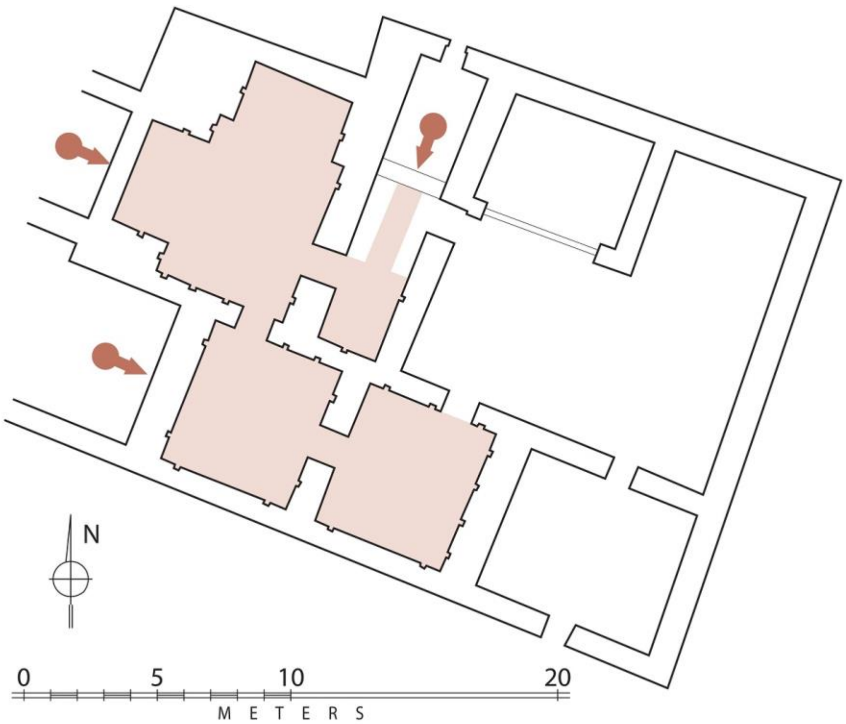

Figure 120: Plan of the baths at Birketein (after Lachet et al. 2015, fig. 4).

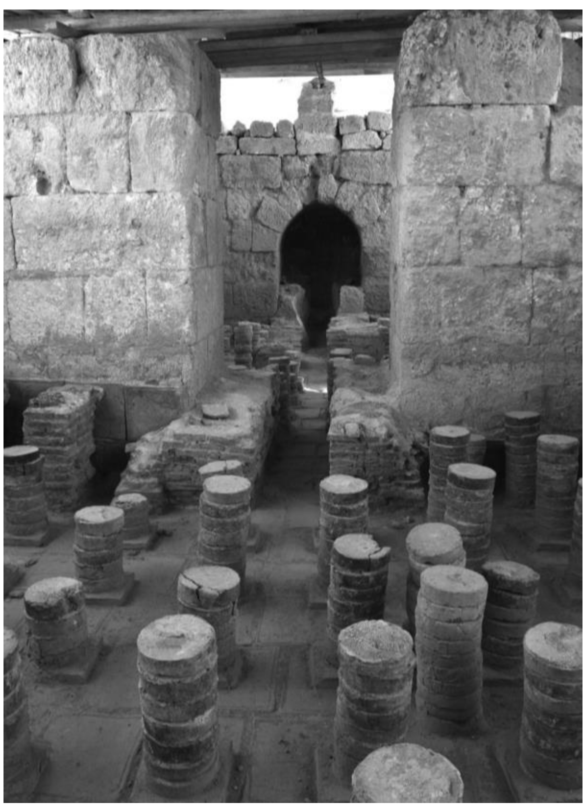

Figure 121: Hypocaust of Room 4 in the baths at Birketein, showing ashlar masonry and *pilae* of circular bricks (Lachet et al. 2015, fig. 6).

Figure 122: Interior of Room 6 in the baths at Birketein, showing ashlar masonry. In the far wall it is possible to see the vertical grooves for flue vents and vertically placed square bricks at base of wall for lining the hypocaust (photo by author).

Figure 123: Plan of the baths at Betthorus (modern Lejjun) (after de Vries and Lain 2006, fig. 7.1).

Figure 124: View of the baths at Betthorus (modern Lejjun), from the north, showing ashlar masonry (photo by author).

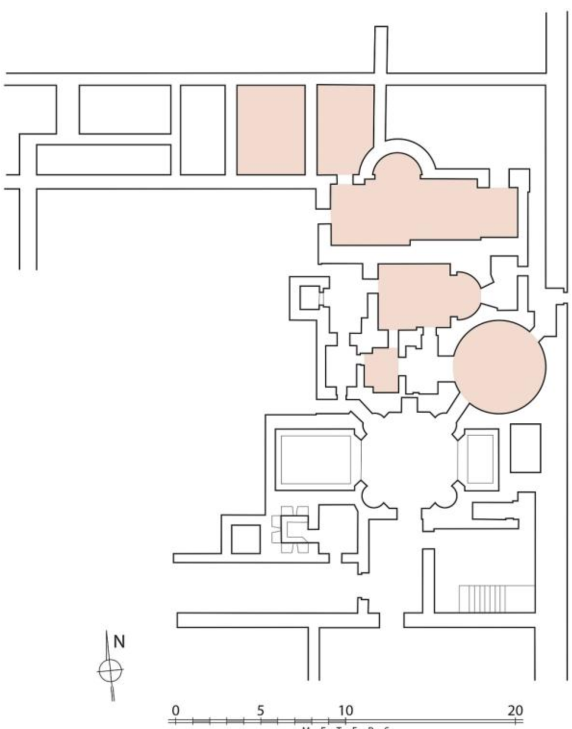

Figure 125: Plan of the baths next to the Petra Great Temple at Petra (after Power 2017, fig. 9.2).

Figure 126: Interior view of baths next to the Petra Great Temple at Petra, showing sandstone ashlar masonry (photo by author).

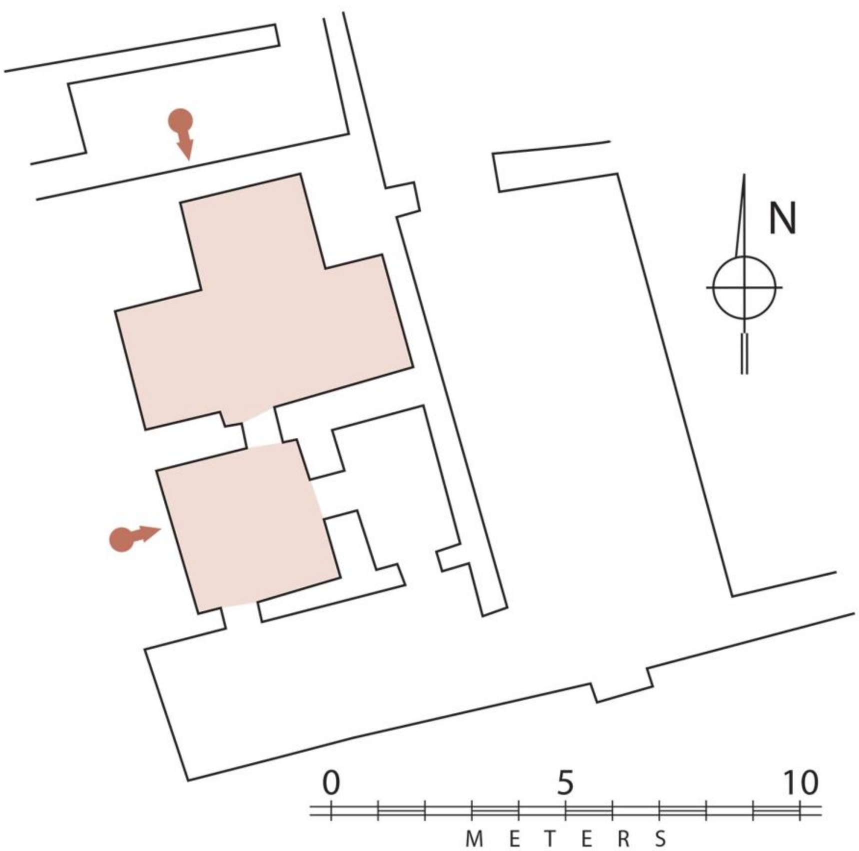

Figure 127: Plan of the baths on Jebal Khubthah at Petra (after Tholbecq et al. 2015, fig. 4).

Figure 128: View of baths on Jebal Khubthah, overlooking Petra, showing use of sandstone ashlar masonry (Fournet and Paridaens 2016, fig. 11).

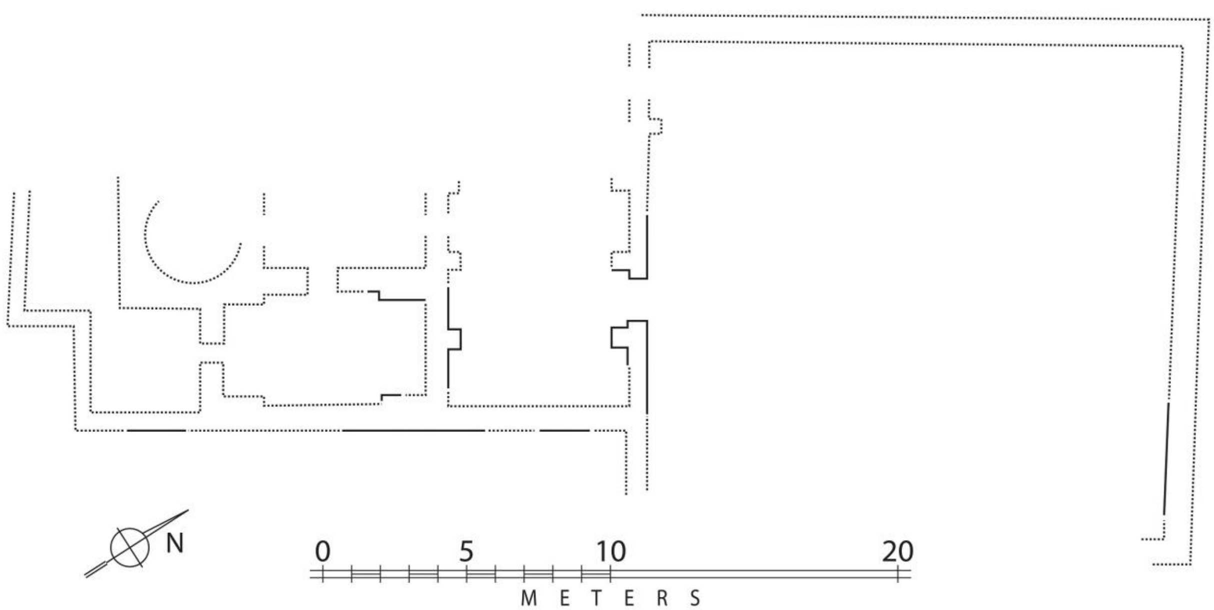

Figure 129: Plan of the baths at Sabrah (after Fournet and Tholbecq 2015, fig. 3).

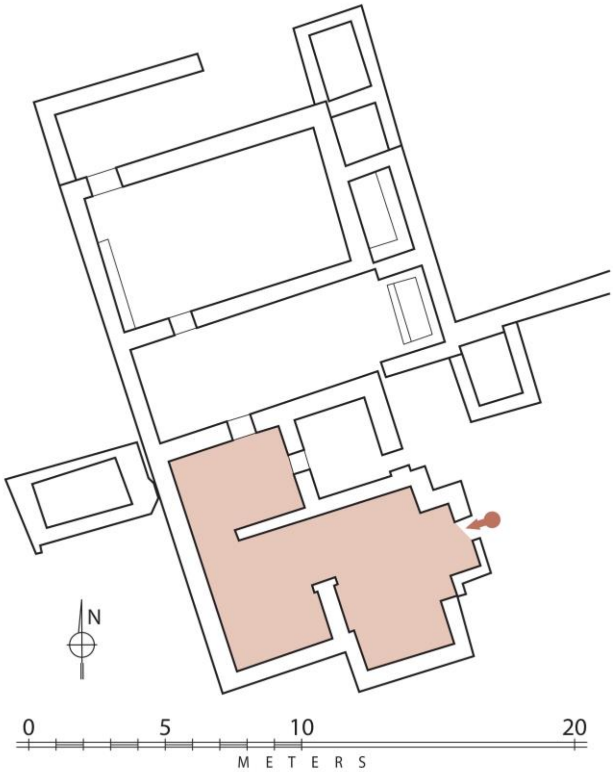

Figure 130: Plan of the baths at Hauarra (modern Humayma) (after Reeves et al. 2017, fig. 6).

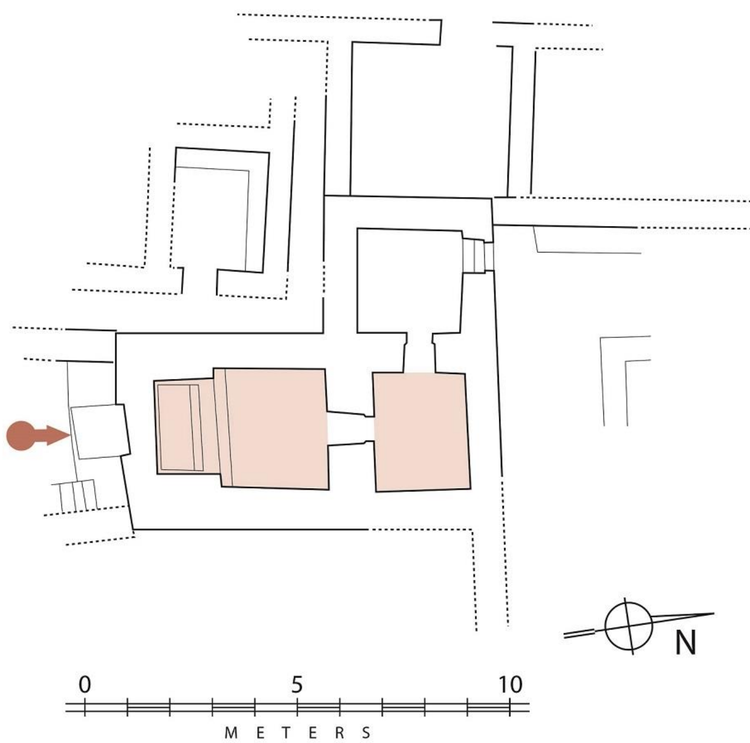

Figure 131: Plan of the baths at Arieldela (modern 'Ayn Gharandal) (after Harvey 2019, fig. 2).

Figure 132: View of the partially excavated baths at Arieldela (modern 'Ayn Gharandal), showing ashlar masonry (Darby 2015a, fig. 7).

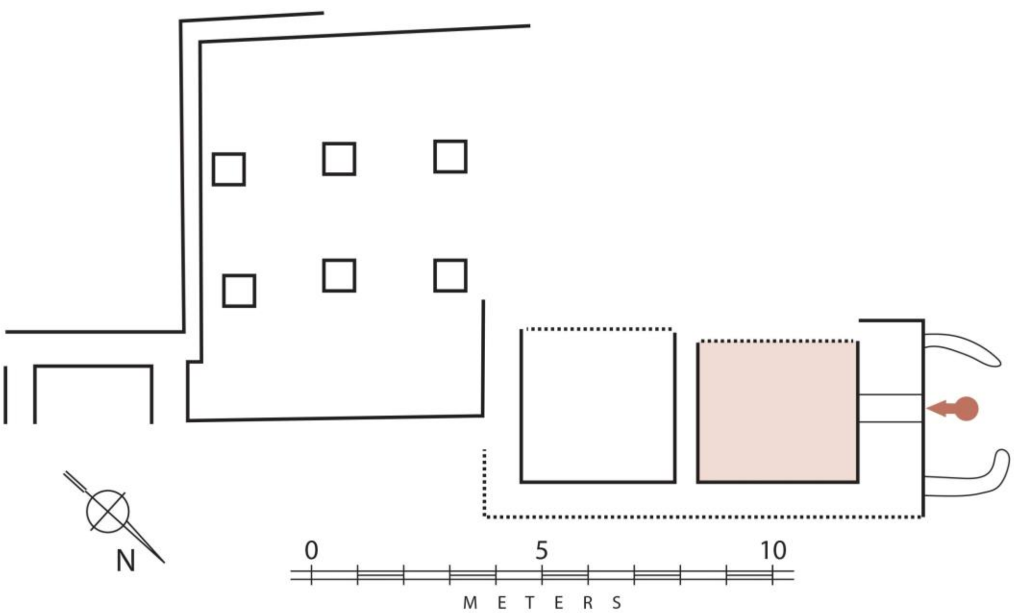

Figure 133: Plan of the baths at Osia (modern Yotvata) (after Davies and Magness 2015, fig. 42).

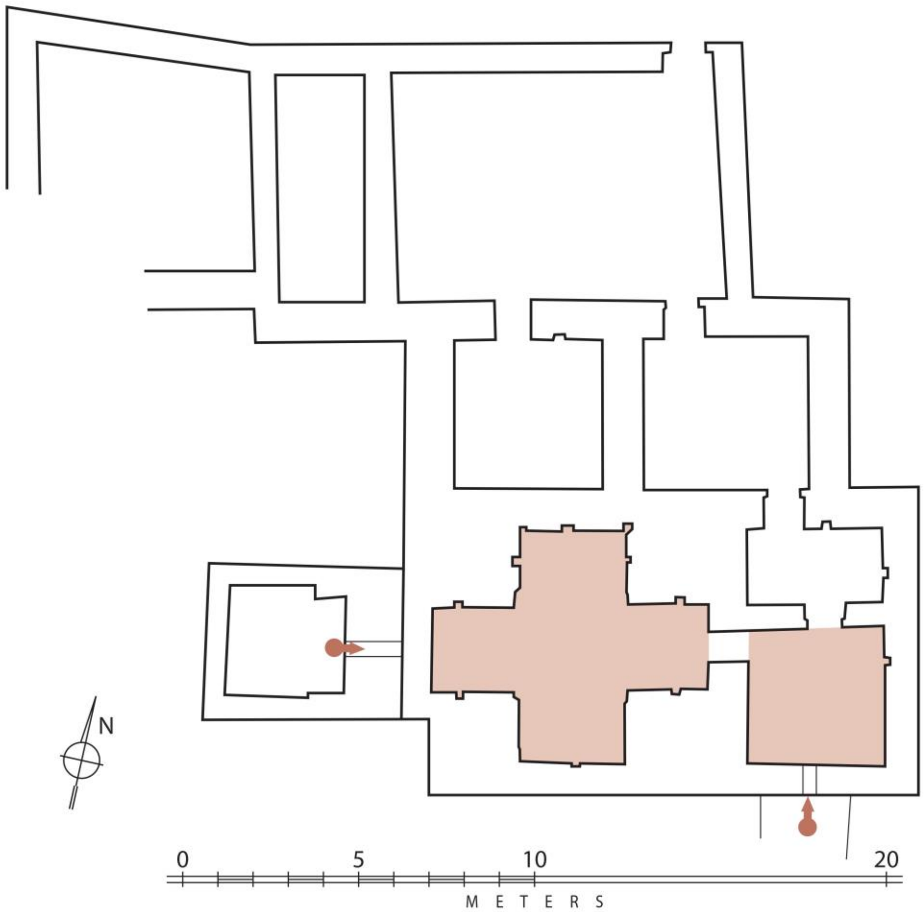

Figure 134: Plan of the baths at Oboda (modern Avdat) (after Negev 1997, fig. 26).

Figure 135: Exterior view of the baths at Oboda (modern Avdat), showing ashlar masonry (photo by author).

Figure 136: Interior of the baths at Oboda (modern Avdat), showing ashlar masonry of the walls and vault (photo by author).

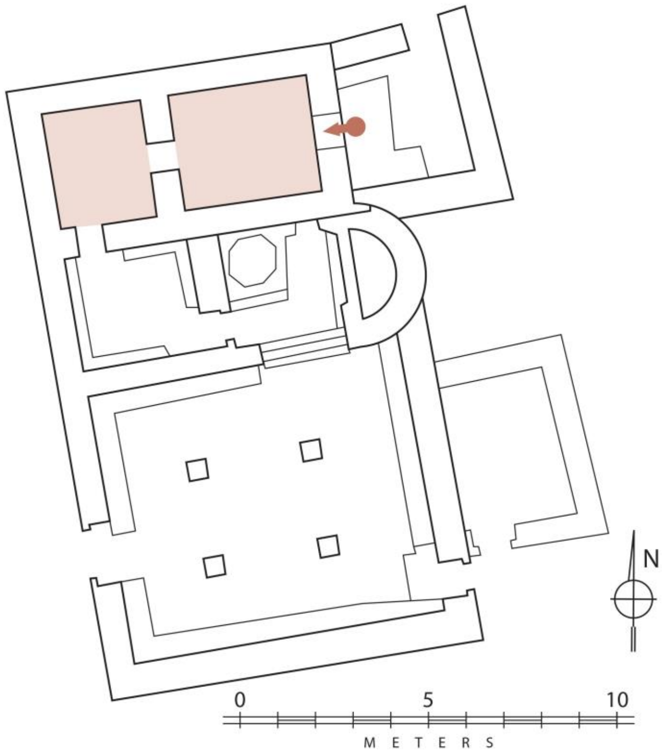

Figure 137: Plan of the baths at Mamshit (Mampsis) (after Negev 1988, plan 35).

Figure 138: View of the baths at Mamshit (Mampsis), from north, showing carefully drafted ashlars in the masonry of the two *caldaria* (foreground) and the course stone masonry of the other rooms (background) (photo by author).

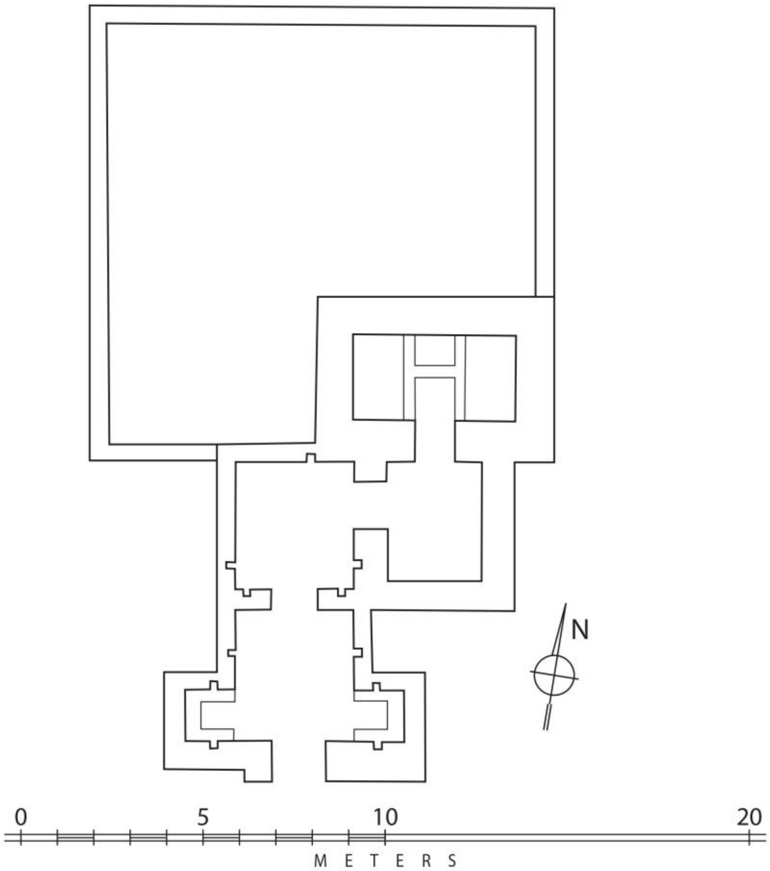

Figure 139: Plan of the baths at Rehovot-in-the-Negev (after Musil 1908, fig. 46).

Fig. 47. Ḫ. er-Rḥejbe. Ḳubbet el-Bîr von Südosten.

Figure 140: Exterior of the baths at Rehovot-in-the-Negev, showing ashlar masonry and dome (Musil 1908, fig. 47).

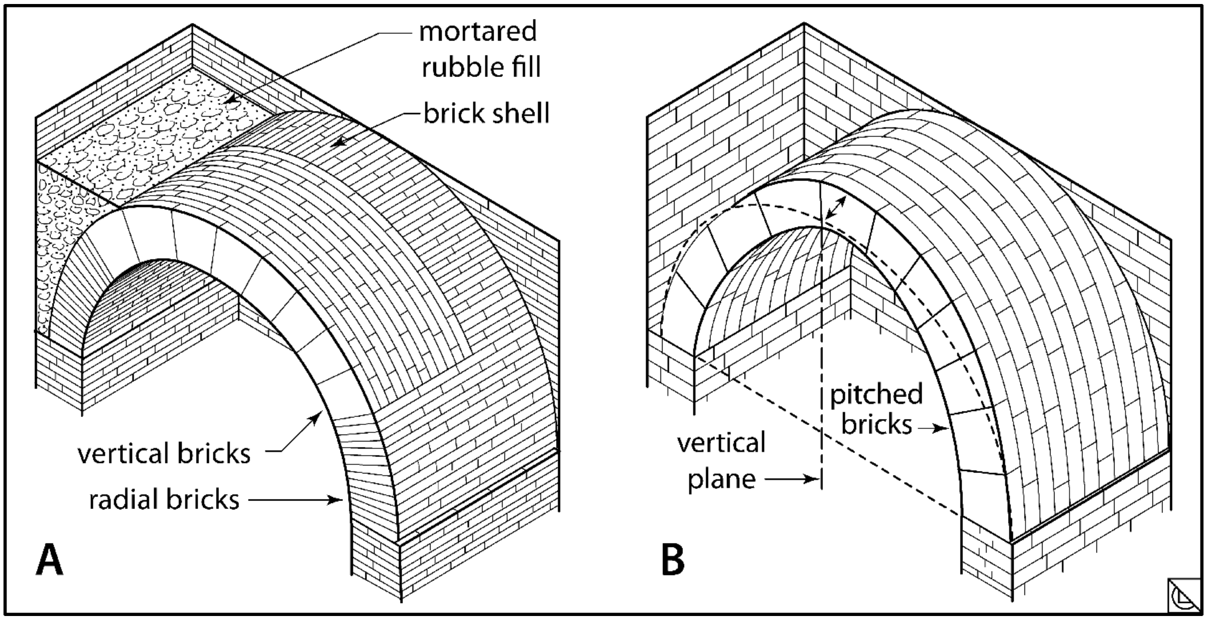

Figure 141: Illustration depicting the construction of vaults using radially and vertically placed bricks (A) and using bricks pitched at an angle (B) (Lancaster 2015, fig. 17).

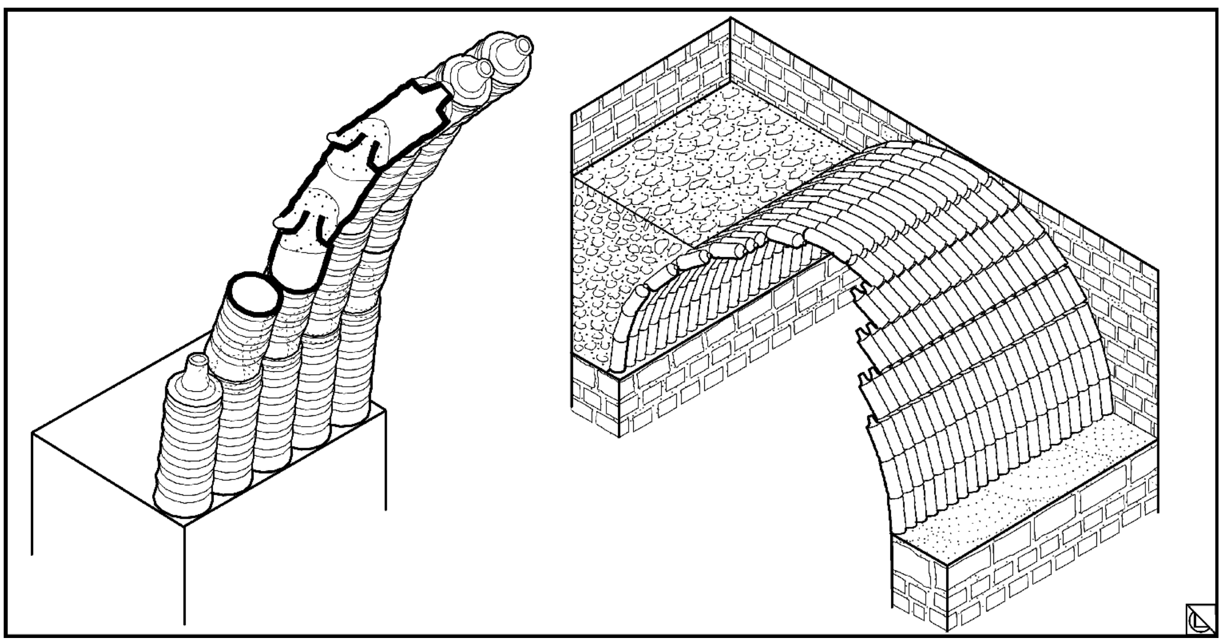

Figure 142: Illustration depicting the construction of vaults using vaulting tubes (Lancaster 2015, fig. 65).

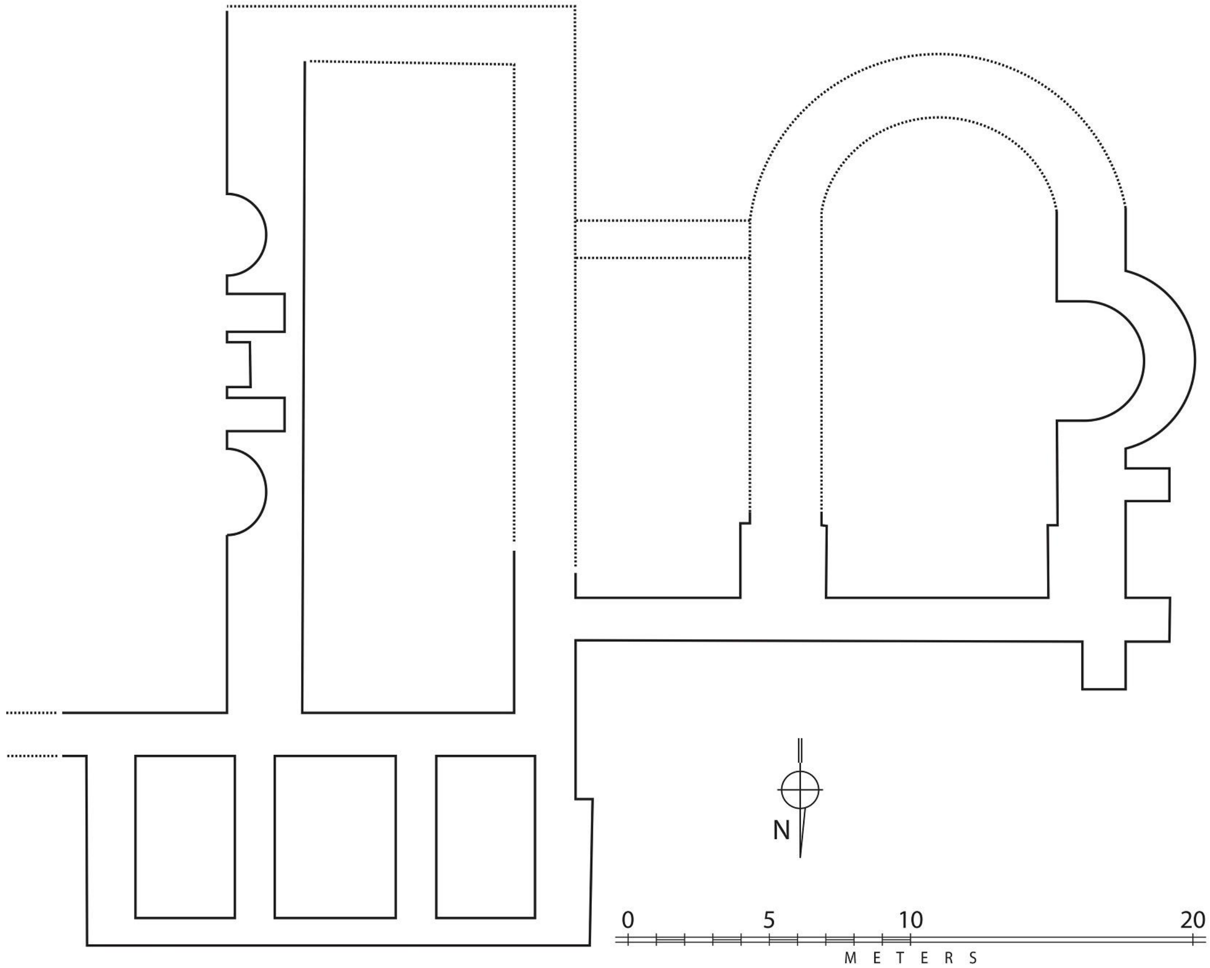

Figure 143: Plan of the Large Bath at Selinus (after Hoff 2013, fig. 12.2).

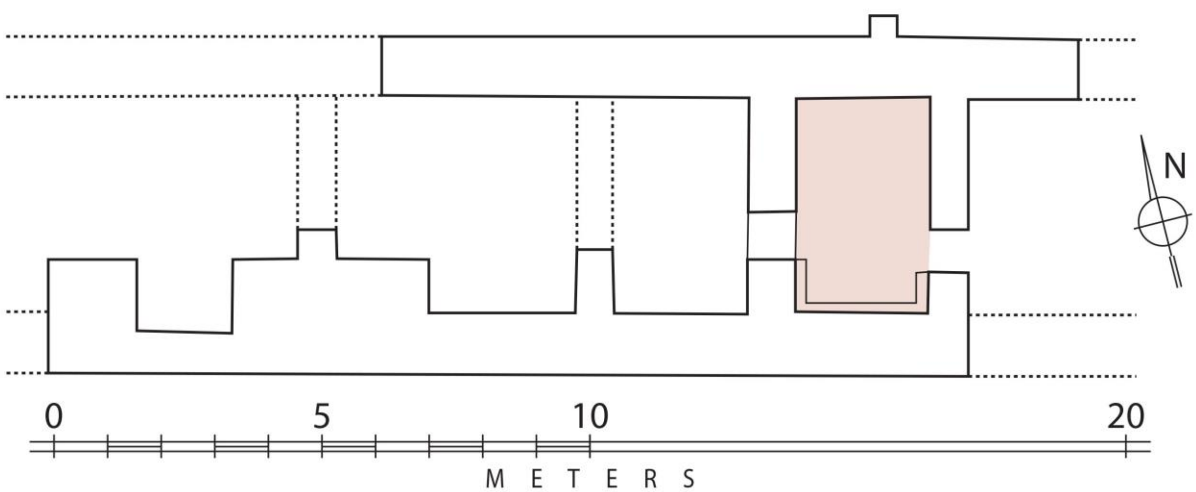

Figure 144: Plan of the River Bath at Selinus (after Hoff 2013, fig. 12.7).

Figure 145: View of the River Bath at Selinus, from north (photo by author).

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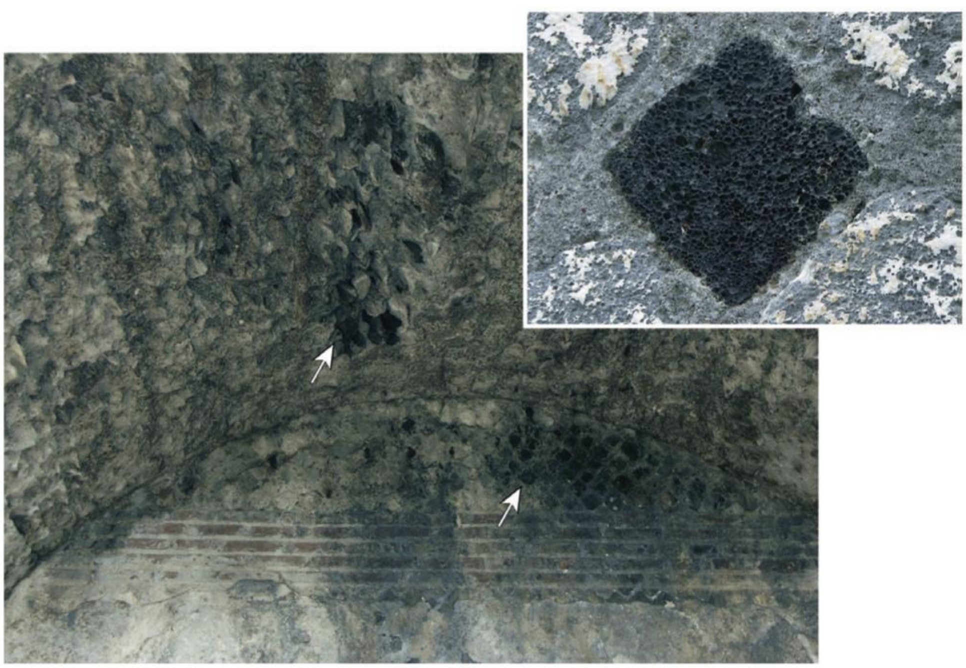

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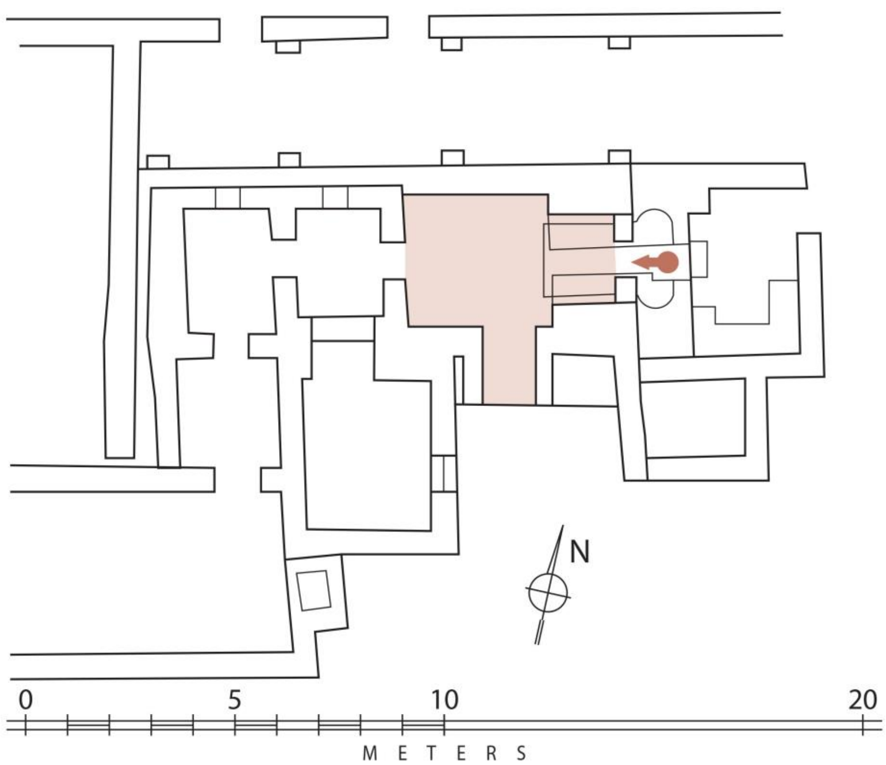

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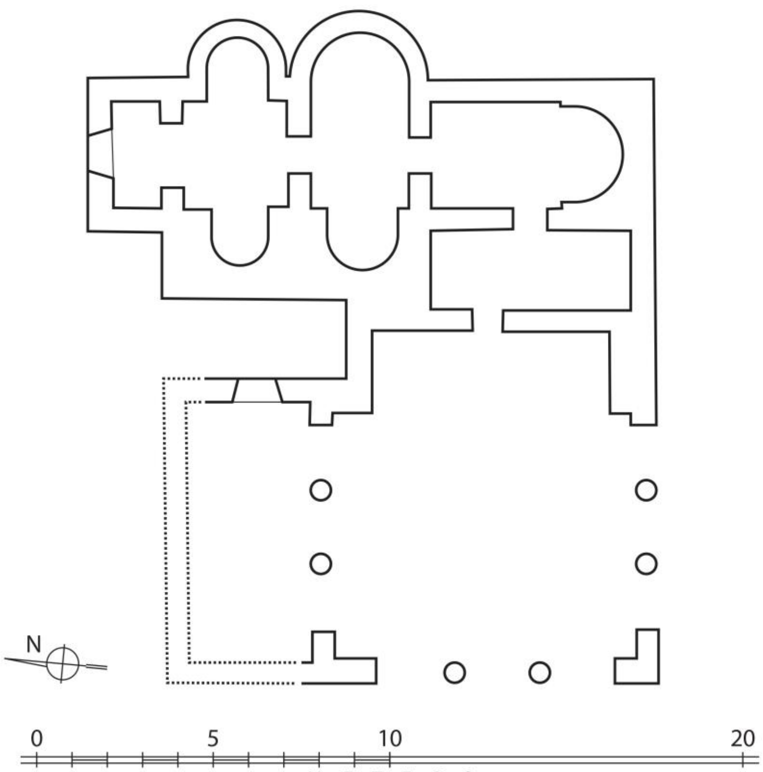

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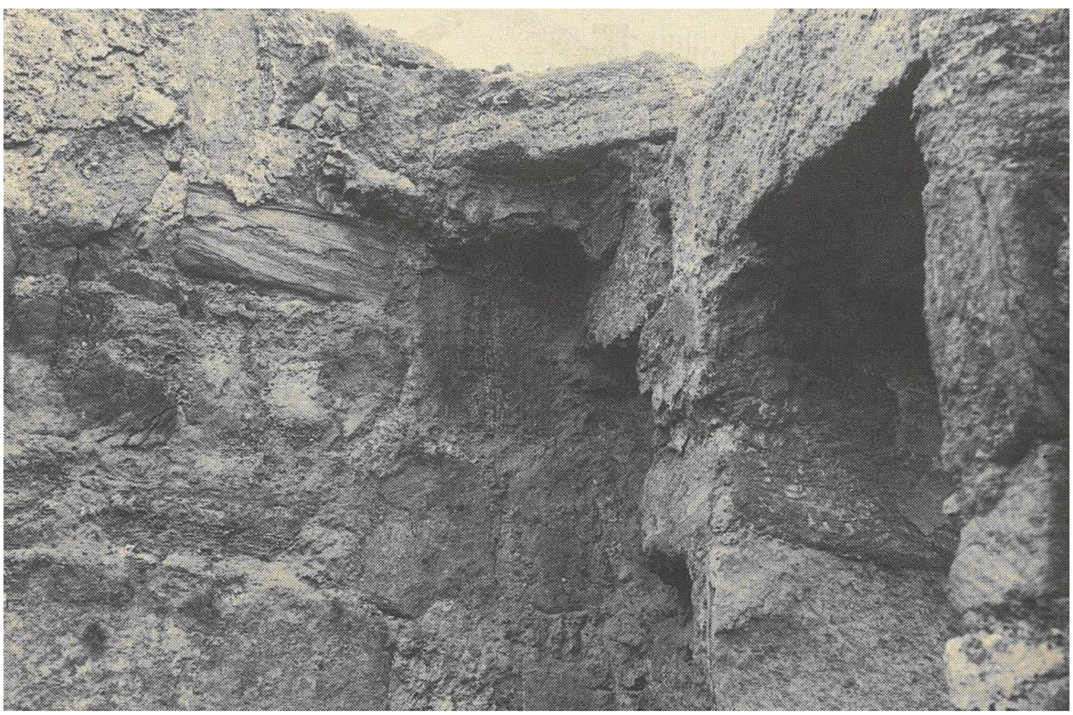

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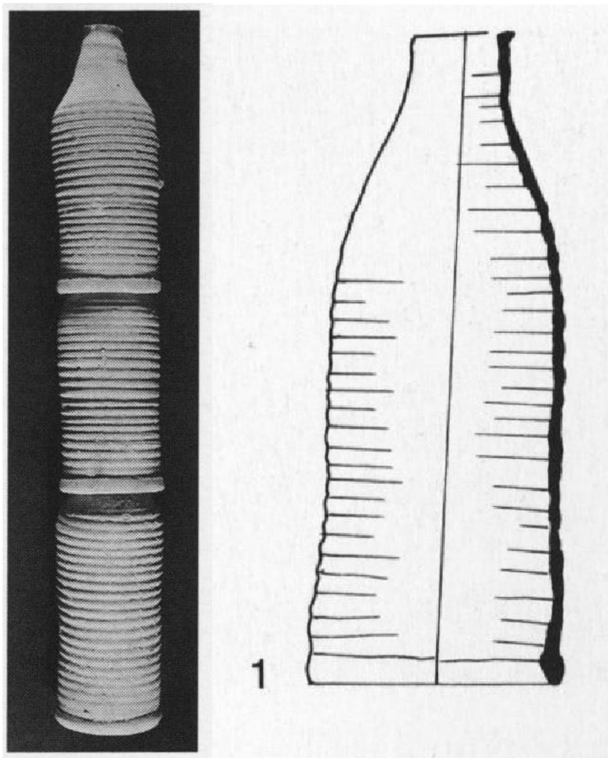

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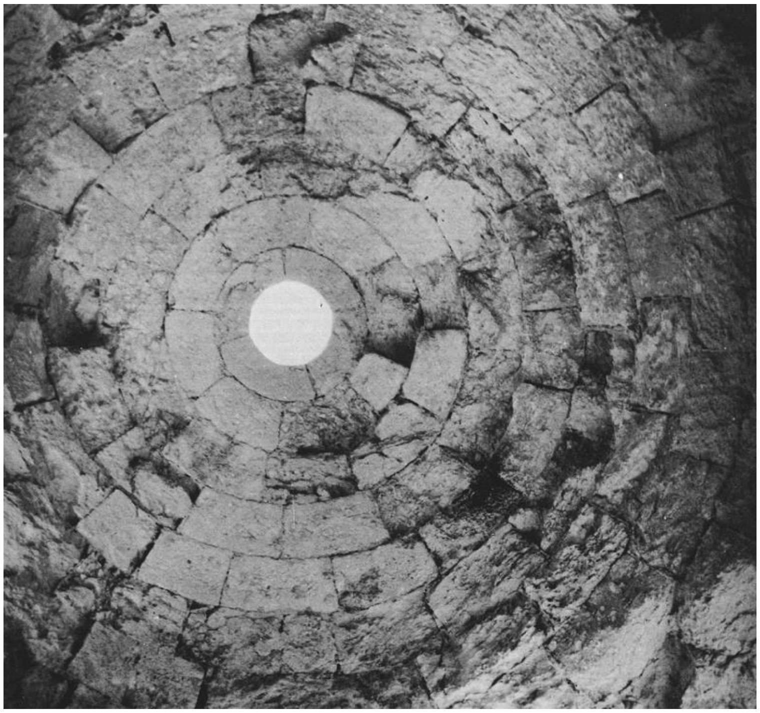

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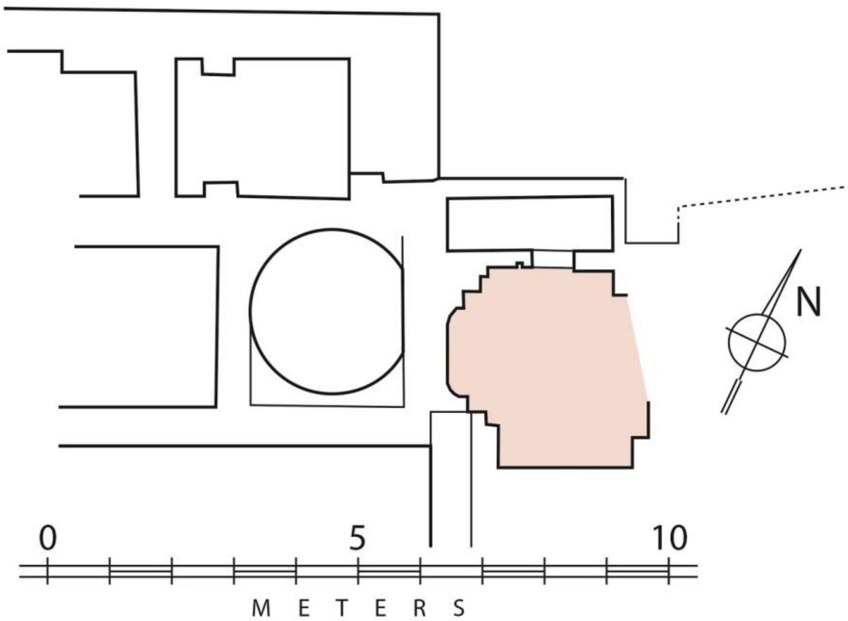

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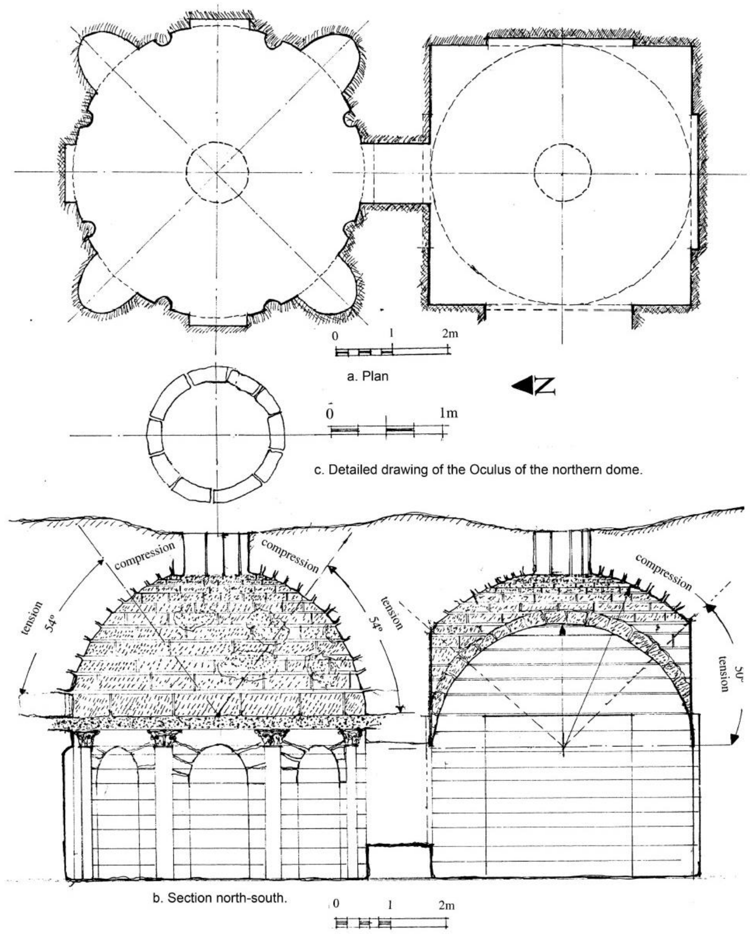

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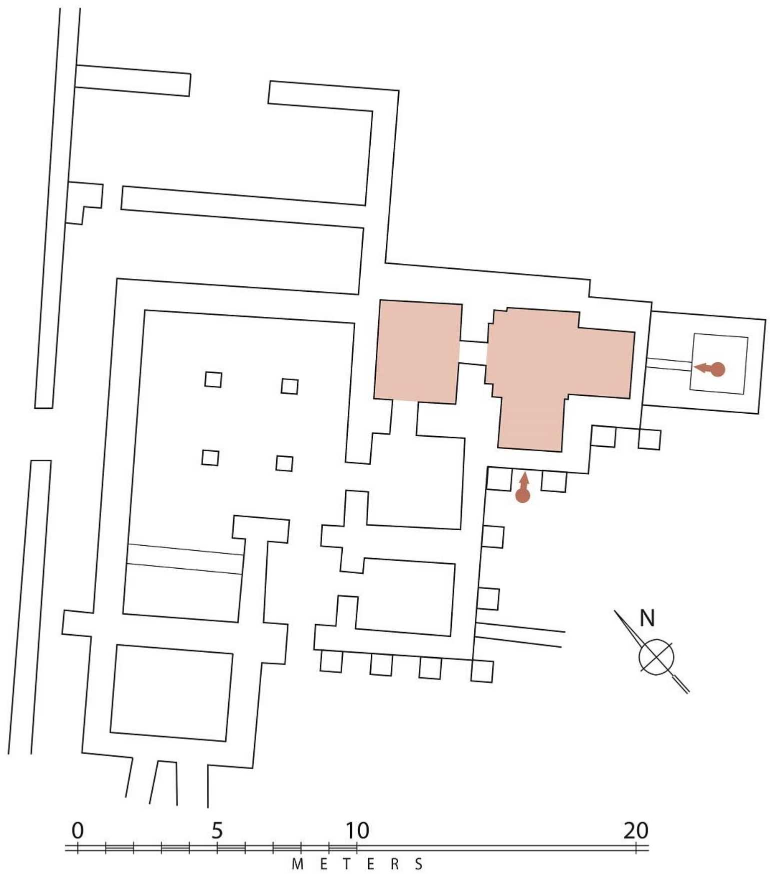

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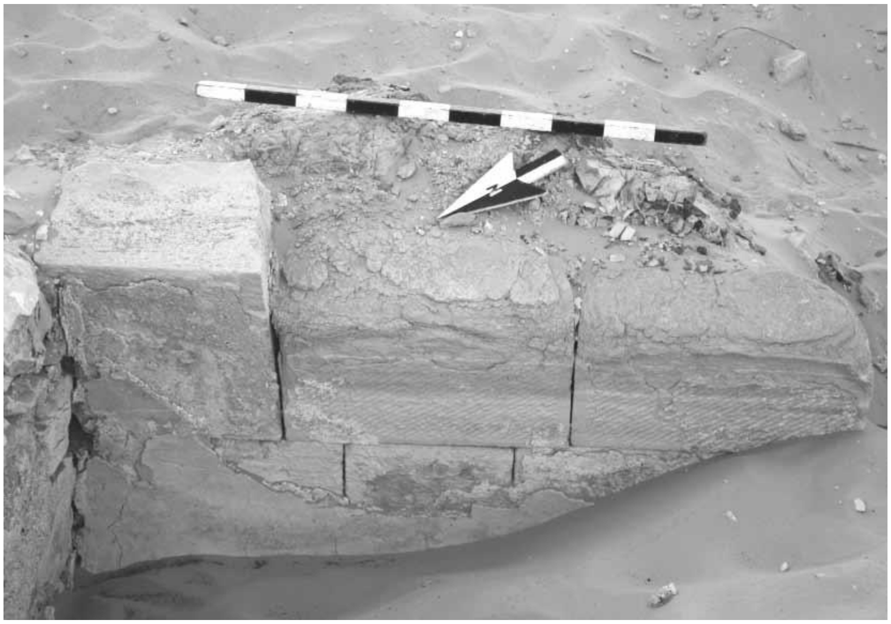

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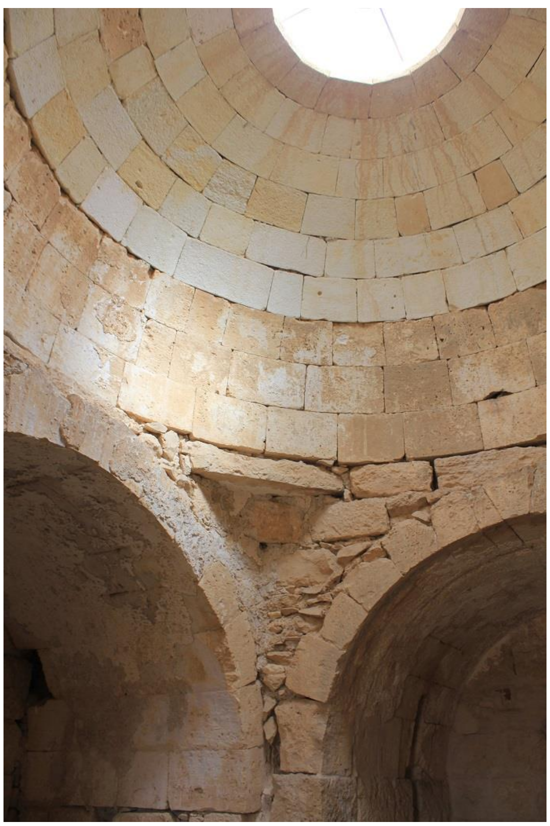

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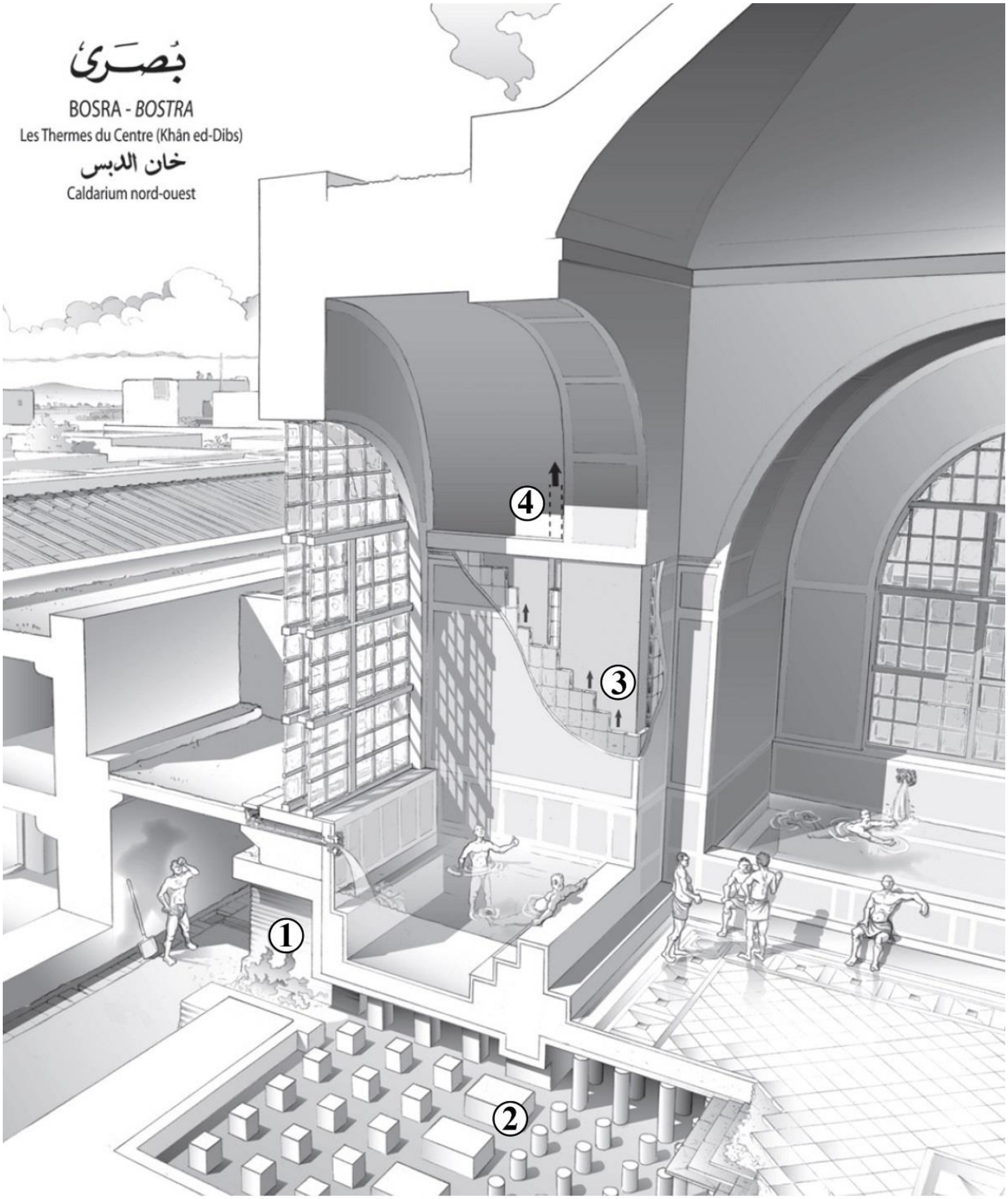

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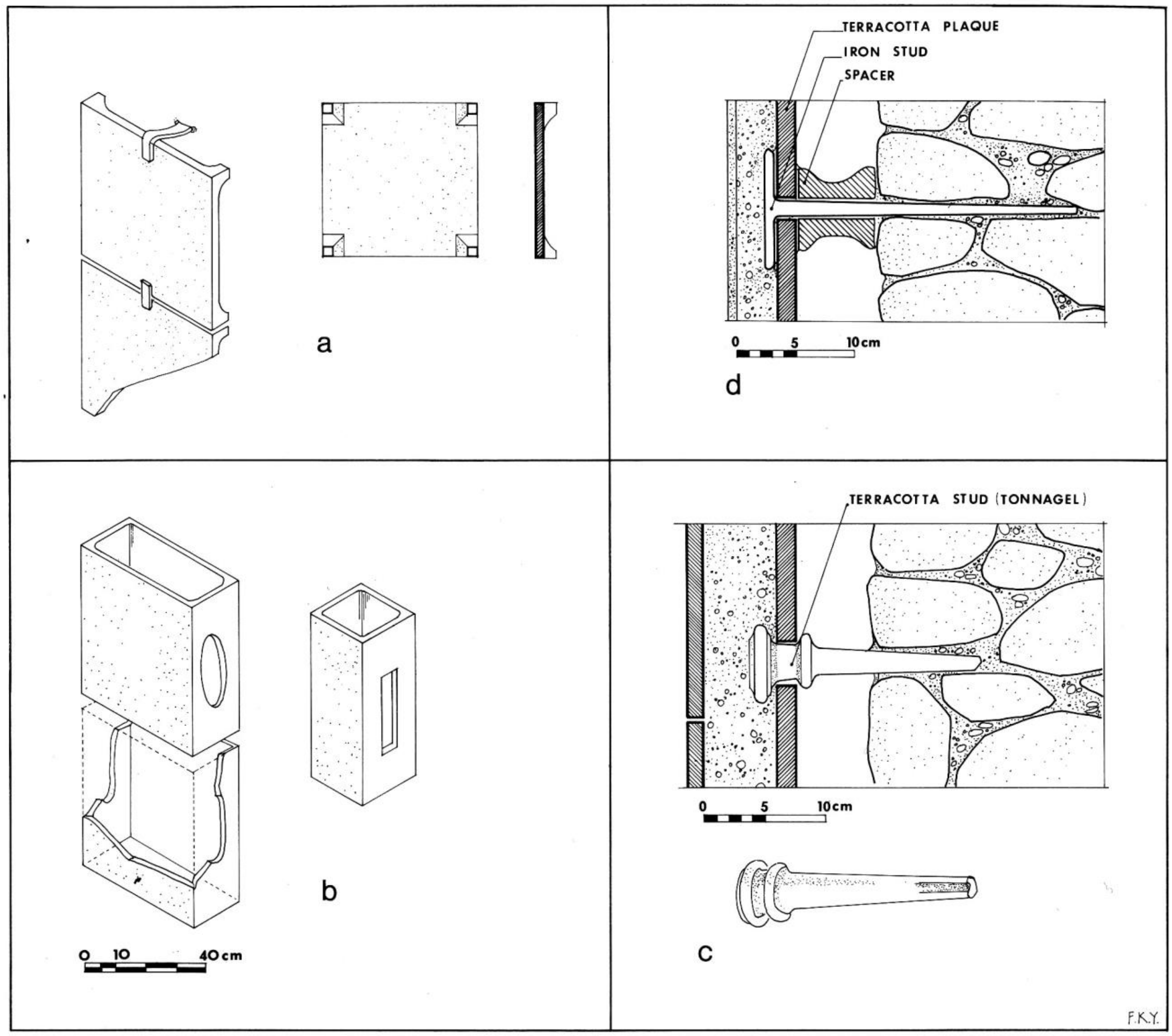

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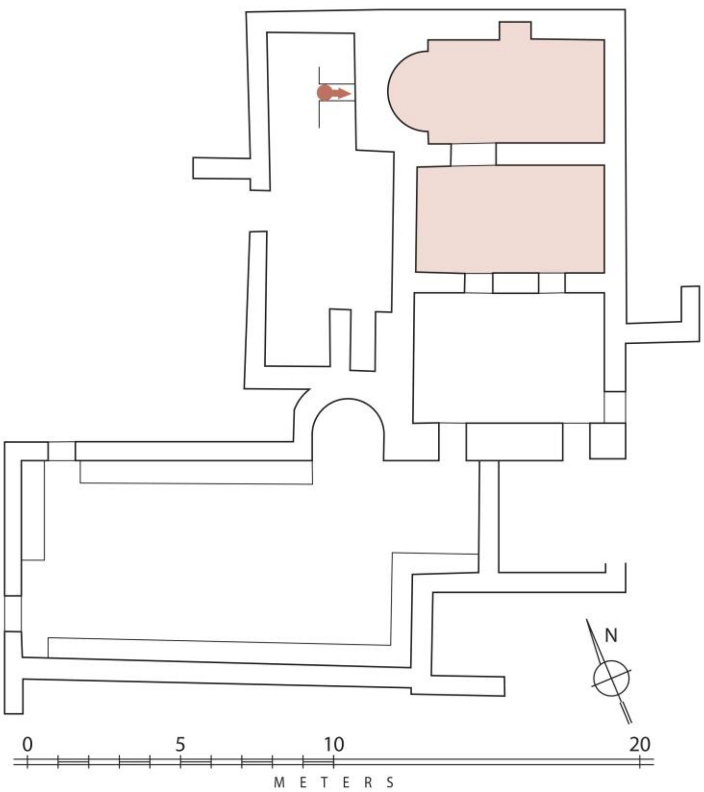

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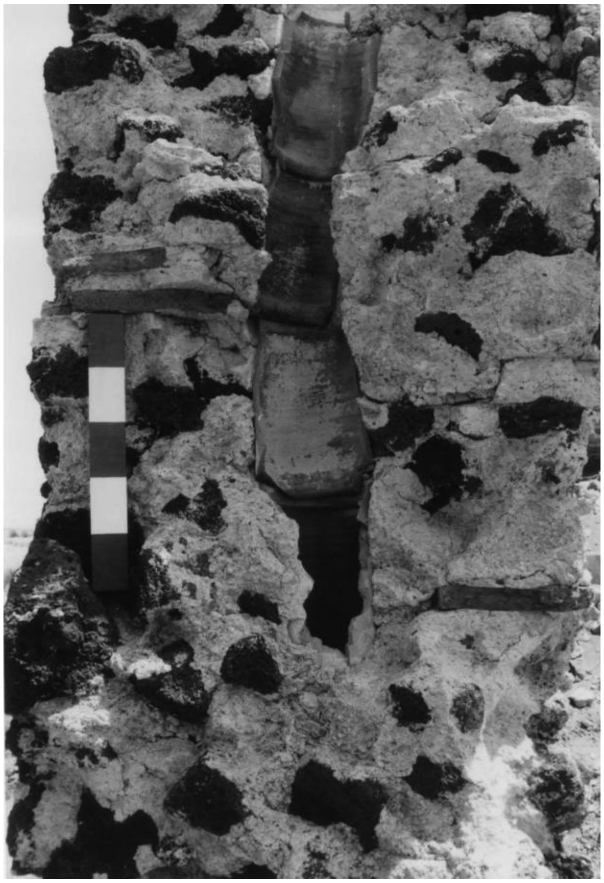

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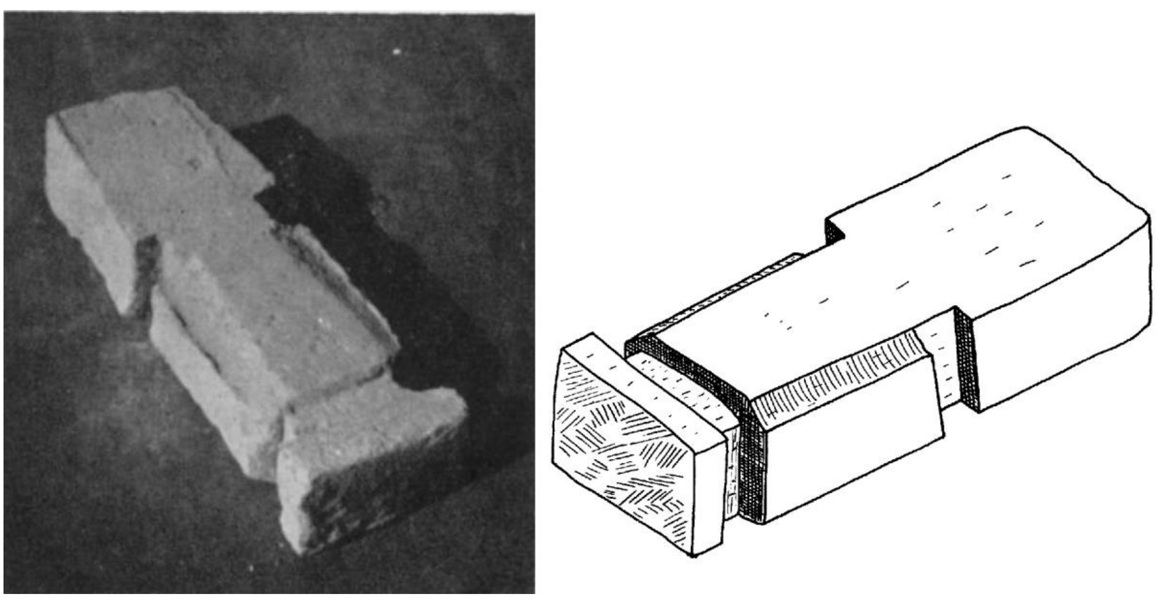

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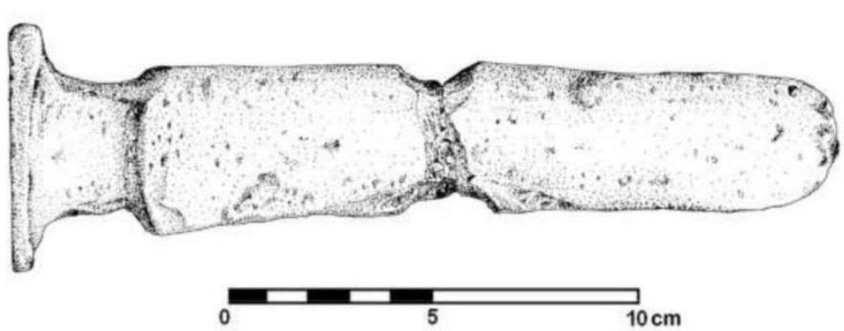

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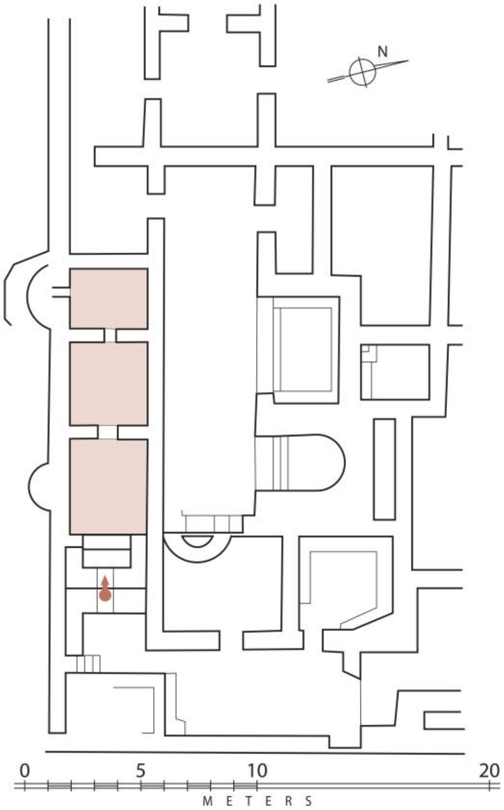

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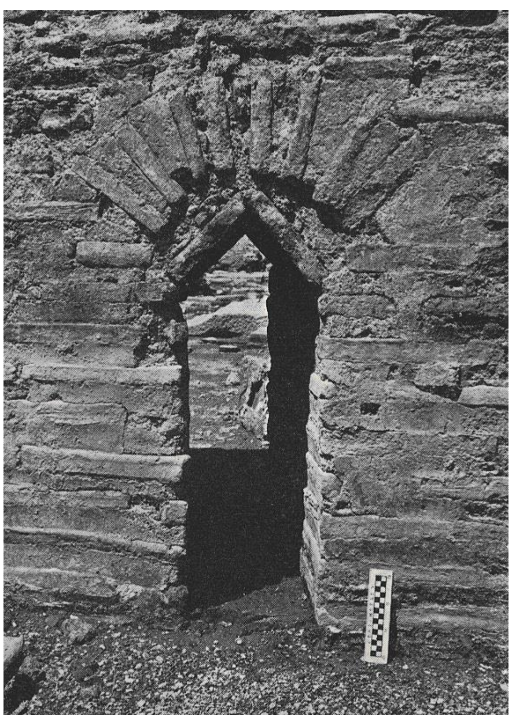

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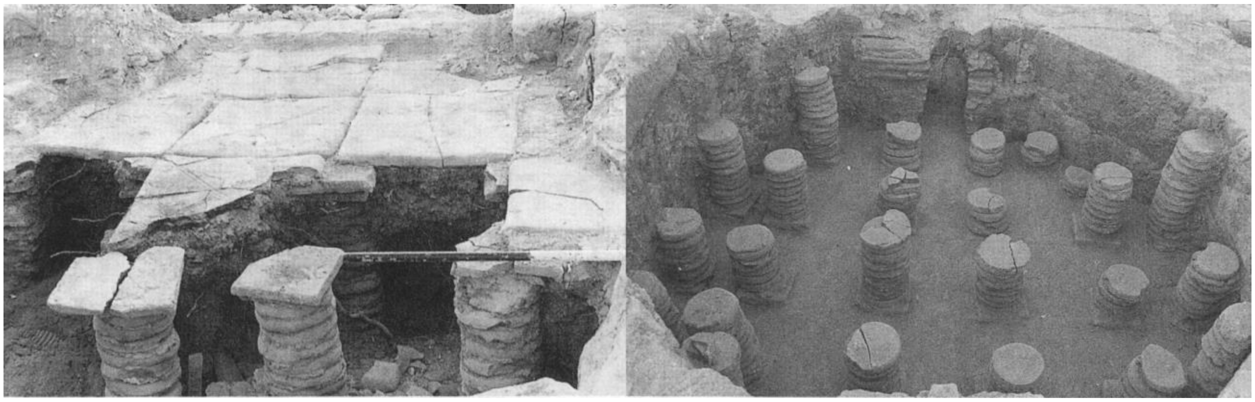

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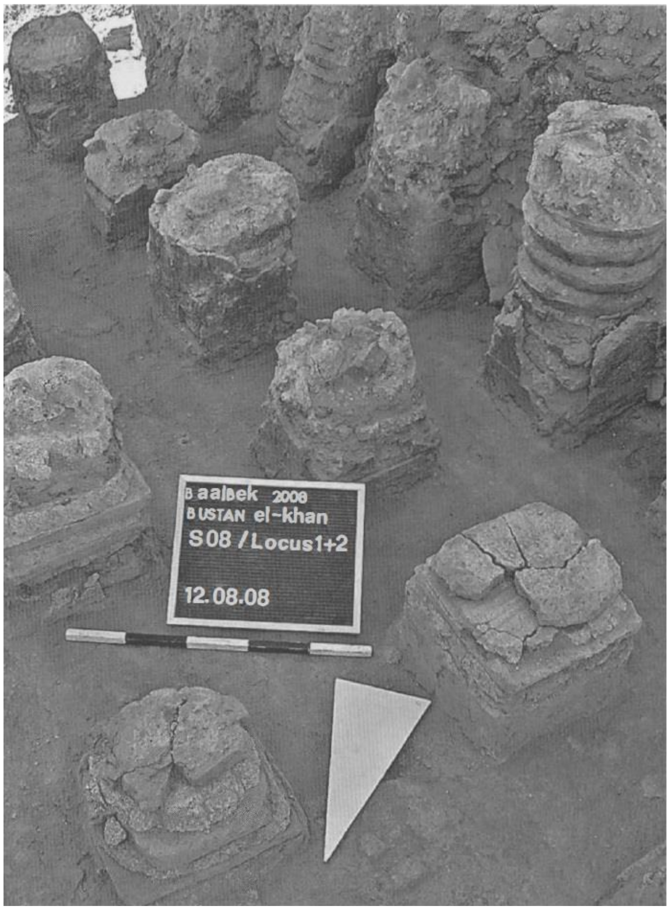

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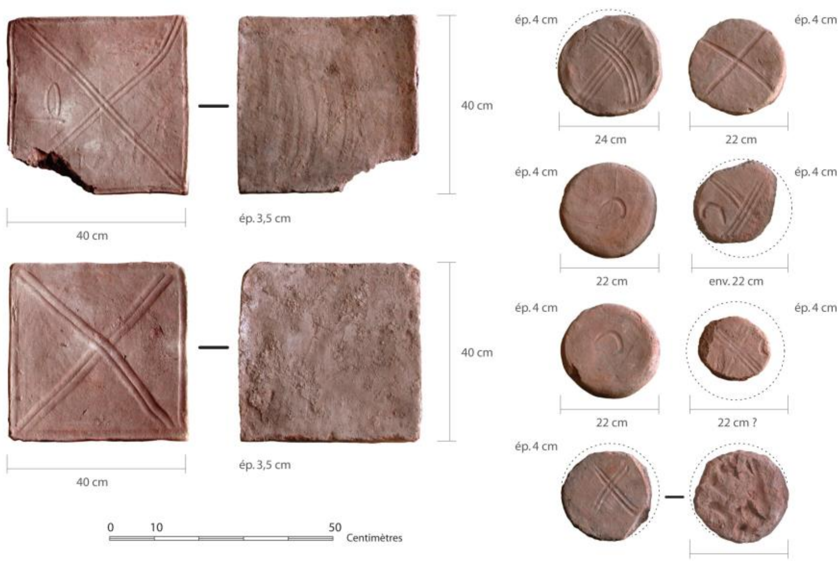

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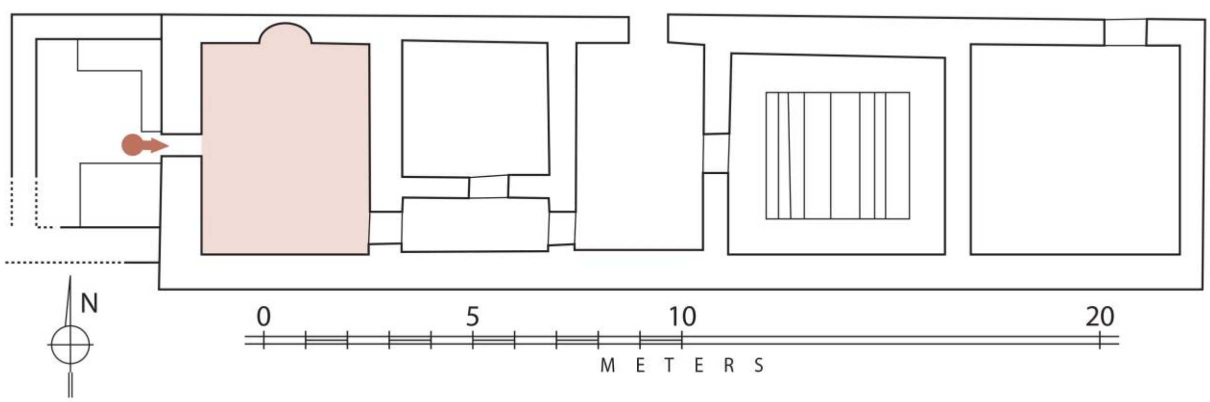

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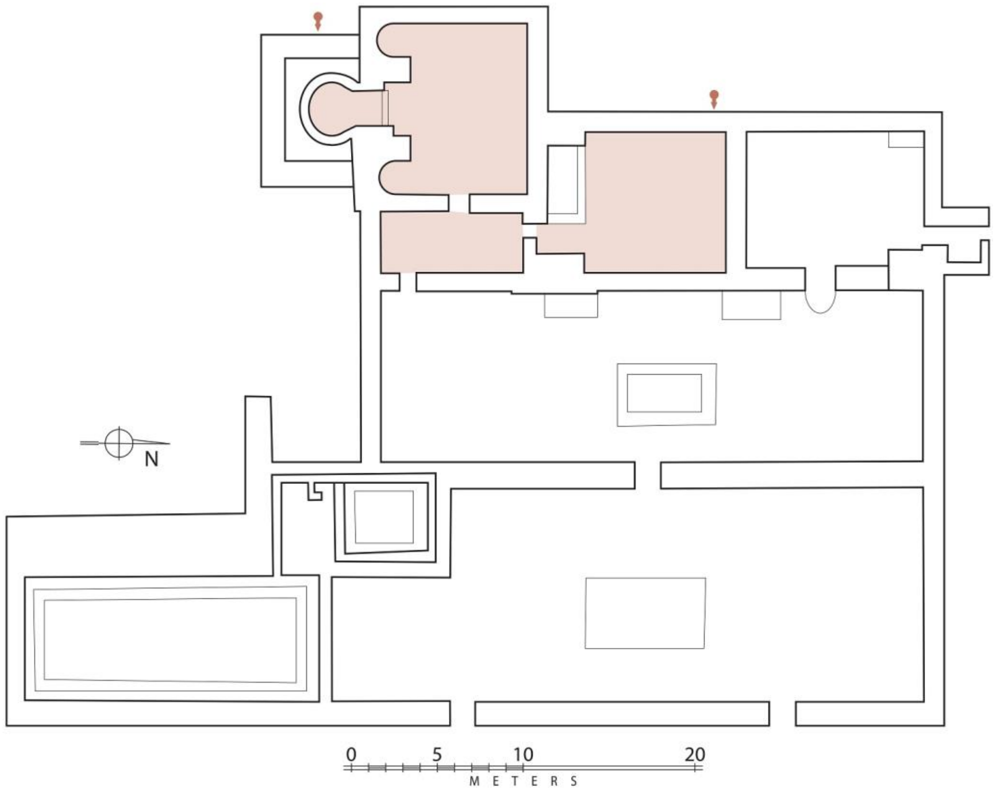

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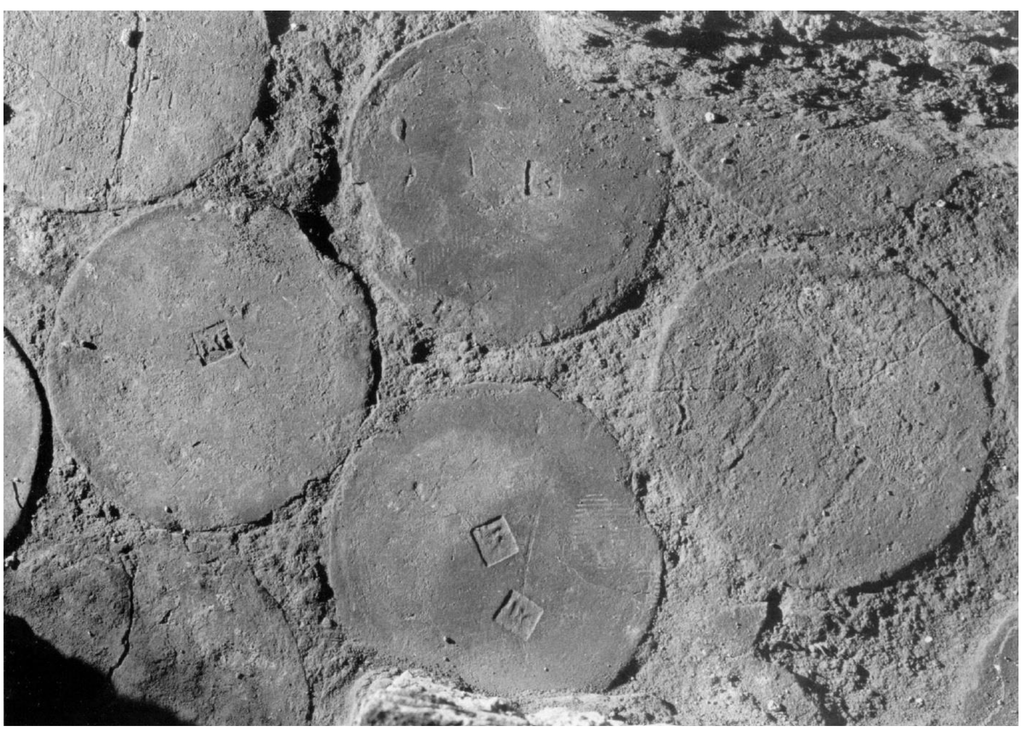

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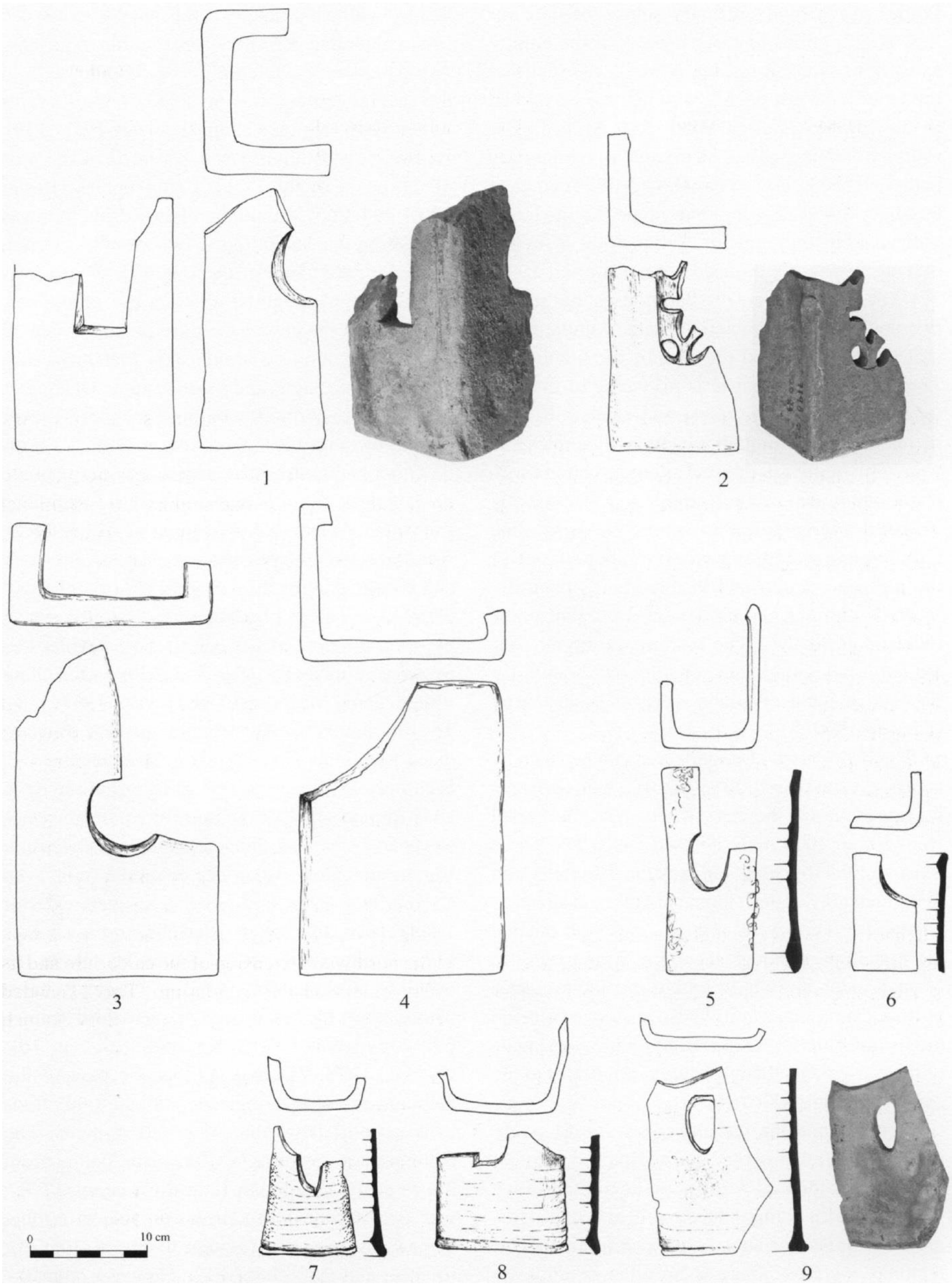

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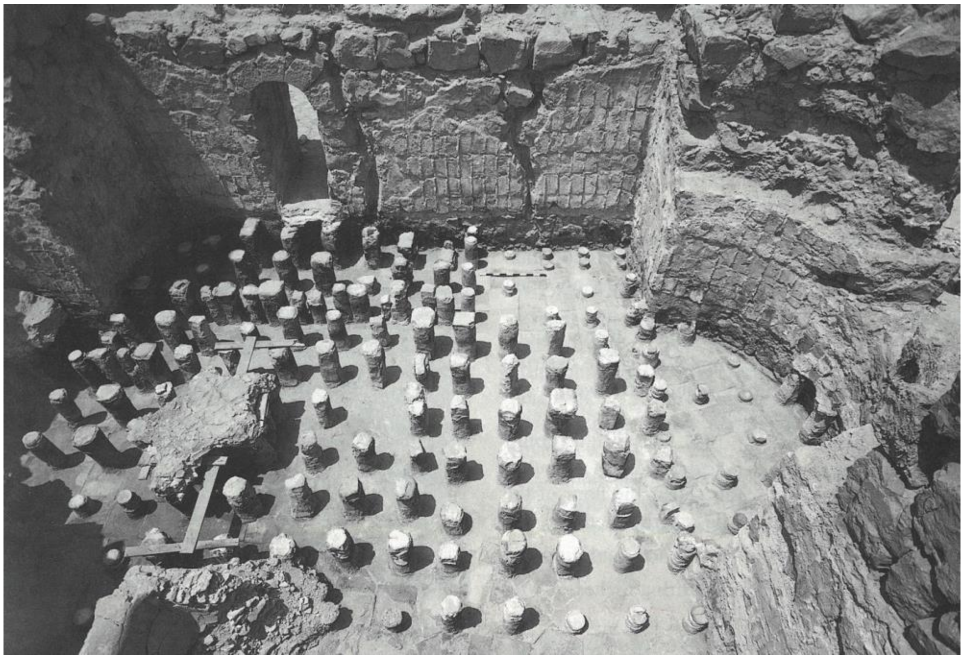

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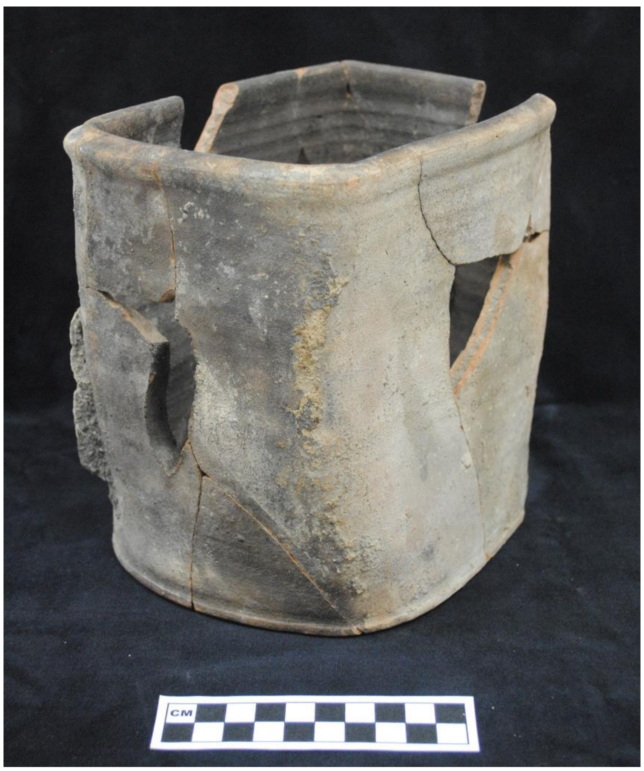

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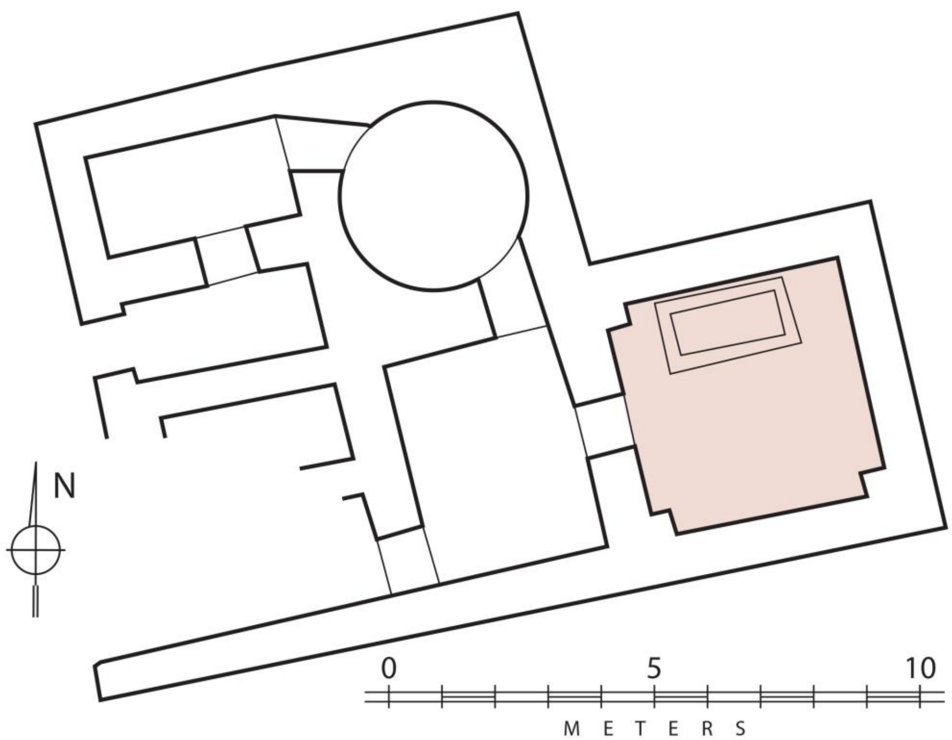

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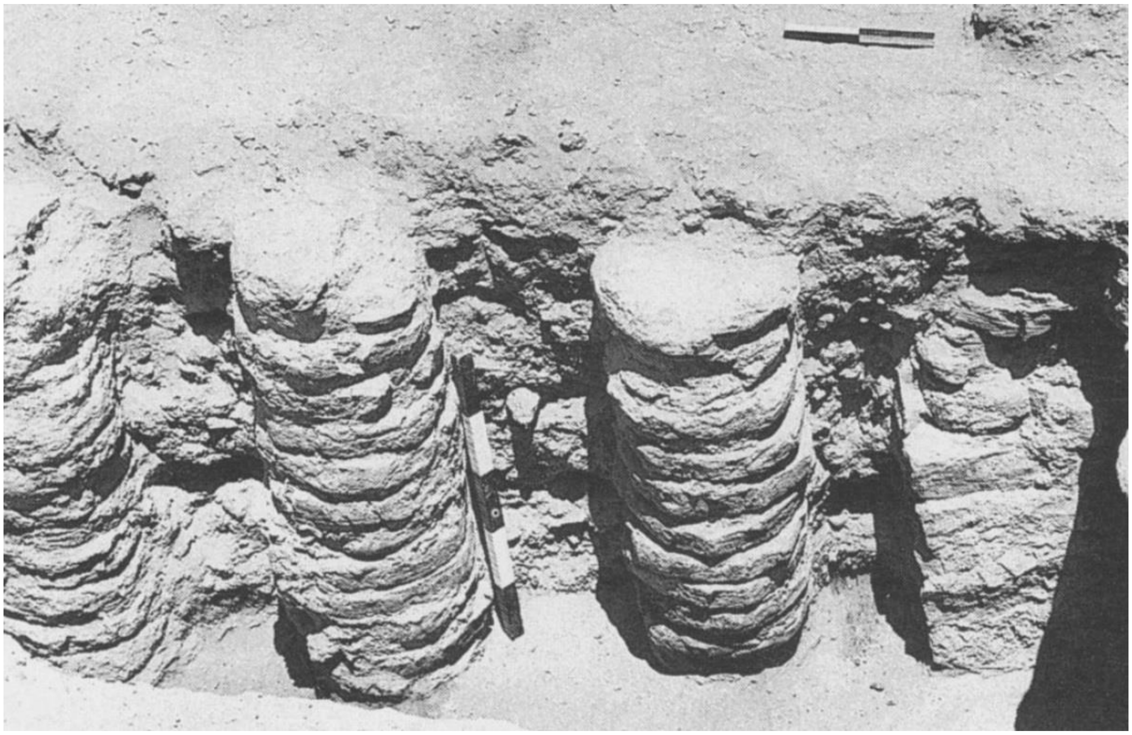

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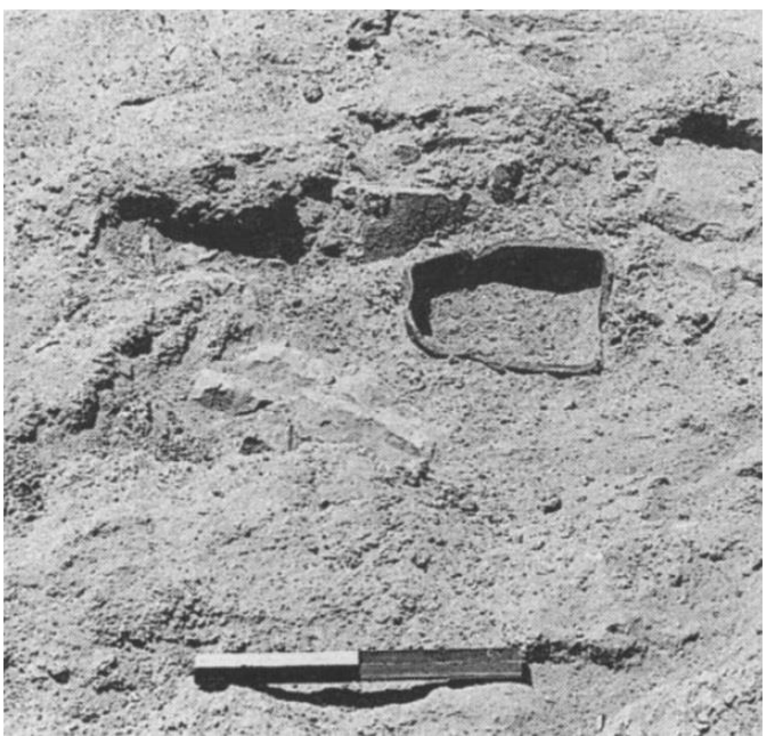

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