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A Typological Assessment of the Nabataean, Roman and Byzantine Ceramic Building Materials at al-Humayma and Wādī Ramm

Ceramic building materials such as bricks, pipes and roof tiles are commonly found on Jordanian archaeological sites, yet generally these materials have generated very little interest from archaeologists¹. This lack of study is unfortunate given that, just like any other artifacts, the appearance of ceramic building materials varies in relation to their time and place of manufacture. This article presents the current state of a project, begun by the authors, to analyze the ceramic building materials (henceforth referred to as CBM) from Wādī Ramm and al-Humayma (FIG. 1). The selection of these two sites for study was based both on the availability of the material and the important fact that the material from these two sites spans the Nabataean, Roman, Byzantine and perhaps Umayyad periods in southern Jordan.

The CBM from Wādī Ramm comes from the bathing suite in a Nabataean villa (the ‘Eastern Complex’) located near to the Nabataean temple (FIG. 2). Evidence from excavation, carried out by M. B. Reeves and D. Dudley in 1996 and 1997 suggests the building was constructed in the first century BC or first century AD (Dudley and Reeves 1997, 2007, 2013).

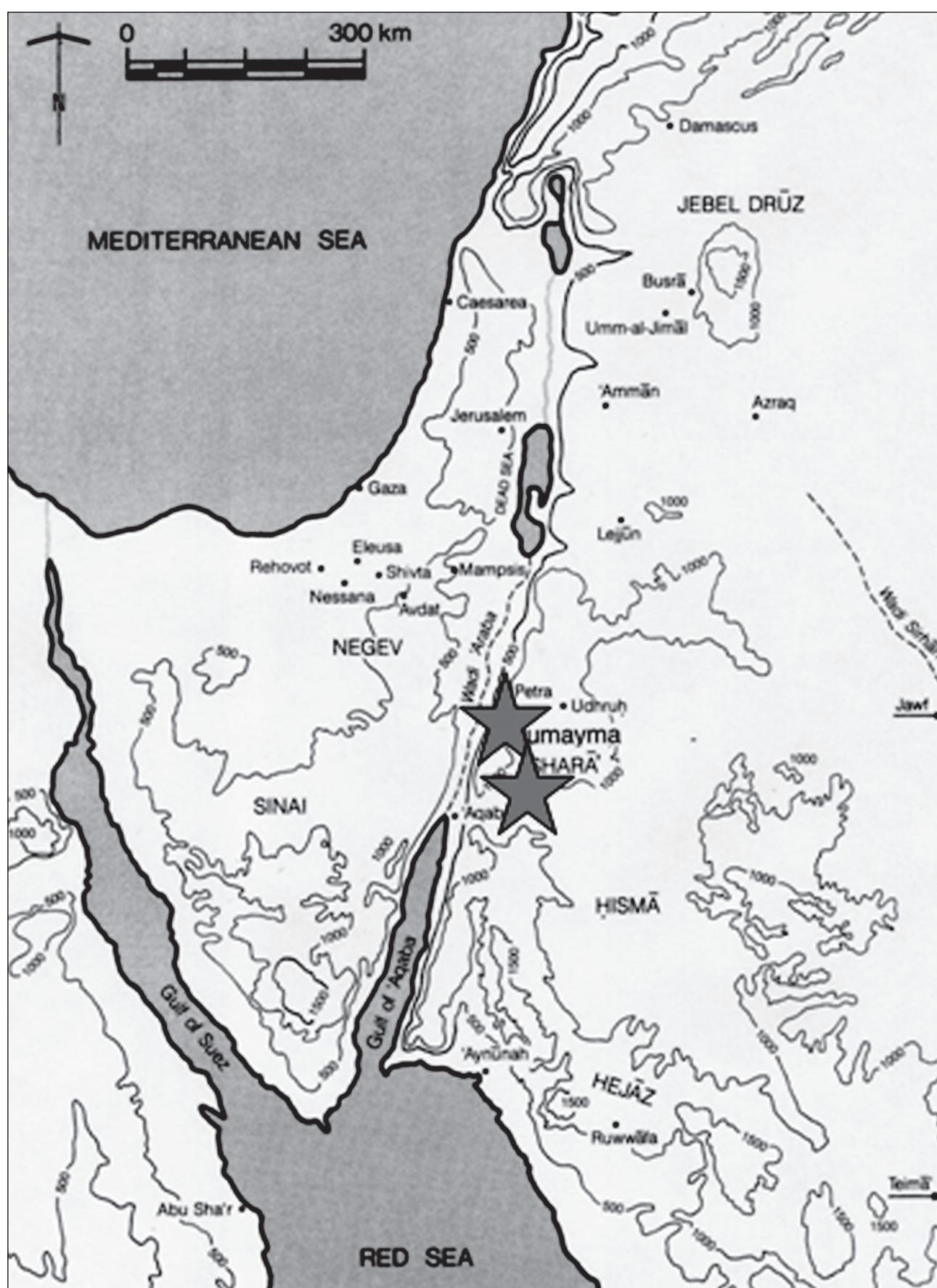
In contrast, the bathhouse at al-Humayma was built in the second century AD to service

the soldiers stationed at Roman fort built immediately after the Roman annexation of the Nabataean kingdom. The bathhouse at al-Humayma, partly excavated in 1989 by J. P. Oleson (Oleson 1990, 2010), has been recently excavated further by M. B. Reeves (Reeves *et al.* 2009, 2013). These recent excavations have determined that there were two main phases in the bathhouse’s design with many sub-phases in each. The first major phase (FIG. 3) dates to the Roman period (*i.e.* the second and third centuries AD) when a large Roman garrison was stationed at the site. The second major phase (FIG. 4) dates to the Byzantine period (fourth to seventh centuries) and coincides with a reduced garrison stationed at al-Humayma.

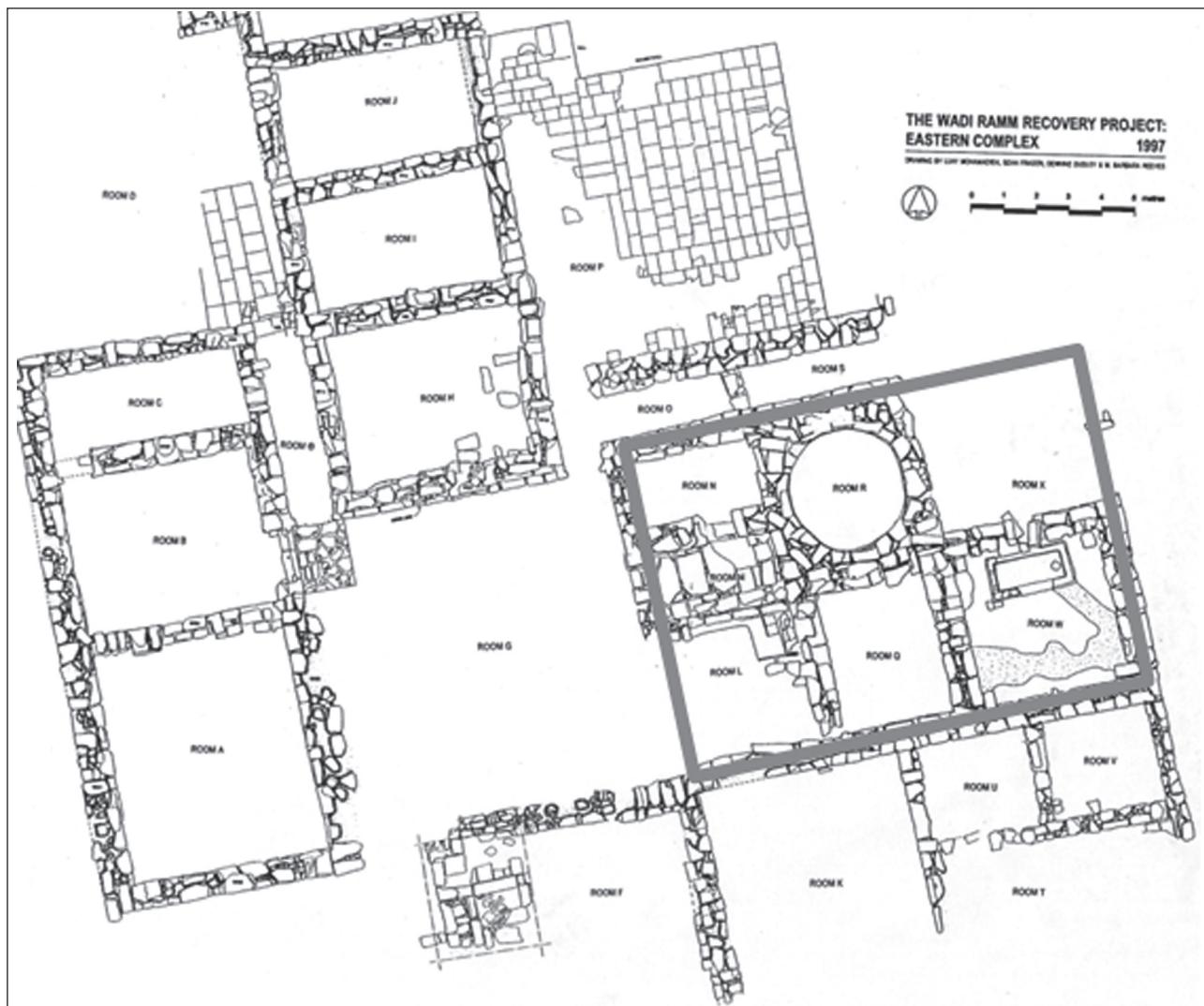
Also of interest at al-Humayma is a heated room in the *praetorium* (commanding officer’s house) of the Roman fort (FIG. 5). This room was added during a renovation in the later second or early third century AD (Oleson *et al.* 2008: 318-24; Reeves *et al.* 2013).

Dating all of these structures has proven difficult as foundation probes typically contain no diagnostic artifacts and the fill in structures only reveals when they went out of use. Moreover, in the case of both the al-Humayma and Wādī Ramm baths, this fill was disturbed

¹ Notable exceptions include El-Gohary and Al-Naddaf 2009; Hamari 2008; Kehrberg 2009; Vriezen and Mulder 1997.



1. Location of al-Humayma and Wādī Ramm.



2. Eastern Complex at Wādī Ramm with bathing suite outlined at lower right.

in the twentieth century before systematic excavations and therefore cannot be used to determine when the baths went out of use.

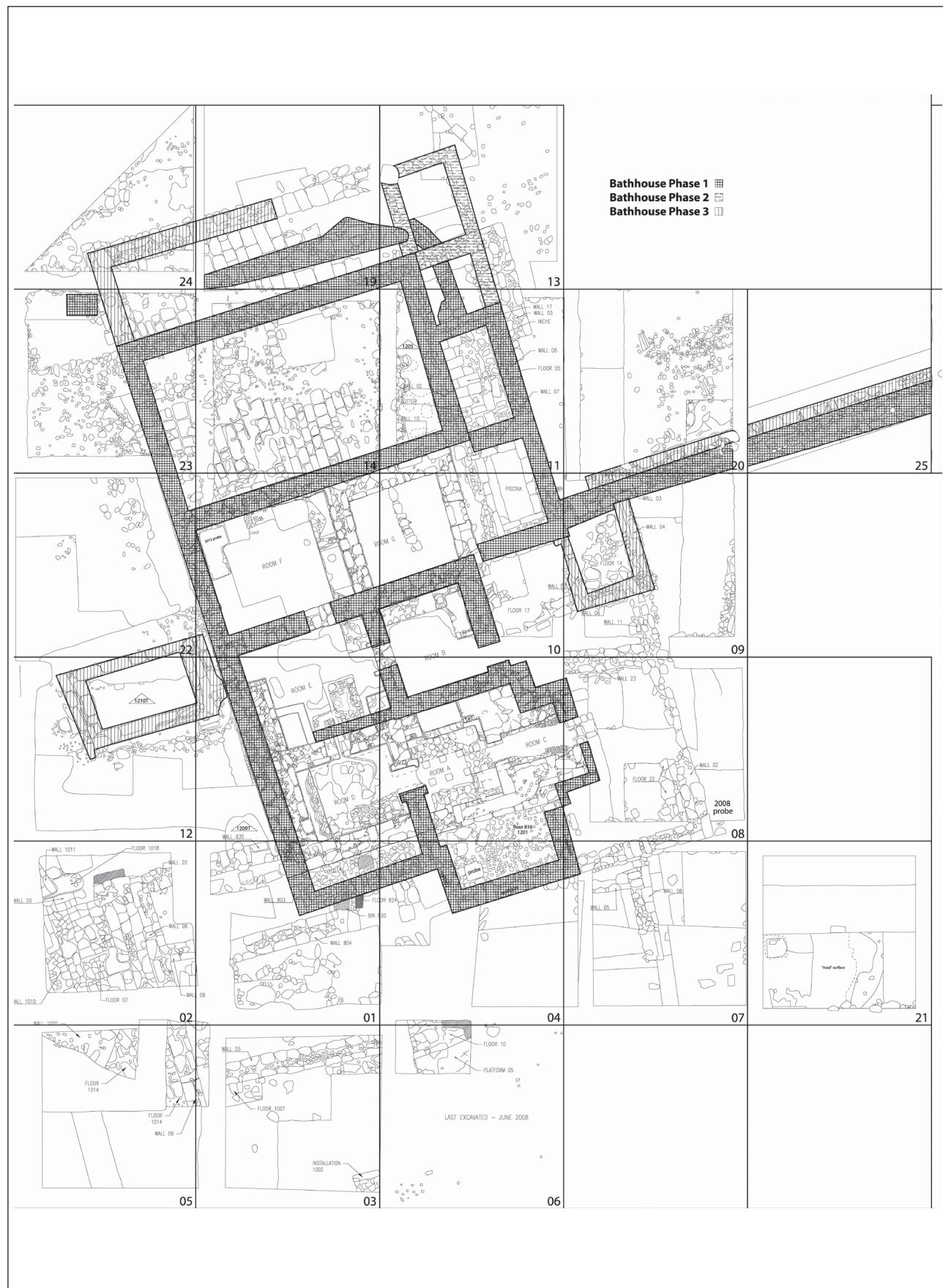
The disturbance at Wādī Ramm came from a Department of Antiquities clearance project in the 1960s, from which no records survive except a couple of photographs and the objects stored in the Aqaba Museum. The disturbance at al-Humayma came from the reuse of parts of the bathhouse as a domestic structure between the late 1940s and the mid-1960s (Oleson 1990; Reeves *et al.* 2013).

As a result of these disturbances, dating by traditional means has proven rather difficult, yet at both sites excavation had uncovered a great deal of CBM both *in situ* and from ancient dump contexts. In 2011, the authors therefore

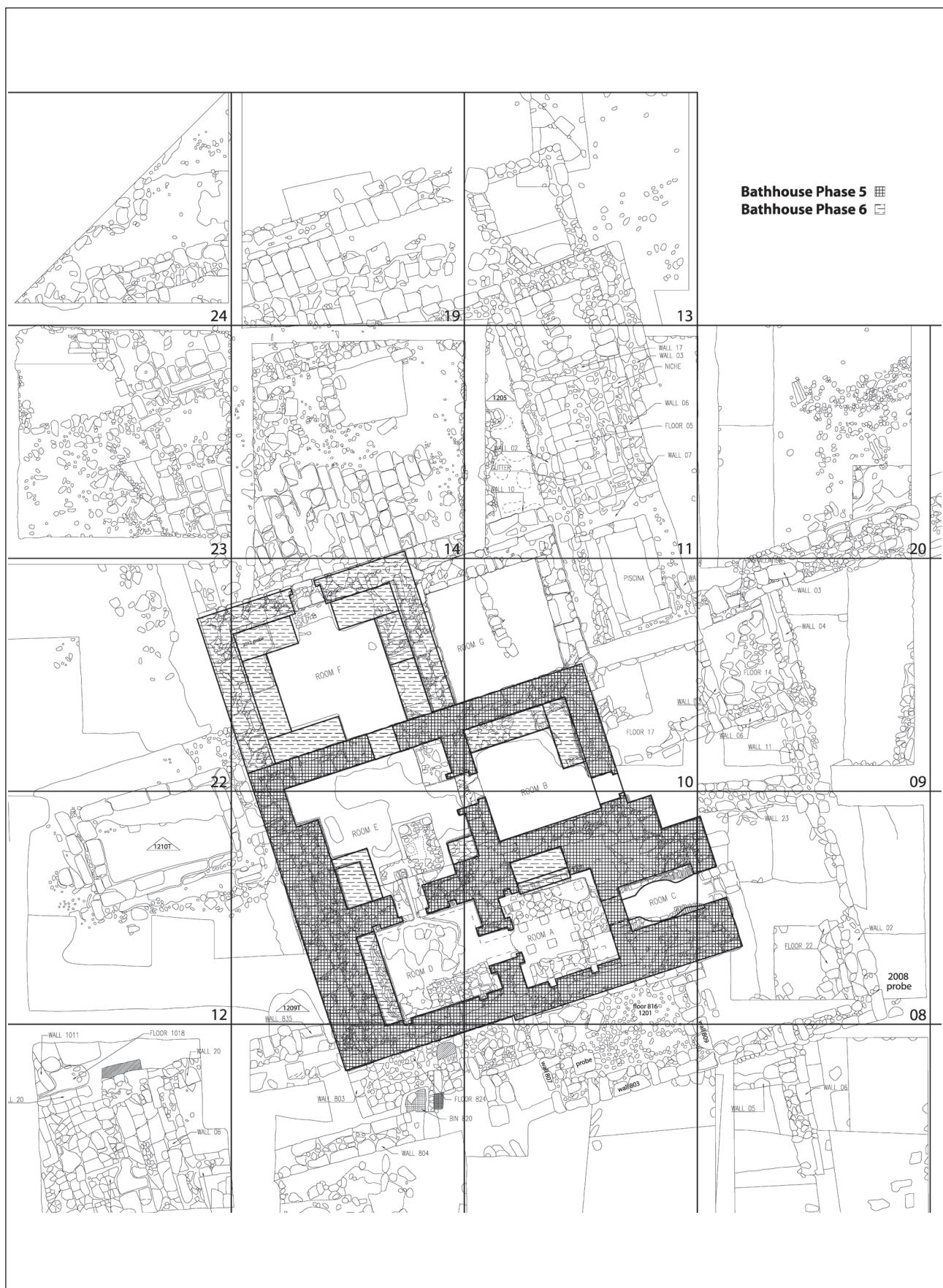
undertook a study season to analyze all the CBM that had been kept from excavations at these two sites.

As a result of this study, it became clear that all classes of this CBM showed distinct variations in form and fabric indicative of distinct subtypes. As a result of this realization, the 2012 excavation strategy at al-Humayma was changed so that all of the CBM found in soil strata would be collected and studied. In addition, during the 2012 excavations at al-Humayma several previously excavated areas were reopened in order to sample the CBM that was still *in situ*.

To make the study reported here more manageable, sampling focused primarily on the material associated with hypocausts (FIG. 6).



3. E077 Bathhouse at al-Humayma with three Roman phases indicated.



4. E077 Bathhouse at al-Humayma with two Byzantine or post-Byzantine phases indicated.



5. E116 *Praetorium* Room J hypocaust at al-Humayma after excavation.



6. E077 Bathhouse Room A showing CBM lining the wall, in the *pilae*, in the suspended floor packing and being reused in the subfloor.

This included several types of bricks used in the construction of the *pilae* and floors (e.g. *bessales*, *pedales* and *pilae*-covering bricks). It also included two types of heating pipes: *tubuli* (a.k.a. box-flues), which have a rectangular profile, and cylindrical flue pipes, which often resemble ceramic water pipes.

Methodology

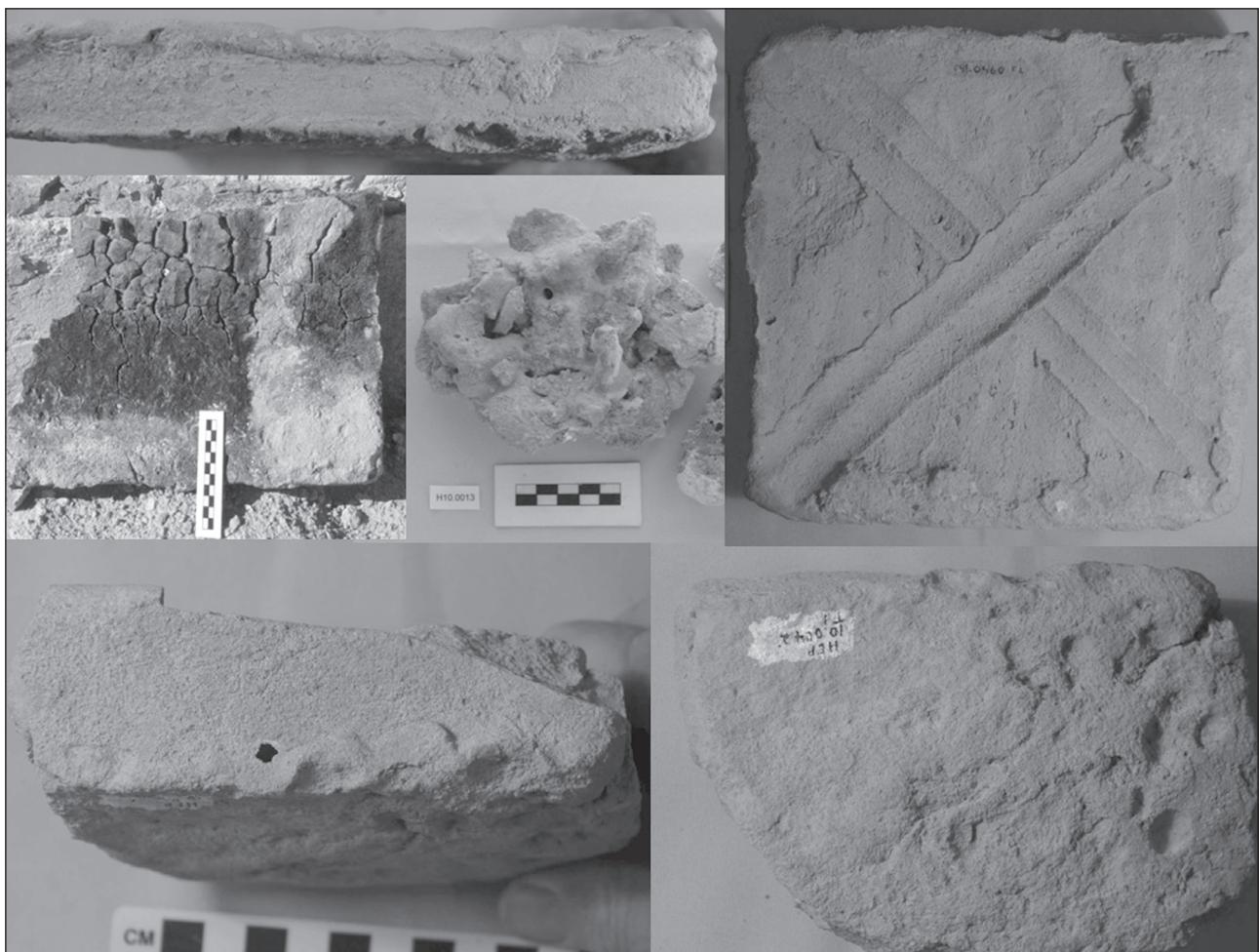
Before processing, all intact CBM and fragments were carefully dry brushed in order to remove dirt while leaving in place mortar, plaster and soot. The characteristics of each piece (as summarized in TABLE 1) were then recorded (see also FIG. 7). Once reoccurring patterns were noted in the characteristics, it then became possible to sort the CBM into

assemblages and to document the common characteristics within each assemblage (see Results). Note that this process is still ongoing so the data presented here are still preliminary.

Results: The CBM Assemblages

After studying the characteristics of the CBM from Wādī Ramm and al-Humayma, it was possible to identify four assemblages based on distinct characteristics and common contexts. For ease of discussion, each assemblage is named for one or more of its main characteristics, but note that these are not the only shared characteristics within each assemblage.

The first assemblage is from Wādī Ramm and is probably a Nabataean CBM assemblage.



7. Examples of CBM characteristics. (Clockwise from top left and ending in centre): side of brick showing outwardly raised edge likely resulting from clay squishing out of form; large “X” drawn across the top face with two fingers; ovoid voids on bottom surface suggesting a drying surface covered by clay beads and / or pebbles; finger marks caused by picking up brick while still wet; heat damage to underside of *pila*-covering brick; fragment of melted brick.

Table 1. Characteristics Recorded

	Bricks	Heating Pipes
Type	Bessalis, pedalis, sesquipedalis, bipedalis, pilae-covering brick	Tubulus; Cylindrical Flue Pipe
Shape	Square, rectangular, circular, etc.	Shape of each end, shape of each rim, shape of each vent
Dimensions	Length, width, thickness, diameter	Height, width, depth, wall thickness
Weight	N.B. Only for complete bricks, or when this variable is informative (e.g. if % complete known)	N.B. Only for complete tubuli, or when this variable is informative (e.g. if % complete known)
Fabric	Colours of fabric, core, surface, slip (using Munsell colour chart); hardness and feel; inclusions (size, frequency, colour, degrees of angularity, degree of sorting); voids (size, frequency, air bubbles or burnt-out temper)	Colours of fabric, core, surfaces, slip (using Munsell colour chart); hardness and feel; inclusions (size, frequency, colour, degrees of angularity, degree of sorting); voids (size, frequency, air bubbles or burnt-out temper)
Production Techniques	Clay kneading. Use of form	Wheel-made, slab-made
Surface Treatment	Smoothing – none, by tool, by hand. Marks – maker's marks, stamps, tallies, etc.	Wheel marks, smoothing
Drying Environment	Embedded materials and imprints – embedded in bottom face from drying floor (gravel, clay beads, straw) or in top face by environment (animal tracks)	Embedded materials and imprints – embedded in bottom rim from drying floor (N.B. not common)
Handling and Stacking before Firing	Finger marks – indicating how the wet materials were picked up and carried. Stacking marks – indicating how bricks were stacked in the kiln.	Finger marks – indicating how the tubuli were shaped or pressed into mould
Mortar	Presence, location, and type of mortar – revealing function (both its final use and its previous use, if recycled)	Presence, location, and type of mortar – revealing function (both its final use and its previous use, if recycled)
Heat Exposure	Soot-staining and buildup – revealing place of use; heat damage – revealing problems with hypocaust and renovation phases	Soot-staining and buildup – revealing place of use; heat damage – revealing problems with hypocaust and renovation phases
Context	In situ (original use or recycled), from dump (secondary or primary)	In situ (original use or recycled), from dump (secondary or primary)

At present only the small rectangular bricks and the wheel-made *tubuli* from the site have been studied (FIG. 8). A full list of characteristics of this CBM can be found in TABLE 2. One defining feature of the 10cm × 20cm small rectangular bricks in this assemblage is that they are smaller than the small rectangular bricks in the other assemblages. The use of a potter's wheel to create the *tubuli* is also particularly interesting for what is probably a Nabataean assemblage.

From al-Humayma there are three distinct assemblages. The first, named the 'Straw-Tempered Fabric Type', consists of bricks in several standardized sizes and slab-made *tubuli* (the 'Type 1' or 'Slab-made Type'), all of which have voids and imprints from vegetative matter (probably straw) in their fabric and straw imprints on their surfaces (FIG. 9). A full list of characteristics of this CBM can be found in TABLE 3. Note that in comparison to the other assemblages, the fabric from this assemblage tends to be much more silty. The 15cm × 21cm small rectangular bricks of this assemblage are also unusual in that they have a width that is more than two-thirds their length, whereas in the other assemblages the width of small rectangular bricks tends to be one-half the length. This is also the only assemblage from either al-Humayma or Wādī Ramm to contain slab-made *tubuli*.

Humayma's next CBM assemblage type was found in, and only in, the heated room in the *praetorium* (commanding officer's house) in the Roman fort (FIGS. 5 and 10). It has therefore been named the '*Praetorium Room J Type*'. This type includes thick circular *bessales*, thin small rectangular bricks, wheel-made *tubuli* (the 'Type 4' or 'Wheel-made Narrow-depth Type') and cylindrical flue pipes, all of which share a common fabric, and all of which show a thin white buildup on their surfaces. The circular *bessales* in this assemblage are notable in being considerably thicker than those in any of the other assemblages from al-Humayma. A full

list of characteristics is presented in TABLE 4.

The third and last assemblage from al-Humayma contains small rectangular bricks, square *bessales* and *pilae*-covering bricks, characterized by a top that has been smoothed by hand or a tool, and a bottom surface that has ovoid imprints (FIG. 11). It has therefore been given the name 'Smoothed Top / Ovoid Bottom Type'. Some of the bricks from this assemblage also have maker's marks on their surface. See TABLE 5 for a full list of characteristics.

In addition to those four types, there are several miscellaneous groups of CBM that were found only in reuse or dump contexts and differed from the aforementioned assemblages in significant ways. These groups include a type of circular *bessalis* that was found in reuse in a subfloor (the 'Room A Subfloor Type'), a type of thin square *bessales* found in reuse (the 'Thin Non Straw-Tempered Fabric Type') and two different types of *tubuli* found in dumps (the 'Type 2' or 'Wheel-made Wide-depth Type' and the 'Type 3' or 'Wheel-made Square-vent Type') (FIG. 12). See TABLE 6 for the characteristics of these miscellaneous CBM groups.

Discussion: The Phasing of al-Humayma's and Wādī Ramm's Hypocausts

Once the assemblages had been identified, we began the process of carefully examining all of the contexts of every individual piece of CBM from each assemblage. Although this examination is not yet complete, our preliminary analyses already suggest that it is possible to use this contextual information to arrange the assemblages into a chronological sequence.

Wādī Ramm: Nabataean Sandstone Hypocaust

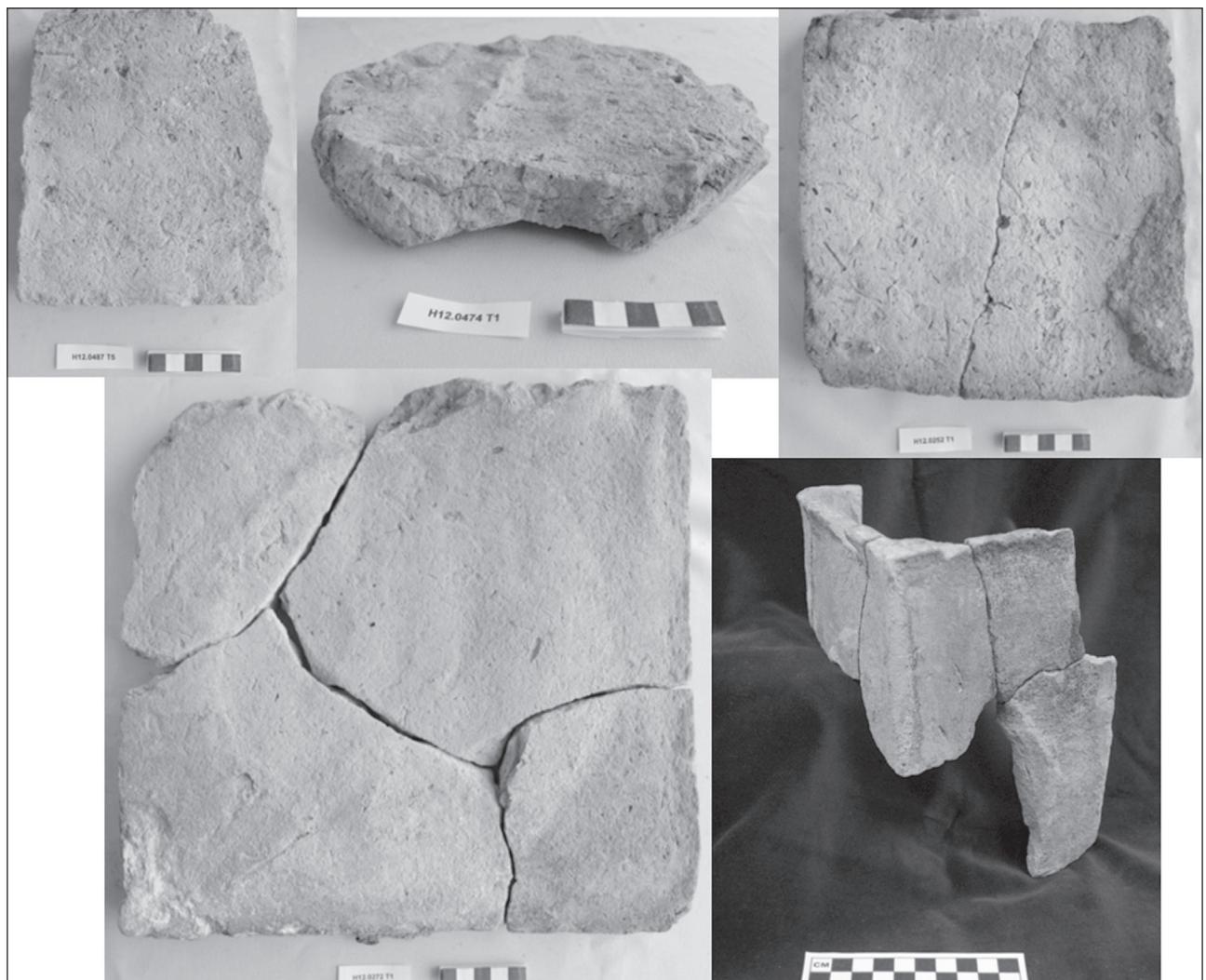
Before discussing the sequencing of the CBM found in these southern Jordanian hypocausts, it is first necessary to bear in mind that the earliest hypocausts in the Near East often did not use brick stacks for their *pilae*. In the case of the bathing suite in the villa at



8. CBM assemblage from Wādī Ramm. (Clockwise from top left): small rectangular brick; reconstructed *tubulus* from 1963 excavations on display in the Aqaba Museum; fragments of *tubuli* from 1997 excavations.

Table 2. Characteristics of Wādī Ramm CBM.

Type	Dimensions and Weight	Feel, Colour and Grain	Fabric Inclusions and Voids	Surfaces	Other Notable Features
Small Rectangular Brick	<u>Length:</u> 20.2cm <u>Width:</u> 10.1-10.3cm <u>Thickness:</u> 2.2-2.6cm <u>Weight:</u> unknown	Feel: hard sandy Colours: fabric and surface: light reddish brown (5YR 6/4) or light red (5YR 6/6) Grain: brick's grain parallel to faces and sometimes goes up at sides	moderately sorted fine sub-rounded clear quartz sand; a few small voids	Top face: slightly concave with an even surface that is smooth to the touch, smoothed lengthwise by fingers or too Bottom face: slightly convex with an uneven surface that is smooth to the touch Sides: flat with an even surface that is smooth to the touch	* presence of a few ovoid voids and voids from straw on bottom surface suggests a drying surface covered by straw and occasional clay beads * likely form-made given flat, even and smooth sides and vertical linear imprints on sides * slightly raised band bisecting bottom face may show stacking in kiln
Wadi Ramm Tubulus	<u>Length:</u> 19.5cm <u>Width:</u> 13.0cm <u>Depth:</u> 9.5-10.0cm <u>Wall Thickness:</u> 0.5-0.9cm	Feel: hard sandy Colours: fabric: red (2.5YR 5/8); interior surface: reddish yellow (5YR 6/6); exterior surface: red (2.5YR 5/6)	well sorted, medium and coarse, sub-rounded, clear quartz sand; some white flecks; some to many small voids	Inside surface: all examples have wheel marks, which resemble ribbing Outside surface: most examples have faint wheel marks, which resemble ribbing	* wheel-made * one end is rectangular, while other is oval * simple rounded rims * irregular or pointed oval vents (6.6 x 2.0-2.8cm)



9. ‘Straw-Tempered Fabric Type’ CBM assemblage from al-Humayma. (Clockwise from top left): small rectangular brick; circular *bessalis*; square *bessalis*; ‘Type 1’ / ‘Slab-made *Tubulus*'; *pedalis*.

Wādī Ramm, the hypocaust *pilae* and covering slabs were not made out of bricks, but rather out of worked sandstone (Dudley and Reeves 2007: fig. 3). Sandstone does not withstand the heat of a furnace well and thus its use seems to have been restricted to early hypocausts (Nielsen 1990: I.14). Indeed, already by the late first century BC, the Roman architect Vitruvius was only describing the use of fired CBM in hypocaust construction (*De Arch* 5.10.2).

The best regional parallels for stone *pilae* come from the baths in Judaea built by Herod the Great, many of which were built between 35 and 15 BC and had carved sandstone *pilae* (Netzer 1999). The public bathhouse at Ramat

Hanadiv near Caesarea also employed carved sandstone *pilae* and was also constructed in the late first century BC (Hirschfeld 1995: 39-42).

Based on these parallels and the fact that Nabataean elites probably knew about these luxurious structures in the neighboring country, a date of the late first century BC is proposed for the construction of Wādī Ramm’s bathing suite. In further support of this date, the various elements in the hypocaust at Wādī Ramm do not conform to the specific measurements detailed by Vitruvius (*De Arch* 5.10.2), suggesting that this bathing suite may predate Vitruvius’ handbook on architecture (or at least the introduction of his ideas to Nabataea)².

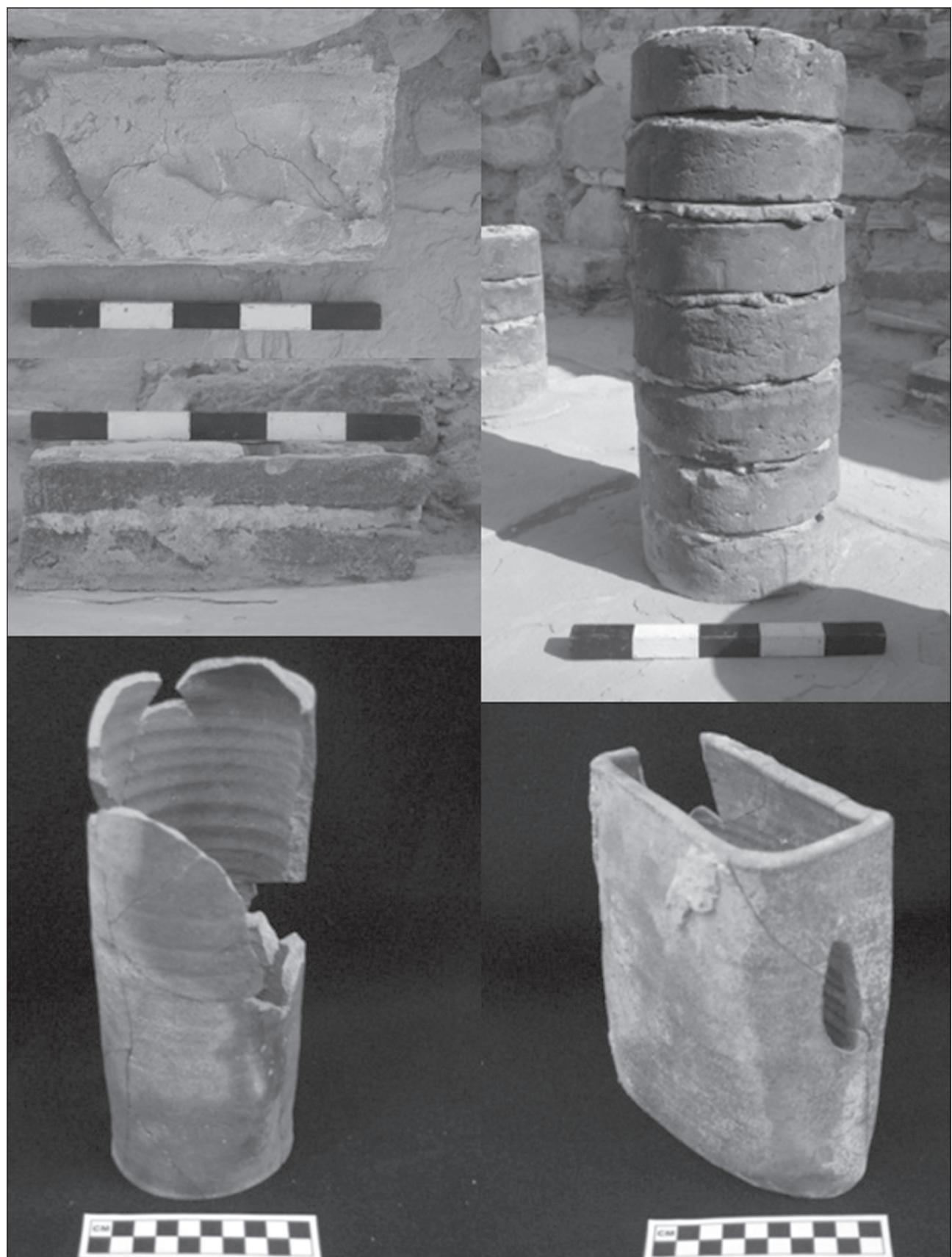
2. This constitutes a revision of Reeves’ dating from that proposed in Dudley and Reeves 2013: 284.

Table 3. Characteristics of "Straw Tempered Fabric Type" CBM.

Type	Dimensions and Weight	Feel, Colour, and Grain	Fabric Inclusions and Voids	Surfaces	Other Notable Features
Small Rectangular Brick	Length: 21.0- 21.5cm Width: 14.5- 15.5cm Thickness: 2.4-3.0 Weight: 1,390- 1,425g	Feel: hard sandy and silty Colours: fabric: light brown (7.5YR 6/4) or reddish yellow (5YR 6/6); Surface: red (2.5YR 5/8) or reddish yellow (5YR 6/6) Grain: brick's grain parallel to faces	well sorted medium sub rounded clear quartz sand; many very small to medium voids, some/many from straw temper	Top face: flat or convex with an even surface that is smooth to the touch; some smoothed lengthwise Bottom face: flat or concave with an even or uneven surface that is rough to the touch Sides: flat with an even surface that is smooth to the touch	* presence of ovoid voids on bottom surface, plus sand and clay beads embedded on bottom surface suggests a drying surface covered by sand and occasional clay beads * likely form-made given thin outwardly raised edge along bottom of some bricks which possibly resulted from clay squishing out of the form
Circular Bessalis	Diameter: 19.0-21.5cm Thickness: 3.0-4.7cm Weight: 1,570- 2,135g	Feel: hard sandy and silty Colours: fabric: very pale brown (10YR 8/3), light brown (7.5YR 6/4), pale yellow (5Y 8/3) or pink (7.5YR 8/4) Grain: brick's grain parallel to faces and sometimes goes up at sides	well sorted fine to medium sub-rounded clear quartz sand; sometimes small to medium brown flecks; sometimes occasional small white flecks; many small to medium irregular voids, some from straw temper	no overall consistency in flatness, evenness, or smoothness on any of the surfaces. All surfaces have many imprints of vegetative temper.	* presence of ovoid voids on bottom surface and sand clay beads embedded on bottom surface suggests a drying surface covered by sand and occasional clay beads * likely form-made given thin outwardly raised edge along bottom of some bricks which possibly resulted from clay squishing out of the form

Type	Dimensions and Weight	Feel, Colour, and Grain	Fabric Inclusions and Voids	Surfaces	Other Notable Features
Square Bessalis	Length and width: 19.5-21.6cm Thickness: 2.5-3.5cm Weight: 1,535-1,560g	Feel: hard sandy and sitly Colours: fabric: brown (7/4) fabric; one has pink (7.5YR 4/4) Grain: brick's grain parallel to faces	well sorted medium sub-rounded clear quartz sand; numerous small to medium irregular voids, some from straw temper	no overall consistency in flatness, evenness, or smoothness on any of the surfaces. All surfaces have many imprints of vegetative temper.	* presence of ovoid voids on bottom surface and sand clay beads embedded on bottom surface suggests a drying surface covered by sand and occasional clay beads * likely form-made given thin outwardly raised edge along bottom of some bricks which possibly resulted from clay squishing out of the form * slightly raised band bisecting bottom face may show stacking in kiln
Pedalis	Length and width: 30.4-31.0 Thickness: 2.6-3.4 Weight: 3,895g	Feel: hard sandy and sitly Colours: fabric: very pale brown (10YR 8/2); Surface: pink (7.5YR 7/4) Grain: brick's grain parallel to faces	well sorted medium sub-rounded clear quartz sand; numerous small to medium irregular voids, some from straw temper	Top face: flat with an uneven surface that is smooth to the touch Bottom face: flat with an even surface that is rough to the touch Sides: flat with an uneven surface that is smooth to the touch	* presence of ovoid voids on bottom surface and sand clay beads embedded on bottom surface suggests a drying surface covered by sand and occasional clay beads * likely form-made given thin outwardly raised edge along bottom of some bricks which possibly resulted from clay squishing out of the form * slightly raised band bisecting bottom face of some examples may reflect stacking in kiln

Type	Dimensions and Weight	Feel, Colour, and Grain	Fabric Inclusions and Voids	Surfaces	Other Notable Features
Type 1 / Slab-made Tubulus	<p>Length: 19.6-20.2cm</p> <p>Width: 16.4cm</p> <p>Colours: fabric and surface: reddish yellow (5YR 6/6), light brown (7.5YR 6/4), (pink 7.5YR 7/4), pale brown (10YR 6/3), very pale brown (10YR 7/3)</p> <p>Wall Thickness: usually 1.1-1.5cm; can be up to 3.0cm in corners</p>	<p>Feel: ranges from coarse/sandy to silty</p> <p>Colours: fabric and surface: reddish yellow (5YR 6/6), light brown (7.5YR 6/4), (pink 7.5YR 7/4), pale brown (10YR 6/3), very pale brown (10YR 7/3)</p>	<p>well sorted, medium, sub-rounded and sub-angular, clear quartz sand; with some very coarse sand; some to many very small voids; some samples have many voids from straw temper</p>	<p>Inside surface: very uneven, with signs of smoothing by hand. Corners usually display finger marks from pressing corners into mould. Heavy soot-staining and soot build-up</p> <p>Outside surface: very flat and even, with no sign of smoothing, suggesting that this tubulus type was formed inside a mould</p>	<ul style="list-style-type: none"> * slab-made * both ends are rectangular in shape * extra clay added to corners causing them to be thicker * small circular vents (1.1 x 1.6cm) likely made by puncturing clay with finger



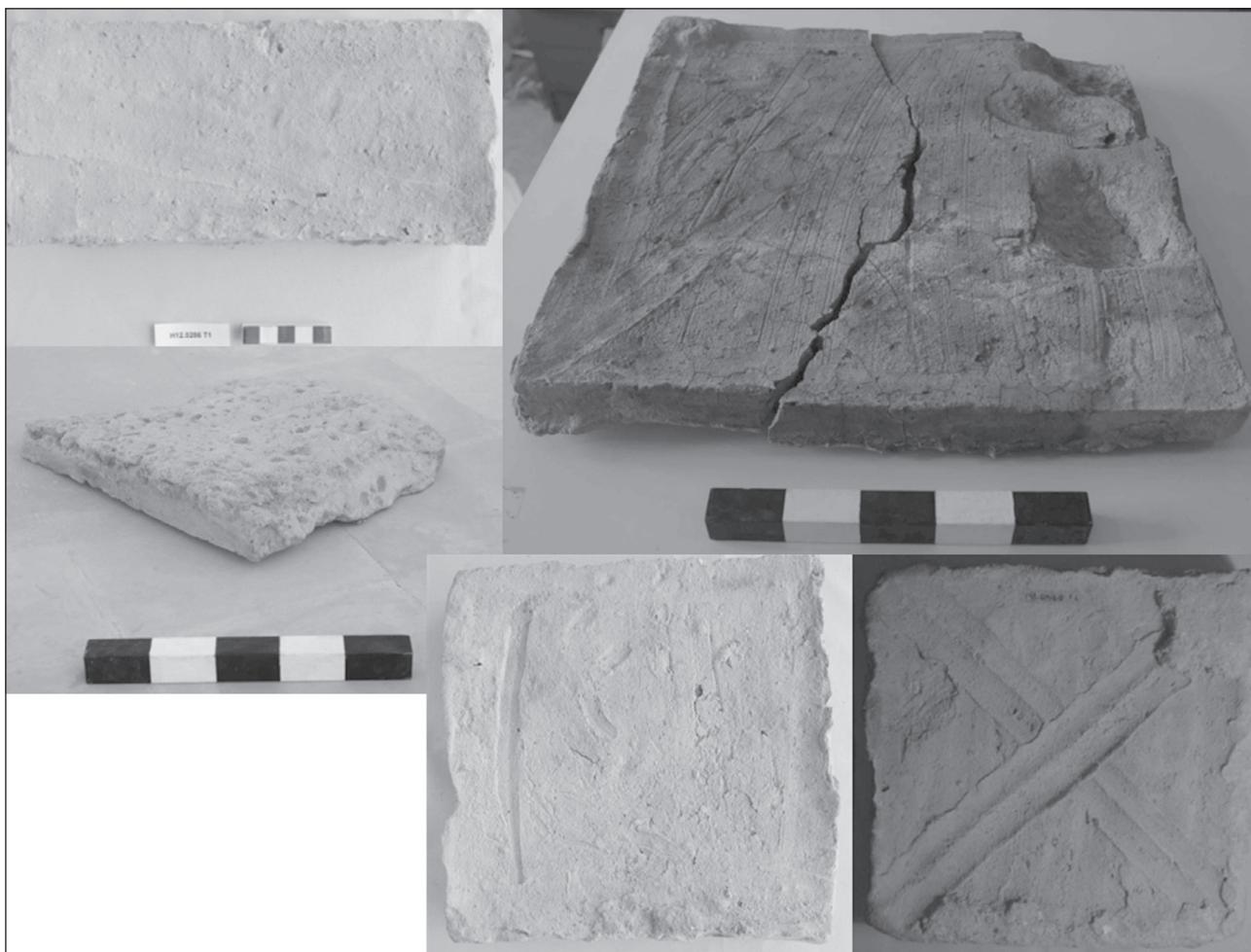
10. ‘Praetorium Room J Type’ CBM assemblage from al-Humayma. (Clockwise from top left): small rectangular bricks being used as *pila* (from above); circular *bessales* being used as *pila*; ‘Type 4’ / ‘Wheel-made Narrow-depth *Tubulus*’; cylindrical flue pipe; small rectangular bricks being used as *pila* (from side).

Table 4. Characteristics of "Praetorium Room J Type" CBM

Type	Dimensions and Weight	Feel, Colour and Grain	Fabric Inclusions and Voids	Surfaces	Other Notable Features
Small Rectangular Brick	Length: 23.3- 24.5cm Width: 11.0- 12.5cm Thickness: 2.3-3.5cm Weight: 1,255- 1,285g	Feel: hard sandy Colours: fabric: light red (10YR 6/6; 10R 6/6; 2.5YR 6/8), red (2.5YR 5.6; 10.5 YR 4/6; 10R 4/6; 10R 5/6; 10R 5/8) or weak red (7.5R 5/4); surface: dark bluish grey (gley 2 5/5), greenish grey (gley 2 6/1) Grain: brick's grain parallel to faces and sometimes goes up at sides	well sorted or poorly sorted fine to very coarse sub-rounded and sub-angular clear and multi-coloured quartz sand; some very small to small white flecks; some very small pebbles; some very small to medium voids	Top face: concave or flat with an even surface that is smooth to the touch; smoothed lengthwise (or in one case widthwise) by tool or fingers; finished by smoothing along one short side Bottom face: flat, slightly concave or convex with an even surface that is rough to the touch; some ovoid voids Sides: flat with an even surface that is smooth to the touch	* thin white build- up on most faces and sides (including over dark surfaces), but not on breaks * likely form-made given flat, even and smooth sides and thin outwardly raised edge along bottom of some bricks which possibly resulted from clay squishing out of the form
Circular Bessalis	Diameter: 19.3-19.8cm Thickness: 5.8-6.7cm Weight: 3,140- 3,315g	Feel: hard sandy Colours: fabric and surface: red (7.5R 5/6; 10R 5/6; 10YR 5/8) Grain: brick's grain parallel to faces	poorly, moderately or well sorted fine to coarse sub- rounded clear quartz sand; some small white inclusions; very many small to medium voids	Top face: slightly concave or flat with an even or uneven surface that is smooth to the touch; evidence of smoothing by hand or tool. Bottom face: slightly concave or flat with an even or uneven surface that is rough to the touch; evidence of smoothing by hand or tool. Side: convex with an even surface that is smooth to the touch; top and/ or bottom edge trimmed with knife on an angle.	* white build- up on surfaces * likely form- made: vertical and encircling imprints on brick's side possibly from form or production process

Type	Dimensions and Weight	Feel, Colour and Grain	Fabric Inclusions and Voids	Surfaces	Other Notable Features
Pedalis	Theoretical length/ width: ca. 29.6cm (1 Roman Foot) Caveat: all samples were fragments so some bricks larger than pedales may have been mistaken for pedales	Feel: hard sandy Colours: fabric: pinkish grey (7.5YR 7/2) or red (10R 5.8) or yellow (10YR 7/6); surface: brown (10YR 5.3) Grain: brick's grain parallel to faces and goes up at sides	poorly sorted or well sorted medium to very coarse sub-rounded and sub-angular clear and multi-coloured quartz sand; some small white flecks; occasional black flecks; some very small pebbles; some very coarse angular sand; some to many very small to medium voids; a few large voids	Top face: concave or slightly concave with an even or uneven surface that is smooth to the touch; smoothed in one lengthwise direction by tool leaving fine linear marks or fingers; smoothed last along one edge Bottom face: flat with an even surface that is rough to the touch; occasional to many straw imprints; some small ovoid voids Sides: flat with an even surface that is smooth to the touch	* thin white build-up on faces and sides * likely form-made given flat, even and smooth sides * some fragments with a charred face have an uncharred central area preserving part of the shape of a circular bessallis
Type 4 / Wheel-made Narrow-depth Tubulus	Length: 17.4-18.3cm Width: 15.5-16.5cm Depth: 8.0-10.0cm Wall Thickness: 0.4-0.8cm	Feel: coarse, sandy Colours: fabric: reddish yellow (5YR 6/6), red (2.5YR 5/8), and reddish brown (2.5YR 4/3); surface: light brownish grey (10YR 6/2) or dark grey (5YR 4/1); core: some are dark grey (5YR 4/1)	well sorted medium sub-rounded clear quartz sand; some course to very coarse sand; some small white flecks; some small voids	Inside surface: all examples have wheel marks, suggesting they were wheel-made; heavy soot-staining and soot build-up Outside surface: some examples have faint wheel marks; some surfaces have soot-staining; many examples have mortar adhering	* wheel-made * thin white build-up on most surfaces * one end is oval, while other is rectangular in shape * oval, pointed-oval, and tear-shaped vents were cut into both short sides

Type	Dimensions and Weight	Feel, Colour and Grain	Fabric Inclusions and Voids	Surfaces	Other Notable Features
Cylindrical Flue Pipe	Length: 26.8cm Diameter of Middle: 9.3cm Diameter of male end: 6.0cm Diameter of female end: 8.4-9.4cm	Feel: coarse, sandy Colours: fabric: reddish brown (5YR 5/4) and red (2.5 YR 5/6); surface: dark grey (5YR 4/1)	well sorted, medium, sub-rounded, clear quartz sand; some coarse sand; some white flecks; occasional very small voids	Inside surface: wheel marks; heavy soot-staining and soot build-up Outside surface: faint wheel marks; some surfaces have soot- staining; other surfaces have mortar adhering	* wheel-made * thin white build-up on some exteriors * all have a wide groove followed by a thick ledge on the interior of the female end just inside from the rim, which was likely designed to grip the mortar that sealed the joint between two adjoining pipes * exact parallels of this form were used as water pipes



11. ‘Smoothed Top / Ovoid Bottom Type’ CBM assemblage from al-Humayma. (Clockwise from top left): small rectangular brick; *pilae*-covering tile; square *bessalis* showing large “X” drawn across the top face with two fingers; square *bessalis* showing maker’s mark of “| <”; underside of ‘Smoothed Top / Ovoid Bottom Type’ showing ovoid voids on bottom face.

Wādī Ramm: Nabataean CBM Assemblage

As noted above, there was an assortment of CBM found in association with the Eastern Complex at Wādī Ramm; however, none of it was found *in situ* in the hypocaust during the 1996 and 1997 excavations. Instead the CBM available for study came from the soil strata of the 1990s excavations, or from the dump piles generated by the 1960s clearance. We were also able to study a complete *tubulus* from the 1960s excavation that was deposited in the Aqaba Museum (FIG. 8). For the purposes of this paper, we will focus on the small rectangular bricks and *tubuli* at Wādī Ramm which, based on comparanda, seem to form part of a Nabataean CBM assemblage.

Both the small rectangular bricks and *tubuli*

found at Wādī Ramm match the form and fabric of samples of the CBM found *in situ* in the hypocaust of a first century AD Nabataean villa at Wādī Mūsā (Amr *et al.* 1997; FIG. 13). It is also interesting that both the small rectangular bricks and *tubuli*, which pre-date the Roman annexation, have measurements seemingly based on modules of the Roman foot. The small rectangular bricks are *ca.* 20cm long and 10 cm wide. At Wādī Mūsā they were placed two abreast in the *pilae* of the *caldarium* with the result that they mimicked the *ca.* 20cm × 20cm size of the Roman *bessalis*, which Vitruvius recommended for brick-stacked *pilae* (*De Arch* 5.10.2). The height of the *tubuli* also seemingly conforms to a module of the Roman foot. The complete example from Wādī Ramm is 19.5cm

Table 5. Characteristics of “Smoothed Top/Ovoid Bottom Type” CBM

Type	Dimensions and Weight	Feel, Colour and Grain	Fabric Inclusions and Voids	Surfaces	Other Notable Features
Small Rectangular Brick	Length: 22.0- 24.5cm Width: 11.0- 12.0cm Thickness: 2.5-4.2cm Weight: 1,235-1,570g	Feel: hard sandy Colours: fabric: light red (2.5YR 6/8; 10R 6/8), reddish yellow (5YR 7/6), or very pale brown (10YR 7/3); surface: very pale brown (10YR 7/3); core sometimes light brown (7.5YR 6/4) Grain: brick's grain parallel to faces	well sorted medium sub-rounded sand; sometimes coarse to very coarse sand or very small pebbles; often a few small to medium white flecks; a few very small voids; one brick possibly has flecks of biotite	Top face: flat or slightly concave with an even surface that is smooth to the touch; smoothed lengthwise by tool or by fingers Bottom face: flat with an even surface that is rough to the touch; usually some ovoid imprints Sides: flat with an even surface that is smooth to the touch	* presence of ovoid voids on bottom surface and sand clay beads embedded on bottom surface suggests a drying surface covered by sand and occasional clay beads * likely form-made given flat, even and smooth sides and thin outwardly raised edge along bottom of some bricks which possibly resulted from clay squishing out of the form * several have maker's marks including large “X” drawn across the top face with two fingers

Type	Dimensions and Weight	Feel, Colour and Grain	Fabric Inclusions and Voids	Surfaces	Other Notable Features
Square Bessalis	Length and width: 20.5-22.5cm Thickness: 3.2-4.4cm Weight: 2,725-3,115g	Feel: hard sandy Colours: fabric: light red (2.5YR 6/8), reddish yellow (5YR 7/6), light grey (5Y 7/2); surface: reddish yellow (5Y 6/6) Grain: brick's grain parallel to faces and sometimes goes up at sides	well sorted medium to very coarse sub-rounded clear quartz sand; a few to many small to medium voids; sometimes some very small pebbles; possibly very small crushed pottery inclusions	Top face: flat or slightly concave with an even surface that is smooth to the touch; smoothed lengthwise by tool or fingers (leaving thin parallel linear indentations); usually smoothed last around edges Bottom face: flat with an even surface that is rough to the touch; a few to many ovoid voids	* presence of ovoid voids on bottom surface and sand and clay beads embedded on bottom surface suggests a drying surface covered by sand and occasional clay beads * likely form-made given flat even and smooth sides and thin outwardly raised edge along bottom of some bricks which possibly resulted from clay squishing out of the form * several have maker's marks including large "X" drawn across the top face with two fingers and others with straight lines and "V", or "<" combinations

Type	Dimensions and Weight	Feel, Colour and Grain	Fabric Inclusions and Voids	Surfaces	Other Notable Features
Pilae-covering brick	Length and width: 50.0-55.0cm Thickness: 3.2-5.6cm Weight: 17,055-19,210g	Feel: hard sandy Colours: fabric: light red (2.5YR 6/6), reddish yellow (5R 7/6); light grey (10YR 7/2); surface: light grey (10YR 7/2) Grain: brick's grain parallel to faces and sometimes goes up at sides	well sorted fine to medium or medium to coarse or very coarse sub-rounded sand; sometimes much very coarse angular sand; sometimes some small to medium pebbles; sometimes black flecks; sometimes white flecks; many small to medium voids; occasionally larger voids	Top face: flat or concave with an even surface that is smooth to the touch; smoothed in one direction by tool (leaving thin parallel linear indentations) or fingers; smoothed last around edges Bottom face: convex or flat with an uneven surface that is rough to the touch; a few to many ovoid imprints; sometimes a couple of straw imprints	* presence of ovoid voids on bottom surface and sand clay beads embedded on bottom surface suggests a drying surface covered by sand and occasional clay beads * likely form-made given flat, even and smooth sides and thin outwardly raised edge along bottom of some bricks which possibly resulted from clay squishing out of the form



12. Miscellaneous CBM from al-Humayma. (Clockwise from top left): square *bessales* of ‘Thin Non Straw-Tempered Fabric Type’ recycled in E077 Room D hypocaust; circular *bessalis* of ‘E077 Room A Subfloor Type’; ‘Type 2’ / ‘Wheel-made Wide-depth *Tubulus*’; ‘Type 3’ / ‘Wheel-made Square-vent *Tubulus*’.

high, or two-thirds of a Roman foot.

Even though the small rectangular bricks and *tubuli* were not *in situ* from the Wādī Ramm bathing suite, the authors tentatively suggest that their presence in soil strata and among the artifacts cleared out in the 1960s may be indicative of a renovation phase to the bathing suite contemporary with the construction of the Wādī Mūsā bath in the first century AD. They therefore seem to form part of a Nabataean assemblage, but like the baths themselves, show the influence of Roman architectural and cultural ideals.

Humayma Assemblage 1: Straw-Tempered CBM

Interestingly, none of these Nabataean bricks or *tubuli* have been found in association

with al-Humayma’s hypocausts. Indeed, both the bricks and *tubuli* from the earliest extant phase of al-Humayma’s E077 bathhouse have a straw-tempered fabric not shared with any of our other CBM assemblages. Circular *bessals*, square *bessales*, *pedales* and small rectangular bricks of this ‘Straw-Tempered Fabric Type’ (see TABLE 3 and FIG. 9) were found *in situ* in various parts of E077’s bathhouse, below later period renovations. These *in situ* bricks represent a homogenous collection in an original use context. Their full context in the bathhouse’s phasing is further revealed by the fragments of straw-tempered bricks and *tubuli* found in numerous ancient dump piles.

The ‘Straw-Tempered Fabric Type’ assemblage is unique at al-Humayma and Wādī

Table 6. Miscellaneous CBM

Type	Dimensions and Weight	Feel, Colour and Grain	Fabric Inclusions and Voids	Surfaces	Other Notable Features
Thin Non Straw Tempered Fabric Type Square Bessalis	Length and width: 22.0cm Thickness: 2.4-3.0cm Weight: unknown (none complete)	Feel: hard sandy Colours: fabric and surface: light reddish brown (5YR 6/4) or light red (5YR 6/6) Grain: brick's grain parallel to faces and sometimes goes up at sides	well sorted medium sub-rounded sand; a few very coarse sand; possibly some black flecks; a few very small voids	Top face: slightly concave with an even surface that is smooth to the touch; smoothing by fingers or tool, smoothed last around edges Bottom face: flat with an even surface that is rough to the touch Sides: flat with an even surface that is smooth to the touch	* likely form-made given flat, even and smooth sides and thin outwardly raised edge along bottom of some bricks which possibly resulted from clay squishing out of the form
Room A Subfloor Type Circular Bessalis	Diameter: 19.1-21.3cm Thickness: 2.7-3.7cm Weight: 1,390-1,735g	Feel: hard sandy Colours: fabric and surface: light reddish brown (5YR 6/4) or light red (5YR 6/6) Grain: brick's grain parallel to faces and sometimes goes up at sides	well sorted medium to coarse sub-rounded and sub-angular clear quartz sand; occasional small pebbles; some white flecks; many very small voids	Top face: slightly concave or flat with an even surface that is smooth to the touch; evidence of smoothing by fingers or tool; one has raised lip around edge Bottom face: flat with an even surface that is smooth to the touch Sides: convex with an even surface that is smooth to the touch	* likely form-made given flat, even and smooth sides and thin outwardly raised edge along bottom of some bricks which possibly resulted from clay squishing out of the form

Type	Dimensions and Weight	Feel, Colour and Grain	Fabric Inclusions and Voids	Surfaces	Other Notable Features
Type 2 / Wheel-made Wide-depth Tubulus	Length: 16.9-21.1cm Width: 16.4-17.8cm Depth: 13.4-14.0cm Wall Thickness: 0.4-1.0cm	Feel: coarse, sandy Colours: fabric: reddish brown (5YR 5/4), light red (2.5YR 6/6); surface: light gray (10YR 7/2), light brown (7.5YR 6/4)	Well sorted, medium, sub-rounded clear quartz sand; some have a few white flecks, some have a few very small black flecks (could be sand); a few very small voids	Inside surface: all examples have wheel marks, suggesting they were wheel-made; heavy soot-staining and soot build-up Outside surface: some examples have faint wheel marks; some surfaces have soot staining; many examples have mortar adhering	* wheel-made * one end is oval, while other is rectangular in shape * oval, pointed-oval, and tear-shaped vents were cut into both short sides (4.5-6.0 x 2.0-2.8cm) * thickened rims that overhang the exterior and, rims on rectangular end tend to be more rounded than those on oval end
Type 3 / Wheel-made Square-vent Tubulus	Length: MPL: 22.1cm; mortar impressions suggest full length of 23.5cm Width: 14.1-14.6cm Depth: 8.0cm Wall Thickness: 0.4-1.2cm	Feel: coarse, sandy Colours: fabric: light reddish brown (5YR 6/4), light red (2.5YR 6/6), pale yellow (5Y 8/2); surface: reddish yellow (7.5YR 6/6), very pale brown (10YR 7/4)	Well sorted, medium, sub-rounded, clear quartz sand; some samples have some white flecks; some small to very small voids	Inside surface: all examples have wheel marks, suggesting they were wheel-made; some have soot-staining and soot build-up Outside surface: some examples have faint wheel marks; some examples have mortar adhering	* wheel-made * square-shaped vents cut into both short sides (2.4-3.4 x 2.4-3.0cm) * three types of rims, the most common is a heavy rim that overhangs the exterior and can be flattened our rounded



13. Small rectangular bricks from Wādī Mūsā (L) and al-Humayma (R). Note mortar ridge on Wādī Mūsā brick from alternating placement of two abreast in *pila*.

Ramm for its fabric. It is also unique among the assemblages from these sites for including *tubuli* made from slabs of clay. Slab-made *tubuli* were used in the majority of Roman baths across the Roman Empire in all time periods, including, of course, Roman military bathhouses (*cf.* DeLaine 1997: 114-15; Lazar 1999; Degbomont 1984: 141, fig. 253). They were also used in the Judaean bathhouses and in bathhouses in the Decapolis cities (Weinberg 1988: 248-49; Stieglitz 2006: 95-6, fig. 90; Vriezen and Mulder 1997: 330). However, they are not the norm in Nabataea and the Roman Province of Arabia, where wheel-made *tubuli* were more common (Harvey 2013: 72-5).

One of the advantages to slab-made *tubuli* is the simplicity of their manufacture. They were formed simply by first creating a flat slab and then bending it to form a pipe (Vriezen and

Mulder 1997: 330, fig. 12). The bending of a slab is a task that can be mastered by the average person, whereas the formation of a wheel-made *tubulus* requires the skill and equipment of a potter. It is therefore not surprising that slab-made *tubuli* were regularly produced in the same production facilities producing the other slab-made CBM (*i.e.* bricks and roof tiles; *e.g.* Lazar 1999).

The ‘Straw-Tempered Fabric Type’ assemblage was used in the first phase of al-Humayma’s bathhouse, which should be contemporary with the Roman fort built in the early second century AD. The fabric of this assemblage does not match the Nabataean CBM assemblage from Wādī Ramm, nor any nearby Roman military kiln site with published CBM descriptions. Given the uniqueness of the fabric compared to other CBM assemblages and the

inclusion of slab-made *tubuli*, it is likely that this assemblage was specifically created for or by the soldiers at al-Humayma who were constructing the Roman fort.

Humayma Assemblage 2: Praetorium Room J Type

The second al-Humayma CBM assemblage comes specifically from a heated room (Room J) added on to the *praetorium* of the Roman fort in the second or early third century (Oleson *et al.* 2008: 323). The assemblage found in that room represents another homogenous collection in an original use context. It is interesting that the CBM assemblage used in the early second century for the construction of the garrison's bathhouse at al-Humayma (E077) was not also used later during the construction of this heated room in the Roman fort.

In the '*Praetorium Room J Type*' assemblage, the CBM are not made from straw-tempered clay, but rather from a clay with an abundance of coarse grained sand. The slab-made *tubuli* of the previous assemblage have been replaced by wheel-made heating pipes, including both *tubuli* and cylindrical flue pipes. The inclusion of wheel-made *tubuli* and the size of the small rectangular bricks of this assemblage more closely resemble the Nabataean CBM assemblage from Wādī Ramm than the straw-tempered Roman assemblage from E077; however, the fabric and forms across *Praetorium Room J*'s CBM assemblage constitute a unique a homogeneous group (see TABLE 4 and FIG. 10).

Based on context, this *Praetorium Room J* assemblage post-dates the early second century construction of the Roman fort and E077 bathhouse, but pre-dates the partial destruction of the fort in the second half of the third century AD. Given that wheel-made *tubuli* are characteristic of Nabataean hypocaust construction, but not Roman, we hypothesize the source for this CBM assemblage was a 'Nabataean' production site supplying the Roman army in Arabia.

Other CBM Groups from al-Humayma's Bathhouse

The remaining CBM groups from al-Humayma's E077 Bathhouse are more difficult to date because they do not constitute homogeneous collections confined to original use contexts. It is therefore very important to consider the provenance of every CBM piece very carefully, as well as the placement of any residual mortar or soot-staining on the piece that might be indicative of a previous use context.

The CBM from the hypocausts in Rooms A and D of the E077 Bathhouse demonstrate the complexity involved in dating them and the Byzantine or post-Byzantine renovations of the bathhouse (FIGS. 11 and 12). Bricks of the 'Smoothed Top / Ovoid Bottom Type' were found *in situ* in the hypocausts of both of these rooms. Foundation probes suggest Room A was renovated in or after the Early Byzantine period (Oleson 1990: 304), and Room C (the furnace) was renovated in or after the Late Byzantine period (Oleson 1990: 305). In addition, *tubuli* of the 'Wheel-made Square-vent Type' were found *in situ* lining the south wall of Room A. The best published parallels for these *tubuli* come from an Umayyad period bathhouse (Qasr al-Hayr East in Syria [Harvey 2013: 81-4]). Based on all this evidence, it is possible that there were at least two Byzantine-period renovations of the bathhouse and another in the Umayyad period. The combined use of the new and recycled 'Smoothed Top / Ovoid Bottom Type' bricks in these hypocausts cannot yet clarify the phasing. Nor can the use of recycled bricks of 'Straw-Tempered Fabric Type', the 'Room A Subfloor Type' and the 'Thin Non Straw-Tempered Fabric Type' throughout the suspended floor, subfloor, *pilae* and wall-linings in these hypocausts. At present the original use context of the 'Room A Subfloor Type' and the 'Thin Non Straw-Tempered Fabric Type' bricks is not known, but they probably predate the original use of the 'Smoothed Top / Ovoid Bottom Type' bricks.

Another clue to dating the ‘Smoothed Top/Ovoid Bottom Type’ bricks might come from maker’s marks on some bricks of this type. The two fingered X-designs on some of our square and rectangular bricks resemble those produced in the sixth century Jarash Hippodrome workshop (Kehrberg 2009: fig. 10); however, they also resemble the scoring patterns on earlier bricks from other sites (*e.g.* third century Dura Europos [Stern 2010]). The straight line and “V” or “<” combinations on some of these bricks (FIG. 11) also resemble those from Jarash (Barnes *et al.* 2006: Fig. 17), but this similarity may not necessarily mean that they came from the same production site. Another possibility is that these marks (and the Xs) were a common way of marking CBM. More study, including a comparison of fabrics, will be necessary to posit that these bricks were produced in common production facilities.

A large quantity of CBM at al-Humayma also comes from dump contexts. Some dump contexts are informative both for what is present and what is absent. For example, the abandoned *piscina* (immersion bath) of the Roman bathhouse contained three distinct soil layers inside (FIG. 14). The top layer contained pottery dating to the second and third centuries AD, but the bottom two layers had no datable finds. All three layers, however, contained used and discarded *tubuli*: both layers contained used *tubuli* of the ‘Slab-made Type’ and the ‘Wheel-made Wide-depth Type’, but significantly none of the ‘Wheel-made Square-vent Type’. Moreover a stack of straw-tempered square *bessales* had been placed on the *piscina* floor, probably with the intent to recycle them. The lime mortar on these *bessales* (as opposed to the mud mortar used in E077’s hypocausts) showed that they had been pulled out of a non-hypocaust feature.



14. E077 Bathhouse *piscina*. Note used ‘Straw-Tempered Fabric Type’ square *bessales* stacked on bottom at front of image.

Dump contexts allow us to say that the ‘Wheel-made Square-vent Type’ *tubulus* comes after the ‘Slab-made Type’ and the ‘Wheel-made Wide-depth Type’. This theory is supported by the fact that ‘Wheel-made Square-vent Type’ *tubuli* were found *in situ* in E077 Room A. This contextual information allows us to suggest that the ‘Wheel-made Wide-depth Type’ *tubulus* dates to the Roman period, whereas the ‘Wheel-made Square-vent Type’ dates to the Byzantine period or later (and perhaps, as the *comparanda* above suggest, to the Umayyad period) (Harvey 2013: 91-2).

Concluding Thoughts

The study of the CBM from al-Humayma and Wādī Ramm is not yet complete, but a close examination of the bricks and heating pipes from these sites’ hypocausts has already resulted in the identification of a small number of discrete assemblages to which tentative dates can be assigned. This supports our expectations that this largely neglected class of artifacts can be used for dating purposes. Moreover, consistent variations between these artifact assemblages are suggestive of different production techniques and values which may be associated with different production centres and / or time periods.

One significant observation deriving from this study is the different use of slab-made vs wheel-made *tubuli*. It was the norm throughout the history and geographical expanse of the Roman Empire to create *tubuli* out of flat slabs of clay. A Nabataean innovation was the creation of *tubuli* on a potter’s wheel (Harvey 2013: 73). This study has shown that *tubuli* were created this way in the Nabataean kingdom in the first century AD as seen at Wādī Ramm and Wādī Mūsā. However for the bathhouse built for the Roman garrison at al-Humayma in the early second century AD, slab-made *tubuli* were used instead. After that time, all subsequent renovations at al-Humayma employed wheel-made *tubuli*. This suggests a change from

the local method immediately following the annexation of the Nabataean kingdom: either the Roman army did not want to use CBM coming from Nabataean suppliers or the annexation had disrupted the Nabataean production facilities so that they could not immediately supply the Roman army’s needs.

This study has also found interesting variations in the bricks used. In the case of dimensions, small variations in brick size within an assemblage probably relate to production values and shrinkage, whereas significant variations in the size of bricks between assemblages may suggest different intended uses. For example, the combined length and width of two Nabataean small rectangular bricks placed long side-by-long side, as they were in the *pilae* at Wādī Mūsā (‘Amr *et al.* 1997: fig. 2), equals the width of a Roman square *bessalis*. This would not be true, however, if two of the wider small rectangular bricks from any of al-Humayma’s Roman and Byzantine assemblages were placed side-by-side. Most dramatically, the width of the “Straw-Tempered Type” of small rectangular bricks is very different than the width of all other types of bricks. The “Straw-Tempered” small rectangular bricks seen to have been manufactured using a different fraction of the Roman foot, but the reasons for this difference are not currently known.

In order to expand this analysis of CBM, more data is needed. Unfortunately, there is not enough published about CBM in Jordan to allow significant comparisons across sites. We hope to expand our study to investigate the CBM from other sites in order to understand the CBM’s distribution across southern Jordan and the surrounding territories in the Nabataean, Roman and Byzantine periods. Moreover, as it is also possible that the al-Humayma bathhouse remained in use into the Umayyad period and that the *in situ* *tubuli* in its *caldarium* date to that period, we would like to expand our comparison set to include the *tubuli* from Umayyad baths. It

would also be desirable to investigate the CBM from kiln sites in order to identify where each CBM assemblage was likely produced. Finally, because evidence from other parts of Roman Empire suggests CBM production centres made multiple types of CBM (Arubas and Goldfus 1995; Lazar 1999), it is likely that the CBM categories from al-Humayma not included in this study (e.g. water pipes and roof-tiles) will fit into the same assemblages as the CBM from al-Humayma's hypocausts. We intend to address this possibility in a future study.

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