Archaeology and Conservation of the Middle Phrygian Gate Complex at Gordion, Turkey

Semih Gönen, Richard F. Liebhart, Naomi F. Miller, and Elspeth R. M. Dusinberre

In 2016, a project was undertaken at Gordion, Turkey, to stabilize and conserve the remains of a rubble platform built early in the Middle Phrygian period (ca. 800–700 B.C.E.) under the vast Gate Complex leading to the megarons on the Citadel Mound. In the process, aspects of Middle Phrygian building strategies came to light that enhanced our understanding gained from the original excavation in the 1950s. This article outlines the archaeology of the Middle Phrygian Gate Complex and the sophisticated internal structures that lent stability to the rubble platform upon which it was built, and examines the recent evaluation and stabilization of the remaining rubble. Internal walls that created a casemate-like structure, combined with strategically placed juniper logs, assisted with the construction of the rubble fill and its structural stability. The use of water-soluble gypsum in the rubble led to the eventual collapse of the walls in antiquity. Conservation and stabilization in 2016 illuminated these features, made the rubble safe again, and improved the visitor's experience of the site, allowing the gateway of the Early Phrygian period behind the Middle Phrygian Gate Complex to come into its own as a visible access point to the megarons within.

Özet

Gordion Antik Kale Höyüğü'ndeki megaronlara açılan kapı kompleksinin altındaki, Orta Frig döneminden kalan (M.Ö. 800–700 yılları) moloz taş dolgu platformunun dengesinin sağlanması ve kalıntılarının korunması için 2016 yılında Gordion, Türkiye'de bir koruma projesi üstlenildi. Bu proje sırasında gün yüzüne çıkan Orta Frig Dönemi yapım tekniklerine bakış ve görüşler, 1950'lerde yapılan özgün kazı sırasında edinilen anlayışı doğrulamak ve detaylandırmak için kullanıldı. Bu makale, Orta Frig Dönemi Kapı Kompleksi'nin arkeolojisi ve bu kompleksin üzerine kurulduğu moloz taş dolgunun, kendi dengesini arttıran, gelişmiş yapım tekniğini inceler. Daha sonra da, günümüzde kalan moloz dolgunun yakın zamandaki değerlendirmesini ve güçlendirme çalışmalarını anlatır. Moloz dolgunun içindeki iç duvarların mazgallı siper benzeri bir yapı oluşturması ve stratejik olarak yerleştirilmiş ardıç kütükler kullanılması hem moloz taş dolgunun yapımında hem de sonrasında dengesinin sağlanmasında destek ve fayda sağlamıştır. Muhtemelen, moloz taş dolgunun içinde suda çözünen alçı taşı kullanılmasına bağlı olarak duvarların çökmesi antik çağda kapının servis dışı kalması anlamına gelmektedir. 2016 yılındaki koruma ve güçlendirme çalışmaları özgün Orta Frig dönemi yapısının önemli yönlerini aydınlatmıştır. Ayrıca, çağdaş dönemdeki moloz taş dolgu güvenli bir duruma getirilmiş ve ziyaretçilerin kazı sahası izlenimleri Orta Frig Dönemi Kapı Kompleksi'nin arkasındaki göz alıcı Erken Frig Dönemi giriş kapısının bir kez daha içerideki megaronlar için görünür bir geçit olarak kendine gelmesiyle iyileştirilmiştir.

Keywords: archaeology; Gordion; Phrygia; fortification walls; site conservation and preservation; architecture; Middle Phrygian period; structural forensic engineering; structural stabilization; heritage management

Semih Gönen: Yapı Mekaniği Laboratuvarı, Kuzey Kampüs, Boğaziçi Üniversitesi, 34342 Bebek/İstanbul; *semihgonen@gmail.com*

Richard Liebhart: 105 Easy Street, Chapel Hill, NC 27516-9034; *r.liebhart@gmail.com*

Naomi F. Miller: Near East Section, University of Pennsylvania Museum of Archaeology and Anthropology, 3260 South Street, Philadelphia, PA 19104; *nmiller0@upenn.edu*

Elspeth R. M. Dusinberre: Classics Department, University of Colorado, 248 UCB, Boulder, CO 80309-0248; *ermd@colorado.edu*

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Fig. 1. Map of western Anatolia showing the kingdom of Phrygia with its capital at Gordion. (© Gordion Archaeological Project, University of Pennsylvania Museum of Archaeology and Anthropology)

The archaeological site of Gordion, in central Turkey near the capital city of Ankara, has been the focus of intensive architectural conservation in recent years (**Fig. 1**). The site includes a fortified Citadel Mound measuring 450 × 300 m, as well as two walled residential districts, the "Lower Town" and "Outer Town" (**Fig. 2**). The three districts together have a combined area of roughly 100 ha (Rose 2017: 146). Ridges around the city were used at times for habitation and as cemeteries, particularly the great tumuli that marked the elaborate burials of the Phrygian elite. Architectural conservation efforts at Gordion have largely focused on the wooden tomb chamber in the largest of the tumuli, Tumulus MM, built ca. 740 B.C.E., and on the architecture of the Early Phrygian period on the Citadel Mound itself. The latter efforts have concentrated on the monumental Early Phrygian Gate Complex (the best-preserved Iron Age citadel gate in Anatolia), dating to the 9th century B.C.E., and on the Terrace Buildings to its northwest. The summer of 2016 saw additional architectural conservation focusing on the Middle Phrygian Gate Complex built above it during the 8th century B.C.E. (**Fig. 3**).[1]

This article provides first a brief overview of occupation at the site during the Iron Age. We then explain the archaeology of the Gate Complex and the nature of the platform that supported the Middle Phrygian Gate Building. Finally, we describe the conservation undertaken in 2016 to preserve portions of the Middle Phrygian architecture and to stabilize a large section of the rubble fill making up its platform, the results of which will enhance the visitor's experience of the site and its spectacular Phrygian Gate Complex. Site conservation and study in the summer of 2016 yielded a refined understanding of ancient Phrygian engineering approaches to the construction of monumental architecture during the 8th century B.C.E. In this way, the recent work paralleled, preserved, and illuminated the actions of the past. The discussion of the architecture that follows is based on discoveries made both during initial excavation in the 1950s and during architectural conservation throughout 2016.

[1] For conservation of Tumulus MM, or the Great Tumulus, see Liebhart and Johnson 2005, and Biggs, Liebhart, and Gönen 2016. The architectural conservation and reconstruction of the buildings on the Citadel Mound were made possible thanks to the generous support of the J. M. Kaplan Fund, the Merops Foundation, and the Selz Foundation. For recent updates on work in progress, see http://sites.museum.upenn.edu/gordion/site-conservation/site-conservation/.

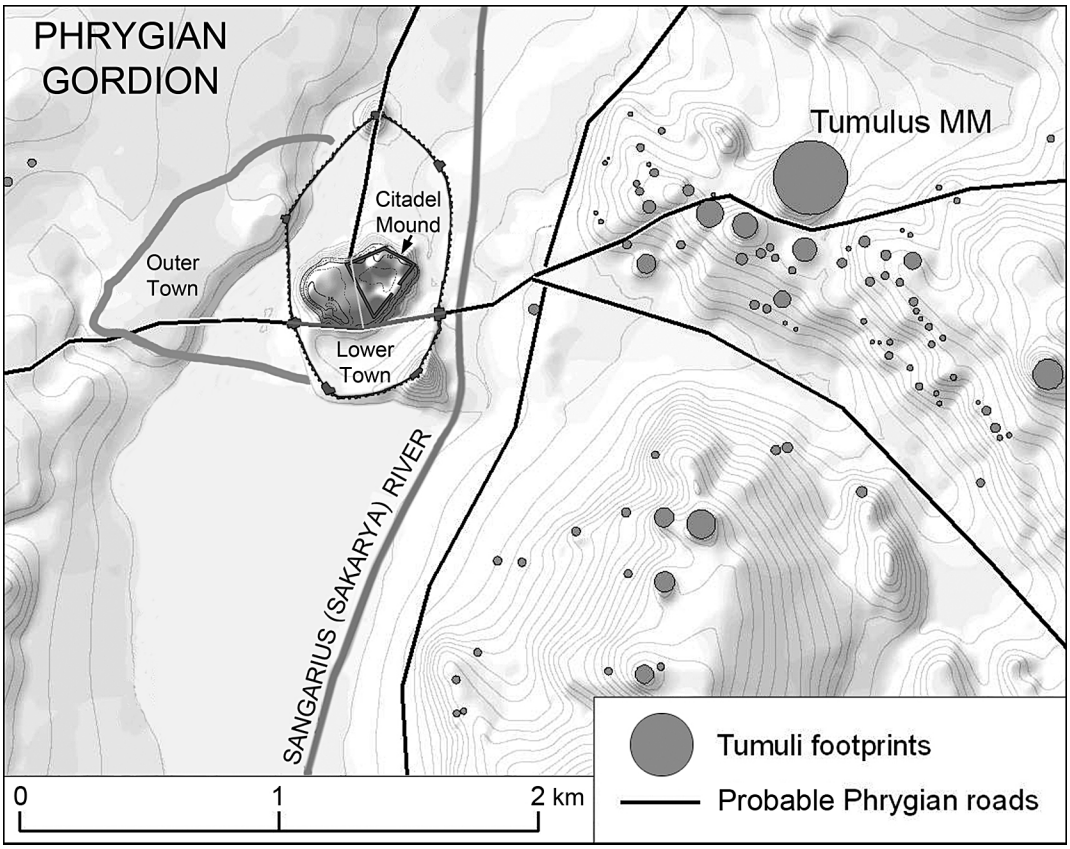

Fig. 2. Map of the area around Gordion in the late 8th century B.C.E. (Map by B. Marsh and R. F. Liebhart; © Gordion Archaeological Project, University of Pennsylvania Museum of Archaeology and Anthropology)

Fig. 3. Aerial photo from 2011 looking northwest into the Early Phrygian Gate Building, showing remnants of the Middle Phrygian Gate Building on top and in the foreground. (Photo by GGH; © Gordion Archaeological Project, University of Pennsylvania Museum of Archaeology and Anthropology)

Historical and Archaeological Background

Gordion was the capital of the Phrygian kingdom in central Anatolia, a cultural center that flourished during the early Iron Age in the wake of the collapse of the Hittite Empire at the end of the Bronze Age. The Early Phrygian period (ca. 950–800 B.C.E.) witnessed the development of monumental and ambitiously built architecture, including a massive Gate Building and highly organized industrial complexes (**Fig. 4**, top), as well as thriving metalwork, textile, and woodworking activities. During this period, the Phrygians started shaping the landscape around Gordion with tumuli to mark the burials of their elite (Young 1981; Sams and Voigt 2011: 166). The Middle Phrygian period (ca. 800–540 B.C.E.) witnessed the apogee of Phrygian influence, power, and architectural creativity; it was the period of construction of Tumulus MM, which is the largest of all the tumuli at Gordion, with a preserved height of 53 m. In this period, the Phrygians built new and spectacular polychromatic fortification walls and a stepped glacis on the Citadel Mound (**Fig. 4**, bottom).[2] The Middle Phrygian period was also the time of the famous King Midas (one of several kings of that name at Gordion), who ruled in the second half of the 8th century B.C.E. and was likely the namesake of the Phrygian king of Greek legend. Phrygian dominance began to wane around 600 B.C.E., as Gordion started to be controlled by the Lydians to the west and then the Persians to the southeast.

The transition from Early Phrygian to Middle Phrygian is marked by an apparently accidental fire that broke out on the Citadel Mound sometime around 800 B.C.E. This destroyed the western megarons and terrace buildings that comprised the city's elite and industrial quarters, respectively.[3] The destruction occurred during an enormous construction project that was well underway at the end of the 9th century, usually referred to as the "Unfinished Project" (Voigt 2012). The plan included a new (Middle Phrygian) citadel gate to replace the mid-9th-century (Early Phrygian) version, with the ground level inside the gate raised to that of the earlier terrace to the west of the megarons. The fire interrupted this project, which was revised by burying the entire area inside the Early Phrygian fortification walls with clay to a depth of up to 5 m (Rose 2012: 5–6).[4] The new citadel plan echoed the pre-fire one (**Fig. 5**), and, in fact, most of the foundations for the Middle Phrygian buildings inside the citadel wall were laid along with the clay as the area was being filled (i.e., the new plan had been established *before* the clay leveling started). The Phrygian designers understood that the new monumental gate building would require a support system more solid than clay to hold it, however, so they created a large rubble platform that would hold the entirety of the new Middle Phrygian Gate Building. By the time the fire broke out, the Early Phrygian Gate had already been partially dismantled and its central passage blocked by a stone "dam wall" that ran diagonally across its North Court to the inner corner of its South Court (**Fig. 6**).[5] It was not a weight-bearing wall: It was founded on the earthen floor of the North Court, and in the Early Phrygian Gate passageway it was set on an irregular earthen fill that seems to have been associated with a large drain belonging to the Unfinished Project (DeVries 1990: 388, fig. 22).

The new Middle Phrygian Gate Complex was built above and to the east of the Early Phrygian Gate Complex. Like its predecessor, the new gate had a North and South Bastion, each with a court (or large room) within, and a paved road running through its central double-gated entryway into the citadel. The Middle Phrygian Gate thus reduced to one building what had been two in the Early Phrygian system, which had in its final form an inner double-gate arrangement with projecting bastions at the north and south flanking its ramped approach. The orientation of the new Middle Phrygian ramp also changed slightly from that of the earlier gate complex, pointing now southeast rather than due east as had its predecessor (**Fig. 7**). All of these massive stone works were founded upon and within the rubble platform or fill that was the focus of the conservation efforts in 2016, as described below. The rubble fill itself was far from being a random heap of stones; it was instead a carefully built structure with particular logistical approaches used to create the strongest and most stable building platform in the shortest amount of time to sustain the great weight of the new Middle Phrygian Gate. The rubble platform did not serve directly as a foundation for the new gate, the actual walls of which were built on three or more courses

[2] For Early Phrygia, see Sams 1994; 1995; 2005b; Voigt 2005; and Voigt and Henrickson 2000. For architecture and contents of the megarons, see DeVries 1980: 34–37; and Sams 1995. For the date, see Voigt 1994: 272–73; DeVries et al. 2003; and DeVries 2005; 2007. For the Middle Phrygian period, see Voigt and Young 1999: 198–220; and Voigt 2005. For the reconstruction, see, e.g., Young 1981; Rose and Darbyshire 2016; and Amrhein et al. 2016. Recent excavations demonstrate that a stepped glacis was built already in the Early Phrygian period (see Rose 2017: 161–66).

[3] For the date, see the contributions in Rose and Darbyshire 2011.

[4] The composition of the layer that has been called "clay" is currently under study; it may prove to be silt rather than clay. It seems to have been laid in alternating layers of clay or dirt (thick) and gravel (thin), as is still visible in the trench balks.

[5] Only the North Court of the Early Phrygian Gate Building was excavated to floor level, and the evidence actually indicated that the space was at one time divided into three rooms and enclosed with a roof. The now traditional designation of this space as a "court" will be used here, despite the technical discrepancy.

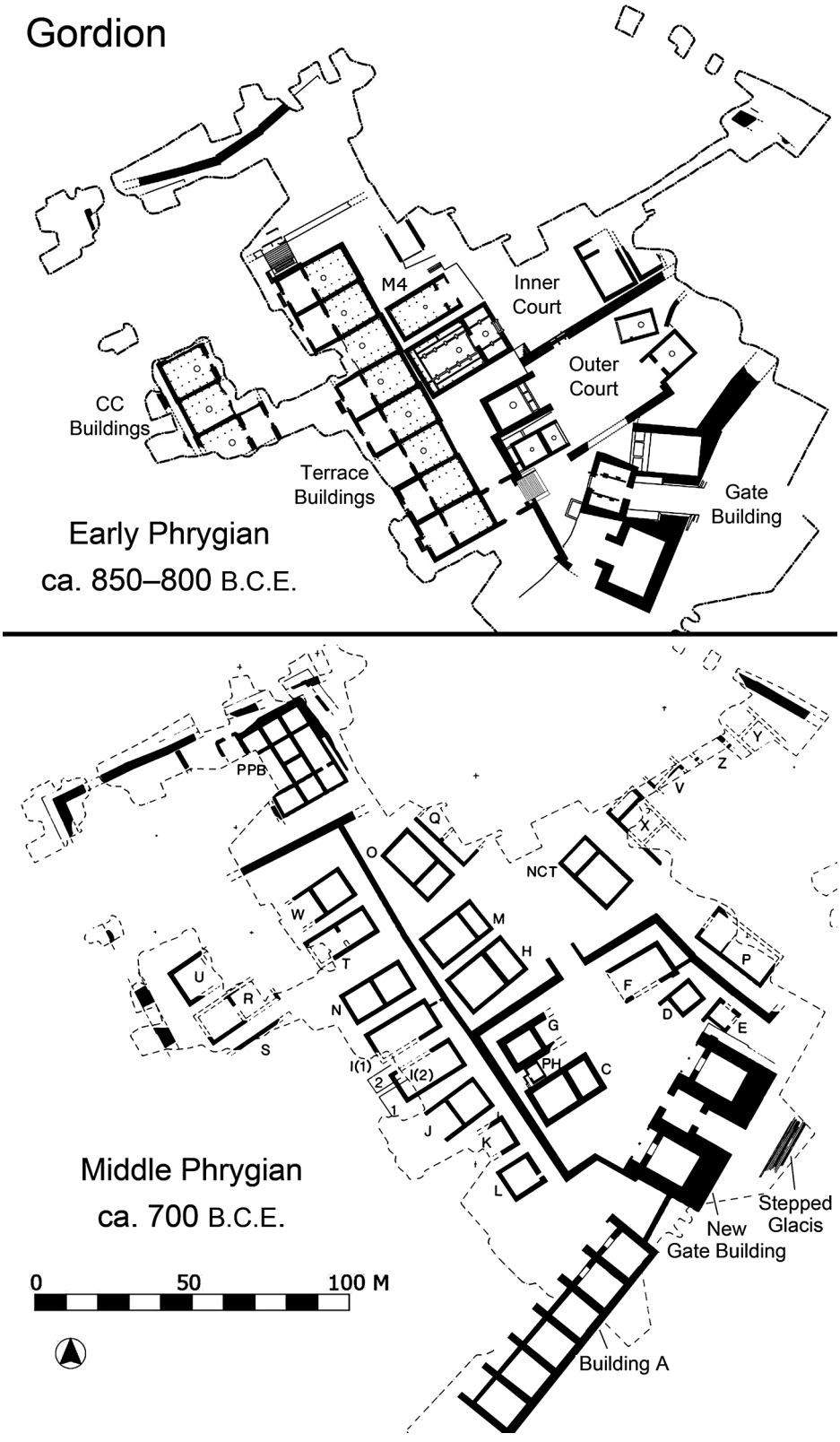

Fig. 4. The Early and Middle Phrygian Gate Complexes with associated buildings. (© Gordion Archaeological Project, University of Pennsylvania Museum of Archaeology and Anthropology)

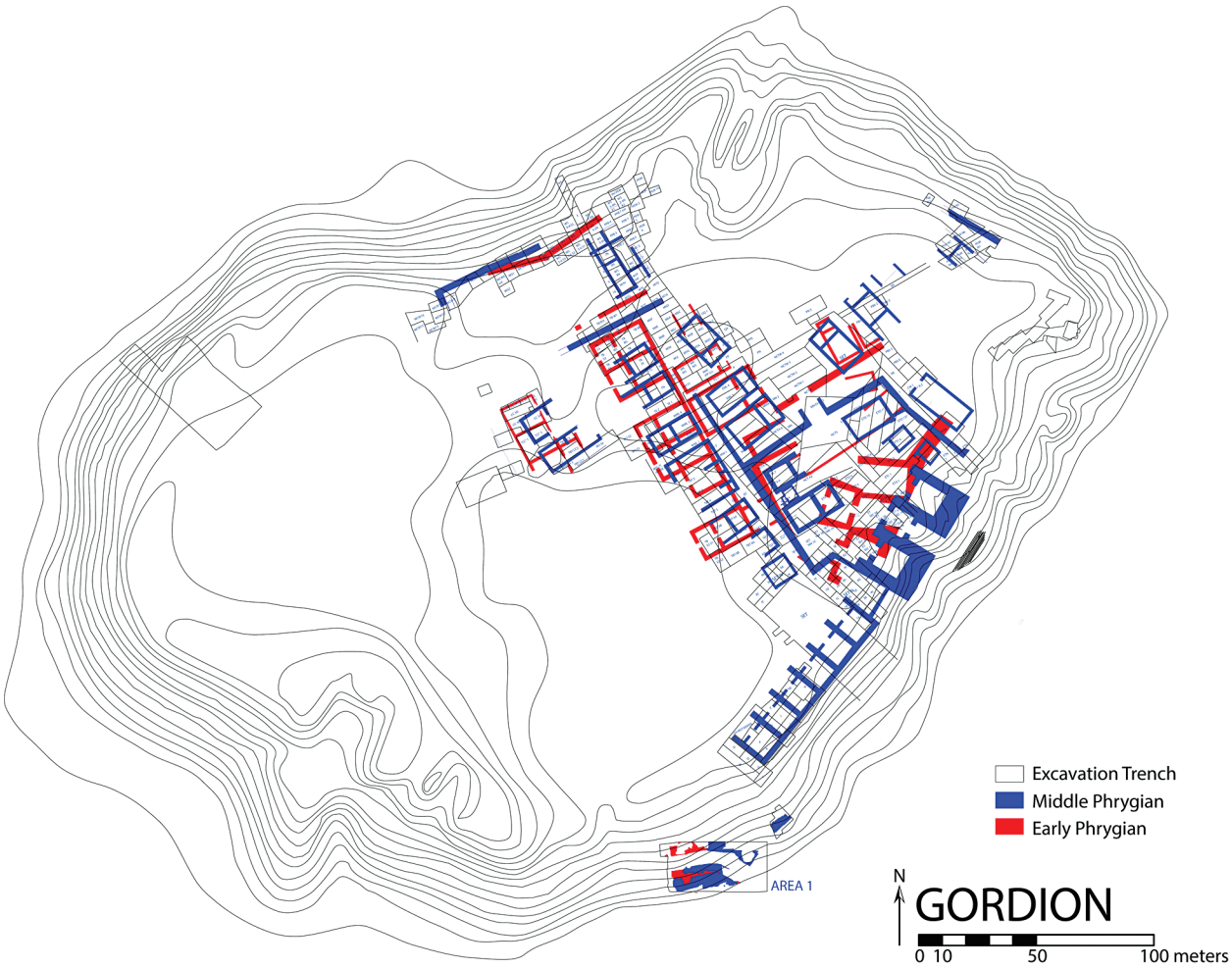

Fig. 5. Plan of Gordion, including recently excavated Area 1 at the south, showing Early and Middle Phrygian architecture. The stepped glacis associated with the Middle Phrygian Gate Building is indicated as black parallel lines to the southeast of the bastion. (© Gordion Archaeological Project, University of Pennsylvania Museum of Archaeology and Anthropology)

of ashlar foundations set into the rubble platform while it was being constructed (except where the walls of the new gate rested directly on the remains of the Early Phrygian Gate Building [see both plan and section in **Fig. 7**]). Thus, the rubble and foundations of the Middle Phrygian Gate Complex were planned and built up together simultaneously. In this way, the Gate Complex paralleled the simultaneous construction of the clay fill and wall foundations in the area inside the fortification wall of the Citadel Mound.

The Gate Complex area was excavated primarily in 1953 and 1955 by Rodney Young of the University of Pennsylvania, and his preliminary reports of these two seasons form the basis of our initial understanding and current description of the rubble below the Middle Phrygian Gate Complex (Young 1955: 11–15; 1956: 252–53). The nature of the rubble fill was complex, as Young articulated. It included occasional blocks of stone incorporated from the Early Phrygian Gate Complex, but it consisted largely of rough bits of limestone and gypsum. Young describes its construction:[6]

> The entire mass of rubble and blocks, threaded by occasional logs of wood put in to serve as binders, was retained at the east by [the Middle Phrygian stepped glacis] of cut blocks. The rubble was not merely piled in behind its retaining wall, but carefully laid in accordance with a plan calculated to assure stability by counteracting any tendency of the rubble to slide down the slope, and by taking away as much pressure as possible from

[6] Note that we have substituted (in brackets) the currently accepted chronological and descriptive phrases for Young's originals.

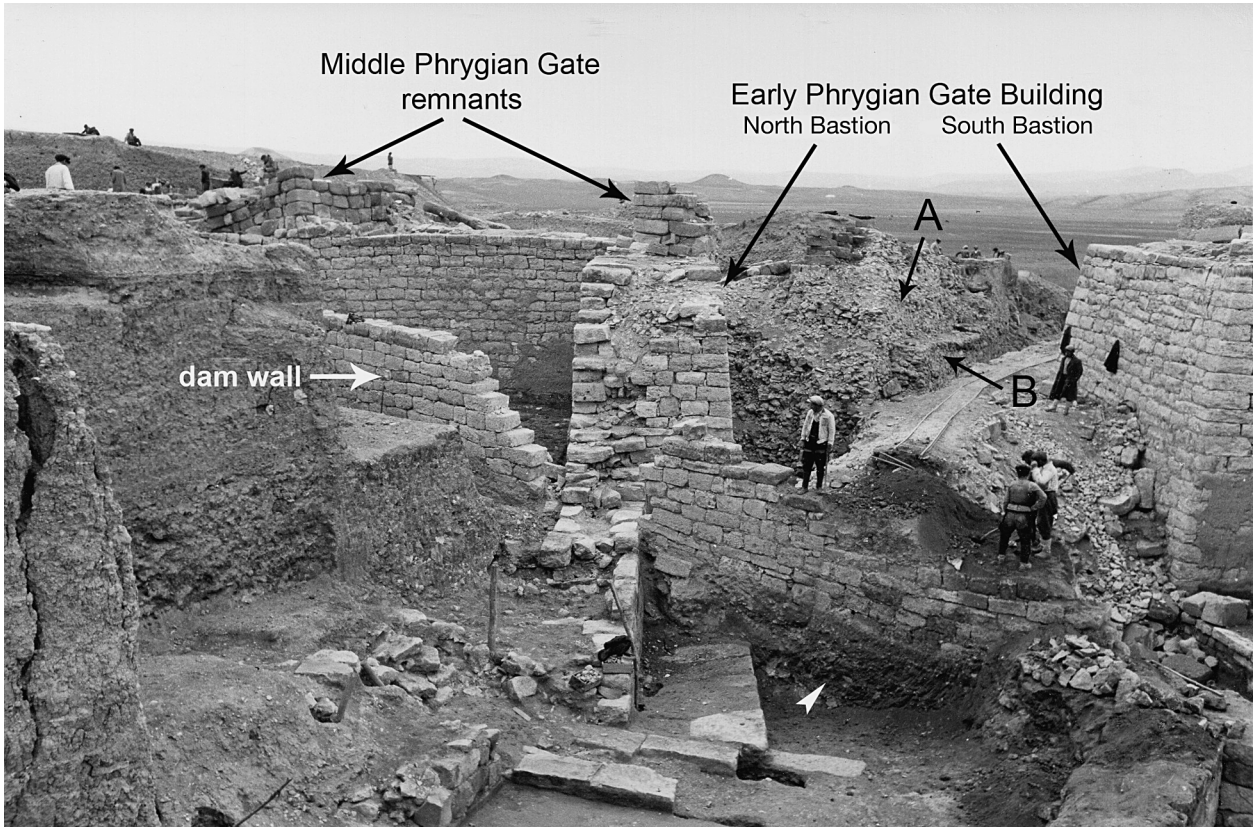

Fig. 6. A view looking east through the Early Phrygian Gate Building during excavation in 1955, showing the dam wall running from the North Court diagonally across the central gate ramp. The dam wall was partially dismantled in 1953 at the center and right to provide better access for workers. The unexcavated rubble packing for the Middle Phrygian Gate Building is seen beyond the Early Phrygian gate passageway: A and B indicate original "faces" of the built strips of rubble. The white arrow points to the earthen fill on which the dam wall was built over the original cobbled ramp surface. (© Gordion Archaeological Project, University of Pennsylvania Museum of Archaeology and Anthropology)

> the inner face of the retaining wall. The opening of the [Early] Phrygian gateway was first sealed by a roughly built wall face of dry stone [**Fig. 8**] carried upward as the rubble and stones were piled in behind; it had no back face. At various levels, series of parallel wooden logs were laid in the rubble in front of this wall face and at right angles to it, so that the logs might serve to bind the rubble and prevent it from sliding down the slope [**Fig. 9**]. The largest of these logs was preserved to a length of nearly 4 m and had a diameter of .65 m; at one end where it had been cut transversely the tool marks of the adze or hatchet were still clearly visible. . . .
>
> The rubble between the retaining wall [i.e., the stepped glacis east of the gate complex] and the outer face of the [Early] Phrygian wall was laid in successive vertical strips about 1.20 m in thickness and at right angles to the retaining wall, each strip faced by a roughly built dry wall. Each successive strip had been built in front of the face of the preceding one, the rubble being packed in behind the new rough wall face as it rose. These strips, extending in the direction of the slope (instead of along it) served as an additional safeguard against any downward sliding of the rubble. In the width of our deep cut in front of the opening of the [Early] Phrygian gate—about 10 m—we noted seven of these successively built rubble strips, those at the north side with the rough wall faces toward the south and those at the south side with the wall faces toward the north, so it seems the area was filled in with built rubble by working from both directions at the same time. (Young 1956: 252–53)

Much of what Young describes can be seen in **Figure 10**, including the presence of vertical joints between the Phrygian builders' northwest–southeast strip walls within the rubble, and an ancient north–south juniper log (JL) lying upon a partially exposed internal surface (or "horizontal plane") of the rubble fill.[7] Each of the strip walls in this northern section has a face to the south with a slight batter. (The photo is somewhat misleading due to the slope of the partially excavated rubble

[7] For the identification of juniper logs and their use in the rubble fill and elsewhere at Gordion, see the appendix to this article and discussions below on the engineering aspects of the rubble platform.

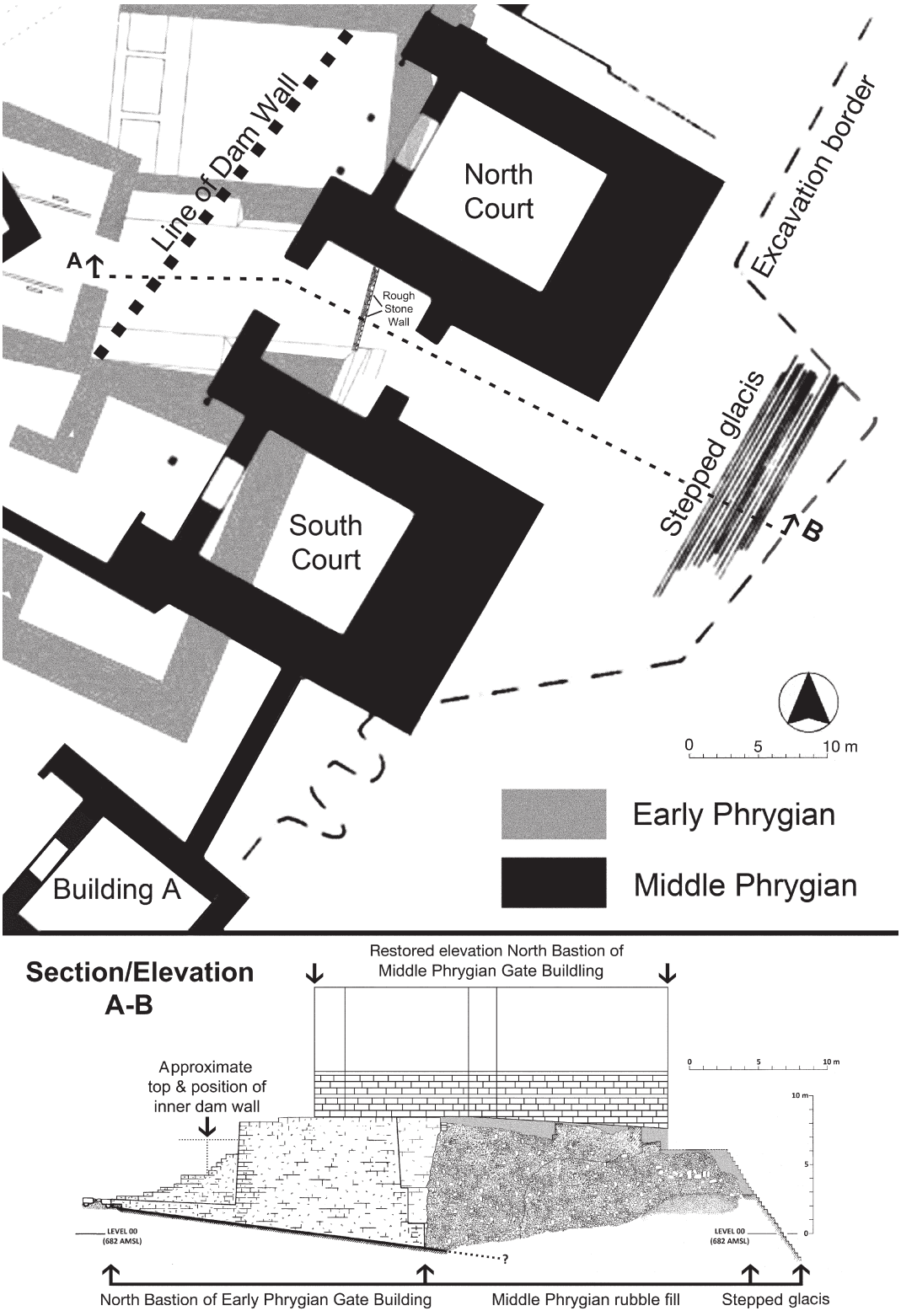

Fig. 7. Overlay plan showing the Early Phrygian Gate Complex in gray with the Middle Phrygian Gate (and Building A) in black and elevation/section of the same area below. The rubble likely continues much deeper than shown here; Young was not able to determine the lowest extent of the rubble due to the modern water table, which is much higher than in the 1st millennium B.C.E. The height of the Middle Phrygian Gate Building shown in the section/elevation is hypothetical, based on the extant height of the Early Phrygian version. (Plan by R. F. Liebhart; © Gordion Archaeological Project, University of Pennsylvania Museum of Archaeology and Anthropology)

Fig. 8. The northeast corner of the South Bastion of the Early Phrygian Gate Building during excavation in 1955, showing to the right of the workmen the corner of the upper ledge and then the face of the rough stone wall that closed the outer opening of the Gate Building. (© Gordion Archaeological Project, University of Pennsylvania Museum of Archaeology and Anthropology)

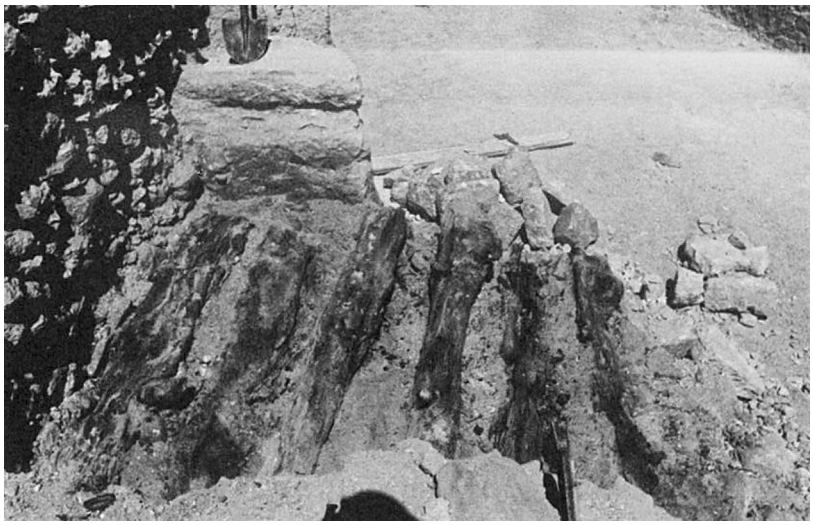

Fig. 9. A series of juniper logs in the Middle Phrygian rubble fill, laid perpendicular to the outer face of the South Bastion (and to the rough stone wall shown in **Fig. 8**) of the Early Phrygian Gate Building. The shovel at the top of the photo rests on the same ledge shown in **Figure 8**; visible at the upper right is the very fine cobbled surface of the Early Phrygian ramp into the Citadel Mound. (© Gordion Archaeological Project, University of Pennsylvania Museum of Archaeology and Anthropology)

Fig. 10. Looking east through the Early Phrygian Gate Building during excavation in 1955. The dam wall runs diagonally from the North Court of the Gate Building on the left across the partially dismantled gate wall at the center. A and B are the original strip-wall faces still visible in 2016; 1, 2, and 3 indicate vertical joints between the rubble faces. JL indicates where the juniper log was unearthed in situ on a "horizontal plane" between two sections of rubble fill that extend into the lower section of A. (© Gordion Archaeological Project, University of Pennsylvania Museum of Archaeology and Anthropology)

and the angle of the photo; the batter can be seen more clearly in the exposed original vertical faces A and B.) The strip walls had faces ca. 1.20 m apart, and each strip was about 1.20 m high. This is a height and distance enabling a single worker to lift moderately sized stones and set them in place without needing to stand on anything or overreach.

The distances and their relation to practical human body use were seen coincidentally in 2014 during an excavation of a small area in one of the units of the Early Phrygian Terrace Building on the Citadel Mound. The terrace itself was stone rubble laid in strip walls with their faces aligned parallel to the slope of the ground in that area, just like that laid for the fill under the Middle Phrygian Gate Building. As more and more stones were taken out from the excavated area and piled up on the side at modern ground level, a local workman automatically started to build a wall between the excavation pit and the stone pile (**Fig. 11**). It was slightly battered for stability, and it had to be built somewhat higher than 1.20 m by necessity, but the workman ended up building anew what the archaeologists were excavating!

Figure 11 also illustrates a problem with the work space. The single workman who is building the new "strip wall" is standing on a narrow space between the wall and the excavation trench, which is essentially the same as the width of one of the ancient strip walls (ca. 1.2 m). Stones for the new "strip wall" are being tossed up from the lowest section of the trench (at right) in two stages to the wall builder. If this was the ancient method of construction, the stones had to have been brought to an area at a lower level and tossed up by a series of workmen. Bringing in the stones along the wall builder's level would have meant carrying stones individually or in small piles on a wooden backpack frame, then turning and passing them to the next stone carrier on the relatively narrow ledge. The efficiency would break down rather quickly. Evidence from the use of juniper logs in the rubble fill, discovered in the course of architectural conservation during 2016 as well as in the 1950s, indicates that the

Fig. 11. Coincidental creation of a modern "strip wall" on the upper left during excavation of the rubble fill beneath Unit 6 of the Early Phrygian Terrace Building in 2014. The student workers in the center are standing on the "surface" of one of the strip walls. (Photo by R. F. Liebhart)

fill was constructed with working platforms measuring at least two strips wide. This makes sense; 2.4 m would provide plenty of room for more than a single line of workers both bringing and setting stones.

The inclusion of juniper logs within the rubble was an important part of the construction technique (see **Fig. 9**). These logs were laid both northeast–southwest and also northwest–southeast, at a vertical distance of about 1 or 1.2 m from the logs below and at a roughly similar horizontal distance from each other (i.e., apparently on the tops of strip-wall sections). They have been found both as extant logs and as cavities (sometimes with fragments of wood) left behind in the rubble fill, as **Figure 12** demonstrates. The logs appear to mark the roughly horizontal joints between superimposed strip walls, meaning that they were generally laid on top of one or more strip walls. The logs may have provided temporary stabilization of the rubble while the construction crews were working on it, but they would seem to have been more of an obstacle for walking than any kind of aid to construction. Besides, the Phrygian builders clearly thought of the juniper stabilization as more than temporary. Juniper grows very slowly and is remarkably dense, and its central heartwood is particularly rot-resistant (Liebhart 2012: 134). However, the juniper tree trunk tapers dramatically (unlike pine, for instance), so its use for squared beams of any significant dimension and length is negligible (and a waste of a precious commodity). Instead, the Phrygians regularly used juniper logs under walls (and typically on top of the wall foundations) and in rubble fill like that discussed here.[8] The very density of the juniper logs

[8] This technique is found also in Early Phrygian construction: Juniper logs have been discovered in the South Bastion of the Early Phrygian Gate Building, set just inside the blocks facing the east wall and running perpendicular to the wall face (see Kuniholm and Newton 2011: 107; and Sams 2005a: 266, figs. 7, 8). For an example of the use of juniper logs under the wall of Building A (seen in **Figs. 4** and **6** here) during the Middle Phrygian period, see Burke 2012: 205–9.

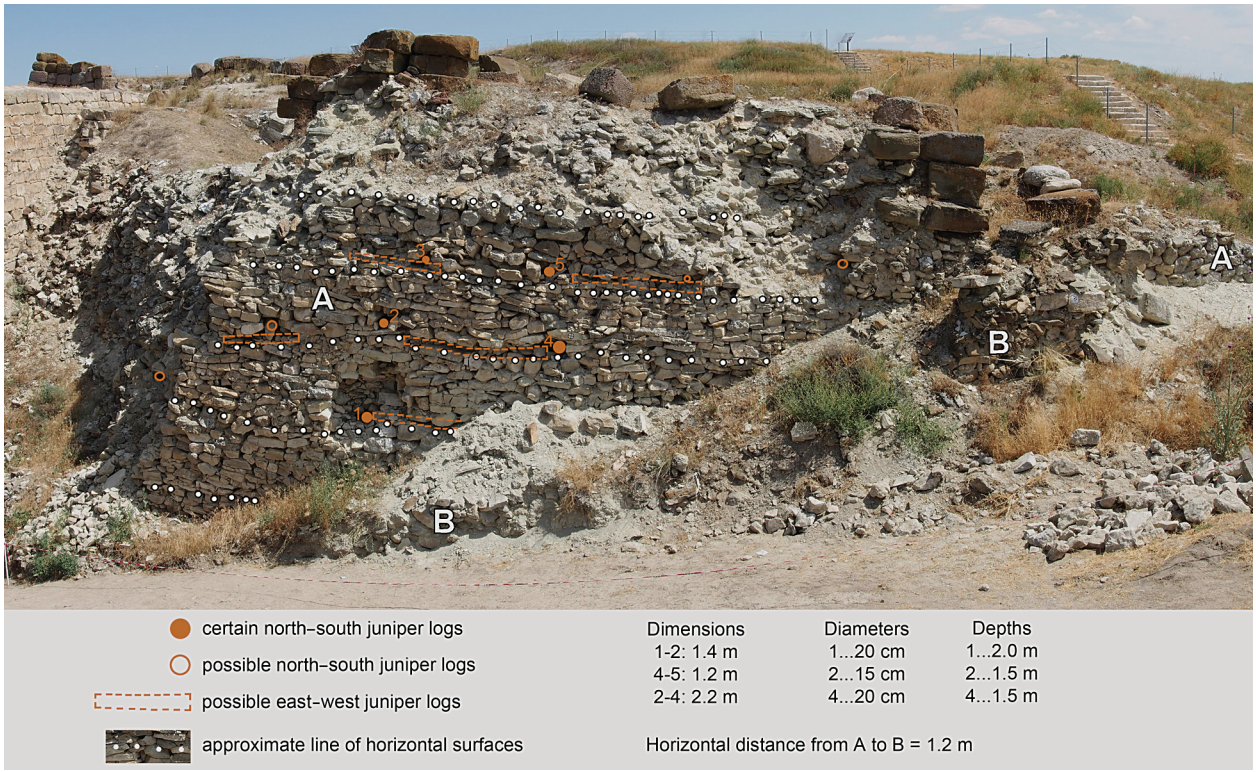

Fig. 12. Rubble foundation of the North Bastion of the Middle Phrygian Gate Complex, looking northeast. A and B designate the same vertical Strip Wall Faces A and B in the previous figures. The white dotted lines show what appear to be working surfaces, roughly 1 or 1.2 m apart from each other in vertical distance. The holes left by rotting or excavated logs are indicated in orange. (Photo by G. Bieg; annotations by R. F. Liebhart)

would have added overall stability to the rubble fill as the base for the Middle Phrygian Gate Building above it.

In the upper right corner of **Figure 10**, a juniper log (labeled JL) that was left by Young is visible on the top of Strip B. The log was oriented roughly north–south, perpendicular to the faces of the strip walls. At the time of excavation when this photo was taken, the log must have been longer than the 1.2 m strip section on which it rested. In fact, the other half (at least) of the log must have been still locked in place under the strip wall to the north. The log itself has long since rotted away (or been removed), but assuming it extended at least the full width of the strip wall in Face A, it would have had a minimum length of 2.4 m. The log had to have been set directly on the top surface of at least two adjacent strip walls before the next layer of rubble was laid. This would have given a wider working platform for the original builders.

While the cavity once occupied by Log JL had been covered by erosion slump since its excavation in the 1950s and was no longer visible in 2016, several extant log cavities were accessible before the stabilization program of 2016. The length of those cavities suggests that the original logs were a bit longer than the width between the strip walls, and the beams extended over the top surfaces of at least two strip walls (see the chart in **Fig. 12**, which gives the depths of the cavities where logs had been placed). This suggests a regular practice of creating and temporarily using a work space wider than the width of a single strip wall.

For the rubble fill under the Middle Phrygian Gate Complex, the original builders first had to establish its outer limits. As Young did not excavate much of the fill on the south side of the area, we can only analyze the northern half of the area in question. In his preliminary report (quoted above), Young mentions only three such limits: the dam wall cutting off the inside of the Early Phrygian Gate Building; the rough stone wall across the outer (east) opening of that gate; and the stepped glacis retaining wall about 18 m east of the Early Phrygian Gate (**Figs. 7, 13**).

On the east, the boundary of the rubble fill was the stepped glacis retaining wall, as is clear from the section in **Figure 7**. This shows the general configuration of the stepped glacis, although the top of the steps has long since been robbed out, and the bottom was never found, since the water-table level prevented deeper excavation. Even so, it is clear that the stepped glacis was the first

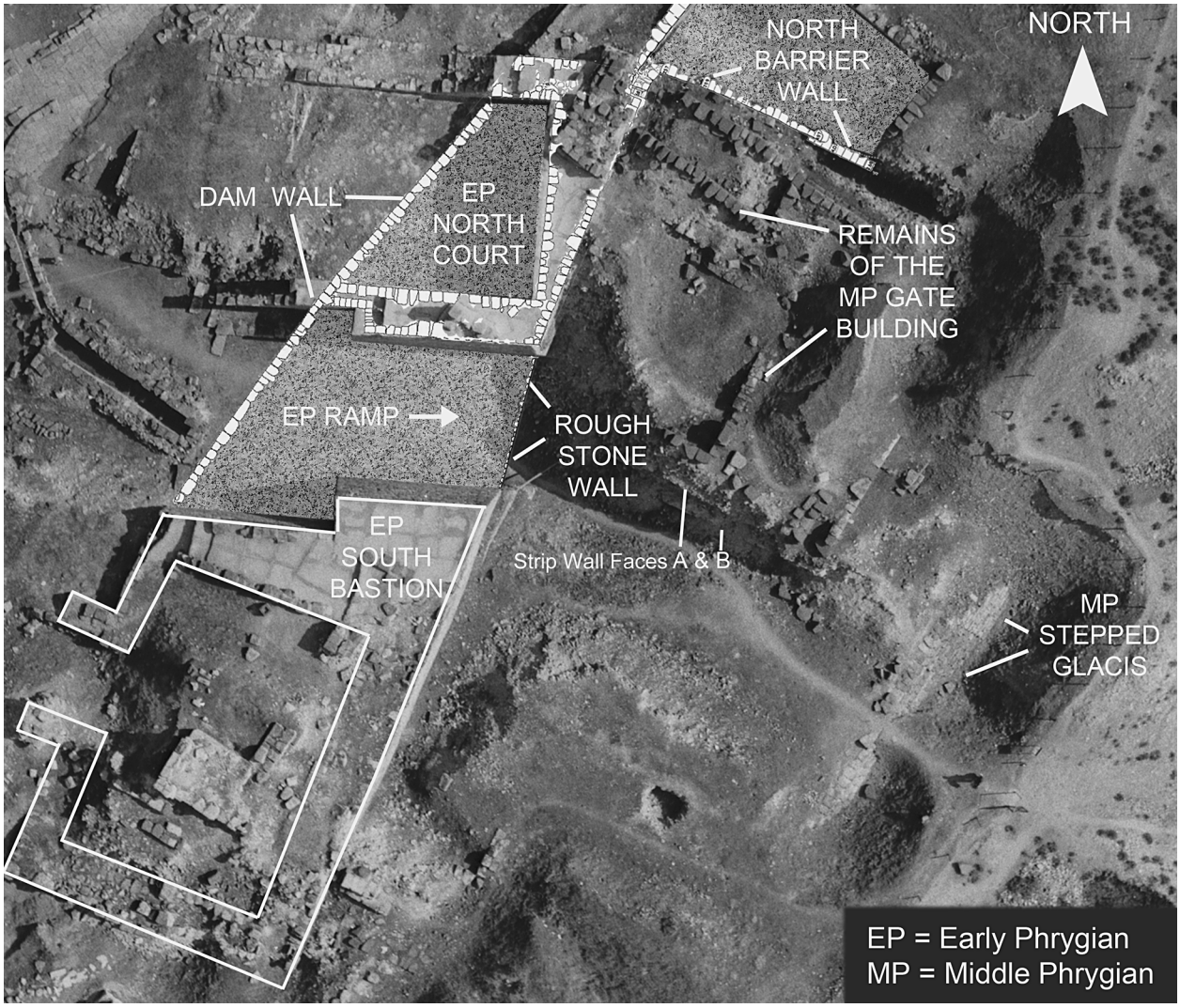

Fig. 13. A 1989 balloon photo of the Gate Building area with overlays in white showing the construction boundaries of the rubble fill under discussion: the dam wall at the west; the rough stone wall at the eastern opening of the Early Phrygian Gate; the Middle Phrygian stepped glacis on the east; and the northern barrier wall running northwest–southeast and perpendicular to the east wall of the Early Phrygian Gate Building, which is also highlighted. (Photo by W. Myers; overlays by R. F. Liebhart; © Gordion Archaeological Project, University of Pennsylvania Museum of Archaeology and Anthropology)

part of the rubble fill system to be built, since it marks the lowest section of the project. **Figure 14** shows Young's sketched section of the stepped glacis and the rubble and clay to the west. Each step consisted of an outer stone block and an inner, rougher block, usually with rubble filling the small space between. The mound of clay was piled about 2 m behind the stepped glacis, presumably before the stepped glacis was built. Young surmised that the clay was laid "to lessen the pressure of the rubble against the back of the stepped retaining wall" (Gordion Notebook 49: 43). Among the details of construction we do not know is how far north and south this clay mound (or ridge) extended. Nor do we know at what elevation the northwest–southeast strip walls began, though presumably the strip-wall system started at the base of the clay mound/ridge. It may be that the clay mound/ridge was created as a starting point for the construction of the strip walls to the west and the stepped glacis to the east (see **Figs. 7, 13**). This would have allowed the strip walls and glacis to be built as more or less separate operations until they reached the top of the clay mound/ridge.

As mentioned above, the western boundary of the rubble fill was the dam wall, which was founded on a soil surface (see **Fig. 6**) and was not intended as a weight-bearing wall. It was built with limestone blocks of varying sizes taken from the Early Phrygian Gate Building,

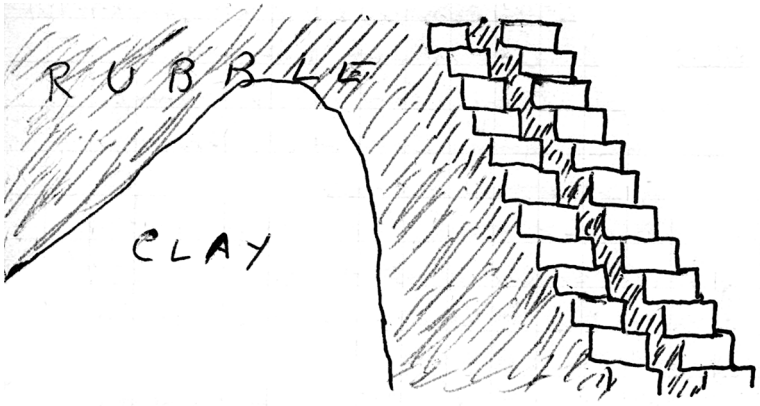

Fig. 14. Looking north, Young's sketched section of the stepped glacis and its relationship with the rubble and the mound of clay to its west (Gordion Notebook 49: 44). (© Gordion Archaeological Project, University of Pennsylvania Museum of Archaeology and Anthropology)

in large part from a section at the west end of the north wall of the early gate ramp (in the center of **Fig. 6**). The dam wall had a smooth face to the west toward the clay fill and an irregular face toward the east and the rubble fill that would underlie the Middle Phrygian Gate Building. It served as a barrier between the clay and the rubble stone, presenting a solid, well-jointed surface to the clay in order to keep it more stable.[9] The dam wall runs almost parallel to what would become the inner face of the Middle Phrygian Gate, indicating its direct correlation to the construction of that building (see the overlay plan in **Figs. 7, 13**). It is not clear from the excavation notes whether the dam wall ever stood to any serious height as a retaining wall without having the clay packed against its west face, or whether the filling of clay inside and rubble outside was undertaken simultaneously as a single, colossal project.

Another built wall, which Young called a "rough stone wall," ran roughly north–south in the middle of the rubble fill. The feature blocked the outer opening between the North and South Bastions of the Early Phrygian Gate Building and is visible in **Figure 8**. Calling it a "wall" is a bit misleading, as it was actually a carefully built face to the rubble fill behind. This is similar to the faces of the strip walls in the rubble fill east of the Early Phrygian bastions, but apparently on a larger scale. The "rough stone wall" was presumably built in the same way as the strip walls, by carefully laying the stones of the face as the fill rose inside: **Figure 8** illustrates several essentially horizontal lines of facing stones in the "rough stone wall" that resemble the faces of the strip walls. Unfortunately, the area of rubble fill between the Early Phrygian bastions was not always dug as carefully as that to the east of the entrance. The digging here was driven primarily by the need to create as quickly as possible a lower surface for the Decauville railway that was used to move excavated debris to the spoil tips at the edge of the Citadel Mound (visible in **Figs. 6, 8, 10**). This entire area between the early bastions was also dug in various stages in multiple trenches, with varying degrees of careful recording. It seems clear, however, that the rough stone wall would have been built up and filled in behind (up to the east face of the dam wall) in keeping with the rising strip walls to the east.

More care was taken in the area of the actual Middle Phrygian Gate Building walls. Those portions of rubble fill under the north wall of the Middle Phrygian Gate central ramp were built with strip walls, although farther from the line of the gate wall, Young found "only a sea of rubble" (Gordion Notebook 49: 33–34). It is clear that the northwest–southeast strip walls in the Middle Phrygian rubble fill to the east of the Early Phrygian Gate Building were built with their western ends abutting either the walls of the gate itself or the rough stone wall between the bastions. The relationship between the faces of Strip Walls A and B and the face of the rough stone wall can be seen in **Figure 13** (and note that the angle here is not exactly 90°). It seems reasonable that the Phrygians built all the rubble fill in this area level by level, moving toward the center from north and south (as noted by Young), using strip walls to stabilize the rubble and with a gradu-

[9] A similar technique was used during the construction of Tumulus MM, which has a stone wall separating the earthen fill of the tumulus proper from the rubble fill directly around the wooden tomb chamber. In that situation as well, the better face of the wall was on the earthen-fill side (see Liebhart 2012: fig. 9.17).

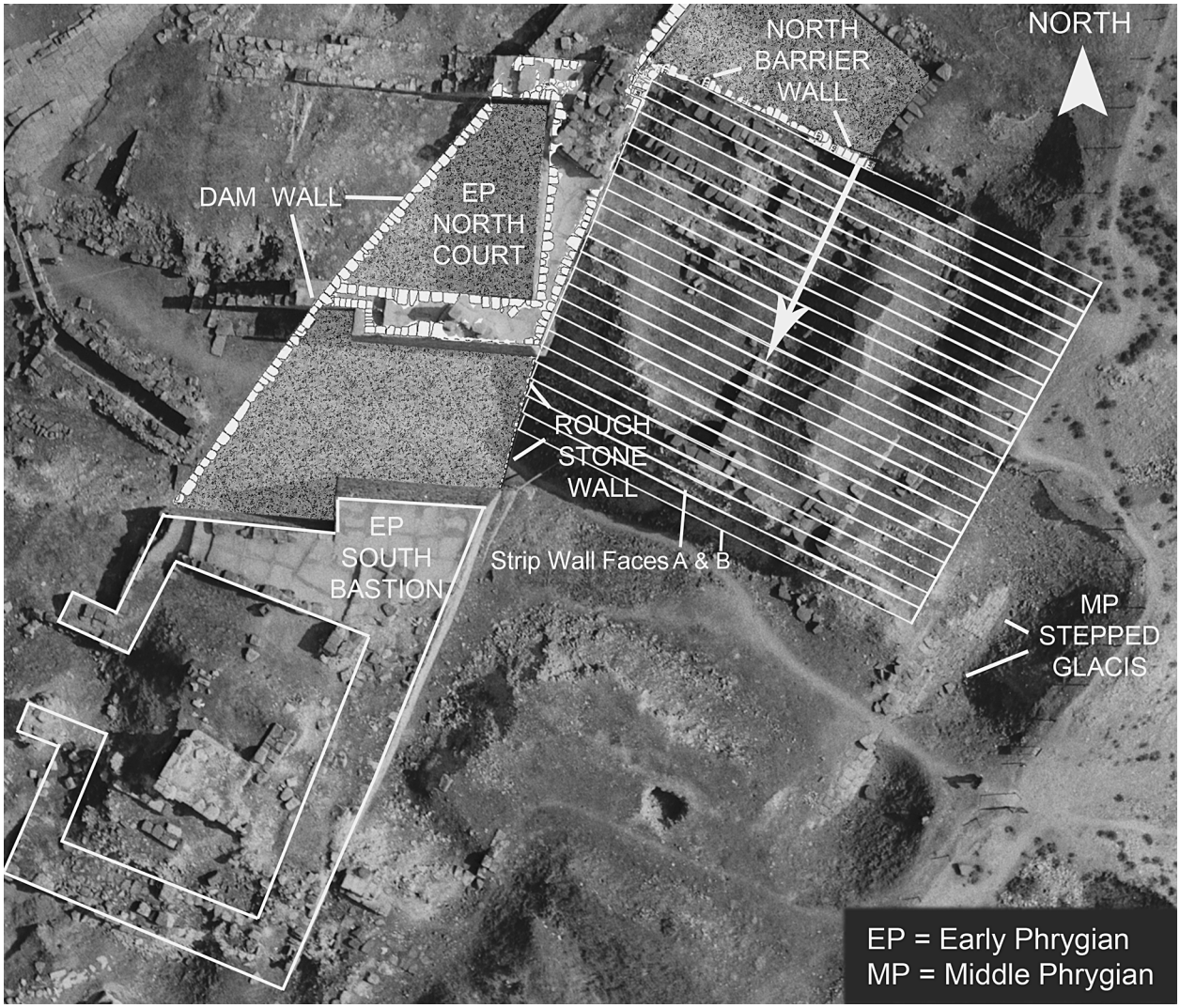

Fig. 15. The same 1989 balloon image in **Figure 13** with Strip Wall Faces A and B extended to the northwest and southeast and then copied and repeated to the northeast. The 1.2 m strip walls eventually coincide with the north barrier wall, suggesting that the wall was built as the northern limit of the rubble fill. (Photo by W. Myers; overlays by R. F. Liebhart; © Gordion Archaeological Project, University of Pennsylvania Museum of Archaeology and Anthropology)

ally rising access way in the center. The exact sequence of construction in all its phases is not likely ever to be understood with confidence.

Young says nothing of the north limit of the Middle Phrygian rubble fill laid east of the Early Phrygian Gate Building, as he did not fully excavate that area; however, he did excavate the upper section of what is here called the "north barrier wall" (see **Fig. 13**). This wall runs perpendicular to the east face of the Early Phrygian North Bastion. The wall (or walls) may be related to construction added on the north side of the Middle Phrygian Gate Building, and the overlap of the walls at the east end of the excavated portion may indicate phases of either the additions to the Gate Building or of the layer-by-layer approach to building the rubble strip walls. Not only does this north barrier wall run parallel to the preserved faces of Strip Walls A and B, but when one extends the lines of these two strip-wall faces and then copies and pastes them onto the aerial photograph, the 1.2 m wide sections meet exactly at the wall in question (**Fig. 15**). While this exercise is only an approximation of accuracy, it is still highly suggestive of the direct connection between the north barrier wall and the construction of the strip walls. It should be noted that the smooth face of the north barrier wall is on the south side (i.e., toward the rubble strip walls), and that this would normally indicate clay on the

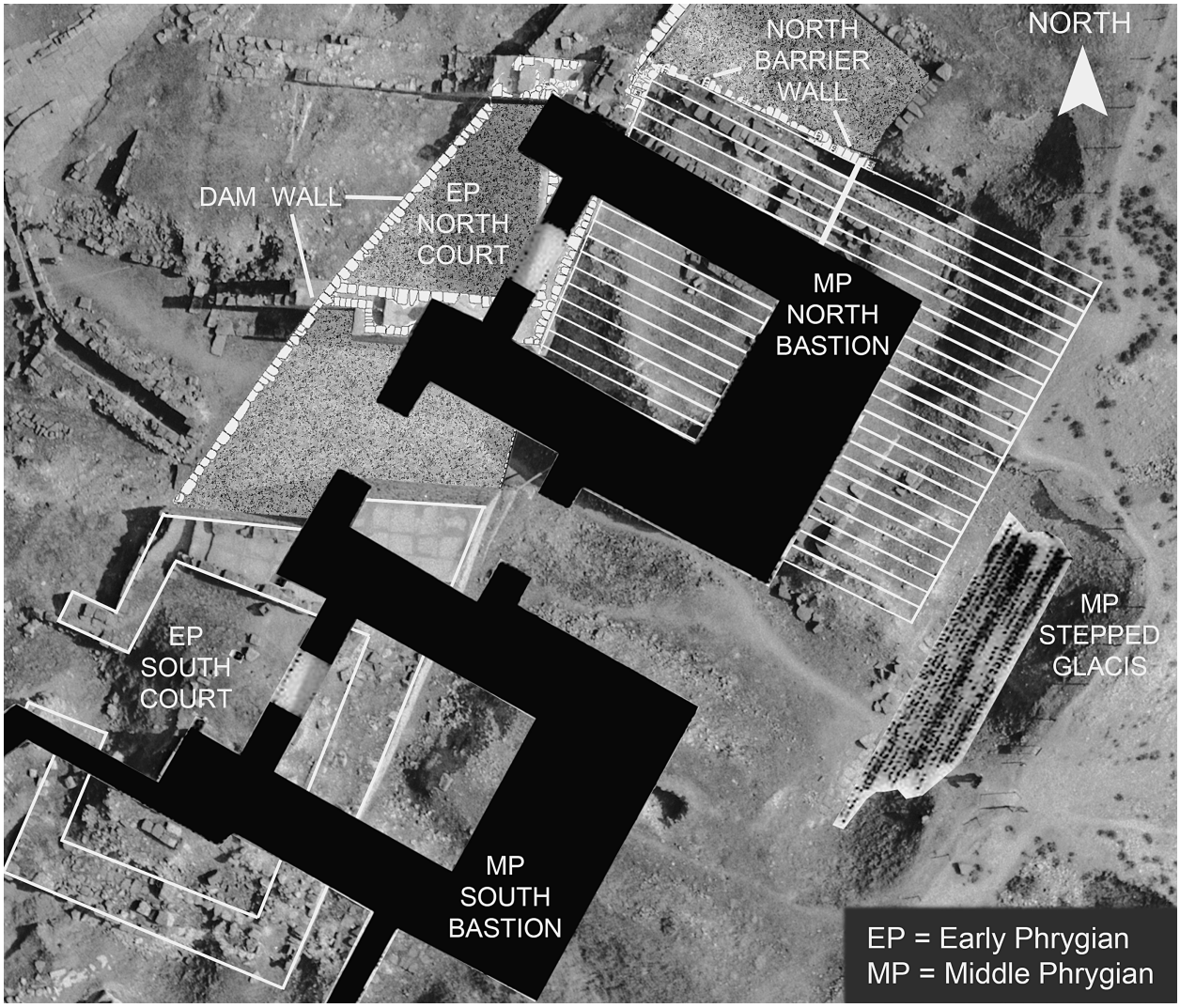

Fig. 16. The 1989 balloon photo from **Figures 13** and **15** with all the previously shown overlays, plus a restored plan of the Middle Phrygian Gate Building to give the ultimate relationship of that building with the rubble fill below. (Photo by W. Myers; overlays by R. F. Liebhart; © Gordion Archaeological Project, University of Pennsylvania Museum of Archaeology and Anthropology)

north, rougher side (Gordion Notebook 52: 157–60). However, rubble stone was found on both sides of this wall, suggesting that the Phrygian builders were concerned with other heavy structures north of the wall—a construction area with a complicated history that is beyond the scope of this article.

Figure 16 shows the same balloon photograph of the area, now overlaid with a restored plan of the Middle Phrygian Gate Building atop the rubble with its strip walls and a partially restored drawing of the stepped glacis at the east. The relationship of the Gate Building to the stone rubble platform is clearly illustrated. What is not so clearly understood is the actual nature of the approach to the Middle Phrygian Gate Building, except that one apparently had to come up a sloping road through a break in the stepped glacis somewhere to the north of the excavated area and then make a sharp left to travel southwest parallel to and at a higher elevation than the stepped glacis before turning right into the Gate Building.[10]

The approach to the area of the Gate Building is obviously related to the construction of the rubble platform. While some of the stone blocks were recycled from the Early Phrygian Citadel Mound, it appears that most of the rubble for the fill was new material, presumably

[10] An apparently similar approach is being excavated farther south from the area discussed here, where another gate complex is under investigation (see Rose 2017: 161–68; and **Fig. 5** above).

Fig. 17. A view of the excavated section of the stepped glacis from the east, with the jog at the center marking changes in stone type and color. (Photo by R. F. Liebhart)

quarry debris (see below). This would have been brought from outside the city, through the Lower City on the east side of the Citadel Mound. The stepped glacis marks the eastern and lowest boundary for the rubble platform, but the actual steps are uncomfortably steep and narrow, so they would not have been suitable for use in transporting the rubble for the platform inside. Most likely, the material was brought in via wagons through the presumed break in the stepped glacis to the north and over whatever elevation the rubble platform and stepped glacis had attained at each point in the construction.

As noted above, there are many unanswered questions regarding the construction of the rubble platform for the Middle Phrygian Gate Building. One of these is inspired by a curious feature of the stepped glacis (**Fig. 17**). There is a jog in the face of the glacis, which is not so unusual in itself, but the jog also marks a change not only of the type of stone but also in the color of the stones used: white limestone to the north, mixed lighter and darker gray stones to the south.[11] In addition, one can see in **Figure 17** that the joints between stones in both sections are not consistently "broken" with those above and below, but in a few horizontal courses the actual jog was cut into a stone. In casual discussion at Gordion, it was suggested that the change in material here indicates two different crews bringing stones from two different sources, which is certainly a plausible explanation. However, there may be more to the jog than first meets the eye.

Figure 18 shows a composite aerial drone photo of the area with the jog clearly visible at the east. Also clear is the alignment of the jog with Strip Wall Face A, which is visible on-site in two parallel sections in **Figure 12**. The section of the strip wall visible on the left in **Figure 18** (Strip Wall Face A1) shows the strip walls and log cavities discussed above. The section on the far right (Strip Wall Face A2) is made with gypsum stones instead of the limestone used in the western section. This might simply be a matter of different work teams utilizing different stone sources. However, the jog and color change in the stepped glacis are so obvious, and the alignment with Strip Wall Face A is so curious, that one wonders if the marking of the stepped glacis is not somehow related to the building of the rubble platform behind it. Did it serve as a marker of some sort? It does not line up with any faces or features of the actual Middle Phrygian Gate walls as built. Given the large number of strip walls built in the rubble platform, it is perhaps not so unusual that the jog in the stepped glacis would align with one of them coincidentally. However, it may be yet another example of how carefully planned and built this rubble

[11] The gray stones have not yet been identified; this remains an issue for future study.

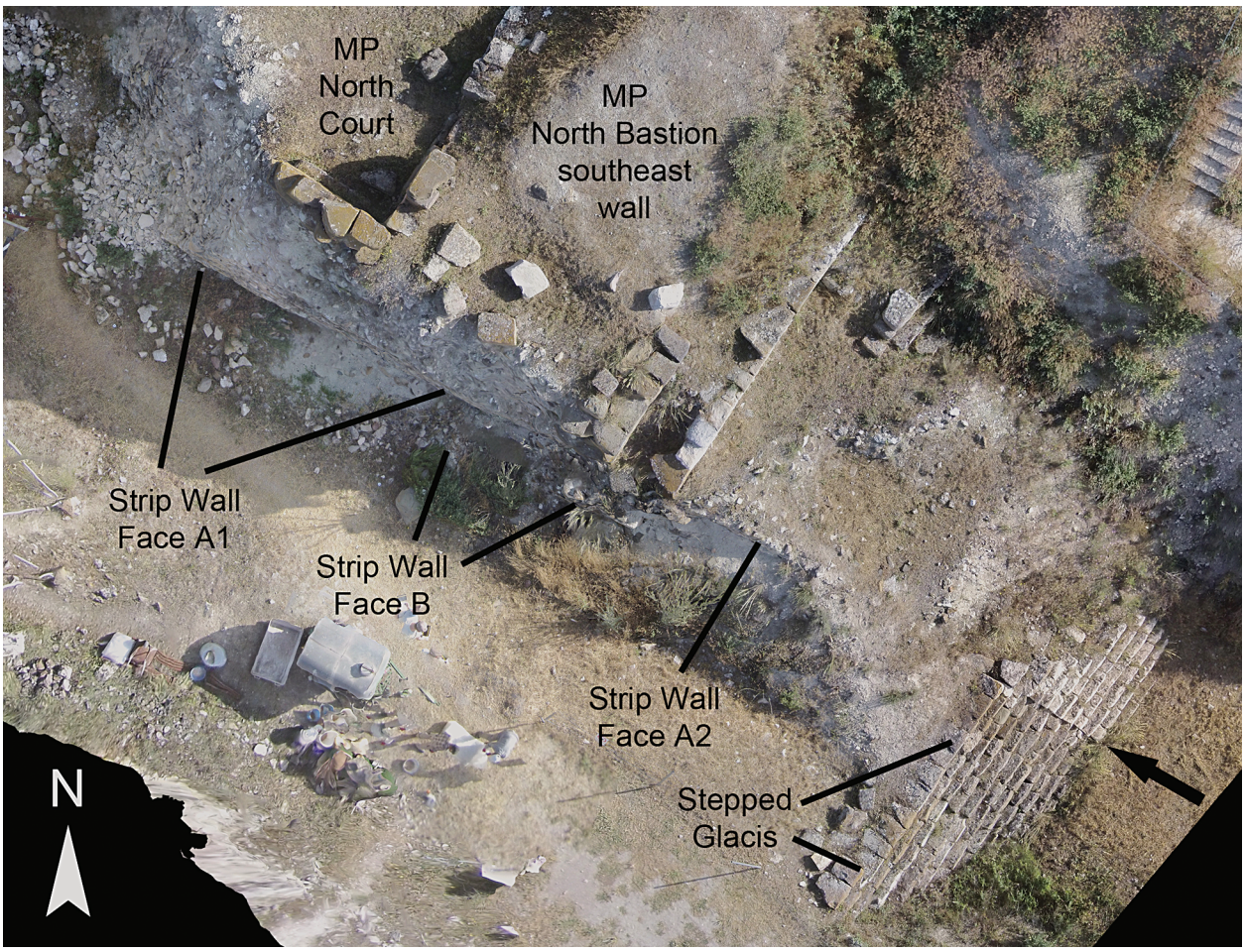

Fig. 18. Composite aerial drone photo showing the eastern section of the area under discussion. The jog in the stepped glacis is marked with the black arrow on the right. Its general alignment with Strip Wall Face A is clear, whether intentional or incidental. (Photo by L. Stephens; © Gordion Archaeological Project, University of Pennsylvania Museum of Archaeology and Anthropology)

operation was—even if today we do not understand it completely.

Modern Engineering Evaluation and the Stabilization Project

The site conservation undertaken in 2016 to stabilize the structure of the Middle Phrygian rubble fill helped shed additional light on the planning and construction of that stone packing, as articulated above, even as it provided necessary stabilization to the ancient architecture and enhanced visitors' abilities to view and understand Gordion's extraordinary Gate Complex structures. It began as an essential project for safety reasons, and it emerged as one that brought with it a significant additional understanding of the Middle Phrygian engineering that created the monumental new gateway, in addition to improving tourists' experiences at the site.

When Young excavated the gate in the 1950s, he removed a large quantity of the Middle Phrygian stone packing, leaving a 5 m high, semi-stable rubble scarp that still supported several fragmentary walls of the Middle Phrygian Gate. The rubble had been eroding steadily for 60 years, and it eventually became far looser and more dangerous. During the winter between 2015 and 2016, many of the stones fell from the main original rubble face, and this meant that several large stone blocks from the south interior corner of the North Court of the Middle Phrygian Gate that were resting on this rubble were in imminent danger of collapse (**Fig. 19**). Moreover, the interior of the North Court of the Early Phrygian Gate Complex had been excavated to ancient ground level by Young's team, leaving the rubble fill as an unbalanced load on the Early Phrygian wall. Cutting back the rubble would be essential to reduce some of the lateral pressure on the wall.

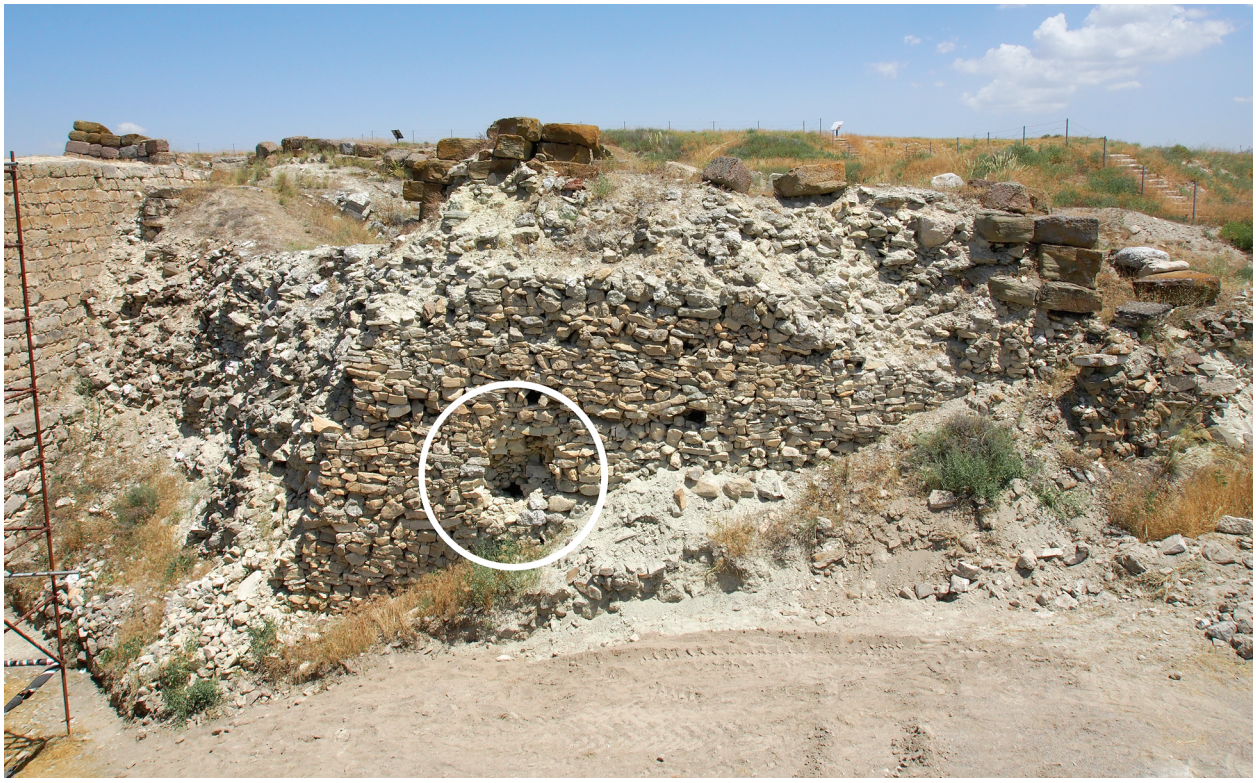

Fig. 19. View looking north toward the rubble fill: The circle indicates the location of the 2015–2016 collapse in the main face of the rubble. At the top above that area are the precariously situated blocks of the North Court of the Middle Phrygian Gate. To the left is the too-steep rubble slope resting in part against the east outer wall of the North Bastion of the Early Phrygian Gate Building. (Photo by S. Gönen)

The Gordion team submitted several proposals for the stabilization of the area, and approval was granted by Ankara's Historic Preservation Commission for a hybrid approach that did not require the addition of any modern materials, such as steel mesh, cables, or beams, but would stabilize the rubble and minimize the possibility of wall collapse and injury to visitors at the site (Biggs 2015; 2016). This approach entailed trimming the southwest corner to a 45° angle of repose; moving the existing Middle Phrygian walls of the gate to the northeast corner, which is still within the original footprint of the gate; and again trimming the south face to 45° by creating long steps, a process known as benching (**Fig. 20**). It would be inexpensive in comparison with the other options while being more appealing aesthetically. The project took place under the supervision of Semih Gönen (Boğaziçi University), with David Biggs (Biggs Consulting Engineering PLLC) acting as consultant.

Before stabilization efforts began, we completed full documentation of the extant state of the Middle Phrygian wall and rubble, including photography (aerial and ground), drawing (digital and manual), and 3D modeling. In the west part of the area approximately 1 m away from the Early Phrygian walls, a north–south wall fragment made of limestone blocks similar to the Early Phrygian wall stones had been exposed in Young's initial excavation and laid bare by weathering (**Fig. 21**). This was identified as part of the actual foundation for the Middle Phrygian Gate Complex walls, which was set into the rubble fill a few courses deep. That part of the wall, preserved within the 45° removal area of rubble, was documented and removed. The blocks from the wall were kept as possible replacement stones for archaeological conservation projects on the Early Phrygian Terrace Buildings in the future.

The conservation work, which involved a contractor, site supervisor, and eight workmen, lasted two weeks. They worked in small teams on the three approved tasks: to stabilize the Middle Phrygian rubble fill by trimming the southwest corner by the Early Phrygian Gate Complex to a smooth slope with a 45° angle, presumed to be the angle of repose for the structured rubble fill; to move the existing Middle Phrygian wall stones to their new location in the northeast corner using a mobile crane, reconstructing the wall in the new stable spot where it could be viewed and appreciated by visitors to the site;

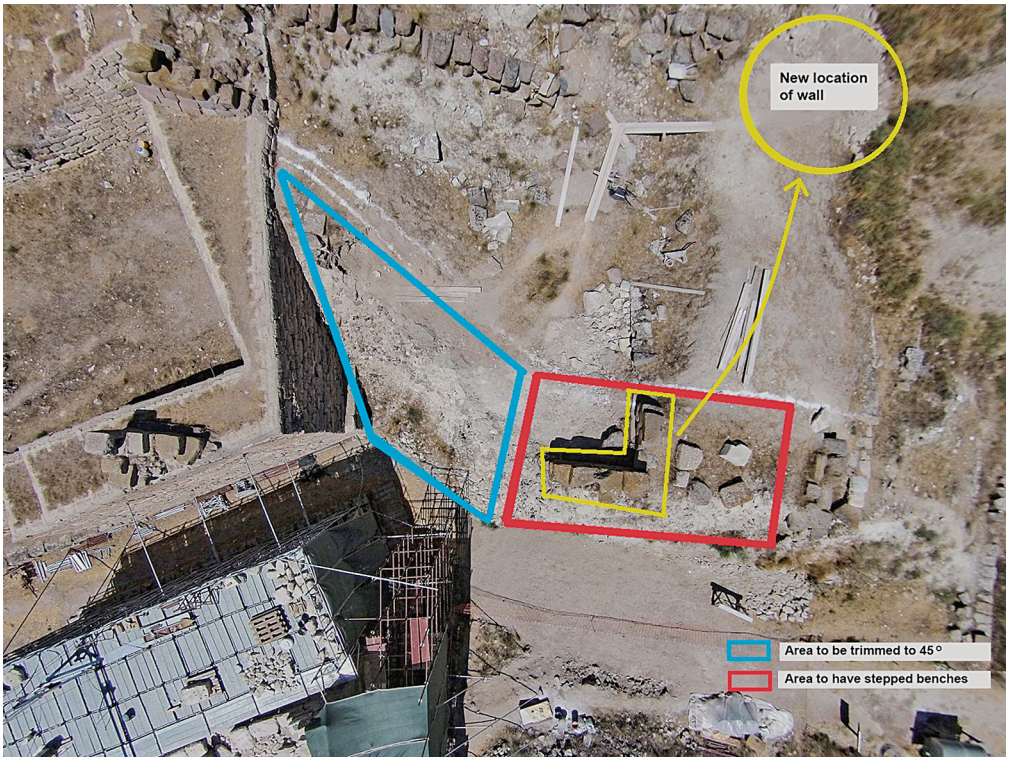

Fig. 20. Planned works: The blue area would be trimmed to a 45° angle of repose, the corner of the Middle Phrygian Gate Complex outlined in yellow below would be moved to the northeast corner and reconstructed within the yellow circle above, and the rubble fill at the south within the red area would be trimmed to 45° by benching. (Photo by L. Stephens; annotations by S. Gönen; © Gordion Archaeological Project, University of Pennsylvania Museum of Archaeology and Anthropology)

Fig. 21. Part of the Middle Phrygian wall foundations, resting on and originally surrounded by the rubble fill, looking northwest. The outer face of the Early Phrygian Gate's North Court is visible in the background. (Photo by S. Gönen)

and to trim the south face of the rubble to a 45° angle by creating multiple rubble steps or benching. Due to weathering and environmental conditions, the facing stones of the rubble steps could conceivably fall off in the future; however, this would not cause stability problems, and the falling stones could easily be replaced if necessary.

The area where the stabilization work took place was marked with lime so that it would be highlighted in drone photos (**Fig. 22**). The conservation engineer and an archaeology student from the Gordion team were always on-site to supervise the conservation work and to record the findings.

Work on the southwest side started with installing plywood at the bottom of the projected slope as a barrier to mark the bottom of the 45° angle. The slope was built by removing rubble from the precipitous and unstable parts of the slope above and constructing a smooth, even slope at the desired angle, from the bottom up. The slope was given a smooth drywall face.

During the work on the southwest side, a few fragments of juniper logs were found in the rubble fill (for the identification of the logs as juniper, see the appendix at the end of this article). Their presence in the fill recalled those known to exist from Young's excavations, although these logs seemed smaller than those Young described. The log fragments were recorded and removed for conservation and study.

Moving the corner wall from the south to the north side of the Middle Phrygian Gate's North Court required the preparation of a new foundation prior to its reconstruction. Before the stones were moved, all of them were marked and numbered with chalk, enabling the contractor to reconstruct the wall as close to its original configuration as possible (**Fig. 23**). The east–west wall was preserved to a maximum height of 2.03 m (including its foundation blocks) and a maximum length of 3.43 m; the northwest wall was preserved to a maximum height of 1.51 m and length of 2.37 m. The total number of stone blocks removed from this wall corner was 36; eight of them were foundation stones originally set within the rubble during the Middle Phrygian period and therefore not visible in antiquity. An interesting feature of wall construction that became clear only during its dismantling was the extensive use of mud mortar between both the stones and the courses. Such mud mortar is lacking in Early Phrygian wall construction.

A mobile crane was used to move the stones, which were temporarily stored on the ground on wooden planks and on top of each other, with wooden pieces placed between them to prevent cracking or damage (**Fig. 24**). The blocks were then reassembled in their original positions (**Fig. 25**) but rearranged to create an outside corner rather than the original inside junction. The wall corner was reconstructed in the northeast corner of the North Court of the Middle Phrygian Gate Complex, where the original stones had not survived but the preserved rubble provided a stable platform for the reconstruction. In this way, the reconstructed wall fragment retained as much of its original integrity as possible. The east–west wall was reconstructed running east–west as before, while the alignment of the north–south wall was changed 180° to face the visitor circuit, so that its original exterior face remained exterior. To duplicate the original construction technique, mud mortar was used during the reconstruction, which made it easier to move the blocks into place; it also prevented any stress concentration that would cause cracking of the stones. In addition, rubble and earthen fill was heaped behind the Middle Phrygian corner walls to provide extra stability.

Trimming the south face of the rubble back to benched steps to create a 45° angle began after the removal of the Middle Phrygian corner walls. This process of building vertical faces along the sides of the benched steps replicated the ancient construction technique of the Middle Phrygian architects with their interior strip walls within the rubble to provide stability and aid in its initial construction. As discussed, such strip walls were faces within the rubble, laid as the rubble fill was built up, functioning almost as a casemate wall within the great mass of the rubble. In modern times as in ancient, the strip walls helped to provide coherence as the rubble was built and greater stability as its height rose, and served as working platforms on which the workers could stand as they built the rubble.

The first step of the slope was built on ground level to support the existing rubble wall face. In order to provide drainage of rain and snow and also to prevent erosion beneath the steps, some earth and rubble material was laid in front of the first step, providing an intentional slope. The steps were mostly a little over a meter high; from the bottom, they were 1.05, 1.20, 1.20, 1.15, and 0.55 m tall, with a tread of 1.30, 1.40, 1.45, and 1.45 m (see **Table 1**). The second step was made by patching the voids of the existing interior rubble wall face with supplementary stones to make it complete again now as it had been in antiquity. Thus, the original ancient strip-wall face that the Phrygian architects once created within the rubble forms the face of the second step in the modern conservation. The remaining steps were constructed by hand with the stones from the rubble fill, during which we adopted a technique similar to that used in the construction of the original rubble fill in the 8th century B.C.E. The result was an offset stack of four full steps and a partial step at the top (**Figs. 26, 27**). As was the case for most of the ancient strip walls, the faces of our modern benches rested on the step below rather than being given

Fig. 22. Aerial photo showing the area to be trimmed/benched marked with lime. (Photo by L. Stephens; © Gordion Archaeological Project, University of Pennsylvania Museum of Archaeology and Anthropology)

Fig. 23. Marking of the interior east–west wall at the southeast corner of the Middle Phrygian Gate North Court before removal. (Photo by S. Gönen)

Fig. 24. Removing stones with a mobile crane. (Photo by S. Gönen)

Fig. 25. Reconstructing the wall corner in its new location. (Photo by S. Gönen)

Table 1. Height and Width of Each Step

*New Step Number**	*Height (cm)*	*Width (cm)*
1	105	130
2	120	140
3	120	145
4	115	145
5	55	n/a

* Counting from the bottom.

a vertical face all the way to ground level. Such offset and short vertical faces create a more stable structure than would a series of tall parallel walls.

To prevent the accumulation of water and water-caused erosion, the surface of each step was given a small east–west slope, while clay-rich earth was laid on top of the steps to provide a gentle inclination in the north–south direction. In the future, these clay surfaces will be planted with local shallow-root plants, such as the *Poa bulbosa* meadow grass used on the Early Phrygian Terrace Buildings of the Citadel Mound, to create a natural erosion-proof soft cap for the steps at the south face of the Middle Phrygian rubble.[12]

During the benching work in the southeastern section, five additional juniper logs were found in the rubble (**Fig. 28**). They were positioned close to the original Middle Phrygian wall corner (once the interior face of the southeast corner of the gate's North Court), approximately 1–3 m away from the wall. They were located at different heights and in different states of preservation; in general, they were found in much better condition than the logs discovered at the southwestern side of the rubble, all of which were preserved only as tiny fragments. Even so, they are small in comparison with those described by Young in his report; the largest we unearthed measured 0.95 × 0.23 m and 1.60 × 0.12 m.

Toward a Deeper Understanding of Middle Phrygian Rubble Construction

As noted above, refacing and stabilizing the rubble fill in July 2016 not only confirmed most of Young's original observations but also re-created and made visible to visitors the extraordinary Middle Phrygian rubble platform and foundations of the monumental Gate Complex. The depth of the rubble fill has never been determined, and even the excavated section of the stepped glacis/retaining wall to the east was never cleared to its bottom. But the stabilization work conducted in 2016 now exposes and clarifies this complex rubble structure striated with parallel strip walls roughly 1.2 m apart, extending east from the Early Phrygian walls all the way to the Middle Phrygian stepped stone glacis.

Several important new realizations and discoveries emerged from the stabilization work. It may be significant, for instance, that many of the southeast–northwest logs discovered in 2016 and those represented by their shadows in the face illustrated in **Figure 12** were set under the corner of the Middle Phrygian Gate's North Bastion. As mentioned, the two best-preserved logs among those found in 2016, lying parallel to each other, measured 0.95 × 0.23 m and 1.60 × 0.12 m. Such wood would have been useful in distributing the weight above it evenly, thereby preventing differential settlement of the rubble as well as cracking and spalling of the somewhat brittle stones that comprised the horizontal surfaces. Indeed, recent laboratory tests have demonstrated that timber ties substantially enhance the deformation capacity of masonry structures under compression, as well as help in reducing vertical cracks.[13]

Modern measurement technology demonstrates that the self-weight stresses on the foundations for large masonry walls are particularly high underneath corners, including in the area directly under the corner and also radiating out horizontally from that particularly heavy zone. This phenomenon is well illustrated using the modern technique of finite element analysis (**Fig. 29**). From the point of view of structural engineering, it makes sense that the area under the planned corners of the bastions would be given the extra reinforcement and weight-spreading capacity provided by the dense and stiff juniper logs laid in the rubble packing underneath.

The unweathered edges and homogeneous size of the stones comprising the rubble fill of the Middle Phrygian Gate Complex, as examined during the stabilization project, suggest they were not collected from the surface but were most likely the by-product of quarrying activities associated with the Middle Phrygian citadel: Stone blocks would be roughly shaped at the quarry, leaving behind piles of rubble chunks that could be carted to the Citadel Mound as described above. The architecture of the Middle Phrygian period at Gordion was so extensively robbed out that it is not clear for which particular

[12] For the use of *Poa bulbosa* on the Terrace Buildings, see Miller 2012: 253–56.

[13] For instance, Elizabeth Vintzileou (2008) comments that the cracking load of timber-reinforced masonry is significantly higher than that of unreinforced masonry, and timber ties allow for substantial diagonal cracks to open without the masonry disintegrating.

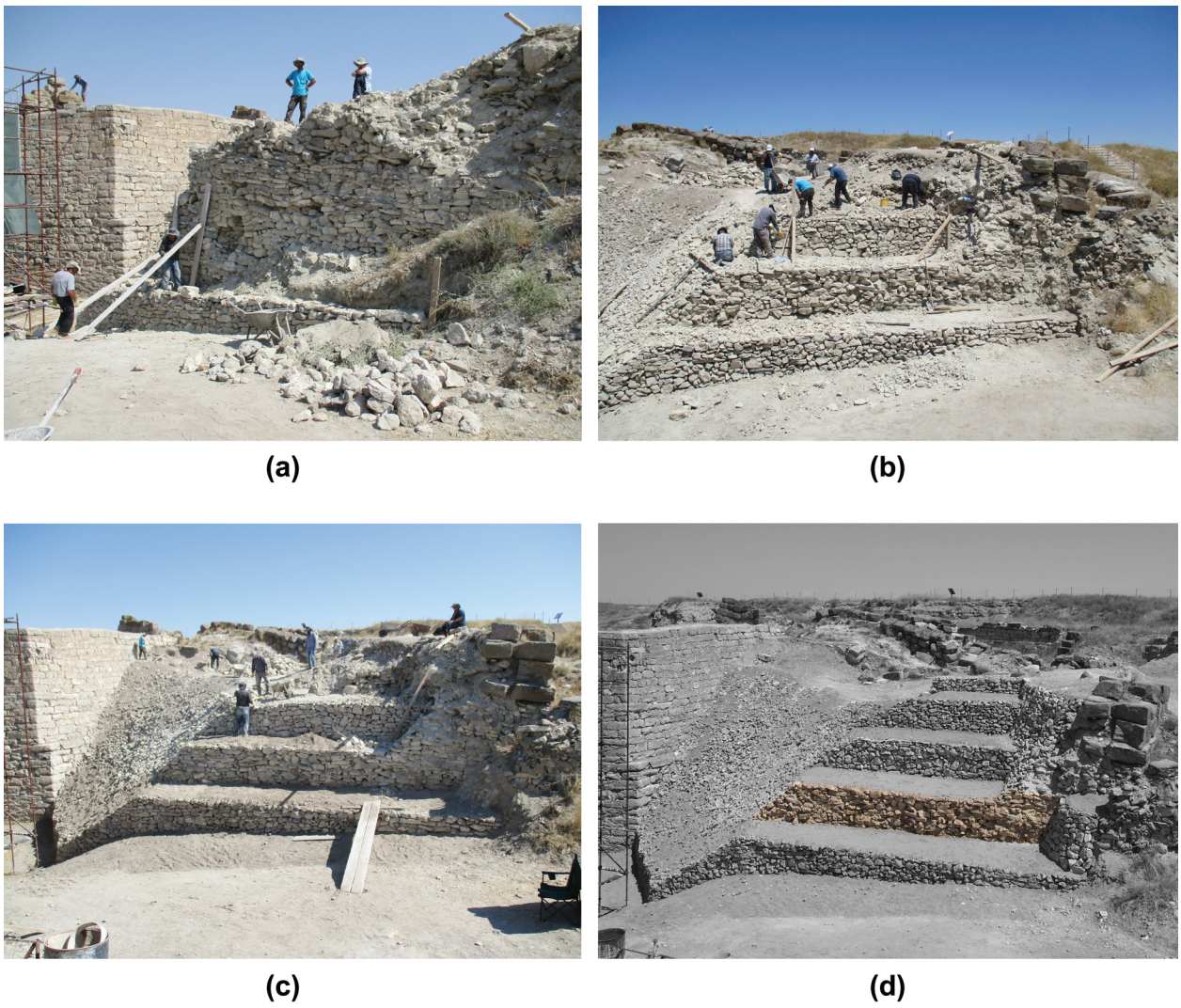

Fig. 26. (a) Benching starts from the bottom; (b) after the third step is finished; (c) providing the steps with earthen caps; and (d) after completion of the steps; the original rubble face is highlighted. (Photos and marking by S. Gönen)

structures the stone was being quarried; however, both limestone and gypsum blocks form part of the preserved superstructure of the Middle Phrygian Gate Complex, and it seems likely that both stone blocks and debris were brought from the same quarries for this building project.[14] Such an explanation also clarifies why the pieces in the Middle Phrygian rubble fill were so clean. The masons working on the Gate Complex had at least two sources for their rubble, as the stones of the rubble include both limestone and gypsum.

We assume that the gypsum originated from an outcrop at a cliff about 3.5 km north of Gordion, but any trace of formal ancient quarries there have presumably been obliterated by erosion, since none is now visible.[15] In many buildings and walls of the Middle Phrygian citadel, large gypsum blocks were used, so gypsum quarry waste would have been readily available. We have, at this point, no idea where the ancient limestone quarries near Gordion were located, but similar new limestone blocks

[14] The extensive robbing of earlier buildings affected the Late Phrygian period, too. For Late Phrygian architecture on the Citadel Mound, see Fields 2011. For the reuse of earlier blocks in Hellenistic architecture on the Citadel Mound, see Wells 2012.

[15] For the gypsum outcrop, see Marsh 2005: table 13-1; and Marsh and Kealhofer 2014: 690, fig. 1. Ben Marsh and Lisa Kealhofer (2014) have demonstrated that the lowlands around Gordion are dominated by gypsum, gravel, and marl sediments, while the nearby uplands are basalt and hydrothermally altered marls.

Fig. 27. Aerial photo showing the final results of the conservation work, with the relocated wall corner and the single remaining original strip-wall face indicated. (Photo by L. Stephens; scale by B. Cordivari; © Gordion Archaeological Project, University of Pennsylvania Museum of Archaeology and Anthropology)

Fig. 28. Position of the juniper logs indicated with a white arrow on the left; juniper logs after cleaning the surroundings on the right. (Photos by S. Gönen)

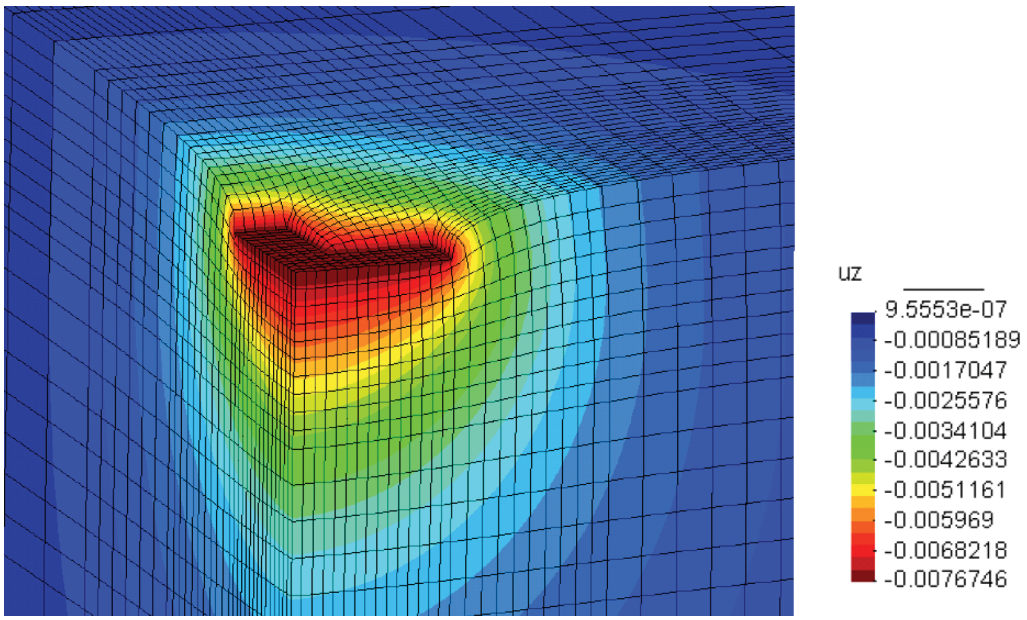

Fig. 29. Stress contour mesh showing increased stress and settlement displacement around and under the corners of a building, using finite element analysis (after Hazzard et al. 2009: fig. 12). (Courtesy of T. Yacoub)

have been acquired in the area for architectural conservation. These were collected in surface exposures by prying up slabs, and this activity left no high-wall quarry sites. Presumably, there are no limestone quarries with such distinctive appearances to be found today. While a comprehensive analysis of all the stones used at Gordion has yet to be completed, there is no indication that any of the stones used in Early and Middle Phrygian buildings were imported from any great distance.

It is somewhat ironic that with all the planning and care invested in the construction of the rubble fill, the builders of the Middle Phrygian Gate Complex did not seem to have recognized or taken into account the fundamental instability of gypsum as a building material. Over time, the gypsum crumbled or even dissolved entirely due to rain and snowmelt. This led to significant ancient subsidence in the North Court of the Middle Phrygian Gate Complex (particularly under its east face and northeast corner), as may be clearly seen in **Figure 30** (Ben Marsh, pers. comm., 1995).

Eventually, the sinking of the rubble fill would have caused the outer wall of the North Court of the Middle Phrygian Gate Building to collapse, although we do not know exactly when this happened. The presence of numerous arrowheads found at the Gate Complex's exterior that date to the beginning of the 4th century B.C.E. suggests it was still standing at the time the Spartan king Agesilaos besieged Gordion in 395, but the orientation and grouping of the 3rd- and 2nd-century Hellenistic houses on the Citadel Mound inside the walls suggest the Gate Complex had gone out of use by then.[16] A similar problem of subsidence occurred just southwest of the Middle Phrygian Gate Complex in Building A, constructed in the 8th century B.C.E., which had its floors (and presumably upper walls and roof) releveled on multiple occasions during the life of the building (Sams and Burke 2008; Burke 2012: 210–11). The reuse of quantities of Middle Phrygian shaped stone blocks in the later Hellenistic constructions was no doubt made possible by the collapse of the earlier structures.

At the Middle Phrygian Gate Complex, the dissolving gypsum rubble presumably caused the walls of the bastion to collapse. The eastern wall of the North Court would have sagged dangerously out to the east as its walls subsided, looming over the northern approach to the gateway passage. After reaching its limits of subsidence, the tower would have collapsed, blocking access. This collapse presumably marked the end of the fortification of this part of the Citadel Mound, unless there is some unrecognized evidence of a rebuilt section of wall with or without any kind of gate (Rose 2017: 161–68).

The ingenuity of the Middle Phrygian builders is demonstrated in the construction techniques they were developing as they built the massive Gate Complex on the eastern side of the Citadel Mound at Gordion.

[16] For the arrowheads and their connection to the Spartan attack, see Rose 2017: n. 47. For the orientation of the Hellenistic houses, including the fact that they fill in the area that would have been an entrance to the Citadel Mound if the gate had remained functional, see Wells 2012: fig. 5.

Fig 30. Interior face of the southeast corner of the North Court of the Middle Phrygian Gate Complex, showing significant subsidence before collapse (i.e., in the wall sloping down to the left at the rear of the image [marked by a white arrow]). The wall was the interior face of the north–south wall on the eastern edge of the Middle Phrygian Gate Complex's North Court. This wall was originally horizontal before subsidence in antiquity. (Photo by S. Gönen)

The stepped glacis served not only as a polychromatic element of the defensive fortifications but also as a retaining wall for the enormous weight of the rubble fill supporting the gate building itself. That rubble was carefully constructed with internal wall faces and juniper logs laid at crucial points to provide a stable and flexible support. The juniper offered a degree of elasticity and tie-in to help spread weight and hold the rubble itself together. When that rubble did not withstand the weathering caused by water dissolution, the walls atop it sagged and collapsed.

The excavations at Gordion have provided ample evidence for enormous building projects involving the shifting of vast quantities of earth and rock. The tremendous rubble fill underlying the great Gate Complex of the Middle Phrygian period offers yet another example of experimentation and ingenuity in architecture by people undaunted by titanic effort.

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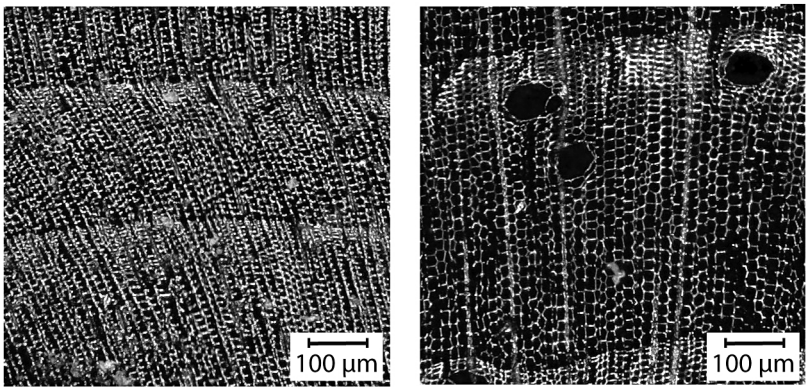

App. Fig. 1. Juniper (left) does not have resin ducts and typically has narrower rings than pine (right), which does have resin ducts. (Photos by the Center for the Analysis of Archaeological Materials, University of Pennsylvania Museum of Archaeology and Anthropology)

Appendix

In 2016, seven pieces of wood from the rubble beneath the Middle Phrygian Gate were examined with a hand lens and low-power microscope (7–45×). All are coniferous. Based on previously reported coniferous woods found at Gordion, three genera are considered: juniper (*Juniperus* spp.), pine (*Pinus* spp.), and Lebanon cedar (*Cedrus libani*). The ceiling beams of Early Phrygian Terrace Building 2A were pine (Miller 2010), while the tomb chamber of Tumulus MM was constructed of pine and juniper, with cedar floors (see the references in Liebhart 2012). As Lebanon cedar does not grow near Gordion, it will not be considered further. *Pinus nigra* and *Juniperus excelsa* are both common in the region.

The coniferous species that grow closest to Gordion are two types of juniper (*Juniperus excelsa* and *Juniperus oxycedrus*) and pine (*Pinus nigra*). Of the junipers, *Juniperus oxycedrus* in this area tends to be shrubby, so the taller, single-trunk *Juniperus excelsa* is more likely to have been used for timber. *Juniperus excelsa* can grow up to 20 m, and its trunk diameter decreases noticeably with height; *Pinus nigra* grows up to 30 m, and its trunk diameter does not narrow much with height (Davis 1965). The key anatomical difference between pine and juniper wood visible at low magnification is that the former has resin ducts and the latter does not (**App. Fig. 1**). At low magnification, a small piece of pine might be ambiguous, if the piece happens not to have resin ducts. Also, irregular holes caused by rootlets or fungal hyphae might be mistaken for resin ducts, which are smooth-walled structures.

Most of the pieces found in the rubble are dense and hard (but fairly easily broken), and the growth rings are narrow—both characteristic of juniper. The intact wood is black (probably due to oxidation, as it is not charred). There are softer, brown parts of rotted wood. One of the pieces had rotted wood in the center and increasingly intact wood toward the edge. The holes seen in these samples are ringed with brown and are not distributed like resin ducts. Instead, they are arrayed radially rather than tangentially, as would have been expected for pine. It is likely that the holes are from fungal hyphae, some of which were seen through the microscope as white linear structures.

The hardness and rot resistance of juniper are particularly appropriate for stabilizing the rubble fill. Regardless, all of the wood examined to date is juniper.

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