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A Typology of Ceramic Pipelines in the Petra Garden and Pool Complex

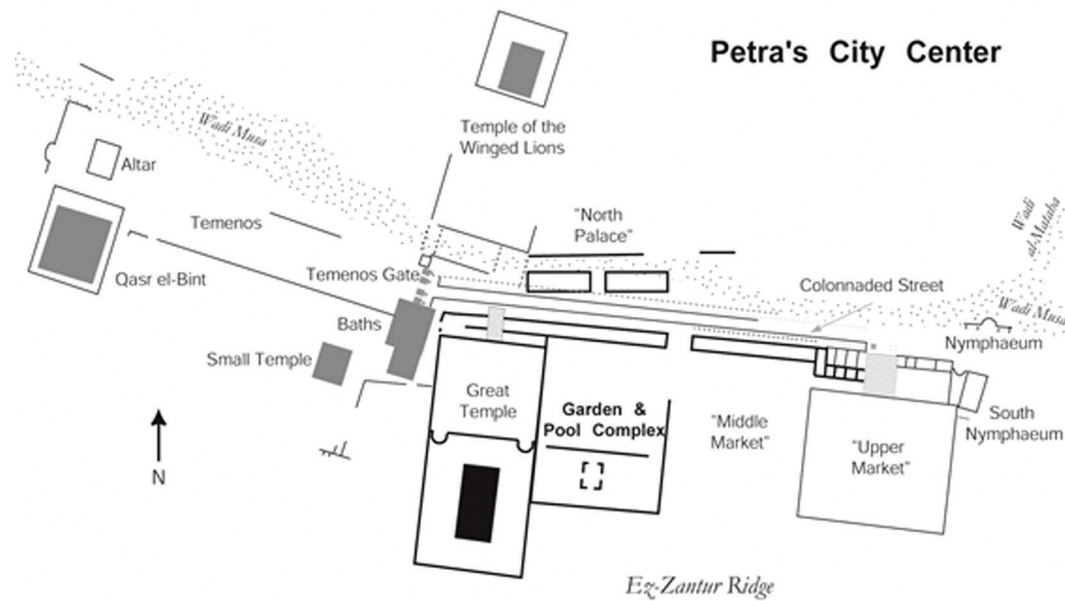
Introduction

The Petra Garden and Pool Complex (henceforth PGPC) is located on the Southern Terrace of the Petra Basin amidst the monumental civic structures that make up the City Center of Petra, the capital of the Nabataean kingdom (FIG. 1). The area measures roughly 65 m east-west x 85 m north-south and is bounded to the north by the Colonnaded Street, to the west by the Great Temple complex (henceforth GT), to the east by the so-called (unexcavated) “Middle Market,” and to the south by the Ez-Zantur ridge. The PGPC is composed of an expansive garden terrace (north) and terraced monumental pool with central island-pavilion (south).

The PGPC is one component of an elite (royal) complex at the heart of the ancient city of Petra, Jordan. Its central location, monumental scale, and labor-intensive construction suggest that this area had an important role in the ceremonial, economic,

and political center of the city. The ongoing archaeological investigation of the garden site provides valuable information regarding Nabataean concepts of landscape design utilizing water, vegetation, and monumental architecture as a display of power and status in the Hellenistic-Roman East.

Despite the important role of ceramic pipelines to the development of human settlement in the Southern Levant in Hellenistic-Roman and Byzantine periods and, more specifically, the achievements of hydraulic engineering in Petra, relatively few of the ceramic pipelines uncovered in archaeological excavations in Petra have been systematically documented to allow analysis of stylistic and technological developments. A similar pattern of poorly documented ceramic pipelines from archaeological sites across the region limits the possibilities of broader regional studies. This paper documents the initial phase of a study of the ceramic pipelines that are one



1. Map of Petra's City Center showing the location of the Petra Garden and Pool Complex.

Table 1. The chronology of the Petra Garden and Pool Complex.

Phase	Location	Dates
I	Pre-garden occupation	Nabataean, 2 nd -1 st c. BC
II	Monumental garden and pool	Nabataean, end of 1 st c. BC-early 1 st c. AD
III	Renovations under Roman annexation	Late Roman, early 2 nd c. AD
IV	Decline and squatters	Late Roman, late 2 nd -4 th c. AD
V	Destruction	AD 363
VI	Squatter farmers	Early Byzantine, late 4 th -early 5 th c. AD
VII	Destruction	Early Byzantine, 6 ^{th?} c. AD
VIII	Agricultural activity	Post-Classical/Medieval
IX	Modern occupation (Bedoul)	> 20 th century

component of the complex hydraulic system designed to transport, contain, and display water in the PGPC, and alterations to that system that reveal chronological phases.

Chronology

The construction of the pool and leveling for the garden terrace date to the last years of the 1st c. BC or early 1st c. AD

during the reign of Aretas IV (9 BC-AD 40), Phase II (TABLE 1). There is evidence for some renovations of the island-pavilion and the bridge in the early 2nd c. (Phase III), at the time of Roman annexation (AD 106). The decline of the site began sometime in the late 2nd c. AD, during which time the pool began to fill up with trash and soil, and conversion to a more utilitarian function of

the site evolved (Phase IV). After the 363 earthquake that caused significant damage to the city's structures and destroyed the hydraulic system that brought water from external springs (Russell 1980; Bellwald 2008: 58–61), the garden terrace was used for agriculture, and some of the water channels were dug up and reused. The site continued to function as an agricultural field for inhabitants of the Petra valley well into the 20th century.¹ The ceramic pipelines of the PGPC date to the time period between the construction of the pool and garden (Phase II) and the 4th century (Phase VI).

Petra's Ceramic Pipelines

Gustaf Dalman (1912: 15–8) was the first Western explorer to describe some of Petra's hydraulic installations in detail. A systematic study of the hydraulic installations in Petra was initiated in the early 1980s by Zeidoun Al-Muheisin (2009) and has been greatly enhanced by reports of surveys and excavations conducted over the last four decades. Of particular importance is the excavation of the *Siq* (the narrow gorge entrance to Petra) in the 1990s, under the auspices of the Petra National Trust, which revealed valuable information about the transport and storage of water in the *Siq* as well as the floodwater diversion system (Bellwald *et al.* 2003), and allowed for a more comprehensive understanding of Petra's hydraulic infrastructure (Bellwald 2008).² According to Vitruvius' *De Architectura* (8.6), the use of terracotta pipes allows for an "easiness of repair when necessary.

¹ For a full review of the PGPC chronology, see Bedal *et al.* 2007: 162–7; 2011: 326–8. Some changes have been made as a result of subsequent excavations and data analysis.

² For studies of the extensive water collection and supply system of Petra and the Nabataeans in southern Jordan not specifically cited in this article, see Laureano 1994: 76–82; Oleson 1995; 2007; 2010; Al-Muheisin and TARRIER 1996; Lindner and Hubl 1997; Bedal 2002; Joukowsky 2004, Drap *et al.* 2006; Schmid 2008; Al-Farajat and Salameh 2010.

Moreover, water running in these canals is preferable to that runs through lead pipes and tasting better when drained in terracotta pipes" (as translated in Pollio and Morgan 1960).

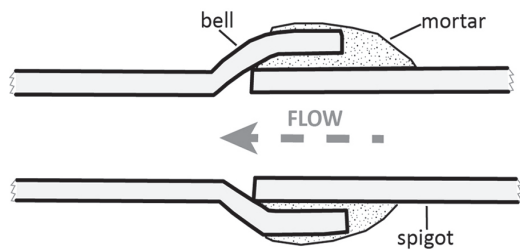
The published general descriptions of the ceramic pipes of Petra's hydraulic system (cf. Bellwald 2008: 90; Al-Muheisin 2009: 53–7, 149–50), highlight several common, identifying characteristics:

- The pipelines are composed of cylindrical segments with bell-and-spigot joins for which each segment has a narrower spigot at one end that fits into the wider flared end of another (FIGS. 2–3); the join is then sealed with a lime plaster. Vitruvius describes this as the "Augustan style" (*De Arch.* 8.6). The spigot end is oriented downstream, creating pressure as the flowing water pushes through the narrowed opening (FIG. 3).
- The Nabataeans adapted their skills and technology for fine ware pottery to industrial terracotta ware pipes by manufacturing the pipe segments on the pottery wheel.³ As a result, their walls are thinner (~7–9 mm) than pipes made by rolling a clay slab around a mold. The benefit of this weight reduction would have allowed the pipe segments to be mass-produced in a workshop and then transported *en masse* to the location. Bellwald (2008: 90) notes that due to their very thin walls, the pipes were completely embedded in lime mortar, which also secured them from movement and fracture as water rushed through them at a high pressure.
- In addition to a thin wall, another

³ Bellwald (2008: 90) reports that the Nabataeans were the first to produce pipes on the wheel.



2. Detail of the bell-and-spigot connection of PGPC Pipeline D (PGPC P5326a-b).



3. Diagram of bell-and-spigot connection showing the direction of water flow.

byproduct of wheel-thrown production is ribbing on the interior surface (FIG. 2). Bellwald suggests that these undulations directed air bubbles upward, resulting in better water flow (2008: 90).

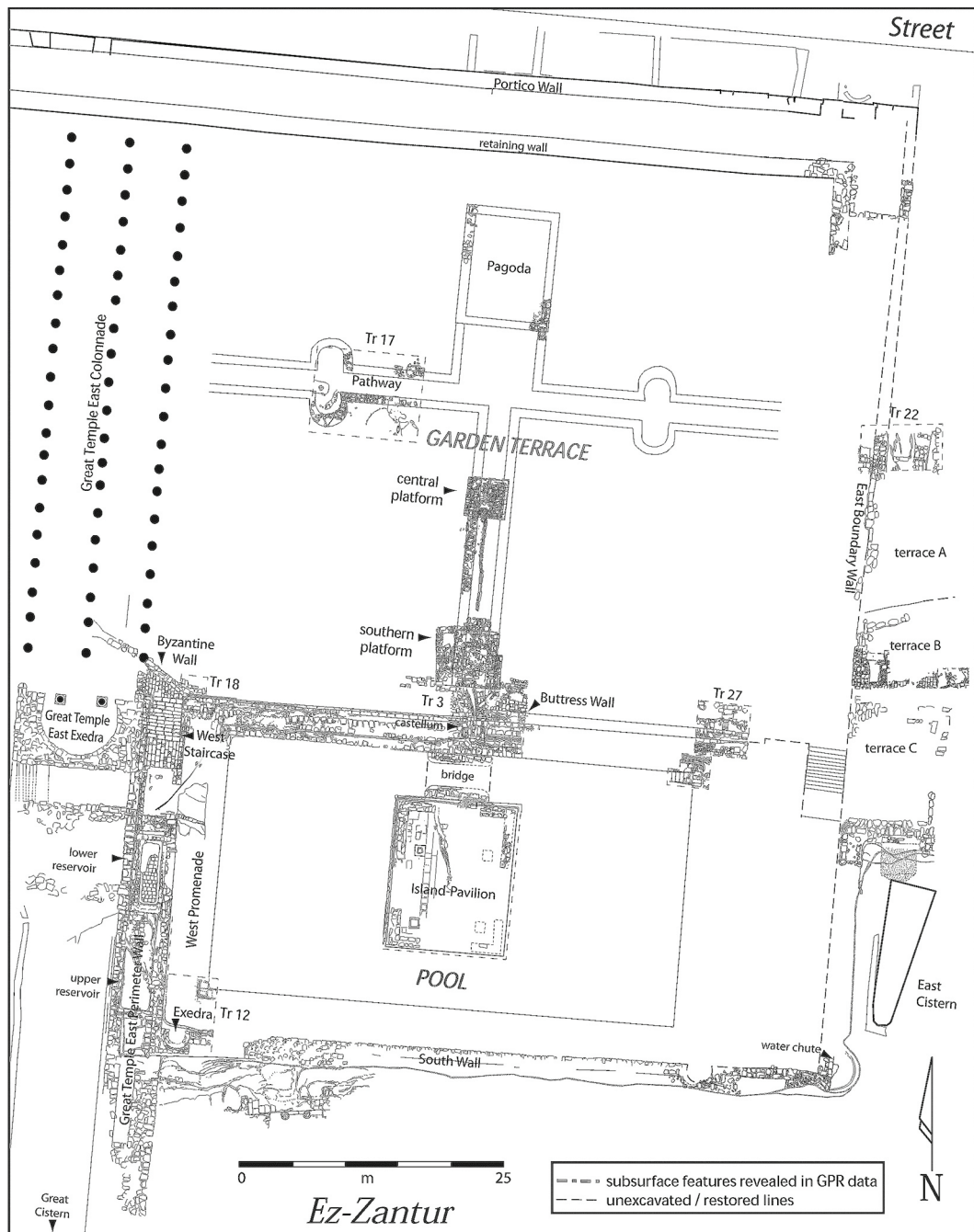
- The ceramic fabric of the pipes is consistent with local pottery production. This is expected for ceramic pipelines for which long-distance transport would be unnecessarily cumbersome and economically inefficient.

While ceramic pipelines are commonly uncovered by archaeological excavations in Petra, the pipes themselves receive little attention other than a passing mention in many excavation publications. One exception is Bellwald's study of the Petra hydraulic infrastructure which includes a photo and scale drawing of a Siq pipe in a review of the development of ceramic pipelines in the Classical world (Bellwald 2008: fig. 66). A more detailed study of Petra pipes resulted from the recovery of several ancient water pipelines when a wastewater system was laid in the area of Wādī Musa in the late 1990s. 'Amr and Al-Momani (2001) established a chronological typology for the assemblage based on their analysis of the pipes' archaeological contexts. The pipes uncovered in central Wādī Musa (the site of ancient Gaia), where there is evidence for domestic settlement and monumental structures, date to the 1st c. BC through the 2nd c. AD. Additional pipes, dated to the 3rd-4th c. AD, were uncovered in the Az-Zurraba area, near a pottery workshop and the Az-Zurraba reservoir (next to the Petra Moon Hotel).⁴ Although based on a small dataset, the typology illustrates changes in form and technology of production over four centuries, and exemplifies how different functions for hydraulic pipelines (private-domestic versus public-communal) led to a variety of forms and diameters ('Amr and Al-Momani 2001: 270 fig. 24). This initial typology provided a basis for the following study and typology of the PGPC pipes.

PGPC Ceramic Pipelines

The hydraulic system of the PGPC is composed of a variety of features to transport, contain, and display water. In addition to the monumental open-air pool (23 x 43 x 3 m), there is a rock-cut water chute, two reservoirs, a castellum,

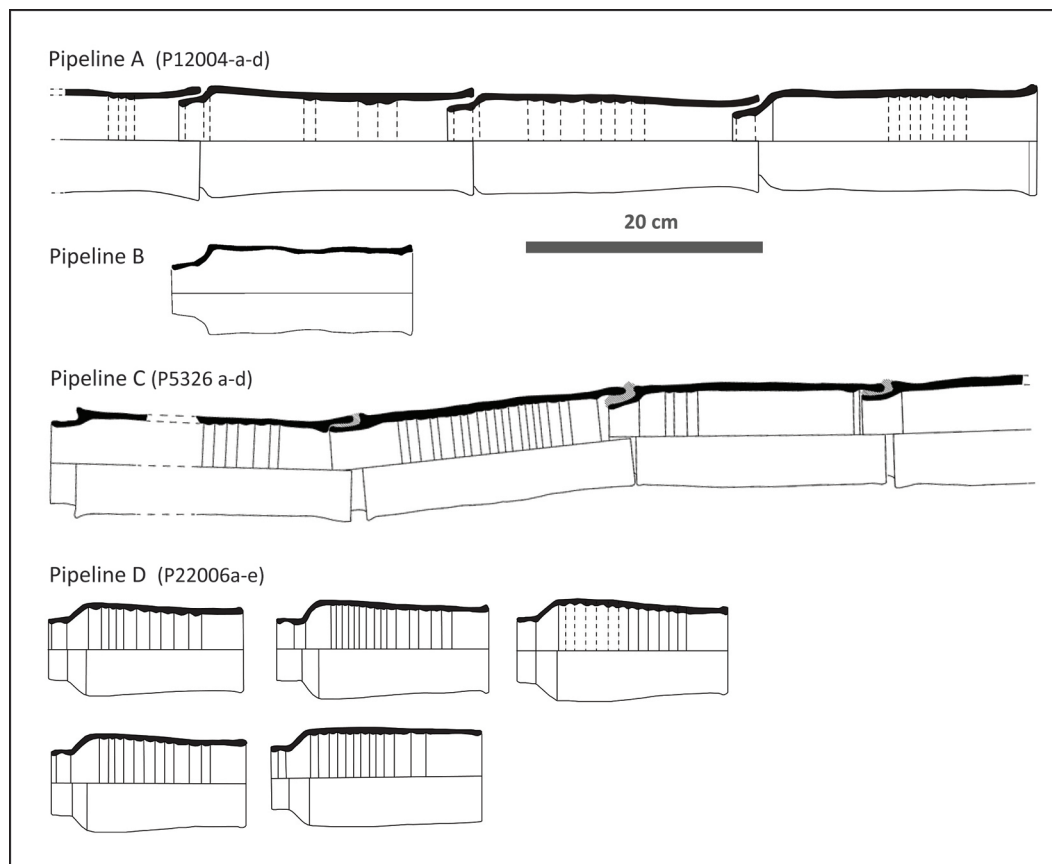
⁴ The Wādī Musa pipes and their typology are currently on exhibit in the Jordan Museum.



4. Plan of the Petra Garden and Pool Complex.

several built stone channels and conduits, rock-cut channels, underground canals, lead pipelines, and ceramic pipelines. Excavations in the PGPC have uncovered

four ceramic pipelines (A–D) located in different areas of the site and not connected with each other (FIGS. 4–5; TABLE 2).



5. Representative pipe segments from Pipelines A, B, C, and D (drawings by Sherry Hardin).

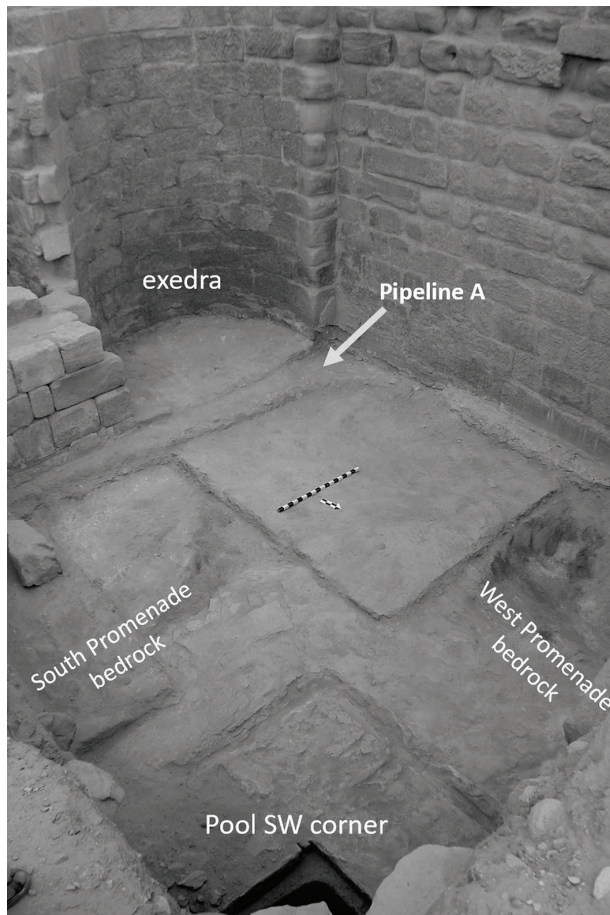
Table 2. Location, measurements, phasing, and comparanda of the PGPC ceramic pipelines.

Pipeline	Location	Trench	L. (cm)	D (cm) shoulder	Direction of water flow	PGPC Phase	Petra comparanda
A	Pool Promenade, SW corner	12	25.5	8.5	west-east	II	Dar al-Birka, Jebel az-Zuhur, GT Pipeline 1
B	Pool façade, buttress wall	3, 27	19.5	7.0	east-west	IVa–b	Dar al-Birka, Jebel az-Zuhur, GT Pipeline 1
C	Basin outlet	3	36.0	13.0	south-north	VIa	Theater, Siq, az-Zurraba
D	Garden terrace, NE corner	22	19.5	9.3	south-north?	IVa–b	GT Pipeline 2

Pipeline A

Pipeline A runs along the west and south perimeters of the pool promenade. The excavated section was first uncovered

in front of the exedra in the southwestern corner of the pool complex (Trench 12) and then traced along the base of the east face of the GT East Perimeter Wall, the



6. Pipeline A *in situ* in the southwestern corner of the pool complex.



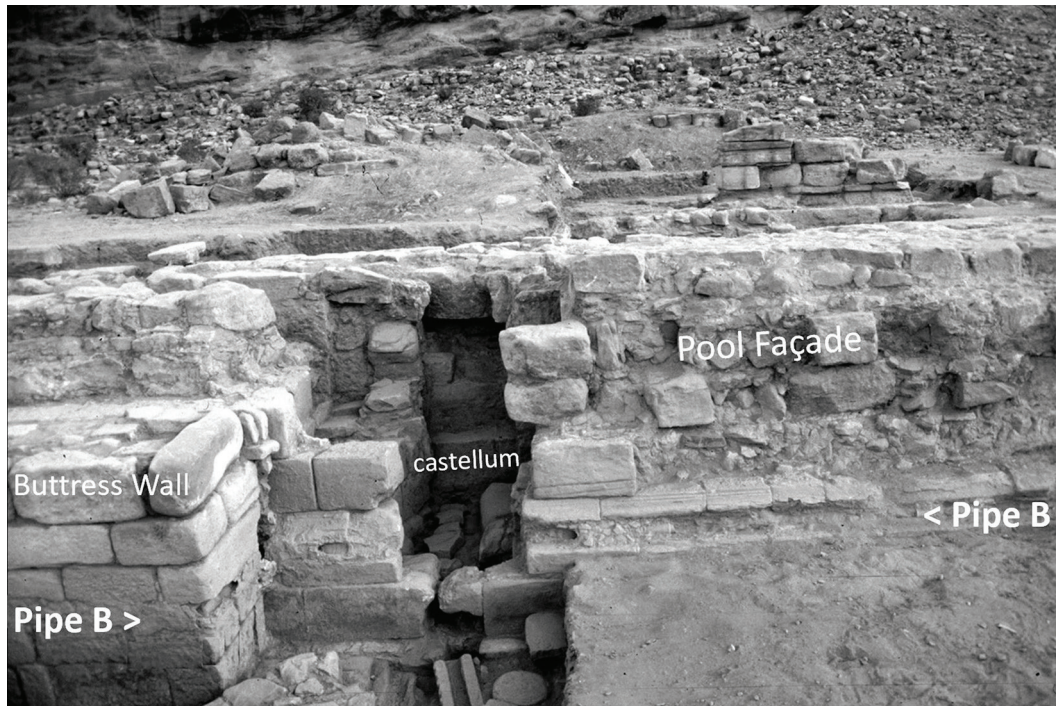
double (casemate) wall that forms the boundary between the pool complex and the upper terrace of the GT complex (FIGS. 4, 6; Bedal *et al.* 2007: 165). The pipe segments are the usual wheel-made, bell-and-spigot form measuring 25 cm in length, with an 8 cm shoulder diameter. The pipe tapers slightly from a carinated shoulder and the bell end flares slightly (FIG. 5). Their form and dimensions are most comparable to the Dar al-Birka (L. 23.5 cm, D 10 cm) and Jebel az-Zuhur (L. 21.5 ; D 9 cm) pipelines of the Wādī Musa typology, both of which are from the central Wādī Musa area and are dated to the 1st–2nd c. AD respectively (‘Amr and Al-Momani 2001: 264, 270–1 fig. 24).

Pipeline A was part of the original plan of the Nabataean pool complex when it was laid underneath the stone-paved surface (robbed out by Phase III). The pipeline remained undisturbed, well-packed in lime-ash mortar and pottery sherds (FIG. 7). The direction of the spigots reveals that the water flowed from west to east, from the direction of the GT and its likely source, the GT Great Cistern (located in the southeastern corner of its upper terrace), and eastward along the base of the South Wall.

Pipeline B

Pipeline B dates to the decline of the PGPC that began approximately a century after Roman annexation (Phase IV). This pipeline is laid in a channel on the face of a buttress wall built up against

7. Profile of Pipeline A packed in mortar and pottery sherds.



8. Pipeline B *in situ* set into a channel on the face of the Buttress Wall and decorative molding along the base of the pool's façade wall.



9. Pipeline B *in situ* set into the decorative molding along the base of the pool's façade wall, adjacent to the west Staircase, and sealed in place with mortar and pottery sherds.

the east half of the pool's façade wall (FIG. 8). It is believed that the buttress wall was constructed to shore up a weak point in the

pool wall, which has not yet been identified. Pipeline B wraps around the west end of the buttress wall and then merges into the

incurve of limestone molding along the remaining stretch of the pool's façade wall. The direction of the spigots shows that the water flowed from east to west from the direction of the Middle Market, seemingly bypassing the castellum and the water system of the Phase II Nabataean pool and garden, and continued westward toward the GT complex. The secondary use of the decorative façade molding as its channel and the crude packing of the pipe (FIG. 9) in a location that was clearly visible from the garden and from the colonnade along the adjoining lower terrace of the GT complex, supports the dating of Pipeline B and the coarsely-built buttress wall to a time after the garden and pool complex were no longer maintained and used as a luxury space. Based on this and its stratigraphic context, Pipeline B is dated to PGPC Phase IV (late 2nd-3rd centuries). The pipe segments of Pipeline B measure 19-20 cm in length and have a 7 cm diameter. This is the smallest diameter of the PGPC pipelines which may have been dictated by the molding's restricting dimensions. Otherwise, the shape is very similar in form to Pipeline A, with a pronounced, carinated shoulder and slight flare at the bell end (FIG. 5).

Pipeline C

Pipeline C belongs to the latest of the PGPC water installations. Excavations in Trench 3 revealed four joined pipe segments laid out on top of the paved surface of a walkway that runs along the southern edge of the garden terrace, in front of the pool façade wall. Stone blocks and cobbles flank either side of the pipeline to secure it in place. An additional single pipe segment was discovered about one half meter to the northeast in alignment with the others. The pipes were oriented so that water flowed from the direction of the castellum and basin northeast toward the garden (FIG. 10).

Associated with Pipeline C was a column drum (modified to take the form of



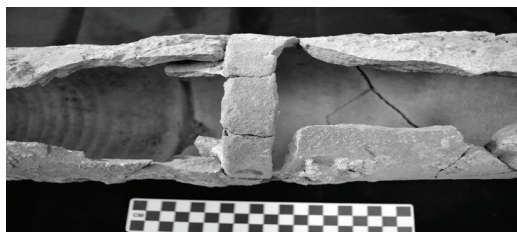
10. Pipeline C *in situ* with other components of a makeshift catchment basin that reused features (the castellum, stone conduits, and modified column drum) of the earlier garden site.

a basin) found resting on a flat stone in front of the pool's castellum. The pavers in front of the castellum had been removed, revealing the original (Phase II) stone conduits that run northward under the south platform and continue northward toward the center of the garden terrace. A thin plaster coat found on the south platform's south face was traced along the edge of a row of stacked stones that formed a curb between the south platform and Pipeline C. It appears that the small area (3 x 3 m) defined by the pool wall and castellum (on the south),

the southern platform (on the north), and the later Buttress Wall (on the east) was converted into a plaster-lined basin, reusing the castellum and stone channels for water catchment, and Pipeline C was installed to drain overflow toward the northeast (FIG. 10).

When excavating the fill in and above this basin, more than 70 copper alloy (bronze) coins were uncovered (Bedal *et al.* 2007: 166). The vast majority of the coins are badly corroded and illegible due to settling in a water collection point, but a handful are readable. Other than one Nabataean coin and one Late Roman provincial coin, the rest that can be identified are Late Roman Imperial, covering the 4th century from Constantine I (324) through Arcadius (385–393) (Bowsher in Bedal *et al.* 2007: 17–3). It appears that the makeshift basin and Pipeline C were components of post-AD 363 Phase VI agricultural activity on the terrace. This basin and reuse of the castellum would have cut off the water flow of Pipeline B which, as stated above, had bypassed the castellum. After the basin went out of use in the late 4th century, the coins washed through the water system from elsewhere and deposited into the abandoned castellum and basin which were filling up with soil.

The pipes of Pipeline C are the largest of the PGPC pipes. They measure 36 cm in length and 12–13 cm in diameter. They have a straight (not tapered or flared) profile,



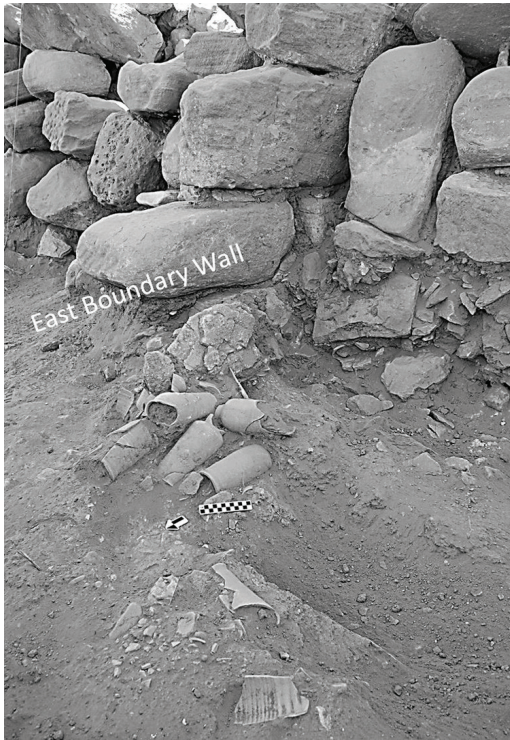
11. Detail of Pipeline C (P5236 b–c) showing the bell-and-spigot fitting with collar.

and in place of a wide shoulder to create the seal behind the pipe's spigot, there is an everted ledge or collar (FIGS. 2, 5, 11). The larger dimensions may be an indicator that the pipe segments of Pipeline C originated from an earlier pipeline elsewhere in Petra that served a public function that required a greater capacity for water flow. The collar is a characteristic of some of the largest pipes in the Petra region. Examples from the theater (1st c. AD; Hayes 1965: 56 pl. XLIII, 2 and 3), Siq north channel (2nd c. AD; Bellwald 2004: 77 fig. 11), and the Wādī Musa-Zurraba site (4th c. AD; Amr and Al-Momani 2001: 261, 270–1) all have the collar. However, their dimensions are notably larger, ranging from 44 to 46 cm in length and 18 to 20 cm diameter, and all three of these larger pipelines are waisted to reduce flow, unlike Pipeline C which has a straight body.⁵

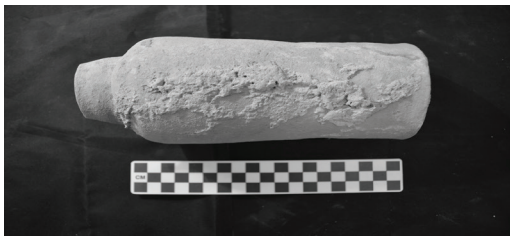
Pipeline D

Pipeline D was uncovered in Trench 22, along the monumental East Boundary Wall of the Garden Terrace. After removing surface rubble and topsoil, excavators uncovered a shallow pit along the wall face containing a scatter of ceramic pipe segments, crumbled plaster, a few roof tiles, and a fragment of a radial lamp (Grawehr Type K, 3rd–4th c. AD). Five complete pipe segments were recovered with an additional half dozen that were fully or partially reconstructable (FIG. 12). While similar in form to Pipelines A and B, the segments of Pipeline D have rounded shoulders, and have a shorter, more robust profile (19–20 cm in length and 8.5 cm diameter; FIGS. 5, 13). Underneath

⁵ The drawing of the Siq North Channel pipe in Bellwald 2004: fig. 11 does not show a waisted form. However, the Siq pipe segments with the same dimensions on exhibit in the 2014 “Desert Wonder” Exhibit in the Jordan Museum are waisted. A public mainline pipeline from Tel Dor, dated to the 2nd–3rd c. AD (Berg *et al.* 2002: 161), also has dimensions and form comparable to the larger-sized Petra pipes.



12. The scatter of Pipeline D pipe segments *in situ* in a disturbed area along the East Boundary Wall.



13. One pipe segment (P22006a) from Pipeline D with remnant mortar on its exterior surface.

the pipes was a rubble-filled pit that was dug to expose an underground rock-cut channel running parallel to the wall and capped with sandstone slabs and a layer of

cobbles. The channel is contemporary with the wall, which belongs to the major design of the Nabataean monumental garden. The pit was dug after the decline of the PGPC to access, and likely reuse, the original water system. If Pipeline D was part of the original water system for the Nabataean garden, it is expected that the pipes would be secured with mortar and potsherds, as exemplified by Pipeline A. It appears that Pipeline D was laid down later and is not directly related to the underground water channel.

Great Temple Pipelines

A look at the water system of the neighboring GT complex is useful for placing the post-Nabataean PGPC Pipelines, B, C, and D, into a larger context. Although its primary water system consists of major underground drainage and diversion channels (Joukowsky 2004), there are two ceramic pipelines described by Cloke (2016), both of which were added when the GT monument was in disrepair and in reuse, and both originate from the direction of the PGPC.

GT Pipeline 1 is found on the north-eastern corner of the upper terrace in an area with the remains of domestic-like structures. One end of this pipeline is inserted into a small hole in the west face of the GT Temple East Perimeter wall. While it was initially thought that the pipeline fed water into the brick-lined reservoir (the Lower Reservoir) that was built into one of the intermural spaces on the other side of that wall (PGPC Phase IV), a look at the direction of the spigots reveals that water flowed *from* the reservoir. The pipeline carried the water westward across the top of the forecourt pavement in the direction of the bathhouse (Joukowsky 2004: 125 fig. 7). Joukowsky dates this pipeline to the late 2nd–3rd century domestic occupation of the GT complex (Joukowsky 2004: 123 table 2) which is supported by its relationship with the Lower Reservoir (PGPC Phase IV, late



14. GT Pipeline 1 in situ on the GT upper terrace. The pipeline originates from the Lower Reservoir in the GT East Perimeter Wall (pictured at right).

2nd–3rd century). There are no published drawings or measurements of the pipeline, but the eastern section remains visible on site (FIG. 14). The pipe segments measure 22 cm in length and 10 cm in diameter.⁶ They appear most similar in dimension to the pipes of PGPC Pipeline D although they do not have the rounded shoulders. Their profiles are slightly tapered to straight as in Pipeline D.

The second GT pipeline is described as 50 cm long (two joined ~25 cm pipe segments) and set into a mortar bedding that is built into the “Byzantine Wall” that was constructed at an oblique angle across the East Triple Colonnade of the GT complex

(Joukowsky 2004: table 1, fig. 16; Cloke 2016: 87). Two segments of this pipeline on exhibit in the Jordan Museum appear nearly identical in form and dimension to the PGPC Pipeline D pipe segments and are labeled as 8 cm in diameter at the bell end, which would be 9–10 cm diameter at the shoulders. This pipeline and its associated wall were constructed, at least in part, to capture the water from PGPC Pipeline B, and northwest across the GT’s lower terrace toward an undetermined destination. One possibility is that the water was deposited into one of the large canals underneath the lower terrace. This redirection suggests that the presumed original destination of the Pipeline B water, the Bath Complex, was out of use and no longer in need of a water supply, placing the date of the redirection

⁶ Based on measurements taken by the author from the pipe segments in the eastern section that remains *in situ*.

soon after the end of the use of the Bath Complex.⁷

Conclusion

The PGPC Pipelines B, C, and D and the two GT pipelines were additions to the water system of the Southern Terrace during a period when the monuments of the Nabataean capital fell into disrepair prior to the 363 earthquake (PGPC Phase IV, late 2nd–mid-4th centuries). The PGPC was no longer maintained as a luxury garden as the pool began to fill up with trash and debris (Bedal *et al.* 2007: 165–6). The Southern Terrace was transforming from an elite luxury complex into an area for habitation and agricultural cultivation, and there was a need to reorganize the water system for such purposes. Such activity is illustrative of Petra's economic decline and restructuring prior to the 363 earthquake (cf. Fiema 2003: 50, 52–3).

The Post-Nabataean pipelines of the PGPC and the GT represent at least three different sub-phases/phases:

- IVa - Pipeline B was the first of the Phase IV pipes to be laid when there was a need to transport water from east to west across the site. It is likely that this ceramic pipe merged with a lead pipeline, along with the Lower Reservoir, which was installed soon after Roman annexation (Phase III) to transport water from the subterranean Great Cistern, through the reservoirs in the GT East Perimeter Wall, to the new Bath Complex on the west side of the GT complex. Although the

decline of the luxury garden and pool had already begun by this date, it seems that the Bath Complex continued in use and required an additional water source to meet demands.

GT Pipeline 1 cannot predate the Phase IV Lower Reservoir and Bath Complex. The fact that it was laid so that it was openly visible across the top of the forecourt pavement signals the transformation of the GT complex from royal/administrative to a more utilitarian function. Its orientation, east to west, across the GT upper terrace, suggests its destination is the Bath Complex. The massive columns of the GT forecourt collapsed on top of fill that covered the pipeline during the 363 earthquake (Joukowsky 2004: 123).

- IVb – As the transformation of the Southern Terrace continued, the Bath Complex went out of use and the oblique wall was constructed with GT Pipeline 2 installed to redirect the water from Pipeline B toward the northwest.

The placement of PGPC Pipeline D within the timeline of Phase IV is not precise due to its disturbed context. The lack of evidence that it was securely encased in mortar indicates that it does not belong to the Phase II Nabataean garden nor to the Phase II renovations by the Romans. Its stratigraphic context places it in the 3rd–mid-4th centuries. Its form and proportions are most comparable to GT Pipeline 2. Without further information, the assignment of Phase IVb is best supported.

- VI – The basin with Pipeline C was installed when water was needed to be directed to the garden terrace as

⁷ This agrees with Joukowsky's date for the ceramic pipeline that runs from the PGPC ("Lower Market") to the GT Triple Colonnade (here referred to as GT Pipeline 2) to the period prior to the 363 earthquake collapse (Joukowsky 2004: 123 table 1) but conflicts with her date for the end of the Bath Complex to the late 6th century (Joukowsky and Cloke 2007: fig. 1.18).

it transformed into an agricultural field. The channels and castellum of the Nabatean pool were cleaned out for reuse, finally cutting off the flow of water in Pipeline B beyond this point.

An overview of Petra's ceramic pipelines dated between the late 1st century BC and the 4th–5th c. AD does show a general shift from thin walls with proportionally narrow and tapered forms and sharply carinated shoulders, to thicker-walled with rounded shoulders for the smaller diameter pipelines such as those found in the PGPC (A, B, and D), and the GT. However, establishing a broad typology is complicated by variations in scale which are related to function primarily. A collared neck and waisted body are seen only in the largest pipes with large flow capacities that serve the demands of the city's public system.

The documentation of a sequence for the three PGPC pipelines and the associated pipelines in the GT helps to differentiate chronological phases that were not previously discerned through the analysis of stratigraphy or other categories of material culture that are typically relied on for such purposes, namely pottery, lamps, and coinage. It is hoped that the identification of the sub-phases of pipelines might help to reveal further sequences in other categories upon re-analysis of the associated materials.

An attempt to discern patterns of form and/or function and temporal distribution over a larger area of Jordan and the Southern Levant is restricted by the small number of pipes that are published with their measurements and illustrations. Some notable exceptions are the reports on excavated ceramic pipes in the water systems of Wādī Musa (ʿAmr and Al-Momani 2001) and Hippos-Susita (Ben David 2002), the Roman forts at Humayma (Oleson 2010: 330) and Lejjun (Parker 2006: 361, 371 fig. 16.80), the Bathhouses at ʿAyn Gharandal

(Harvey, this volume) and Gadara/Umm Qais (Nielsen *et al.* 1993: 158 Taf. 34), and workshops at Jerash (Kehrberg 2009) and Jalame (Berry 1988: 247). One goal of this article is to appeal to excavators who have unpublished ceramic pipes in their corpus to include more details in the reports.

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