THE FUNERARY MONUMENT OF KING KHASEKHEMWY AT ABYDOS (ca. 2700 BCE): CONSERVATION AND ARCHAEOLOGY, 1999-2006

Final report on the "Documentation and Conservation of King Khasekhemwy's Funerary Monument at Abydos," a sub-project of the Egyptian Antiquities Project of the American Research Center in Egypt

2007

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With

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This report was prepared for
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under USAID Grant No. 263-G-00-93-00089-00 (formerly 263-0000-G-00-3089-00)

Table of Contents

Preface

The subject of this report, "Documentation and Conservation of King Khasekhemwy's Funerary Monument at Abydos," is a project undertaken by the Institute of Fine Arts, New York University, led by David O'Connor, Director, and Matthew Douglas Adams, Associate Director, under the auspices of the University of Pennsylvania Museum-Yale University-Institute of Fine Arts, New York University Expedition to North Abydos, Egypt (William Kelly Simpson and David O'Connor, Co-directors). The project has been made possible with the support of the Egyptian Antiquities Project of the American Research Center in Egypt under a grant from the United States Agency for International Development.

The project was developed with three primary goals pertaining to the funerary monument of Khasekhemwy:

i) To undertake systematic and detailed architectural and archaeological documentation of this uniquely significant monument and its history.
ii) To determine the exact nature and extent of structural and other condition problems affecting the monument.
iii) To develop and implement conservation measures to address the condition problems affecting the monument.

The project's field program has so far been developed over the course of seven seasons to include the archaeological investigation and architectural documentation and conservation of king Khasekhemwy's funerary monument. Project consultants involved in the architectural documentation and conservation of the monument to-date include preservation architect, William C. S. Remsen of International Preservation Associates, Inc. (USA), mudbrick conservation specialist, Anthony Crosby of Architectural Conservation, LLC (USA), and structural engineer, Conor Power of Structural Technology, Inc. (USA).

In addition to the documentation, conservation and archaeological investigation of Khasekhemwy's enclosure, the project also focuses on a group of Early Dynastic boat graves at Abydos. Although unrelated to the funerary monument of Khasekhemwy, the boat graves represent a significant aspect of Early Dynastic royal activity at Abydos, and their study and preservation have been additional objectives of the project. Project consultants involved in the excavation and conservation of the Early Dynastic boat graves at Abydos include Associate Professor of Nautical Archaeology, Cheryl Ward of Florida State University, and Lawrence Becker and Deborah Schorsch of the Metropolitan Museum of Art.

During the course of the field program to-date, Seasons 1, 3, 4, 5, 6 and 7 (Fall 1999-Winter 2000, Spring 2001, Fall 2001-Winter 2002, Spring 2004, Fall 2004-Winter 2005, Fall 2005-Winter 2006) have focused on the enclosure of Khasekhemwy, and Season 2 (Spring 2000) was focused on the boat graves.

Introduction

The funerary monument of king Khasekhemwy at Abydos, known today as the Shunet el-Zebib, or "Shuneh," was the last and largest of a series of monumental mudbrick cult enclosures built at the site by Egypt's earliest kings (Figure 1). Constructed by Khasekhemwy, the last king of Dynasty 2 (ca. 2700 BCE)[1], it represents half of the king's two-part funerary complex; the other half is his underground tomb situated some 1.5km to the south of the enclosure at a part of the site of Abydos known as Umm el-Qa'ab. As far as is currently known, the tradition of constructing royal enclosures began at the start of Dynasty 1 with king Aha, corresponding to a dramatic increase in the scale and complexity of the royal tomb. All the kings of Dynasty 1 and the last two of Dynasty 2 were entombed at Abydos, and each appears to have built a corresponding enclosure on a low desert terrace overlooking the ancient town. Given that the tombs were underground features located in the desert relatively far from ancient habitation, and that there is little direct evidence that they were marked aboveground by any large-scale constructions other than (possibly) relatively modest tumuli, the Abydos enclosures should be taken to represent the primary monumental statement for each king of royal presence and power at the site.

The enclosure of Khasekhemwy is the only one of the Abydos enclosures still standing today. Most of its walls remain close to their original height of 11-12m. The preceding enclosures all appear to have been deliberately demolished after having been used for a short time during the reign of each king. Demolition may have occurred after the conclusion of each king's funeral ceremonies, when the cultic function of his enclosure had been fulfilled.

Khasekhemwy's enclosure has a unique significance in Egypt's cultural heritage. As the only surviving royal funerary enclosure, it is uniquely representative of Egypt's earliest tradition of royal monumental building. As the largest and most complex of the enclosures, it may be taken as the fullest achievement of this tradition. The Shuneh also has an important position in the broader evolution of Egyptian royal funerary monuments. Many of its design elements were reflected in the funerary complex of Khasekhemwy's successor, Netjer-khet Djoser, the great Step Pyramid complex at Saqqara, which relates it and the other Abydos enclosures directly to the development of the royal pyramid complexes that characterized royal monumental building for many centuries thereafter. Khasekhemwy's enclosure, along with another, smaller cultic building built by the same king at Hierakonpolis, represent the oldest standing mudbrick structures in Egypt and quite possibly the world.

In its most basic aspects, the enclosure of Khasekhemwy follows the same template as earlier royal enclosures at Abydos (Figure 2). The enclosure is a massive mudbrick wall that defines a rectangular, unroofed interior space. The exterior of the wall was characterized by a pattern of alternating niches and pilasters known as a niched or "palace" façade, an architectural motif that occurs frequently in both contemporary architecture and the iconography of the period (Figure 3). The northeast side of each enclosure, facing the alluvial plain and the river (representing the "local" or "river east" side), was given special

[1] Chronology generally follows Redford (ed. 2001).

emphasis. The simple niches present on the other three sides of the enclosure here alternate regularly with wider, deeper and more elaborate, or "complex," niches, with the usual pattern that every fourth niche is of the complex variety.

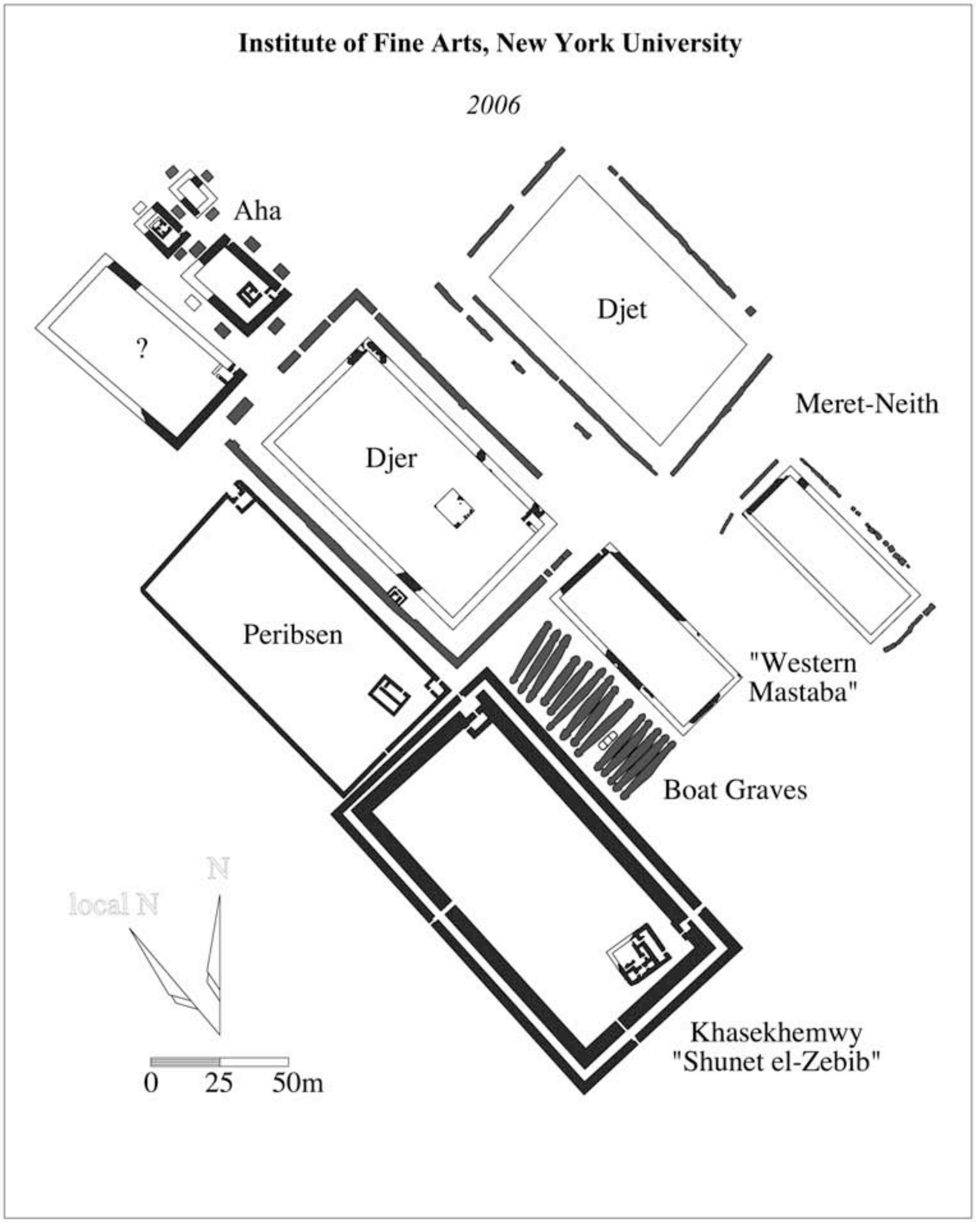

Figure 1. Map of the known royal enclosures and associated features of Dynasties 1 and 2 at North Abydos. (Institute of Fine Arts, New York University 2006)

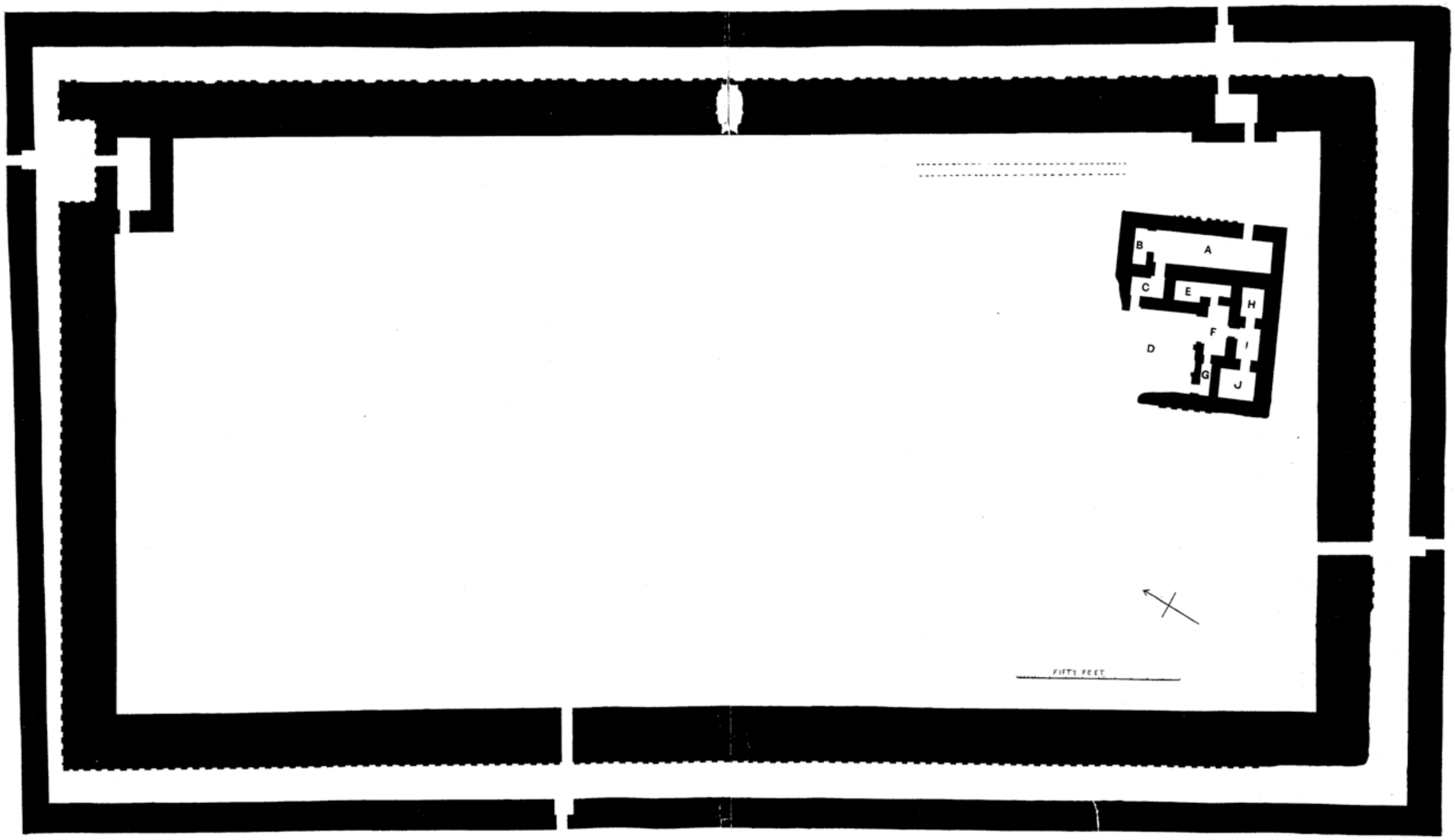

Figure 2. Plan of the funerary enclosure of king Khasekhemwy produced by E. R. Aryton during his 1902-1903 excavations. (Ayrton et al. 1904:Pl. 6)

Figure 3. Detail of the preserved niched, or palace, façade of king Khasekhemwy's funerary enclosure; this architectural motif of alternating niches and pilasters originally covered the full façade of the main enclosure. (Photo: Robert Fletcher 2004-2005)

All of the known enclosures at Abydos appear to have had gateways at the north and east corners. For Dynasty 1, the east corner gateways are the most elaborate, while for Dynasty 2 the northern gateways become the more complex. Inside the enclosures (typically in the southeastern part) were small, freestanding mudbrick chapels. None of the enclosures presently appears to have had built features in the northwestern part of the interior. In Dynasty 1, the enclosures, as well as the royal tombs, were surrounded by the tombs of sacrificed courtiers, but this practice did not continue into Dynasty 2. The Dynasty 2 enclosures of Peribsen (ca. 2725 BCE) and Khasekhemwy are missing an architectural detail present in each of the Dynasty 1 enclosures, namely, a low, flat-topped mudbrick bench constructed against the wall base around the entire exterior side of the enclosure.

The monument of Khasekhemwy is unique in that it is comprised of two concentric mudbrick enclosures. The total area covered by Khasekhemwy's monument is more than 10,000 square meters (138 x 78m). The more massive inner, or main, enclosure wall is approximately 5m thick at the base and was probably originally 11-12m high. The exterior faces of this wall exhibit the niching pattern typical of royal enclosures. Surrounding the main enclosure wall is another less massive enclosure, termed the "perimeter wall," averaging just over 3m thick at the base and perhaps originally 6-7m high. The perimeter wall had a completely plain façade, and it would have obscured the lower part of the main enclosure. Only the upper part of the main wall would have been visible from beyond the outer wall. All wall surfaces were originally covered first with a thick coat of mud plaster, then with a thinner secondary coating of grey-buff colored plaster containing gypsum, and finished with a thin coat of whitewash.

In the Shuneh, as in the adjacent Dynasty 2 enclosure of Khasekhemwy's predecessor king Peribsen, the north gateway was the most elaborate, with the façade set back to create a kind of small forecourt and a walled chamber just inside the gateway. The walls of this chamber blocked direct access to the northern part of the enclosure's interior from the outside. Anyone passing through the north gateway would have to turn right, walk several meters, and pass through a second doorway at the southwest end of the gateway chamber, to gain access to the open interior of the enclosure. The east corner gateway included a small chamber-like space built into the wall itself, and the openings in the exterior and interior sides of the wall were offset from one another, such that a change in direction would be required of anyone passing through the gateway. The enclosure had additional, simpler gateways in its southeast and southwest walls, and, unlike the north and east corner gateways, these provided direct access to the interior. Opposite each of the four gateways in the main enclosure wall was a corresponding opening in the perimeter wall.

Despite its unique historical, cultural and architectural significance, Khasekhemwy's enclosure is a monument at risk. Prior to the commencement of this project, a casual visitor to the site could easily observe that large sections of the walls had collapsed and that still others were in danger of collapse. Even the best-preserved wall sections exhibited numerous holes, cracks, voids and ominous-looking overhangs. Some of these holes penetrated completely through the walls. Adjacent to the holes, voids, cracks and overhangs, the original fabric of the walls frequently appeared to be in an extremely precarious state, ready to collapse at any moment. Archaeological excavations in the early

20th Century exposed large areas of the original finish of the façade, which were subsequently left exposed to the elements, and as a consequence, almost entirely lost. Observations throughout the 1980s and 1990s determined that major losses were occurring in the original fabric of the monument (such as the collapse of a large section of masonry in the northwest wall following torrential rains in the mid-1990s) and that, with increasing pressure from modern development at the site, the situation was likely to worsen over time.

Although the Shunet el-Zebib is shown on maps of Abydos as early as the beginning of the 19th Century, such as that produced by the Napoleonic expedition and published in the *Description de l'Égypte*, the earliest known archaeological work at the monument was undertaken by, or more properly, on behalf of, Auguste Mariette in the mid-19th Century (Mariette 1880a:46-49, 1880b). Mariette's publication includes schematic (although not entirely accurate) plan and section drawings of the walls of the enclosure, however these do not show the locations of his excavations (Mariette 1880a:Pl. 68). It is clear from Mariette's discussion that he did not understand the early date or purpose of the monument, although he recognized evidence for its re-use in later times.

Gaston Maspero examined the walls of the enclosure in the later 19th Century, and at first concluded that it likely belonged to Dynasty 18 (Maspero 1887:17-22), although he later revised his view in favor of a First Intermediate Period date (Maspero 1894:450-452).

E. R. Aryton, working on behalf of the Egypt Exploration Society, excavated at the Shuneh in the early 20th Century, and the results of his work are published in *Abydos, Part III* (Ayrton et al. 1904:1-5). On the basis of seal impressions bearing the name of Khasekhemwy, as well as ceramics datable to Dynasty 2, Ayrton deduced the true age of the monument, but its original purpose remained elusive and he interpreted the structure as a fortified royal residence.

During his extensive excavations in north Abydos on behalf of the University of Liverpool between 1905 and 1910, John Garstang re-excavated the mudbrick chapel inside the Shuneh. Garstang published little on the results of this work, but a brief report of 1909 did include drawings of a number of seal impressions, including examples with the names of Khasekhemwy and Netjer-khet (Garstang 1909).

In the 1980s, David O'Connor undertook excavations at the Shuneh on behalf of the University of Pennsylvania Museum-Yale University Expedition. At that time, a feature was found inside the enclosure that was identified as the edge of a brick-covered mound of sand and gravel, which O'Connor (1991) interpreted as a prototype for the mound-like construction in stone that was the first phase of the Step Pyramid at Saqqara. Subsequent excavations have demonstrated conclusively that there was no such mound in the enclosure (see Archaeological Investigation of the Monument, to follow).

In response to the obvious urgency of the need for stabilization and conservation measures at the Shuneh, the Institute of Fine Arts, New York University, organized a project intended not only to identify and address the condition problems at the monument, but also to investigate and document systematically and comprehensively, for the first time, its architecture and the archaeological record of its history of use. The research components of the project relate to a broader program of inquiry focused on all the royal constructions in north Abydos in Dynasties 1 and 2 and the full definition of this earliest tradition of royal monumental building.

One particular component of this broader tradition is also part of the research and conservation program of this project. On the northeast side of the Shuneh, situated between it and an earlier royal enclosure of Dynasty 1, known as Petrie's "Western Mastaba," is a group of long, low, parallel structures built of mudbrick, each containing the wooden hull of a boat. Other boat graves of the Early Dynastic period have been found at Saqqara and Helwan (Emery 1961; Saad 1947, 1951), where they were built adjacent to the mastaba tombs of the Memphite court elite. These boat graves occur singly and are substantially smaller than those at Abydos. The Abydos boat graves are unique in terms of context (situated among royal cult enclosures), size (both of the grave structures and of the wooden boats they contain) and number (fourteen boat graves have been identified to-date). The Abydos boat graves are the antecedents of both the actual boats and the symbolic boat features that were incorporated into later royal pyramid complexes. They are also significant in a broader sense, as they represent some of the oldest watercraft yet discovered in the world.

The Architectural Design and Construction of the Monument (ca. 2700 BCE)

Preliminary evaluation of the original design and construction of king Khasekhemwy's funerary monument at Abydos contributed to an extensive architectural field report produced by members of the Pennsylvania-Yale-IFA/NYU documentation and conservation project, following initial field survey in 1999-2000 (William C. S. Remsen, International Preservation Associates, Inc.; Anthony Crosby, Architectural Conservation, LLC; and Conor Power, Structural Technology, Inc.). The purpose of the architectural evaluation was to document the original character and existing condition of the monument, as well as to provide a basic understanding of decay mechanisms to aid in selecting compatible methods and materials for subsequent conservation treatment. As such, a central goal of the study was to identify the principal character-defining features of the monument as the single surviving example of Egypt's earliest monumental building tradition.

It is evident from the existing structure that the funerary monument of king Khasekhemwy was designed within an established building tradition and constructed according to planned specifications. Located ten kilometers west of the Nile River in an area characterized by rolling sand dunes continually shifted by prevailing north winds, the site of the monument incorporates over 10,000 square meters of area, measuring 138 x 78m in perimeter (Figure 4). The enclosure itself is a rectangular, mudbrick structure comprised of two concentric sets of enclosure walls, the inner of which defines an interior space measuring approximately 117 x 55m (Figure 5). The outer, or "perimeter," set of walls originally stood to an estimated height of seven meters, somewhat more than half the original height of the inner, or "main," set of walls, which reached eleven to twelve meters. The lower perimeter walls surround the main enclosure walls at a distance of approximately three meters on three sides (northeast, southeast and southwest), while on the northwest side the perimeter and main walls are closer. The space between the two sets of walls forms a corridor along the outer circumference of the main enclosure. Each set of walls features four gateways (one per wall), which are corresponding passages through the perimeter and main enclosures at points north, east, south and west. Longitudinally, the monument is oriented northwest to southeast and its placement intentionally responds to earlier funerary enclosures at Abydos; that is, it represents the last in a series of enclosures erected successively in a north-and-east to west-and-south direction, and its axial orientation is approximately parallel to the adjacent earlier enclosures. For descriptive purposes, architectural elements are labeled in reference to site north, which lies approximately 43° west of true north, so that the "north" walls are those which face northwest by magnetic compass, "east" corresponds to northeast, "south" to southeast, and "west" to southwest (Figure 6). The monument was built directly on a leveled base of very stiff, fine sand, with no additional foundation supporting the first course of mud brick.[2] The original appearance of the main enclosure was of a solid, rectangular structure most likely absent of any openings or voids other than the gateways, featuring a decorative niche-patterned, or "palace," façade and two coats of plaster with a whitewash finish covering both the interior and exterior surface.

[2] "Course" refers to a horizontal layer of masonry.

Figure 4. The exterior area of the enclosure (facing south); note the east gateway area of the Peribsen enclosure (ca. 2725 BCE) at lower right. (Photo: Robert Fletcher 2004-2005)

Figure 5. The interior area of the enclosure (facing north). (Composite photo: William Remsen 2000)

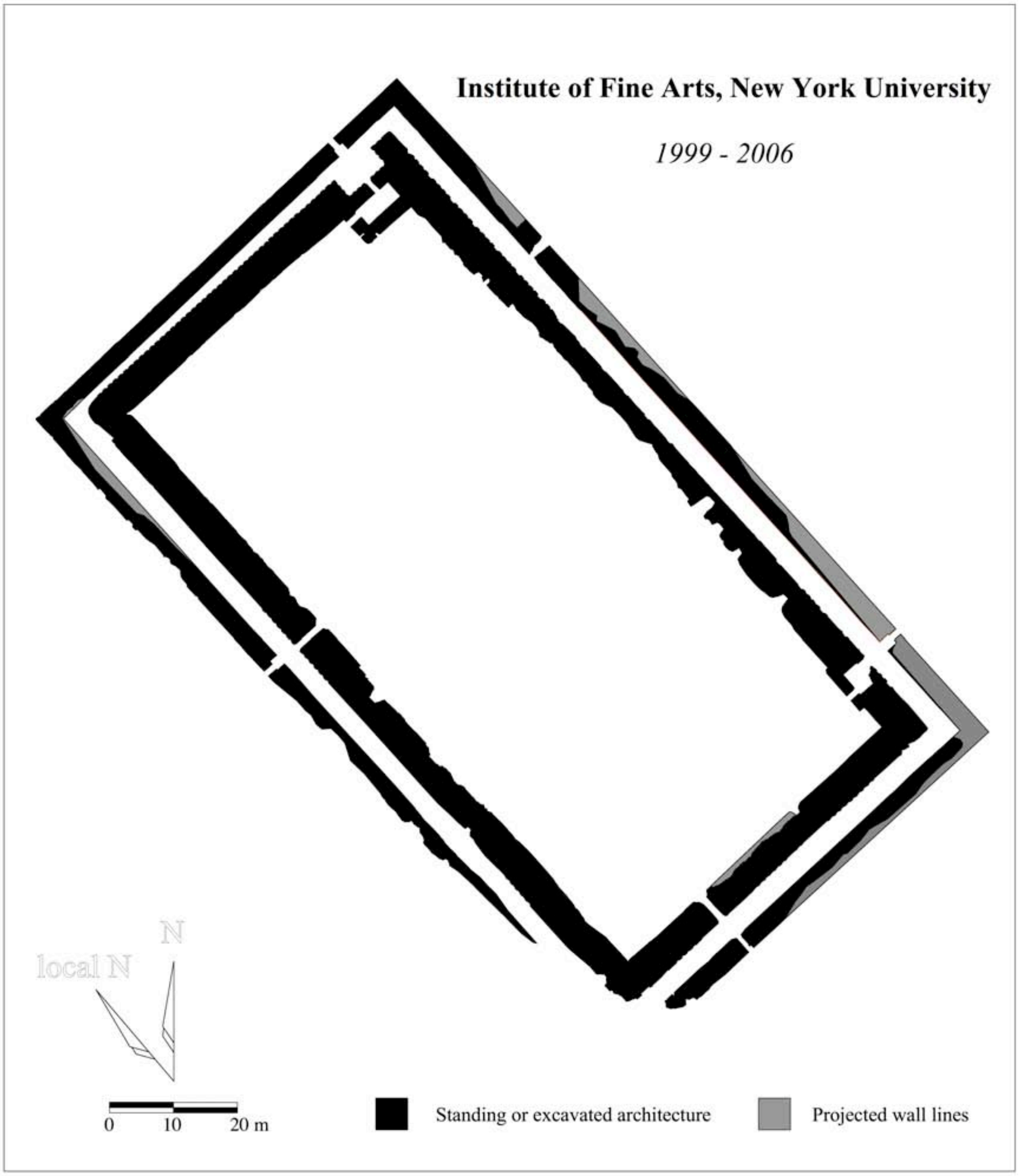

Figure 6. Plan of the funerary enclosure of king Khasekhemwy at North Abydos. (Institute of Fine Arts, New York University 1999-2006)

At their original height, the main enclosure walls contained approximately 6,400,000 bricks with an additional 2,700,000 bricks in the perimeter walls, for a total construction estimate in excess of 9,000,000 mud bricks. The materials and technique of mudbrick manufacture were of a consistent and uniform quality throughout construction, with a standard brick unit measuring 26-27cm long by 12-13cm wide by 8-9cm high. Based on random, non-destructive sampling at several wall locations, the average brick measures 26.13 x 12.51 x 8.1cm (L x W x H). These dimensions are squarely in the range of Early Dynastic mud brick sizes studied by Kemp (2000:87). The minor variations observed in brick sizes at various locations throughout the structure are attributed to practicalities of fabrication and do not represent a significant distribution pattern. The bricks were composed of very fine, light brownish gray silts and sands from nearby alluvial deposits with a binder of very fine chopped straw, and were fabricated with smooth molds at an unidentified location likely near the edge of adjacent cultivation to be transported to the site after drying (Figure 7). Apart from one localized area of the monument, where a limited number of bricks on the west main wall exhibit grooved impressions molded into their header ends, most likely as the result of an irregular mold element (Figure 8), no stamps or markings have been observed on any of the bricks and there is no evidence for the re-use of bricks from any earlier site in construction of the monument. The main enclosure was constructed using cubit dimensions, which are reflected in brick size as well as in niche and wall design as described below. In the third millennium BCE, the royal cubit had an approximate value of 52cm, so that one brick-length (or 26cm) is roughly equivalent to one-half royal cubit and one brick-width (or 13cm) represents one-fourth royal cubit.

The outer, perimeter wall of the monument is comprised of the north perimeter wall, the south perimeter wall, the east perimeter wall and the west perimeter wall, each with one gateway. The perimeter wall measures 138 x 78m (L x W) in exterior dimensions and 132.4 x 71.6m in interior dimensions; it is 3.2m thick at the base and is preserved to a maximum height of 5-6m on its south side. The north, south, east and west perimeter gateways are essentially identical in design, each a two-sided passage with an inner, rectilinear recess opening into the adjacent corridor, which may have allowed a wooden door to swing inward (Figure 9). The perimeter wall does not feature a decorative program and there is no preserved evidence of specific design features or details added to the finished wall surface. Magnetic orientation measurements indicate that the perimeter walls are just shy of being perfectly straight and are reliably parallel to the inner, main enclosure walls, with the exception of the north perimeter wall, which is slightly askew, probably due to the position of the south wall of the nearby enclosure of king Peribsen. The interior face of the perimeter wall has a significant batter angle, which may correspond to the slope of the exterior face of the main wall directly opposite (see below); the gates, however, are nearly vertical.[3] The exterior face of the perimeter wall is poorly preserved and its batter is not certain, although it is likely to have been similar to that of the interior face.

The corridor separating the perimeter wall from the main wall comprises the north corridor, the south corridor, the east corridor and the west corridor, which are a consistent three meters across with the important exception that the north corridor narrowed from east to west due to the angle of the north perimeter wall (Figures 10-14). This adjustment seems to

[3] "Batter" refers to the slope angle of a wall, expressed in terms of its degree from vertical.

represent a planned construction feature based on the intended siting of Khasekhemwy's enclosure, although the specific significance of this siting is unknown.

Figure 7. Detail of a typical mud brick from the original construction. (Photo: William Remsen 2000)

Figure 8. Detail of the limited occurrence of grooved mud bricks in the west main enclosure wall. (Photo: William Remsen 2000)

Figure 9. The north perimeter gateway with a well-preserved floor consisting of a thin layer of mud plaster over a deposit of compacted brick debris; this area may also originally have been finished in whitewash. (Photo: Robert Fletcher 2004-2005)

Figures 10, 11. Two details of the east corridor, from south (top) and from north (bottom). (Photos: William Remsen 2000)

Figure 12. The south corridor (at right), facing east. (Photo: William Remsen 2000)

Figure 13. The west corridor, facing south. (Photo: William Remsen 2000)

Figure 14. The northern, exterior area of the enclosure (facing west); from far left are the north main enclosure wall, the north corridor, the north perimeter wall, and, at center, the south wall and east gateway of the funerary enclosure of king Peribsen. (Photo: Jason Goodman 2005-2006)

The main enclosure wall of the monument- and its principal visual component- comprises the north main enclosure wall, the south main enclosure wall, the east main enclosure wall and the west main enclosure wall, each with one gateway. The main enclosure measures 127 x 65m (L x W) in exterior dimensions and 117 x 55m in interior dimensions; it is 5.3m thick at the base and 3m thick at the top, as preserved, and still stands over most of its extent to a height of 10-11m. The ratio of the width to the length of the main enclosure is approximately 1: 1.95.

The north and east gateways of the main enclosure are of a complex design, while the south and west gateways represent simple two-sided passages leading from the corridor to the interior (Figure 15). Both the north and east gateways feature two doorways opening into small interior rooms. The north gateway is the more elaborate of the two, and the only gateway to feature a decorative pattern; as such, it likely represented the main enclosure's most important entrance. The north gateway area incorporates a niche-decorated recess in the exterior face of the north main enclosure wall, which serves as a forecourt leading through the main gateway and into an interior gateway chamber (Figures 16 and 17). The north interior gateway chamber is a rectangular room, measuring 3.25 x 6.75m, situated just inside the main enclosure at its northernmost corner. In contrast, the east gateway chamber is built directly into the thickness of the main enclosure wall.

Both the interior and exterior faces of the main enclosure walls exhibit a consistent inward slope or batter, narrowing by an average of approximately 2° from bottom to top. As with the perimeter gates, the inner walls of the main gates are approximately 90° or vertical. The batter angle measurements, which were taken at several locations (ranging from eroded to well-preserved) along the interior and exterior main wall and the interior perimeter wall, indicate that (for reasons unknown) the monument was intentionally designed and constructed to reflect an approximate two-degree variation from vertical. This variation is nearly identical to the angle derived from the ratio of one Egyptian digit (1.87cm) to one royal cubit (52cm). It may be noted that such a slight batter angle would be extremely difficult to produce with modern tools. Sample measurements also indicate that the wall batter increases slightly inwards from south to north along the exterior east main wall, where batters ranging from 2.5° to 15° were measured at various heights above the modern grade of the east corridor, but these measurements probably reflect the inward lean of the wall due to undermining on the interior side rather than a variation in original design (see the Condition of the Monument in 2000, to follow).

The exterior face of the main enclosure was originally decorated in a palace-façade motif of alternating niches and pilasters. A simple niche pattern is evident along the preserved lower portions of the exterior north, west and south main enclosure walls (see Figure 15). On the south wall, although eroded, evidence for alternating niches and pilasters can be seen eight meters high on the wall. A more complex pattern, in which every fourth niche is wider and deeper, characterized the east main enclosure wall, and is preserved there to a maximum height of four meters (Figure 18). The niching patterns most likely extended the full height of the façade in the original construction, however no niche pattern was present on the interior of the main enclosure or on any of the perimeter walls or gates. It is clear from construction evidence that the decorative façade was included in the monument's original design plans, as the construction of pilasters is reflected in the base course and the pilasters were tied into the fabric of the wall at regular intervals.

Figure 15. Exterior detail of the west gateway in the main enclosure, during excavation and prior to conservation; note especially the preserved remains of the original façade, characterized by alternating niches and pilasters, finished in white plaster. (Photo: Robert Fletcher 2004-2005)

Figure 16. Exterior detail of the north gateway, which is the most elaborate of the four enclosure gateways, with a decorated forecourt in front of the passageway leading to an interior gateway chamber; note the preserved plaster finish on the lower walls of the exterior gateway façade. (Photo: Robert Fletcher 2004-2005)

Figure 17. Interior detail of the north gateway and interior chamber with a large deposit of offering pottery (facing north); the hole cut into the end of the adjacent east wall (at upper right) is what remains of a monastic chamber from late antiquity (see following sections). (Photo: Robert Fletcher 2004-2005)

Figure 18. This foreground view of the east corridor illustrates the extent of niche and pilaster preservation on the exterior face of the east main enclosure wall; originally, the niches, pilasters and whitewash finish would have covered the full height of the main enclosure. (Photo: Robert Fletcher 2004-2005)

The simple niche pattern in palace-façade style decorating the north, west and south main enclosure walls, as well as the exterior north main gate, consisted of recessed niches, approximately 52cm in width, alternating with protruding pilasters of equal width. The pilasters thus defined the outer plane of the wall face, with the alternating niches recessed to a depth of 13cm from the line of the adjacent pilasters. As each brick used in construction typically measured roughly 26cm in length by 13cm in width, each brick course in the alternating niches and pilasters comprised either two brick-lengths, or "stretchers," or four brick-widths, or "headers," for a total width of roughly 52cm across (the regular use of header courses aided in bonding the wall components; see below)[4]. A niche-width of 52cm corresponds to one royal cubit and a niche-depth of 13cm corresponds to one-fourth royal cubit. Based on compilation from an early site plan produced in 1904 (Ayrton et al. 1904**)** and field measurements taken in 2000, enumeration of the original niches and pilasters reveals a total of 60 pilasters, 57 simple niches for the north wall, 97 pilasters, 95 simple niches for the west wall, and 56 pilasters, 54 simple niches for the south wall. The design of the north main enclosure wall is somewhat complex due to the recessed forecourt of the north gateway; the outer face to the east of the gateway represents one simple pilaster group (4 pilasters, 3 simple niches), the gateway recess itself incorporates one simple pilaster group on either side of the gateway opening, and the main outer face to the west of the gateway includes 49 pilasters alternating with 48 simple niches. Each gateway opening in the main enclosure is equivalent in width to one larger "false-door" niche (or approximately two royal cubits).

The false-door niche motif decorating the east main enclosure wall consisted of complex (false-door) niches alternating with simple pilaster groups (of 4 pilasters and 3 simple niches). The false-door niches on the east façade were wider and deeper than the simple niches, with a recessed depth of 26cm (1 brick-length) from the outer face of the wall. The outer width of the false-door niches was approximately 104cm (4 brick-lengths or two royal cubits) and the complex design included a decorative step or molding at a depth of 13cm (1 brick-width) from the line of the adjacent pilasters (Figures 19 and 20). Enumeration of the original niches and pilasters along the east wall reveals a total of 23 false-door niches and 25 simple pilaster groups (or 100 pilasters, 75 simple niches). The east gateway opening again represents the width of one false-door niche.

No proportional or other design analysis has yet been attempted to elaborate on the original intent of niche and pilaster construction, for example, to explain the design dissimilarity between the north and south walls. There is no preserved evidence of either actual or false windows on the main enclosure, however it is possible that the more elaborate east main wall included additional features in its now missing upper portions. The presence of painted exterior decoration of some kind is indicated by drip-traces of red pigment on plaster surfaces exposed by excavation at the exterior base of the east and south main enclosure walls (see Archaeological Investigation of the Monument, to follow), but no other evidence of inscription or decoration has been documented on any preserved, finished surface.

[4] The terms "stretcher" and "header" refer to the position in which a brick, or course of bricks, is laid in construction; a stretcher is a brick laid lengthwise (parallel to the wall face) and a header is a brick laid widthwise with its end oriented toward the wall face.

Figure 19. Detail of preserved niches and pilasters on the lower, exterior side of the east main enclosure wall; the 3m stadia rod standing upright in the false-door niche at left calls attention to the decorative molding on the adjacent pilaster. (Photo: William Remsen 2000)

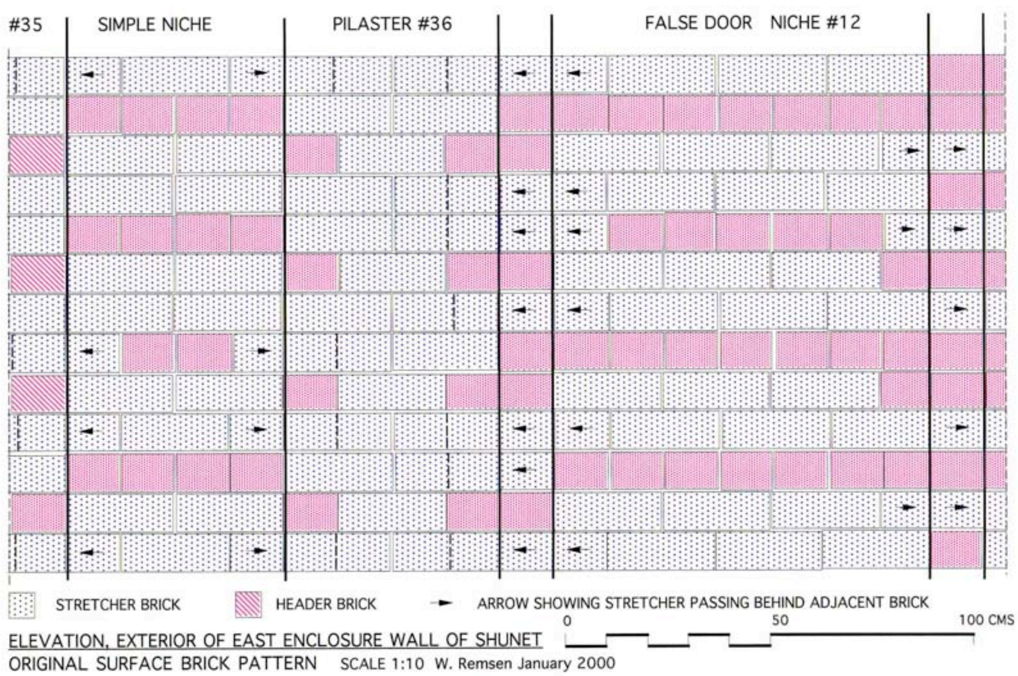

Figure 20. Schematic detail of niche and pilaster construction on the exterior face of the east main enclosure wall. (Graphic: William Remsen 2000)

The main enclosure walls were constructed of an outer "veneer" two brick-widths (or 24-26cm) thick, attached to a massive inner core (Figure 21). The veneer was generally constructed with alternating courses of headers and stretchers (Figure 22), although some variation in the lay-up pattern does occur to accommodate changing wall thickness in the battered walls and periodic course leveling. For example, a pattern of one header course between two stretcher courses occurs near the north, south and east main gates to adjust for the wall thickness immediately adjacent to the opening (Figure 23). Despite such variations in coursing, however, the veneer is a uniform two brick-widths thick throughout. The exterior pilasters are bonded to the veneer with headers at every second to fifth course, however the veneer is bonded to the inner wall core in a somewhat irregular fashion.[5] The bond bricks used to join the veneer to the core are relatively few in number and do not seem to follow a regular distribution pattern (Figure 24). The mortar used in construction aids in strengthening the bond between the veneer and the core, however inconsistencies in its application are also common. Consequently, the wall veneer has a high rate of deterioration when exposed, and much of the original veneer surface has been lost. In contrast, the bonding method used in the transverse direction of the wall core (perpendicular to the wall face) is significantly stronger than that of the veneer, and it is this inner wall core that comprises the primary portion of the main enclosure standing today.

The core of the main enclosure wall was constructed using a very different technique than that observed in the veneer. The bricks comprising the wall core are simply stacked one atop another with all of their ends oriented toward the face of the wall in a continuous elevation of header courses referred to as "through-wall headers" or "stack bonding" (Figures 25-29). This construction method generally causes the monument to act as a solid mass rather than a component structure. In the longitudinal direction, this bonding method is inherently vulnerable to vertical cracking and erosion of the open joints, and particularly so at wall ends, where the brick mass is unrestrained and therefore highly susceptible to cracking and erosion. In the transverse direction however, this construction is characterized by header bricks overlapping one another in a lengthwise arrangement referred to as a "running bond," which is, by contrast, highly resistant to vertical cracking. In rare cases along the wall core, the header stacks were joined by bonders and certain joints were reinforced with fiber matting (see below), but generally the stack-bonded construction of the wall core, in addition to limited adhesion in the vertical joints (which are generally not well filled with mortar), has resulted in vertical lines of weakness and associated crack patterns throughout the monument. The brick bonding is comparatively strong in the transverse direction of the wall core, which increases the wall's resistance to collapse, however this bonding method also increases the *consequences* of collapse, as brick losses tend to be substantial when a mass of wall surface is delaminated and falls perpendicular to the wall. In addition, stack-bonded bricks will tend to corbel (that is, to step up and out), rather than arch (or span longitudinally), over degraded areas and cavities. Consequently, the main enclosure wall possesses limited ability to arch over degraded areas in the longitudinal direction and potential wall failures thus follow corbelled zones of weakness, such as undercut wall portions (see the Condition of the Monument in 2000, to follow). The four corners of the main enclosure wall are fully bonded by headers and stretchers laid

[5] "Bonding" refers to the use of bricks in joining two architectural elements.

in a radial pattern and separation of the intersecting walls is considered structurally unlikely.

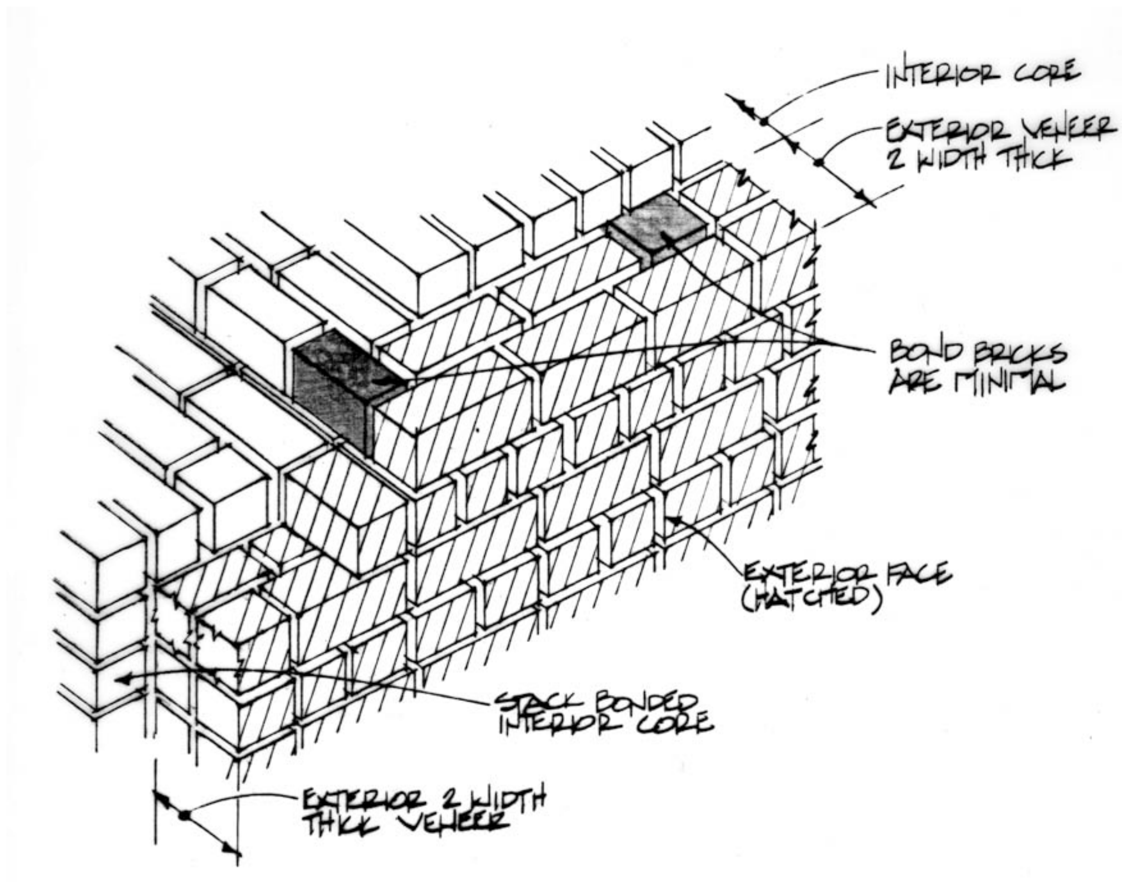

Figure 21. Schematic detail of veneer and core construction in the main enclosure wall. (Graphic: Conor Power 2000)

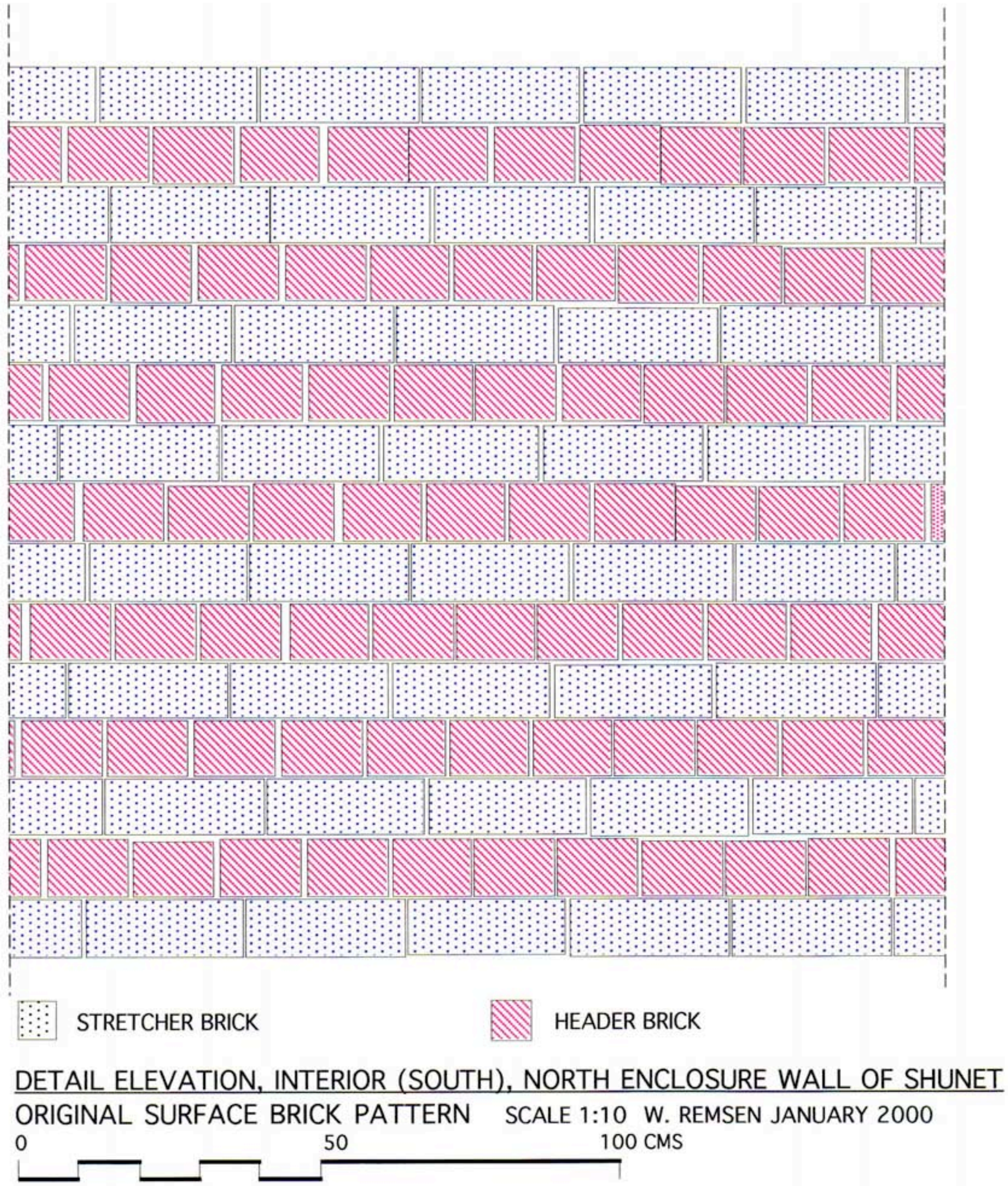

Figure 22. Schematic detail of the alternating courses of headers and stretchers in the outer veneer on the interior side of the north main enclosure wall; this coursing pattern is typical of the outer wall veneer. (Graphic: William Remsen 2000)

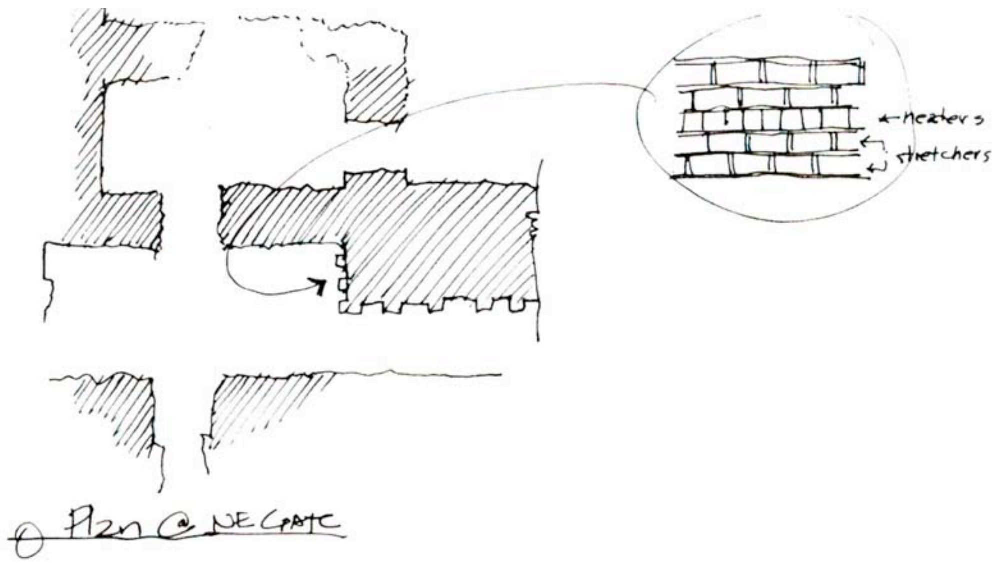

Figure 23. Sketch detail of a 2: 1 (stretcher: header) coursing pattern at the north main gate. (Graphic: Anthony Crosby 2000)

Figure 24. Detail of pilaster remains on the exterior east main enclosure wall, depicting the sheared header bricks that were originally used to bond the veneer bricks to the core of the wall. (Photo: William Remsen 2000)

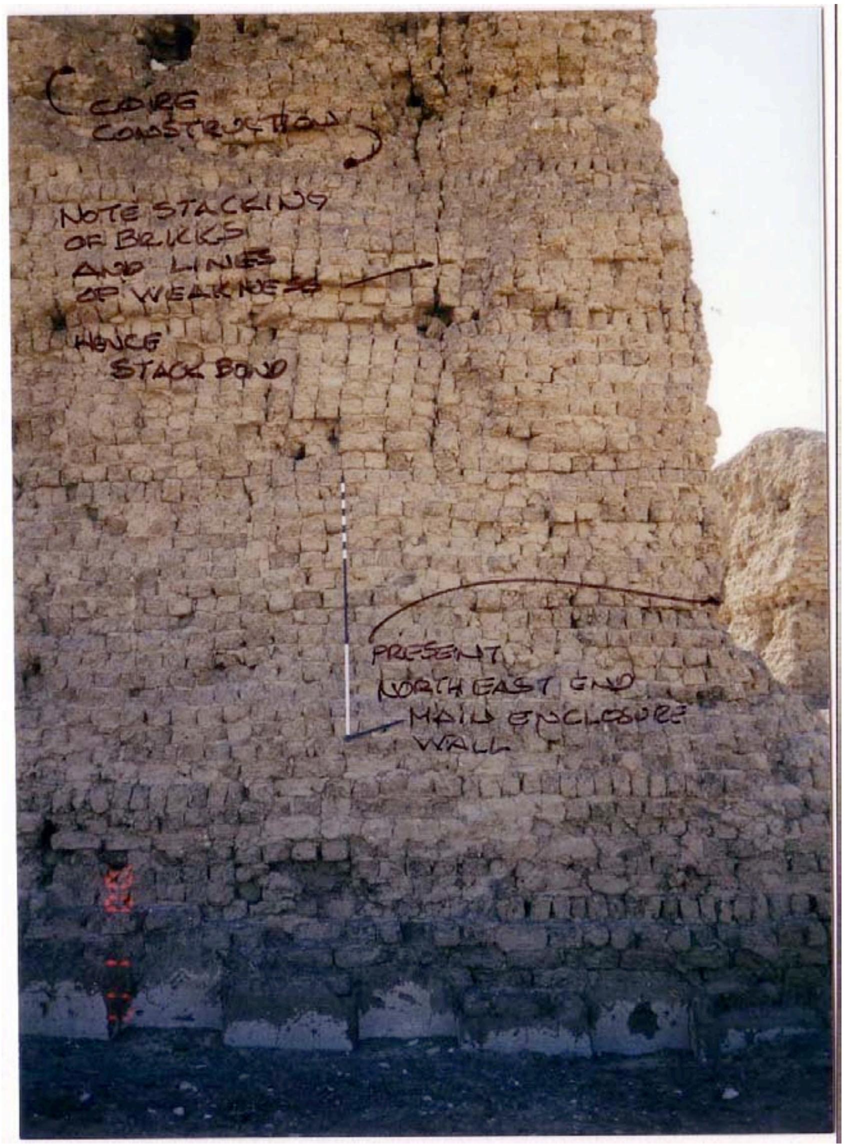

Figure 25. Detail of stack bonding in exposed wall core at the northern, exterior end of the east main enclosure wall; note vertical cracking at this location. (Photo: Conor Power 2000)

Figure 26. Detail of preserved pilaster bases, outer veneer and exposed inner wall core on the northern, exterior face of the east main enclosure wall. (Photo: Conor Power 2000)

Figure 27. Detail of through-wall headers and stacked joints in the core of the main enclosure wall. (Photo: Anthony Crosby 2000)

Figure 28. Detail of mudbrick coursing in the outer wall veneer (lower area) and inner wall core (upper area); “S” stands for stretcher course, “H” for header course, and “B” for bond brick. (Photo: Conor Power 2000)

Figure 29. Detail of brick-bonding between the outer wall veneer (at right) and inner wall core (at left). (Photo: Conor Power 2000)

The main enclosure walls (and possibly the perimeter walls) may have been constructed using the walls themselves as a working surface, rather than by erecting additional scaffolding. In this scenario, the working face would have been limited to what exposure could be approached from the top of the wall with construction crews working away from each corner (either one at a time or simultaneously, depending on the size of the workforce). Assuming the use of only one ramp or ladder to supply the masons with bricks and mortar, the work may have proceeded corner by corner, permitting crews to work on first the (exterior) veneer and then the (interior) core of one wall section at a time. Alternately, if multiple ramps or ladders were used to supply the masons, the work may have proceeded simultaneously on multiple wall sections. The exterior veneer was probably laid up first and the core then filled in with header bricks. Comparison of masonry practices at the corners and midpoints of the main walls suggest that the veneer corners were laid up first and with greater accuracy than the midsections of the core and that the veneer courses were following a string between corners and intermediate points, while the core courses were stacked by eye and leveled at regular intervals.

The walls of the monument were constructed using a “lift” technique, in which vertical sections of masonry are constructed to a uniform height (generally less than 1m) forming the length of the wall, which is then raised lift by lift. Horizontal lift lines are visible in the interior wall core at varying courses (ranging from six to ten) on the preserved lower surface, and consistently at every sixth course on the preserved upper surface above a six-meter height. These lift lines are not visible on the preserved outer veneer of the main enclosure and are observed only in the core of the main enclosure and perimeter walls (Figures 30 and 31). One continuous, horizontal lift line, referred to as the “construction nonconformity,” is visible for 360° at an approximate height of six meters from the base of the interior main enclosure wall (Figure 32). Below this line, the wall lifts were constructed of varying numbers of courses and above it the wall lifts were consistently six courses each. The significance of this nonconformity and the change in coursing pattern that it represents remains to be determined; no such nonconformity is visible on either side of the perimeter wall, which is preserved to a height below the occurrence of the line in the main wall.

There is no real difference in brick composition above or below the lift lines and the mortar composition at these lines is consistent with other horizontal mortar joints throughout the wall. The visual differentiation of these lines may be in part attributable to subtle differences in brick batches, joint thickness, brick orientation and differential erosion, but is most likely due to the presence of horizontal layers of reed matting used in leveling the top course of each lift. The practical purpose of lift construction is to maintain levelness and to aid in mortaring, in addition to easing manual labor. The header courses in the wall core were leveled at the top of each lift section and a layer of reed matting was perhaps set down before raising the next lift (Figure 33). Matting exposures in the wall core were generally inadequate for measurement and no reed matting was found associated with any other features of construction. Groups of header bricks rotated 90° (referred to as “bull headers”) were used in association with thickened top courses in various lifts near the midpoint of each wall. Thickened mortar joints and bull headers were used in these lifts in order to raise the top course for leveling, which suggests that the mid-wall courses of the core were constructed only after the corners and intermediate points had been laid.

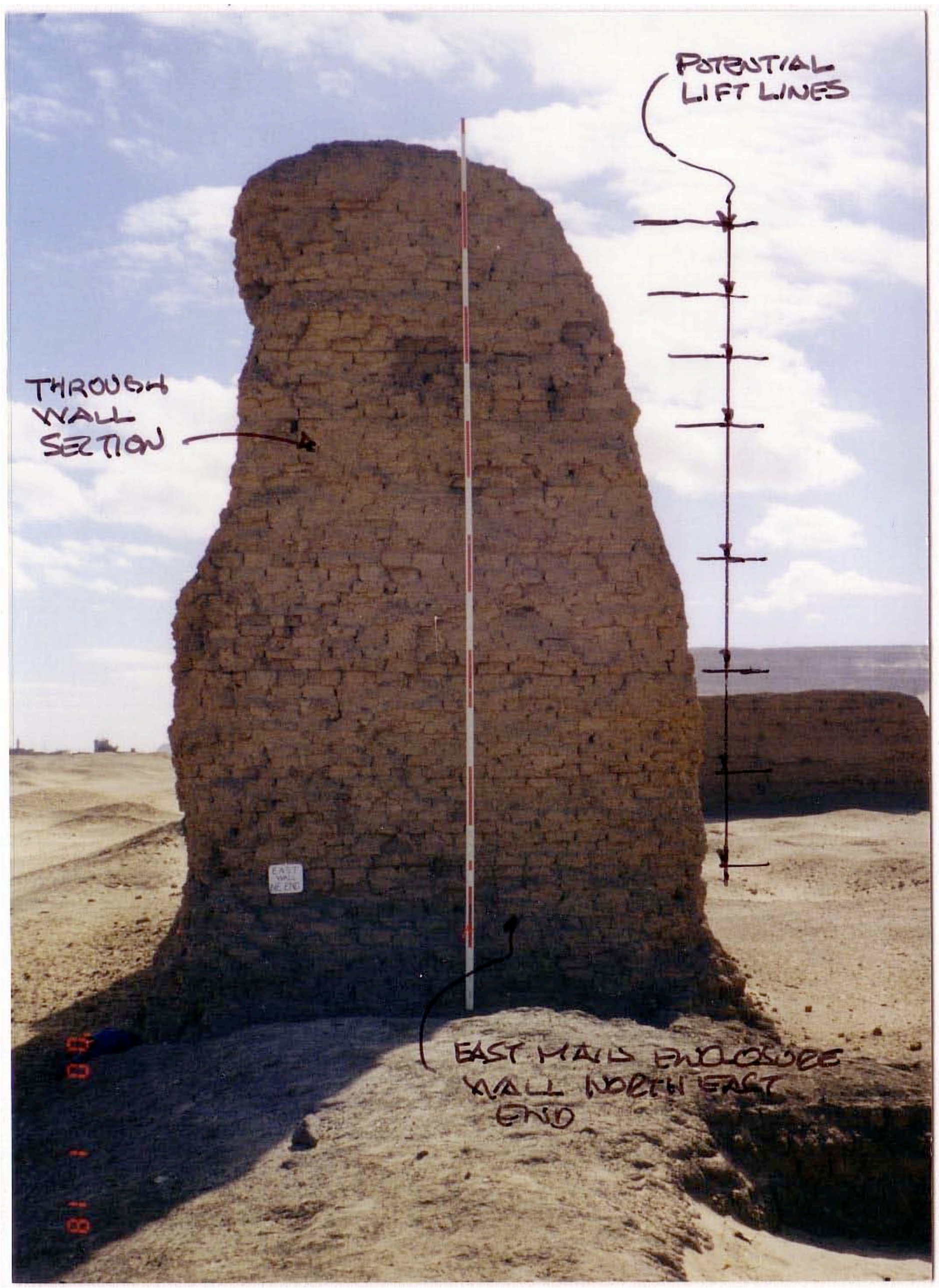

Figure 30. Exposed wall core at the northern end of the east main enclosure wall; note the through-wall header construction with transverse running bonds and the locations of potential lift lines. (Photo: Conor Power 2000)

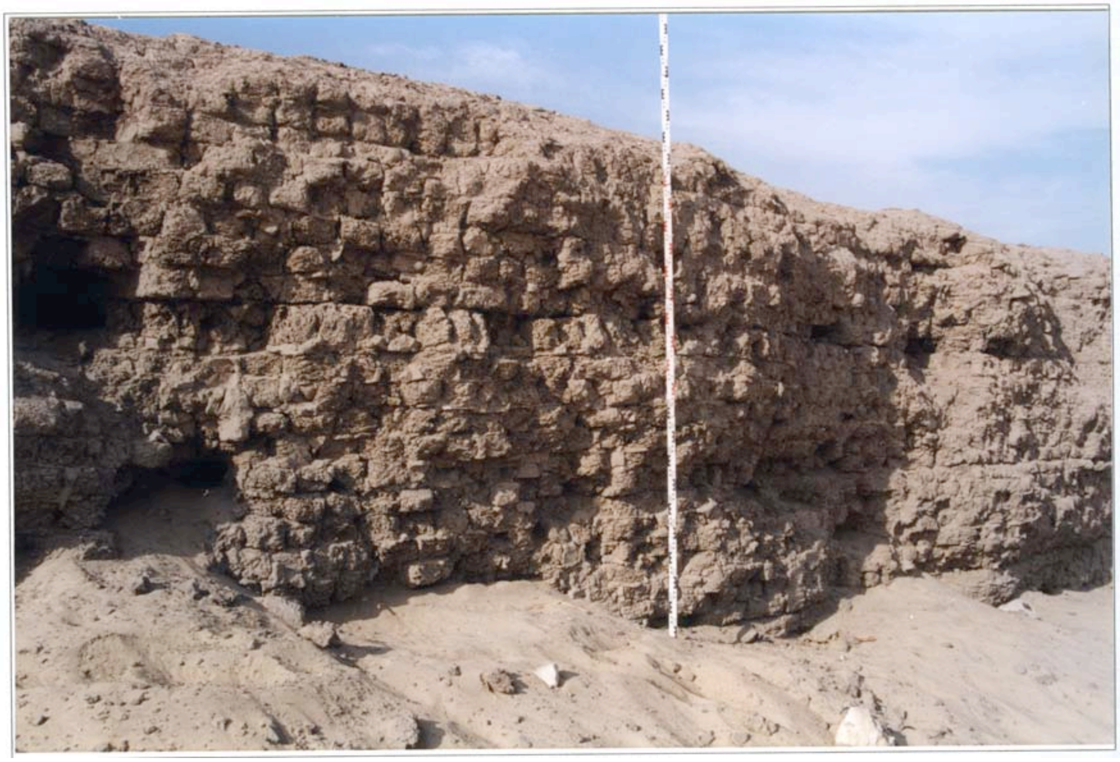

Figure 31. Detail of a horizontal lift line (through center) in the exterior face of the east perimeter wall. (Photo: William Remsen 2000)

Figure 32. The interior face of the west main enclosure wall (facing northwest); the continuous horizontal lift line, or "construction nonconformity," is visible midway up the interior elevation and is seen to intersect with the top of the sand dune that is built up against the northwest, interior corner (at upper right). (Photo: William Remsen 2000)

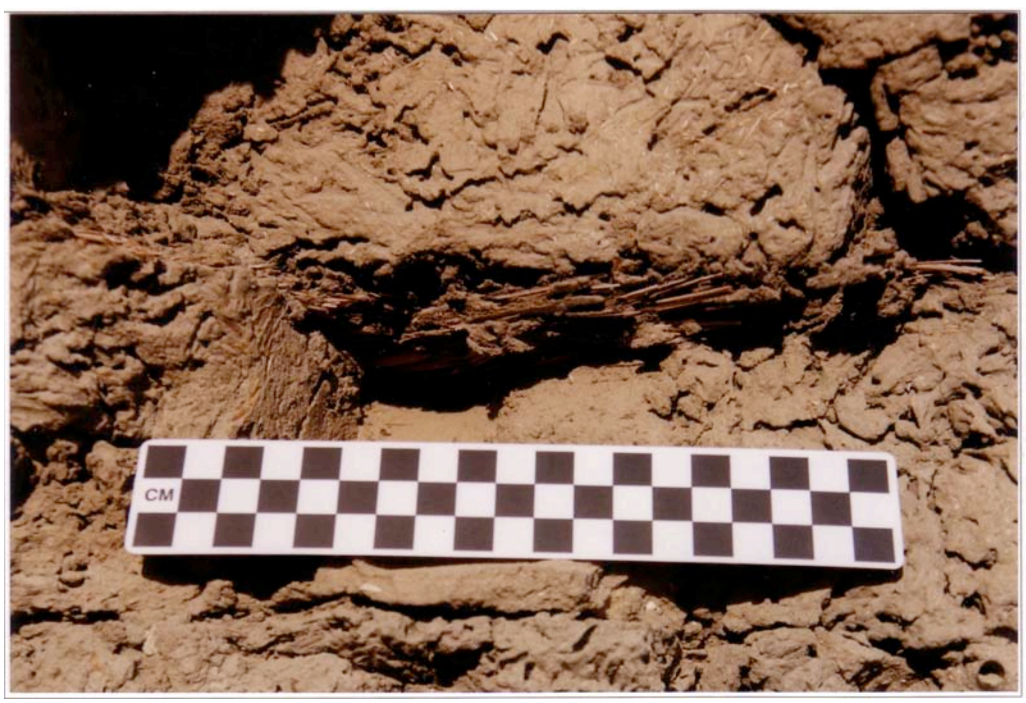

Figure 33. Detail of the horizontal-joint matting used in lift construction. (Photo: William Remsen 2000)

The architectural design of the monument, at least with respect to the main enclosure, was fully determined prior to its construction for a single use and there is no evidence of changes to the work in progress, nor of extended work breaks, construction failures, secondary constructions, repairs or maintenance. Once the building site and design were determined, the footprint was laid out using simple surveying techniques. Hypothetically, labor organization, material preparation, brick fabrication, work site preparation and material transportation preceded construction, which began with the base course of the main enclosure. Following construction of the base course, the niches and gates were laid out (probably using string, chalk or ink lines) and construction proceeded from the first lift, beginning with the corners of the outer wall veneer. As the outer veneer lifts were constructed, the inner core lifts followed. The top course of each lift was leveled, and mortar was applied, before continuing to the next lift level. Once the walls were raised, the masonry would be finished, plastered, whitewashed and the exterior decoration applied; the floor would be prepared and plastered; and the addition of doors and/or other hardware would conclude construction of the main enclosure.[6] This basic construction scenario proposes, insofar as possible, a baseline for further study and detail. Ongoing analysis of sample materials from the monument will support a more complete understanding of the methods, practice and sequence of its original construction.

As noted above, the masonry elements used in construction of the monument were of a uniform quality throughout. Mud brick is formed by a certain combination of soil and water, to which pressure is applied before drying. The physical (rather than chemical) process of dehydration, as molded bricks dry in the sun, provides primary cohesion. An effective distribution of sands, silts and clays and the appropriate amounts of water and pressure to ensure cohesion are often determined by particular material sources. The material used in the fabrication of both brick and mortar for the monument was of a very similar composition, which simple field tests revealed to be 65% sand and 35% silts and clays, with an actual clay fraction of 1-2%. The material was classified according to *Munsell soil color charts* (Munsell Color 1975), as shades of light-brownish and light gray (2.5Y 6/3, 10YR 6/2 and 2.5Y 7/2). Although the mud brick contains a binder of very fine chopped straw, neither organic nor cultural inclusions of any kind were observed in the mortar. The bricks were fabricated using smooth hand molds of standardized proportions and, except as noted above, no markings or identifying features were included. A conservative estimate based in part on previous descriptions of traditional mudbrick manufacture in Egypt (Clarke and Engelbach 1990, Kemp 2000) is 6000 man days for production of the estimated 9,000,000 mud bricks used in the monument's original construction. No meaningful variations in the composition, size or color of mud bricks beyond the normal variations of hand fabrication were detected in the walls of the monument, and the mortar used in construction was also extremely uniform in composition and strongly adhesive. The source (or sources) of sands and sediment comprising the materials were naturally well sorted, however the extreme uniformity of both brick and mortar composition may indicate that the components were also dry-sieved prior to production in order to remove large particles and foreign objects. The mortar appears to

[6] Significant findings regarding the nature of the floor and other interior features are discussed in Archaeological Investigation of the Monument, to follow.

have been quite wet when applied and it is probable that the dry, cleaned components were carried to the site and mixed with water as needed during construction.

Slightly different approaches to mortar-joint composition are represented in the base course, the veneer and the wall core. Based on limited exposure of the east main enclosure wall, the vertical (or "head") joints in the base course appear to have been filled with a loose, fine yellow sand rather than with mortar, although it is not known whether the sand was placed in the joints intentionally or simply filled in over time. No mortar was used beneath the base course and a mortar bed approximately 10mm thick was used on top of the base course, from which some of the mortar has sagged into the vertical joints. The mortar joints in the exterior veneer are uniform in dimension (0-10mm, vertical; 5-15mm, horizontal) and generally well filled, while the mortar joints in the wall core vary greatly in size and quality (see Figure 27, above). Based on sample ranges collected from various locations throughout the monument, mortar joint dimensions average 1.3cm for vertical (head) joints, 0.9cm for lower horizontal (or "bed") joints and 1.4cm for upper horizontal (bed) joints. No joints appear to have been tooled or shaped after brick placement.

The estimated wall volume of the main enclosure is 19,110 cubic meters and of the perimeter enclosure is 8,048.64 cubic meters, for a total volumetric estimate of 27,158.64 cubic meters. Assuming an average joint size of 1cm, the average brick volume is estimated at 2,979.5 cubic centimeters (or 0.0029795 cubic meters), which produces an estimate of 335.6 bricks per cubic meter and a combined total of 9,114,426 mud bricks for construction of the main enclosure and perimeter walls. Brick strength was measured on-site at a value of 400-700kPa (60-100psi), which is lower than anticipated, however this value was derived from only one brick sample and should not be considered conclusive (adequate testing should consist of a three-brick high masonry sample including mortar). The density of the brick mass was calculated using several site specimens as 1511kg/m3 (100pcf). Because the monument primarily resists gravity loads, actual compressive stresses based on this density were computed and found to be approximately one-half the field-measured value; there are however, several locations where severe degradation has taken place, which may be at maximum stress (see The Condition of the Monument in 2000, to follow). As noted previously, there is no evidence for brick recycling in the original construction of the monument and no broken or damaged bricks appear to have been used.

According to modern formulas developed for the construction of residential-scale, mudbrick walls (Doat et al. 1991), the ratio of thickness to height to length should not exceed 1: 8: 12. The Shuneh's east and west main wall proportions are approximately 5m thick to 10.5m high to 127m long for a ratio of 1: 2.1: 25.4; and the north and south main wall proportions are approximately 5m thick to 10.5m high to 65m long for a ratio of 1: 2.1: 13. As indicated by their proportions, the main enclosure walls exceed the maximum empirical extent for strong residential-scale construction. Actual failures corroborate this formula's suggestion that the main enclosure walls are too long (rather than too high) for their thicknesses. Although alterations to the wall in certain areas have contributed to failures, structurally the main enclosure has failed at all four gateway locations and at the southwest corner, where the west and south main walls intersect. The east main enclosure wall has failed extensively, with two standing piers remaining at the northern and southern ends of a largely missing mid-section, however the collapse of this wall was largely due to undermining activities throughout the interior wall base.

Local excavations in 2000 briefly exposed small areas at the exterior base of the east main enclosure wall, the interior base of the south main enclosure wall, and the interior base of the east perimeter wall in order to determine the foundation properties of the monument (Figures 34 and 35). Based on measured wall base elevations at these locations, the structural grade was found to slope to the south approximately two meters. The base course footing of the monument was constructed without additional foundation on a prepared surface of stiff to very stiff, fine sand. Generally speaking, the footprint of a massive and uniform wall, such as that of the Shuneh, can provide adequate structural support, provided a strong and uniform subsurface. Soil bearing studies at the site assigned an estimated bearing capacity of 4000-6000lbs per square foot of direct bearing soil. At both its assumed original and existing heights, the soil pressure produced by the monument falls well within these values. Although the sands upon which the existing structure bears are easily disturbed and must be regarded carefully, given the monument's inability to span over areas of reduced capacity, there is no evidence (such as sudden changes in elevation or excessive differential settlement) to indicate weak underlying strata or weak bearing capacity further below the footing.

At the excavated area on the exterior base of the east main enclosure wall, located at the northern end of the corridor, the base course of bricks was comprised of headers, whose outer edges lined up with the outer faces of the adjacent pilasters. There was no mortar or plaster observed on the exterior faces of these bricks, which were well preserved and unvermiculated.[7] A 10mm-thick mortar bed was preserved on top of the base course at this location and no mortar was found beneath the base course. The vertical (head) joints were approximately 4-10mm wide and filled with loose sand. Near the area of a false-door niche at this location, the base course of headers served, perhaps inadvertently, as a "footer" or partially spread footing (the occurrence of this relatively advanced feature may simply represent a byproduct of the structural layout). No foundation trench was observed in the excavated sand stratigraphy at this location and its base elevation was measured as 100.212m.[8,9] At the adjacent excavated area on the interior base of the east perimeter wall, the base course of bricks was also comprised of headers, whose exterior surfaces lined up with the outer face of the wall. The bricks and base course at this location appeared very similar to the exterior base of the east main wall, absent the spread footing observed in association with the latter's false-door niche (niches and pilasters were not included on the perimeter wall façade). The base elevation at this location measured 100.050m. At the excavated area on the interior base of the south main wall, located at the south gate, the base course was comprised of header bricks, whose long axes however, did not appear to be perpendicular to the wall plane (as in the preceding locations). The base course at this

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[7] "Vermiculation" refers to the development of holes or voids in the bricks leading to general surface decay (see the Condition of the Monument in 2000, to follow).

[8] It should be noted that a foundation trench was revealed by excavation along the north perimeter wall in field season 7 (2005-2006), however no such trench has as yet been identified in connection with the main enclosure wall.

[9] Note that reported elevations refer to an arbitrary site datum.

location was not seen to cross the floor of the gate, which may be due to poor preservation or disturbance, and it could not be determined whether the base course projected beyond the interior wall plane. The base elevation at this location measured 99.332m. An additional surface elevation at the interior southeast corner of the main enclosure measured 98.844m, which represents a dip 1.368m below the northern wall base and 0.488m below the southern wall base. This dip and rise in southward elevation may indicate the existence of footing steps in the wall base, possibly following natural land contours. The base course bricks in these three excavated locations were all typical of the monument's upper construction.

Figure 34. Detail of the exterior base of the east main enclosure wall, which was revealed by local excavation at the northern end of the east corridor; note one-course-thick brick footing on a foundation of stiff sand. (Photo: William Remsen 2000)

Figure 35. Detail of the interior base of the south main enclosure wall, which was revealed by local excavation at the south gateway. (Photo: William Remsen 2000)

Evidence from these base course examinations suggests a plausible construction sequence for the entire base course footing to include preparing the natural surface into a uniform, compact sand foundation; laying out the footprint of the building with string; filling the footprint with a base course of header bricks; (possibly) filling the vertical joints with dry sand and back-filling along the edges to hold the bricks in place during the initial stages of construction; adding a uniform top bed of mortar to consolidate the base course; and finally, delineating the niches and gates beginning with the second course.[10]

Following completion of the brickwork constituting the core fabric and structural decoration of the monument as described above, a base coat of grey-brown mud plaster was applied to each wall surface, followed by a second coat of buff-colored gypsum plaster and a thin finishing coat of whitewash. The mud plaster was composed of fine silts, sand and chopped straw, similar in composition to the mortar, but with the addition of straw to provide greater cohesion. When excavated by Ayrton in 1902-1903, the well-preserved niches and pilasters on the exterior face of the east main enclosure wall were still covered with their original finishing coats of plaster and whitewash, of which almost no trace remains today. Traces of preserved plaster exposed by Ayrton's excavations were, however, observed on the interior face of the east perimeter wall with a base coat measuring 1.5-2.5cm thick. Preserved original plaster that was first exposed in 2000 at the excavated location on the exterior side of the east main enclosure wall was measured with a base coat approximately 8-9cm thick (Figure 36). The original plaster surface was extremely smooth and relatively compact, having been applied to the walls from bottom to top in a sweeping, horizontal pattern evident in tool marks observed on well preserved plaster fragments.

The massive mudbrick walls, corridors, gateways and exterior palace-façade decoration represent the principal architectural character of the finished original monument. No put holes or timber traces have been found to indicate functional details and no other stylistic design features, such as stairs or windows, are recognized in the building's remains. The interior of the main enclosure did however contain additional constructions, some of which have been partially revealed by excavation. In addition to the north interior gateway chamber, a freestanding mudbrick cult building or chapel (measuring 15 x 18m) was constructed in the southeast quadrant of the main enclosure, containing a series of small interior chambers (see Figure 6, above). The mud bricks used in construction of this interior building were of a very different size, composition and color than those used in the main enclosure and perimeter walls. The remains of this and other interior features of the monument are discussed in Archaeological Investigation of the Monument, to follow.

[10] Local excavation of the west gateway area in field season 6 (2004-2005) revealed that the base course was a continuous construction and that the niches and gates were defined beginning with the second course.

Figure 36. The area of preserved original plaster (lower right), which was revealed below grade by local excavation on the lower façade of the east main enclosure wall. (Photo: William Remsen 2000)

The Condition of the Monument in 2000

The character of the monument as it stands is much changed from its original appearance. The Shuneh lies in a modern desert landscape, situated between the villages of Deir Sitt Damiana and Beni Mansur to the north and east, and young agricultural fields to the west, beyond which stand the cliffs that form the western edge of the Nile Valley (Figure 37). Between completion of the monument in the Second Dynasty (ca. 2700 BCE) and its monastic occupation during the Late Roman/Byzantine period (337-641 CE), sand dunes slowly accumulated to various heights in and around the main enclosure and remained relatively constant into the late 19th Century prior to early archaeological excavation. The distribution of these ancient sand dunes, as documented by resulting patterns of surface preservation at the monument, represents a fairly predictable pattern based on the monument's orientation to the natural environment. The exterior north, east and west main walls were covered to a height of approximately four meters by accumulated sand parallel to the wall surface. These sand dunes would have completely filled the north, east and west corridors, except where wind scour tapered the corners. The exterior side of the south main enclosure wall was covered by a larger sand dune at least six meters high, perhaps more, filling the south corridor parallel to the wall face. The interior side of the north main enclosure wall was covered by an embankment reaching up to six meters in height while sand was deposited 1-2m high along the interior face of the west main enclosure wall (with its highest level at the northwest interior corner). The ancient sand levels remain largely present on the interior sides of the north and west walls and the exterior side of the south wall (Figure 38). Extensive past disturbance of the embankments along the interior east and south main walls, and the resulting deterioration of these surfaces, has obscured their original levels. It is important to note that only those original surfaces protected by ancient sand dunes have survived intact and that the preserved surfaces exposed by early archaeological excavations have eroded rapidly over the past century.

The visual character of the monument today can be described through both its losses and remains as a whole structure (Figure 39). The development of this character over time incorporates a variety of influences, both intrinsic and extrinsic, which are described in detail in this section. The condition of the monument in 2000 is described in terms of various causes and effects of decay over its 4700-year history, which generally fall into one of two categories: intrinsic effects include structural and material considerations, and extrinsic effects include both natural and cultural factors. This section describes specific structural conditions resulting from these effects, however it is important to note that actual rates of decay relating to these conditions have not yet been studied.

Figure 37. The Shunet el-Zebib in its modern, natural landscape, bordered by sand dunes in the foreground and the western cliffs of the Nile Valley in the background. (Photo: Matthew Adams 2007)

Figure 38. Exterior view of the monument from the southeast, depicting sand-dune profiles along the south and east perimeter walls, and preserved original surfaces on the south and east main enclosure walls. (Photo: William Remsen 2000)

Figure 39. Panoramic view of the main enclosure from the northwest; the deep cavities visible on the exterior west wall are the collapsed remains of living spaces excavated into the original masonry during late antiquity, when the monument was occupied by an early Christian monastic community. (Photo: Robert Fletcher 2001)

The field survey responsible for this condition assessment was a collaborative program involving design, engineering and conservation expertise relevant to mudbrick architecture. This survey represented the first stage of the Pennsylvania-Yale-IFA/NYU documentation and conservation project at the site of Khasekhemwy's funerary monument at Abydos. The purpose of the initial condition assessment by a team of architectural conservation experts (William C. S. Remsen, International Preservation Associates, Inc.; Anthony Crosby, Architectural Conservation, LLC; and Conor Power, Structural Technology, Inc.) was to serve as the basis for developing a comprehensive conservation treatment plan. As such, it identified causes, effects and threats of decay in broad as well as constituent terms in order to determine the relationship of factors influencing study and preservation of the monument. Additionally, a photogrammetric survey (Robert Letellier, Heritage 3D, Inc.) produced high-resolution, rectified photoelevations, which aided conventional film and digital photography in providing detailed baseline documentation of the monument prior to intervention. The three-dimensional data resulting from this survey provides a precise record of the existing condition of all standing walls, against which subsequent conservation work and future conditions can be compared.[11] With the permission of the Egyptian Supreme Council of Antiquities, samples of mud brick and mortar were also collected during the field survey and delivered for laboratory analysis at the New Mexico Institute of Mining and Technology in Socorro, New Mexico. The resulting analysis (Bruce Harrison, team leader, New Mexico Institute of Mining and Technology) has provided data on the constituent components and physical properties of the construction material, which have further informed long-range conservation planning.

Causes of loss to the monument's original fabric are generally attributed to long-term factors (such as intrinsic flaws, intrusions and climatic conditions) rather than short-term events (such as seismic activity or vibration). Surface erosion caused by wind-sand abrasion and undermining activities in the wall bases have had the most significant effects on the condition of the structure. The collapse of large wall sections and resulting loss of fabric is an evident and ongoing process. Locally unstable conditions throughout the monument have produced a structure that is extremely sensitive to any form of disturbance, and which presents strong potential for failure in the absence of intervention.

Although short-term destructive events such as earthquakes and severe windstorms would dramatically increase the possibility of failure and collapse, such circumstances are considered unlikely. According to information provided by the Global Seismic Hazard Assessment Program (Giardini et al. 1999; Grünthal et al. 1999), Abydos falls within a region of low earthquake hazard and in fact lies in one of the lowest areas of seismicity along the Nile River (Figures 40 and 41). While there is no datable context for wall collapse at the monument, no clear evidence of past seismic damage is present and any major event would have caused a catastrophic structural collapse. Based on a review of data from the National Earthquake Information Center (USGS 2007), the nearest significant earthquake to Abydos between 2150 BCE and the present occurred in 1201 AD at a distance of 242km, well outside the 100km radius considered hazardous. The rectangular structure of the monument and its direct footing on dry, compact sand provide some

[11] The digital photographic documentation captured by the project's photographers and architectural consultants during the field survey is primarily used for the purposes of this report.

strength against lateral ground motion, but without structural reinforcement in its present condition even a moderate seismic event is potentially devastating. Nevertheless, although slight and infrequent ground motion may be anticipated, the likelihood of significant earthquake damage at the site is considered negligible given the monument's location at the center of low seismic activity in Egypt.

Other possible but unlikely sources of short-term damage would include excessive wind pressure, vibration caused by farm vehicles or water damage resulting from rising ground water. Weather patterns at the site do not seem to suggest the threat of cataclysmic wind speeds, and traffic vibration does not represent a threat to the monument unless it approaches within five meters of the monument. The local water table is an estimated 6-10m below the existing grade of the monument and not likely to rise to a dangerous level (within one meter of the base course) due to uphill field irrigation west of the site.

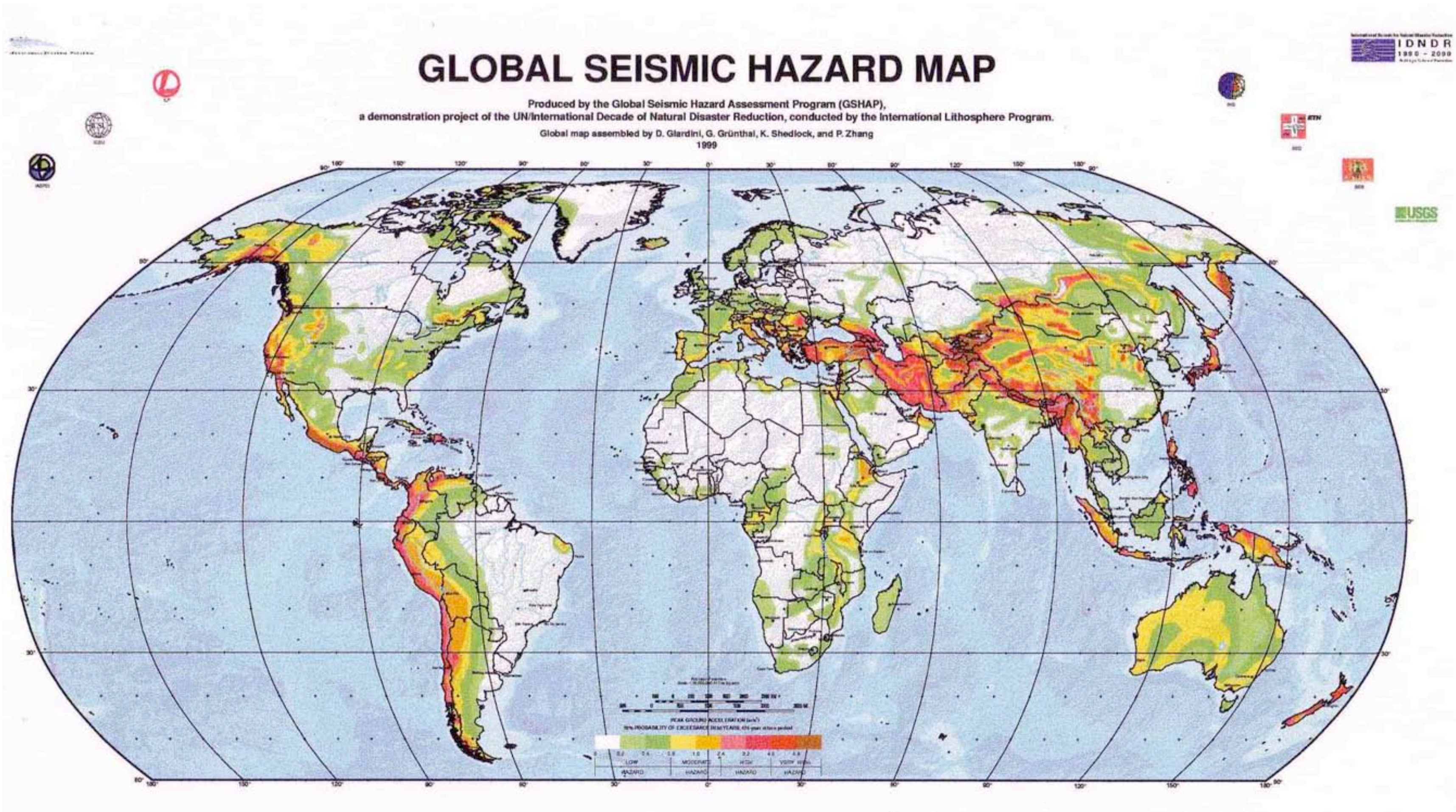


Figure 40. The GSHAP Global Seismic Hazard Map. (GSHAP, http://www.seismo.ethz.ch/GSHAP/ 1999)

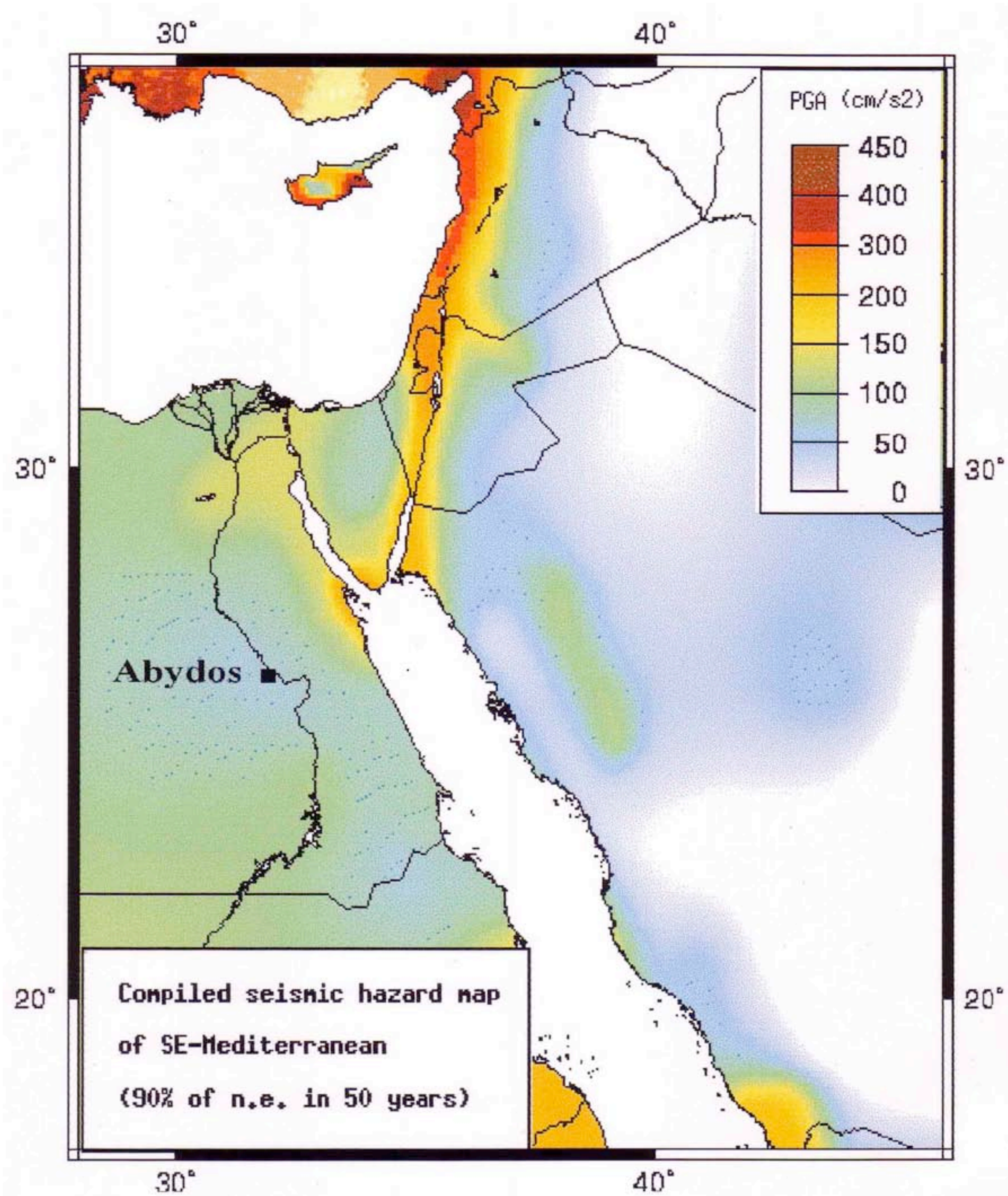


Figure 41. Map of seismic hazard for the Near East region, expressing Peak Ground Acceleration expected at 10% probability of exceedance in 50 years. (Grünthal et al. 1999:Fig. 2)

Certain construction properties of the monument, particularly within the core of the main enclosure wall, have a substantial effect on the longevity and stability of the existing building. In structural terms, causes of inherent weakness leading to long-term deterioration of the main enclosure include the poor bonding of the wall veneer (or outer two brick-widths) and consequent high rate of exterior surface degradation; the stack-bonded construction of the wall core and consequent vulnerability to cracking and erosion; the likelihood of high brick loss in transverse delamination; and the inability of the wall core to arch over degraded areas in the longitudinal direction (see the Architectural Design and Construction of the Monument, preceding). The gateways of the monument are also intrinsically problematic from a structural point of view. The gates were almost certainly originally spanned with wooden lintels that have been lost to decay and/or vandalism, resulting in a loss of bearing support and eventual collapse of the upper masonry. Attendant stresses on the walls adjacent to the gateways have resulted in further and cascading collapses, and consequently, the loss of major wall sections. The effects resulting from or exacerbated by structural weakness (in conjunction with other, non-structural factors) include calving, delamination, cracking, erosion, corbelling, loose brickwork and cavitation.[12] The combined occurrence of these effects has created local conditions of decay and instability throughout the main enclosure, which were classified according to repair priority (urgent, high, normal or low) during the initial field survey (see below).[13] All areas characterized by structural instability are, by definition, in danger of collapse. Subsurface soils are not a threat to the stability of the monument, as they provide adequate bearing support for the structure. There is no indication of differential settlement in the foundation or associated signs of distortion in the masonry courses.

In material terms, the sensitivity of mud brick to moisture and salts is a potential and actual cause of inherent decay in the structure. As rainwater or runoff gains access to mud brick, the compressive and tensile strength of the material is significantly reduced, essentially reversing the cohesion gained in the dehydration process during fabrication. Likewise, the migration of soluble salts through evaporation can lead to efflorescence and sub-florescence (surface and subsurface salt crystal formation) in the material, resulting in the loss of mudbrick cohesion. The effects resulting from these processes include increased surface friability and loss of surface integrity. Excessive dehydration of mud brick can also occur with high temperatures and aridity, producing a brittle and weakened wall surface. Generally, unprotected horizontal surfaces exposed to rainfall (such as the top of the main enclosure wall) will erode at ten times the rate of vertical surfaces; and, although unlikely, the event of water accumulation at the main enclosure wall bases would result in extensive failure. The inherent properties of mud brick combined with the extrinsic factors of wind, rain and insect activity have produced several effects of decay at the monument, including

[12] "Calving" and "delamination" refer (somewhat interchangeably with "detachment" or "separation") to brick masses that have separated from the main structure along crack lines, and specifically in the case of delamination, along somewhat distinct mortar-joint planes. "Cavitation" refers (somewhat interchangeably with "holes" or "voids") to areas defined by a negative (missing) brick mass.

[13] "Urgent" refers to priority conditions affecting the overall stability of the structure and likely to result in massive failure or loss if left untreated; "high" refers to priority conditions affecting the local stability of the structure and likely to result in massive failure if left untreated; "normal" refers to priority conditions affecting the stability of adjacent areas and likely to accelerate deterioration of the structure if left untreated; and "low" refers to priority conditions likely to result in a local failure of relatively small proportion.

erosion, vermiculation, efflorescence, mud drips, surface friability and delamination.[14] The mud mortar exhibits no vermiculation and the present condition of the mud brick ranges from solid and compact with little vermiculation to highly decayed and vermiculated material with individual surface losses of up to fifty-percent (Figure 42). There was no evidence, however, of cracking associated with the natural loss of mudbrick cohesion alone and no documentation of decay resulting from high temperatures. Mud brick is not susceptible to animal byproducts, and although it may contribute indirectly to decay by serving as a source of food for other organisms, animal excrement does not represent a material threat to the monument.

The principal extrinsic causes of structural deterioration at the monument are climate, biological activity and cultural activity. The weathering effect associated with wind and rain erosion represents a long-term process of decay. Currents of wind turbulence created by the main enclosure have concentrated erosion on the upper wall portions, producing a scalloped effect that occurs over much of the upper surfaces; and simple wind-sand abrasion has significantly eroded the lower portions of exposed main enclosure and perimeter walls, removing both plaster and brick surface (Figures 43 and 44). The changing contour of the monument over time has affected local wind patterns, thus shifting the patterns of erosion, however wind scour has had a particularly consistent impact on the exposed edges and corners of the structure.

The deleterious effects of wind abrasion alone however, are not as threatening as the combined effects of wind and rain. Rainwater absorption has progressively weakened the material constituting the upper sides and top of the main enclosure wall, leading to gradual erosion and surface loss over time. Mud brick weakened by rainfall is removed by runoff or left in place as a friable surface material vulnerable to further decay, while exposed mortar joints are washed out toward the edges of the walls. Structural cracks provide drainage and accelerate water absorption by capillarity into adjacent materials. Salt formation has occurred in association with water absorption, which intensifies surface corrosion. In addition, a thin deposit of silt covers much of the monument's surface as a result of runoff. These deposits are concentrated as "mud drips" in certain areas, particularly along the exterior north main wall (Figures 45 and 46), however the distribution of these mud-drip concentrations in relation to the direction of weather at the monument is poorly understood. The thickness of the main enclosure walls has allowed the structure to resist complete erosion, although the top of the main enclosure wall has eroded to a three-meter thickness (on average), representing a probable loss of at least one meter. Annual rainfall at the site appears to have been consistently low enough over the past 4700 years to allow the monument to buffer some of these climatic effects. Apart from wind and rain, no other significant climatic stresses (such as freeze-thaw processes) are recognized as a threat to the monument.

[14] "Mud drips" refer to a phenomenon of local erosion due to surface water runoff.

Figure 42. Detail of the surface decay pattern in a typical mud brick. (Photo: Anthony Crosby 2000)

Figure 43. A high concentration of surface erosion caused by wind-sand abrasion on the upper, interior face of the east main enclosure wall. (Photo: Anthony Crosby 2000)

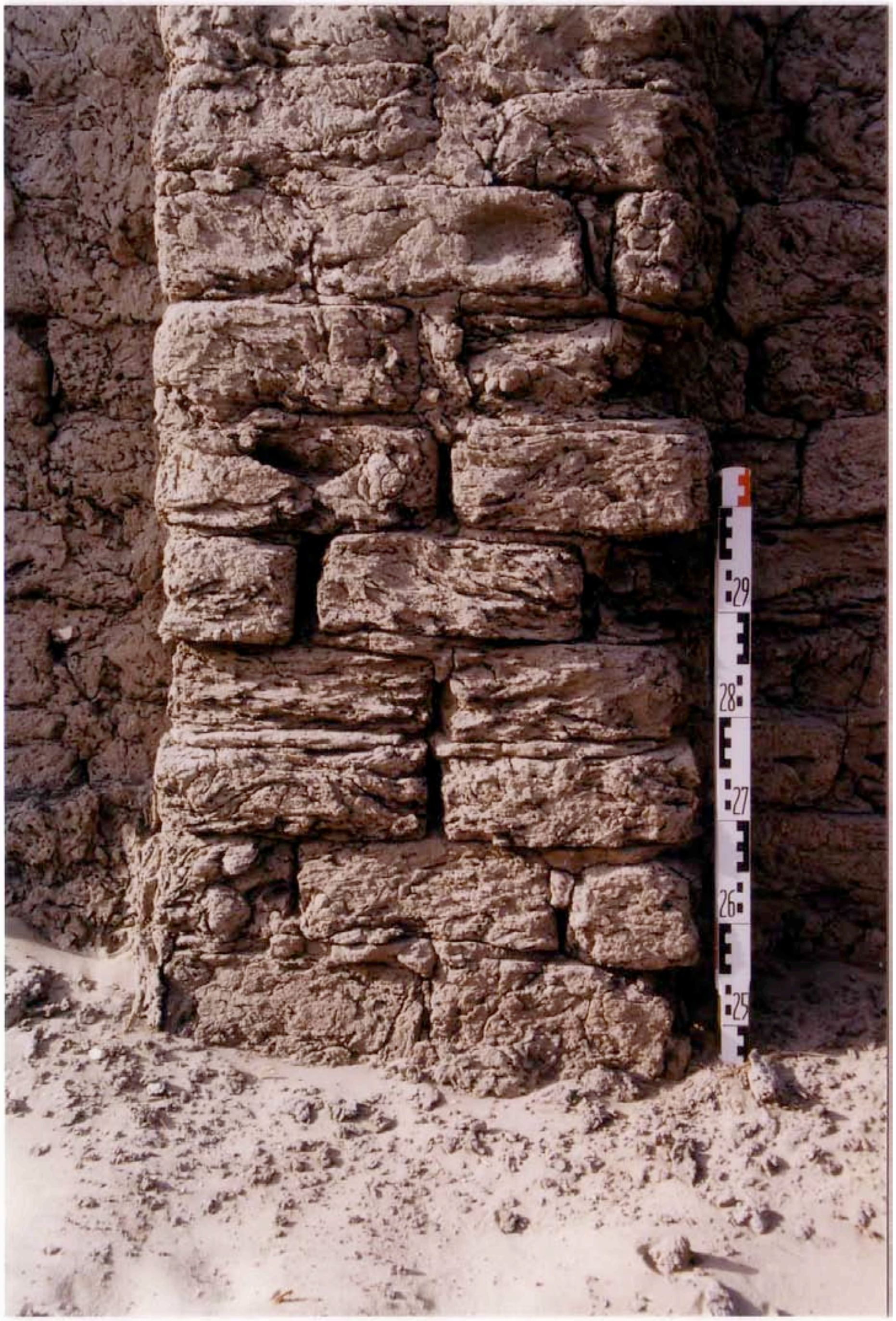


Figure 44. Detail of wind erosion at the exterior base of the east main enclosure wall. (Photo: William Remsen 2000)

Figure 45. Heavy water erosion (near top) and mud-drip concentrations (at mid-points) on the western, exterior face of the north main enclosure wall. (Photo: Anthony Crosby 2000)

Figure 46. Detail of mud-drip concentrations on the exterior face of the north main enclosure wall. (Photo: William Remsen 2000)

Considerable structural deterioration has occurred as a result of animal activity at the site, including that of foxes and possibly jackals, insects and birds. Canid activity has involved the burrowing of dens along the wall bases, resulting in local undermining throughout the structure (Figures 47 and 48). These dens represent rough holes, which are low and round with sandy floors, penetrating deep into the walls. They typically measure 50-75cm high by 50cm wide by 1-3m deep. Their interiors are irregular in shape and generally much larger than their openings. It was not possible to determine the relative ages of these dens or the extent of their use, and with the exception of one active fox den in the east main enclosure wall, there is no indication of canid activity in or near the majority of holes, suggesting sporadic past use and possible vacancy. The quantity of these holes within the walls may indicate that the occupants preferred the continued excavation of new dens rather than the re-use of existing dens. The loss of building material represented by these burrows corresponds to a loss of bearing support and contributes to an undermining effect, which forces the surrounding wall to act in tension rather than in compression and can lead to further cavitation and surface loss. This is a cumulative effect that acts in conjunction with other factors to produce structural conditions of instability and collapse.

Insect damage is represented by the activities of hornets and wasps, which have had a singular impact on the standing walls and are responsible for a significant loss of wall fabric. A type of hornet long active at the site, identified as the Oriental Hornet (*Vespa orientalis*), burrows small but deep cavities into the mud brick, in which extensive paper nests are made (Figures 49-54). Nearly all of the hundreds of small to medium-sized holes that occur on all faces of the main enclosure and perimeter walls are in origin hornet-nest burrows. Characteristically disk-shaped, with smooth interior surfaces, these nest holes are frequently clustered in the walls and have been found to extend as deep as two meters into the wall fabric at some locations. While each nest represents a source of localized structural weakness and gradual collapse, numerous holes occurring in proximity interact and threaten much larger surface areas with networks of cavitation and detachment. As the conditions caused by hornet nesting affect vast areas of original wall fabric, this activity alone represents one of the single greatest threats to the overall stability of the monument.

Mud-wasp activity at the monument involves pervasive nest building, which produces an accretion effect resulting in severe and progressive surface detachment and undercutting (Figures 55-59). These wasps (as-yet unidentified) do not burrow directly into the mud bricks, but rather build their irregular nests on overhangs and protrusions in the walls, which begin as small mud accretions that have occasionally enlarged to massive proportions (see Figure 57). An unidentified organic binder is added to the mud in the nests, producing an extremely tough material that is continuously expanded upon. This nest material is significantly stronger than the masonry to which it is adhered, and as the nests increase in size, the tensile strength of the mud brick is exceeded, causing separation of both the nest and the surrounding masonry from the wall. This separation exposes new overhangs that attract further nestbuilding, allowing the process to cycle over time. In areas where these accretions occur, the wall surface is gradually removed by a depth of one-to-two bricks and a height of one-to-three bricks; the width of surface detachment varies according to nest size, the largest observed exceeding 1.5m in extent. The nest material is extremely heavy and stress resistant (some specimens weighing hundreds of kilograms), and is densely filled with pupae chambers 4-5mm in diameter. The effects of undercutting, detachment and erosion associated with this process are especially concentrated along along the exterior face of the west main enclosure wall and interior side of the east main enclosure wall, where nest colonies occupy large concavities, and along the interior face of the south main enclosure wall, which has, in effect, been harvested by nest-building activity to an approximate height of five meters (see Figure 55). The specific biology and nesting behavior of these wasps has not yet been studied in relation to their activity at the monument.

Unidentified termite-like insects have caused material damage throughout the structure by consuming the straw found in the mud brick and plaster. This process has produced a vermiculated effect in the bricks of both the veneer and the core of the main enclosure wall. Extensive tunneling was observed throughout the mud brick and while frass was evident in these tunnels, no insect remains were documented. Plaster base coats containing chopped straw also exhibited this vermiculated decay, however neither the mortar (which contains no organic material) nor any of the bricks preserved below ancient sand deposits were affected. Although this process does not appear to be ongoing, it has affected the overall strength of the building material.

It is unclear whether bird activity itself has caused notable damage to the monument, however several bird species are active at the site. These most commonly include species of sparrow, swallow and hawk. Numerous holes averaging 20-30cm in diameter appear in the upper portions of the main enclosure wall, which provide perching and nesting places for these species. The holes used by these birds are frequently enlarged from existing hornet burrows and are particularly damaging in interaction with other nearby cavities (Figure 60). Although it was not possible to examine the burrows in detail, bird visitation appears to be prevalent on the north, south and west main enclosure walls, and Kestrels are especially evident on the exterior face of the west wall.

There is no record of damage having been caused by plants or other wildlife active at the site, including small mammals, reptiles, fungi, arachnids and various species of insect. There is no significant plant life on or around the monument and no evidence for past damage due to plant growth. A white fungus was observed in some bricks, most likely feeding on the organic residues of straw and insects, but this fungus is not considered a significant threat. Silverfish and diverse species of wasp are present but non-threatening, and scorpions, spiders, snakes and rodents known to the area have not noticeably affected the building. No other reptile or mammal tracks have been observed on or near the monument.

Figure 47. Detail of the typical undermining and cavitation caused by fox burrowing in the wall bases. (Photo: Robert Fletcher 2005-2006)

Figure 48. Detail of an undermined base location on the west main enclosure wall. (Photo: Conor Power 2000)

Figure 49. The nest-building Oriental Hornet (*Vespa orientalis*) responsible for excavating the majority of small to medium-sized holes found throughout the monument. (Photo: Robert Fletcher 2001)

Figure 50. Hornets entering a large void behind this apparently small hole in the upper surface of the west main enclosure wall. (Photo: Robert Fletcher 2001)

Figure 51. Detail of a paper hornet nest. (Photo: Robert Fletcher 2001)

Figure 52. Detail of a hornet nest in the south perimeter wall, which has compromised the surrounding masonry. (Photo: Robert Fletcher 2001)

Figures 53, 54. A small hole surrounded by loose brickwork in the west main enclosure wall (top) concealed this multi-layered, paper nest and large cavity (bottom), which is typical of the damage caused by Oriental Hornet nesting throughout the monument. (Photos: Jason Goodman 2005-2006)

Figures 55, 56. Elevation and detail of the undercutting caused by mud-wasp nest accretion on the interior side of the south main enclosure wall (top and bottom, respectively). (Photos: William Remsen 2000)

Figure 57. Detail of an active mud-wasp nest colony (at center) on the southern, interior face of the east main enclosure wall. (Photo: William Remsen 2000)

Figure 58. Detail of a typical mud-wasp nest accretion. (Photo: Conor Power 2000)

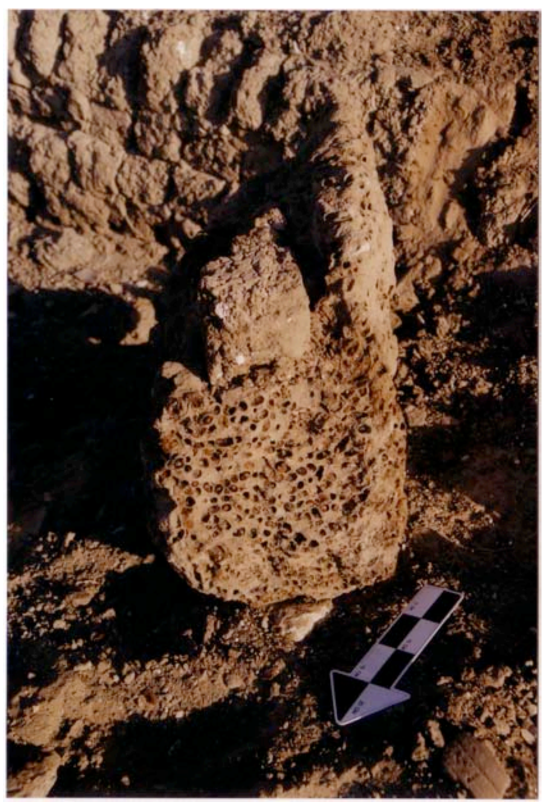


Figure 59. Detail of a bisected, fallen mud-wasp nest with attached mud brick. (Photo: William Remsen 2000)

Figure 60. Surface conditions caused by nesting insects and birds on the western, interior face of the north main enclosure wall; the smaller holes concentrated at right are typical of bird activity. (Photo: Anthony Crosby 2000)

The cultural factor with the greatest adverse effect on the monument over time was its occupation in late antiquity by an early Christian monastic community. Along with the burrowing activity of insects and canids, the removal of major areas of wall fabric by human occupants of the Shuneh between the 4th and 7th Centuries CE has had a significant impact on the condition and overall structural integrity of the monument. During Late Roman/Byzantine times, large voids were excavated in a number of the walls to serve as living spaces, or "cells," for members of the monastic community. The elevations of these voids were at or above the contemporary floor levels defined by sand deposits along both the interior and exterior sides of the main enclosure and perimeter walls. The cavities represented by these monastic cells have produced an extremely critical undermining effect in several locations, leading to unstable conditions and gradual deterioration of surrounding wall areas. The cells were originally constructed to an approximate height of two meters, with secondary excavations for internal features and ancillary chambers (see Archaeological Investigation of the Monument, to follow). Such secondary installations within the cells have further compromised local wall stability. In some instances, as much as four meters of masonry was removed out of five meters of wall thickness during the process of cell construction. The structural effects associated with these cavities include calving, delamination, cracking, erosion, loose brickwork and overhangs, which have expanded into more general conditions of instability and collapse. The cavitation and overhanging brickwork resulting from the initial void progressively undercuts the fabric of the wall above and adjacent to the cell, such that the resulting deterioration extends nearly the full height of the wall in some areas (Figures 61-66).

The remains of monastic cells and related features are found in both the main enclosure and perimeter walls, and are especially concentrated on the exterior side of the west main enclosure wall, where a total of six cells has been documented. In addition, there are two cells in the west main enclosure gate (one on either side of the gateway); one (possibly two) cell(s) in the north main enclosure gate; one (possible) cell on the interior side of the north main enclosure wall; two cells on the interior side of the east main enclosure wall; and one cell in the upper, exterior face of the south main enclosure wall. There are additional cells on the exterior side of the west perimeter wall, as well as associated features built against its interior side, and one cell in the east perimeter wall with a series of small features built against its exterior face. To-date, there is no evidence of cell construction in either the north or south perimeter walls.

Another significant cultural factor affecting the monument was its use in the Third Intermediate and Late Periods as a cemetery for sacred ibises. The birds were buried in pits in the interior space defined by the main enclosure. The greatest impact of this activity was on floors and other interior features, which were destroyed where burial pits penetrated through them into the underlying basal sands, although in some areas, particularly along the interior side of the west main enclosure wall, some damage to and undermining of the lower parts of the wall may have resulted (Figure 67; see also Archaeological Investigation of the Monument, to follow). A series of notched features is also present along the eastern façade of the south main enclosure wall, which contained infant burials in small ceramic coffins that likely date to the Third Intermediate Period (Figure 68). These burials were excavated by Mariette in the mid-19th Century (Mariette 1880a, b).

Archaeological activity at the monument, beginning with Mariette's excavations in the mid-19th Century, has also contributed to its structural deterioration. Mariette's excavations appear to have left the interior base of the east main enclosure wall unsupported, resulting in the collapse of massive wall sections. The exposure of this wall base, along with the voids created by upper wall collapses, has led to severe and extensive cracking that threatens the catastrophic collapse of remaining wall segments. The niches, pilasters and large areas of original wall finish that were preserved by enveloping sand dunes on the exterior side of the east main enclosure wall were also exposed by archaeological excavation in the 19th and early 20th Centuries, which resulted in the accelerated decay, and sometimes complete loss, of these features. In addition, the removal of protective sand dunes during these early excavations probably included the removal of collapsed architectural material and undocumented, original debris from the upper walls of the main enclosure.

Figure 61. The collapsed remains of two monastic cells from late antiquity in the southern, exterior face of the west main enclosure wall (background); note also the denuded surface and collapsed masonry of the west perimeter wall (foreground). (Photo: Robert Fletcher 2001-2002)

Figure 62. Detail of two large voids in the northern, exterior face of the west main enclosure wall; these voids are the remains of monastic cells from late antiquity, which clearly illustrate the extent of original fabric loss at this location. (Photo: Matthew Adams 2004)

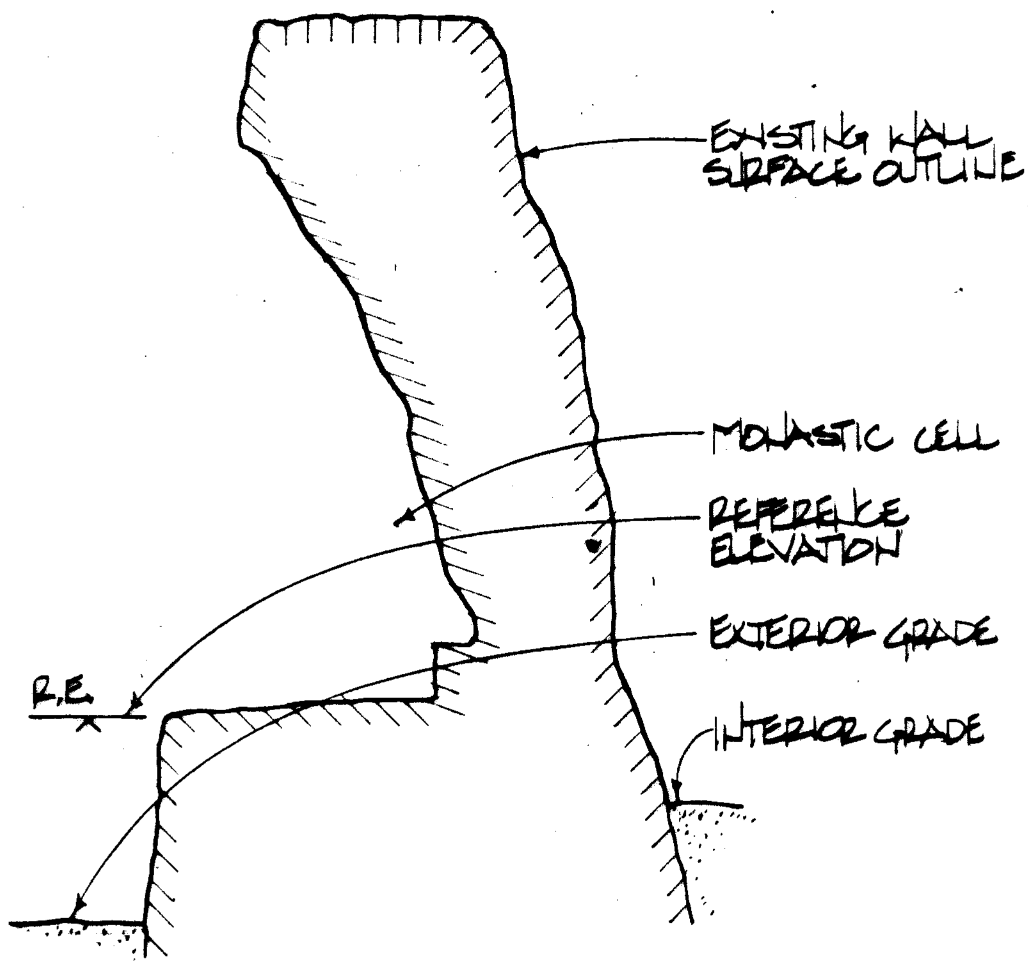


Figure 63. Schematic detail of a monastic cell void in the west main enclosure wall (scale 1: 75); this location was excavated as Operation 120 in field season 6 (see Figures 292 and 317, below). (Graphic: Conor Power 2000)

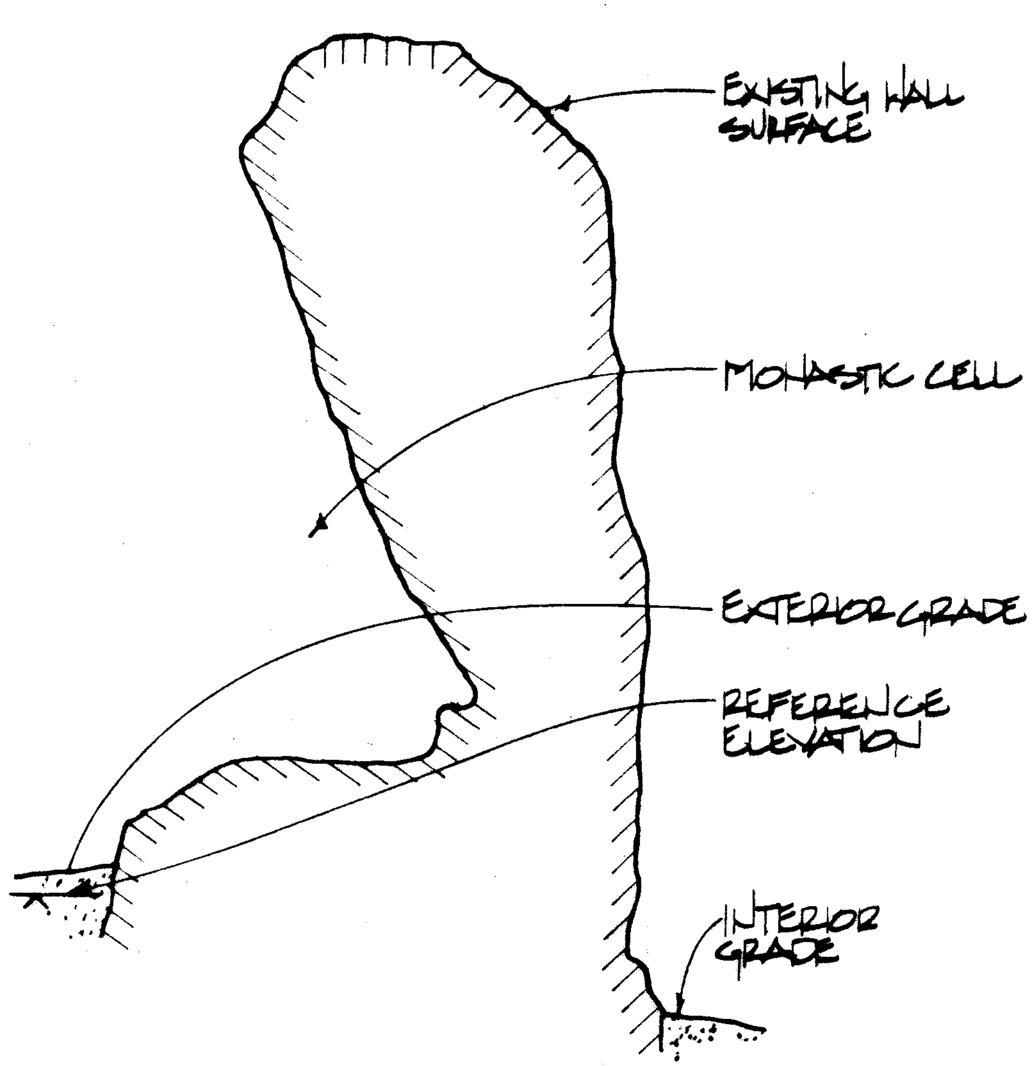


Figure 64. Schematic detail of a monastic cell void in the west main enclosure wall (scale 1: 75); this location was excavated as Operation 119 in field season 6 (see Figures 292 and 317, below). (Graphic: Conor Power 2000)

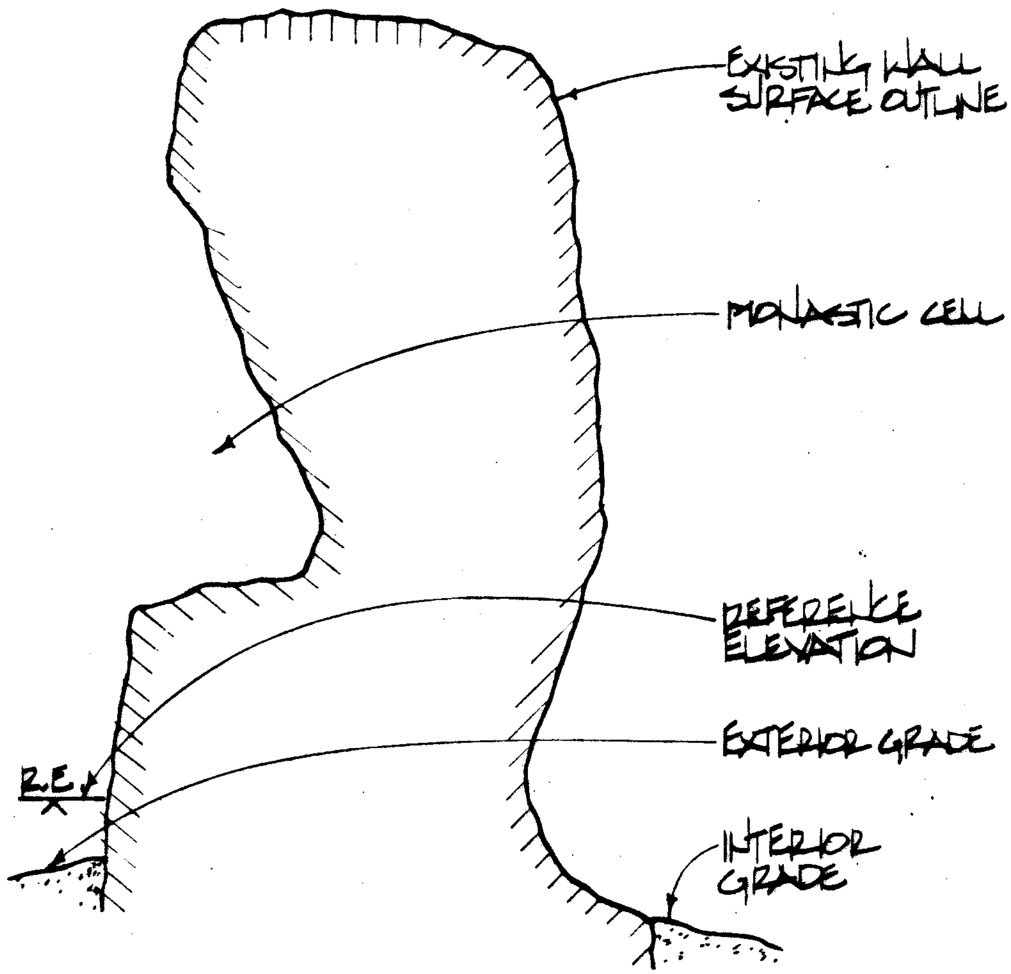


Figure 65. Schematic detail of a monastic cell void in the west main enclosure wall (scale 1: 75); this location was excavated as Operation 122 in field season 6 (see Figures 292 and 317, below). (Graphic: Conor Power 2000)

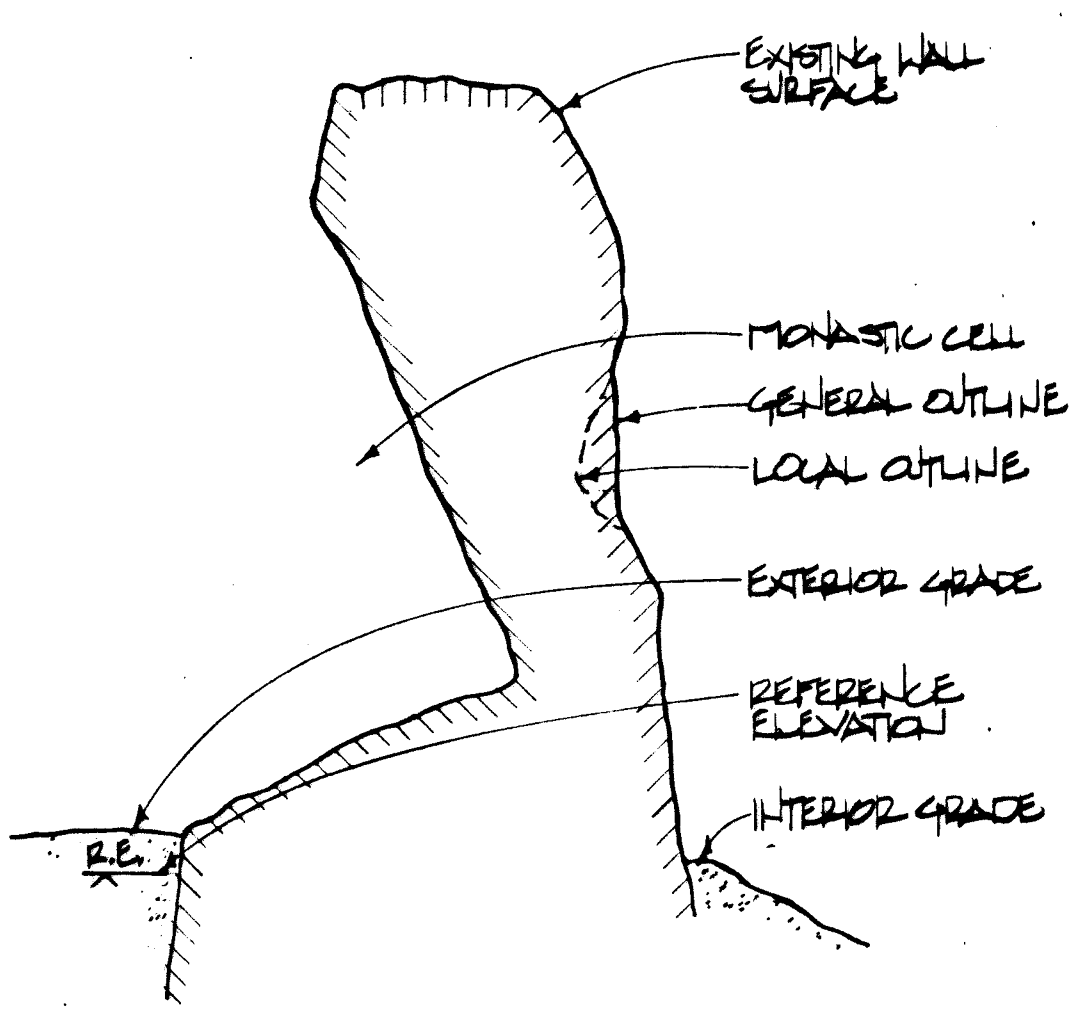


Figure 66. Schematic detail of a monastic cell void in the west main enclosure wall (scale 1: 75); this location was excavated as Operation 121 in field season 6 (see Figures 292 and 317, below). (Graphic: Conor Power 2000)

Figure 67. Detail of partially excavated, Third Intermediate/Late Period ibis burials at the southwest, interior corner of the main enclosure (adjacent to the south gateway). (Photo: William Remsen 2000)

Figure 68. Detail of the cavities in the exterior face of the south main enclosure wall (lower left), which were found by Mariette to contain the burials of infants and children, probably dating to the Third Intermediate Period. (Photo: William Remsen 2000)

Surface erosion caused by wind and rain is generally evident at the monument, although it has not affected all wall surfaces equally. The interior sides of the south and east main enclosure walls appear to be most affected by wind abrasion, and in general, the upper walls of the main enclosure exhibit more advanced weathering than the lower walls (Figure 69). The west perimeter wall is severely affected by wind erosion (in addition to cavitation from insect and other animal burrows) and has lost as much as half of its original thickness in some locations. Specific wind patterns and rates of erosion have not been thoroughly documented at the site, however prevailing winds (particularly in the winter season) are from the north and northwest, and these generally correspond to the patterns of erosion seen on the monument. Although no more specific conclusions have been reached, the general pattern derived from a single occurrence of wind in January of 2000 demonstrates a relationship to sand deposition at the Shuneh (Figure 70).

The greatest loss of original wall volume has resulted from the cavitation caused by brick removal for monastic cell construction, as well as insect and other animal burrowing. Local cavitation results in a loss of compressive strength and leads to horizontal detachment and loose brickwork in adjacent areas. In this process, a small void eliminates support for the bricks directly above it, and lacking this support these bricks also eventually collapse, consecutively producing large masses of detached brick and more extensive voids. The vertical detachment that commonly occurs at the ends of unrestrained walls is likewise caused by undercutting, as supporting masonry is disturbed and surrounding brick masses delaminate. In these cases, surface detachment is not caused by a loss of cohesion in the material but rather a loss of structural bearing support. The cumulative effects of cavitation, undercutting and detachment are clearly illustrated by conditions on the west main enclosure wall and along the interior base of the opposing east wall, which is continuously collapsing (Figure 71). Stresses caused by cavitation, undercutting and detachment also produce local and through-wall (or vertical) cracking. Vertical cracks are not always associated with detachment, however, and commonly occur at the ends of long wall expanses resulting from decay of the wall bases in these locations; this pattern occurs consistently throughout the main enclosure (Figure 72). Mud patches were applied to several cracks in order to monitor their movement during the initial field survey and all were found to be active, however the actual rate at which both detachment cracks and vertical cracks separate is unknown. Loose brickwork throughout the structure is related to areas of greater fracturing and erosion. Loose bricks behave both as individual and group elements in response to extenuating factors of decay, often resulting in significant wall fall. As loose and overhanging brickwork collapses, new and larger overhangs are formed, which contributes to undercutting in the walls. Acting in concert, these and other conditions threaten the overall performance and stability of the building system, which is at high risk for failure if untreated.

As identified by the field survey in 2000, specific locations of structural deterioration on the surviving north, east, south and west main enclosure walls are presented below. Friable surfaces with loose brick and excessive cavitation were typical characteristics of all walls examined, however each of the main enclosure walls represents a unique set of conditions resulting from the particular combination of factors affecting it over time. It should be noted that problems associated with the perimeter enclosure wall were not systematically documented as part of the initial condition survey.

Figure 69. Detail of the weathered brick surface on the top of the south main enclosure wall. (Photo: William Remsen 2000)

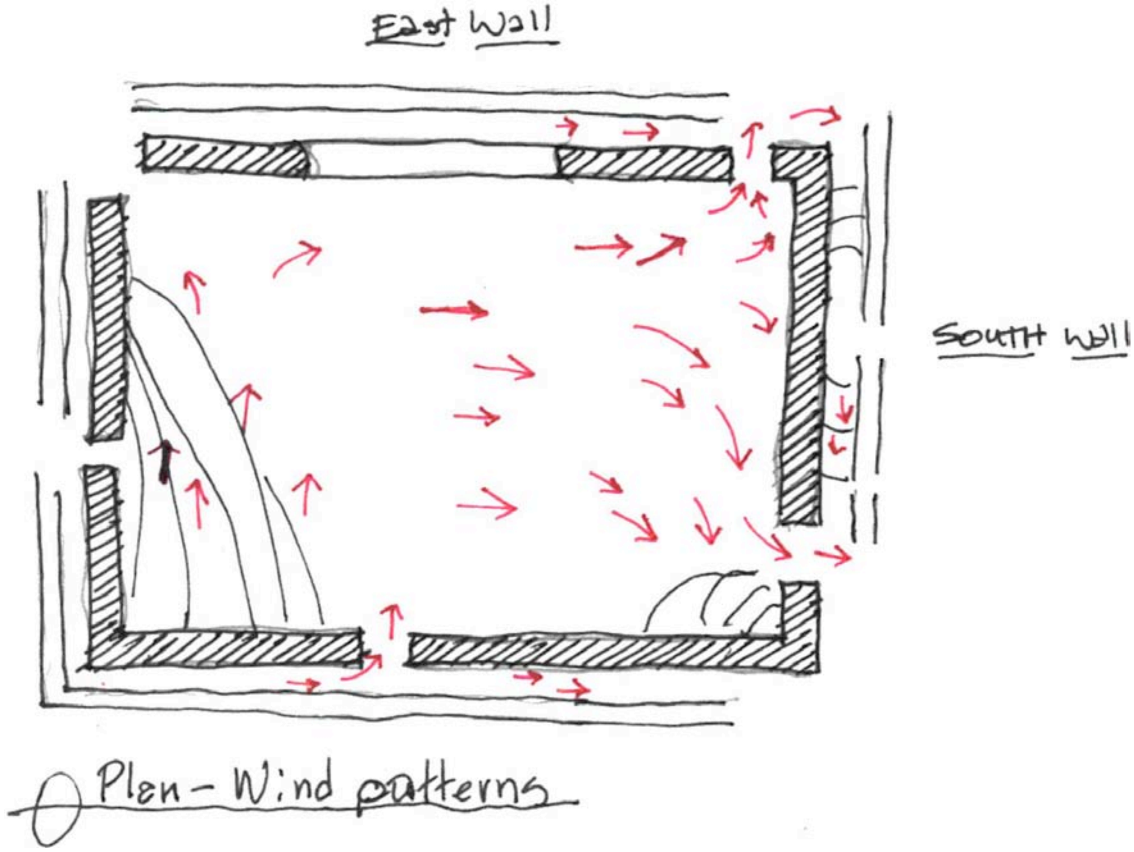


Figure 70. General wind pattern documented at ground level on 17 January 2000. (Graphic: Anthony Crosby 2000)

Figure 71. General structural conditions on the interior side of the east main enclosure wall (at left), seen from the top of the south main enclosure wall (at right); note especially the extent of missing fabric due to collapse, as well as the undermining and gradual loss of remaining surface on the east wall. (Composite photo: William Remsen 2000)

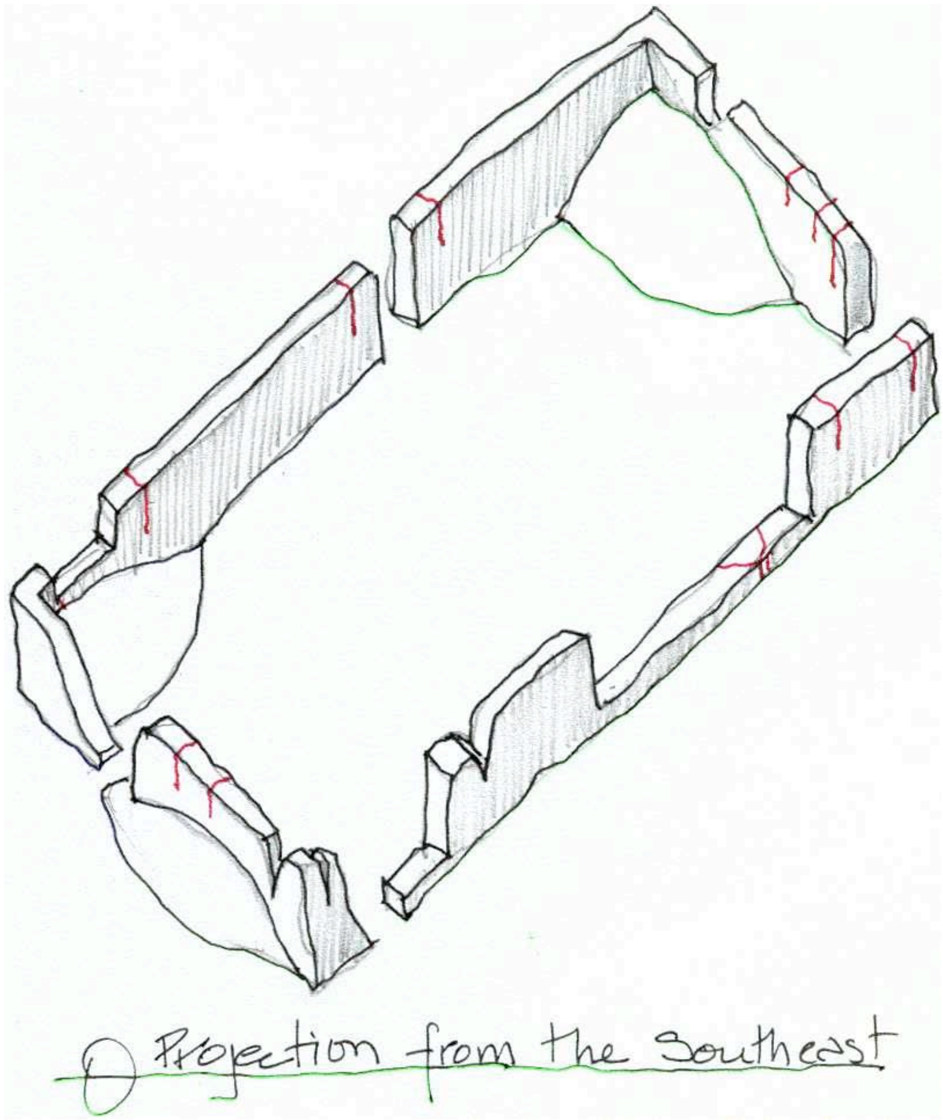


Figure 72. General locations of vertical, through-wall cracks in the main enclosure wall (noted in red). (Graphic: Anthony Crosby 2000)

Structural Conditions on the North Main Enclosure Wall (2000)

The north main enclosure wall is defined by a narrow cleft separating an eastern from a western portion (Figure 73). The intact segments of this wall represent a particular set of conditions characterized by weathering effects not generally observed elsewhere on the monument.

The exterior face of the north main enclosure wall generally exhibits moderate cavitation, detachment, cracking, erosion and surface friability as a result of weathering and insect activity. The central void separating the eastern and western sections exhibits urgent-priority cavitation, erosion, calving and loose brickwork stemming from local wall failure as well as an unstable overhang associated with mud-wasp nest accretion (Figures 74-76). Earlier stages of wall failure at this location are visible in photographs from the early 20th Century (Ayrton et al. 1904:Pls. 5[1, 3], 6[1]), and it is likely that this failure was caused by a combination of weathering effects and animal activity over an extended period of time. Cleaning of the void in 2001 produced evidence that it may originally have been created for a monastic cell, however, as no plaster or other cell traces were preserved, the presence of a cell at this location is inconclusive. The collapse of the wall top that spanned this void until recently was exacerbated by expansion of the mud-wasp nest accretion still visible on the upper surface of the cavity and by torrential rains that occurred in the mid-1990s (see Figure 76).

The eastern extremity of the north wall exhibits a high-priority overhang on the vertical wall end, representing one side of the north main enclosure gate (Figures 77 and 78). Although cleaning of the area in 2004 did not reveal any direct evidence for a monastic cell in the end of the wall, the flatness of the lower part of the wall end (below the overhang), as well as the presence of a cell on the opposite side of the gateway, suggests that the major loss of wall fabric at this location may have been related to the existence of a cell.

The western, exterior face of the north wall exhibits normal-priority cracking and cavitation along the length of the upper wall surface (Figures 79 and 80). The westernmost end of the wall also exhibits heavy erosion, mortar washout and loose brickwork resulting from concentrated water damage to the upper wall, and mud-drip concentrations caused by surface water runoff (Figures 81 and 82).

The interior elevation of both the eastern and western sections of the north wall exhibit normal to urgent-priority cavitation, calving, cracking and loose brickwork associated with extensive hornet nesting and bird activity (Figures 83 and 84).

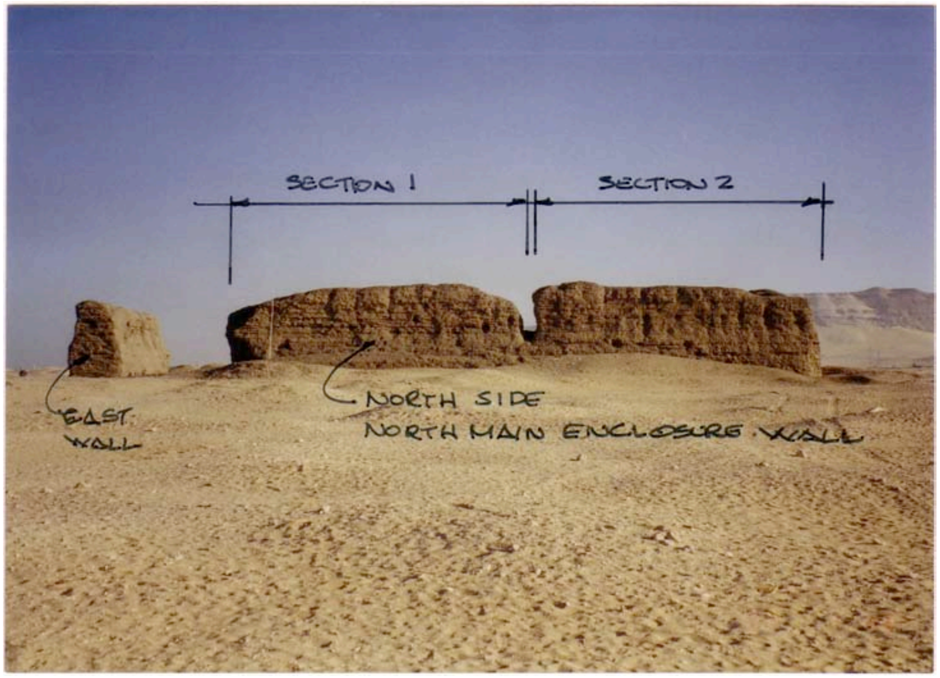


Figure 73. The eastern and western, exterior faces of the north main enclosure wall (noted as sections 1 and 2, respectively). (Photo: Conor Power 2000)

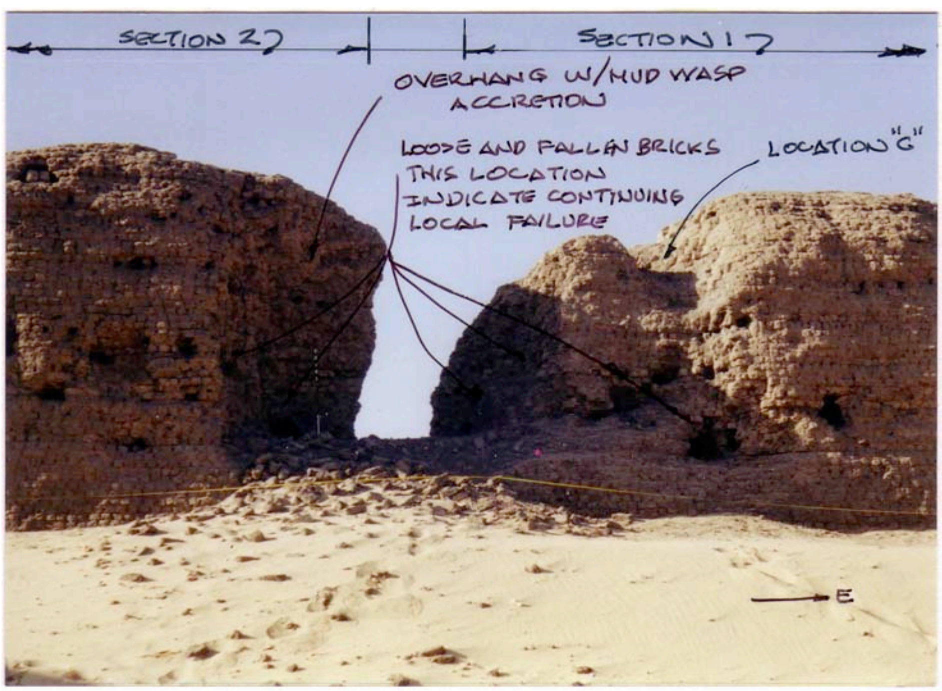


Figure 74. Detail of the central void in the north main enclosure wall. (Photo: Conor Power 2000)

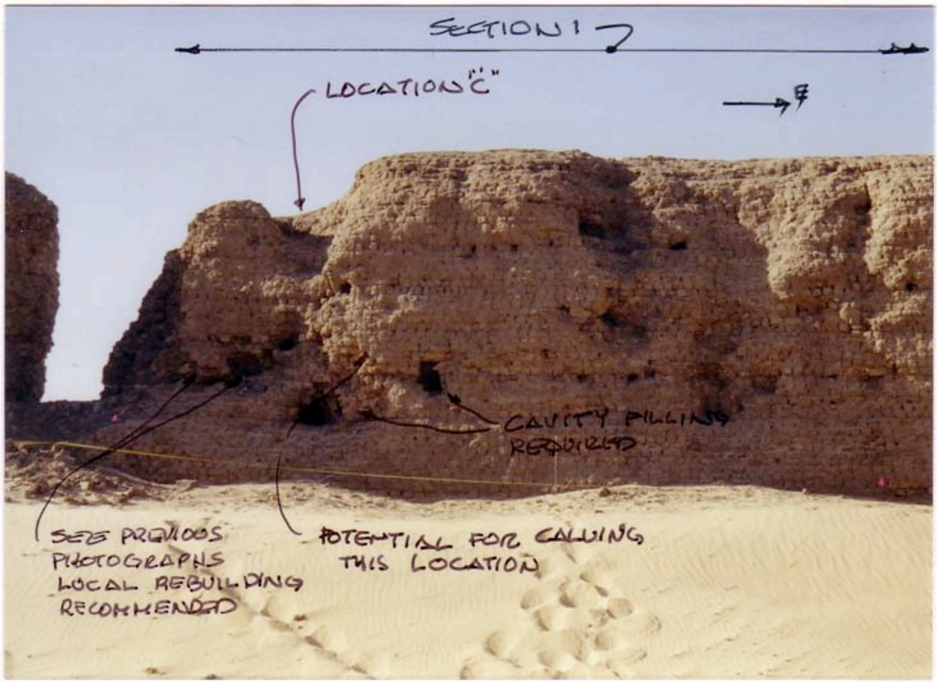


Figure 75. Structural conditions adjacent to the central void in the north main enclosure wall include urgent-priority erosion, cavitation and unstable brickwork (noted as location C). (Photo: Conor Power 2000)

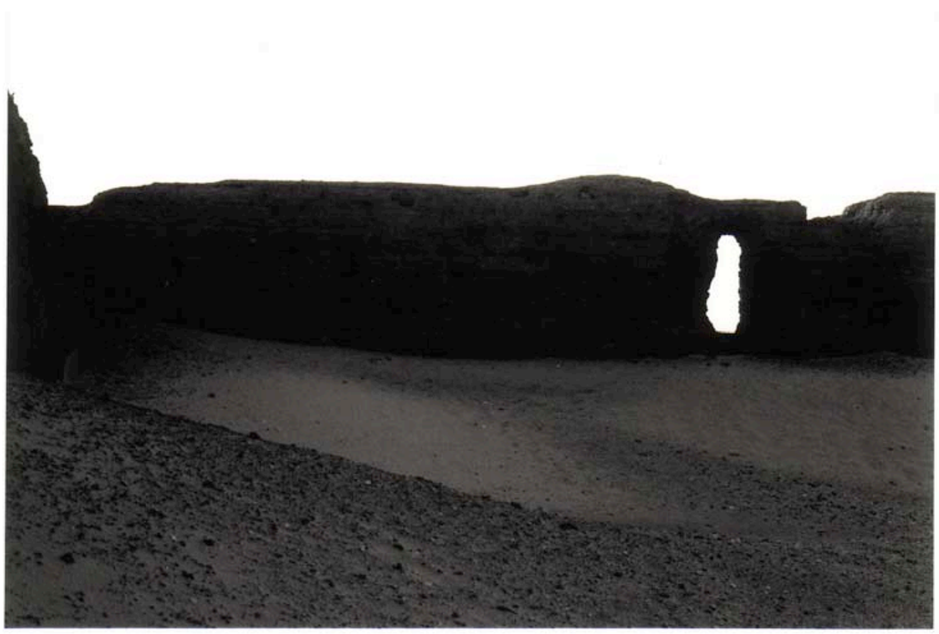


Figure 76. Interior detail of the central void in the north main enclosure wall prior to the collapse of the top span in recent years. (Photo: Matthew Adams 1987)

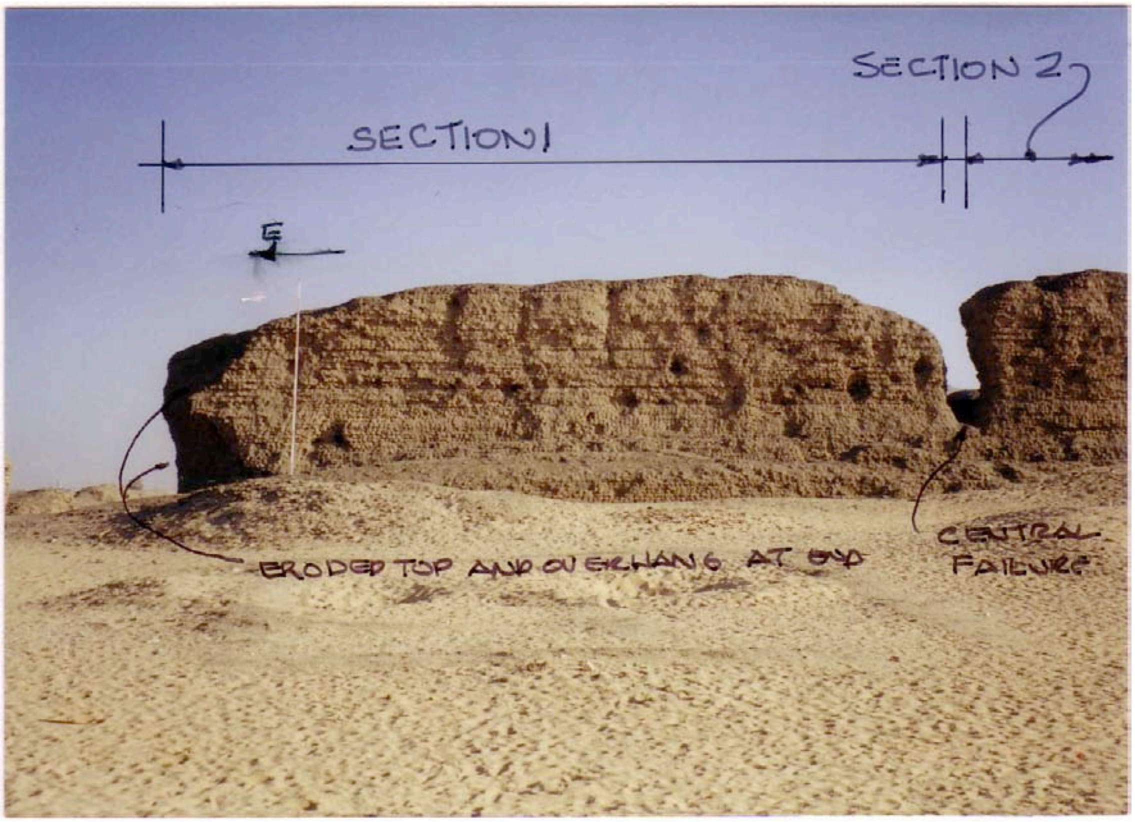


Figure 77. The eastern, exterior face of the north main enclosure wall (noted as section 1). (Photo: Conor Power 2000)

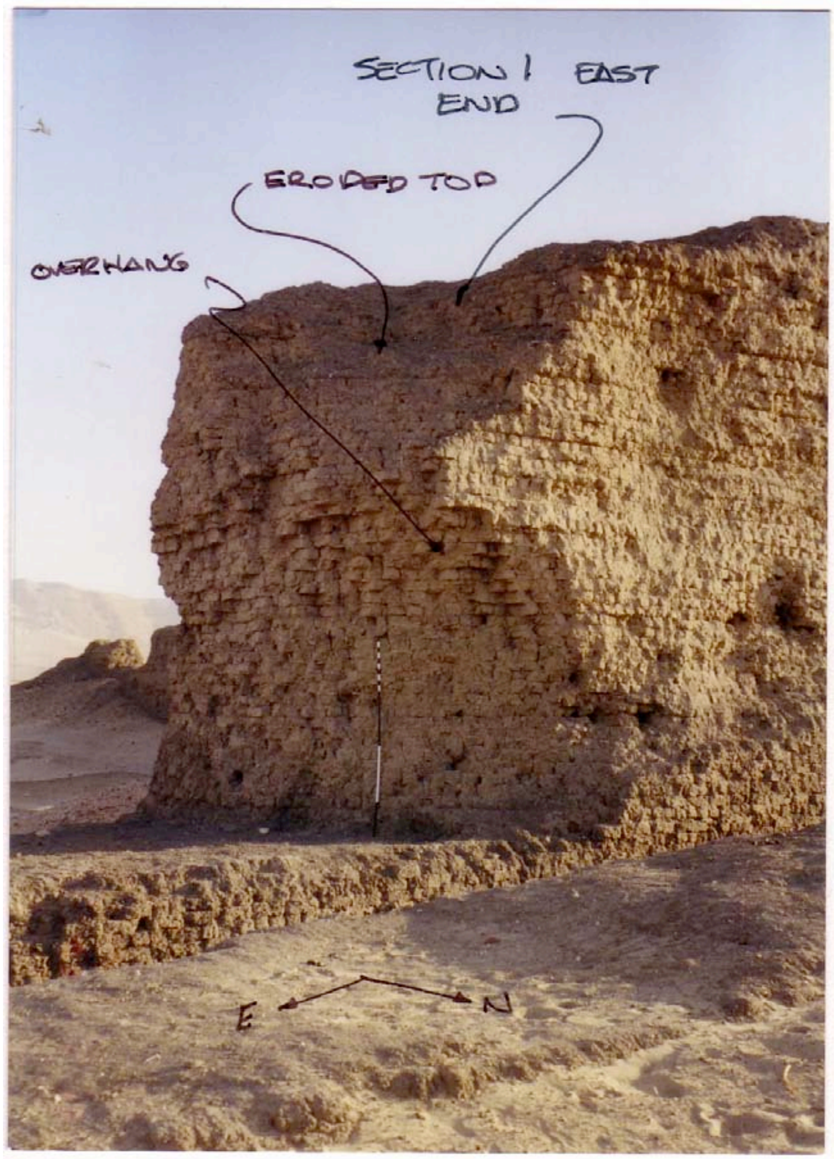


Figure 78. Detail of the high-priority overhang at the eastern, vertical end of the north main enclosure wall. (Photo: Conor Power 2000)

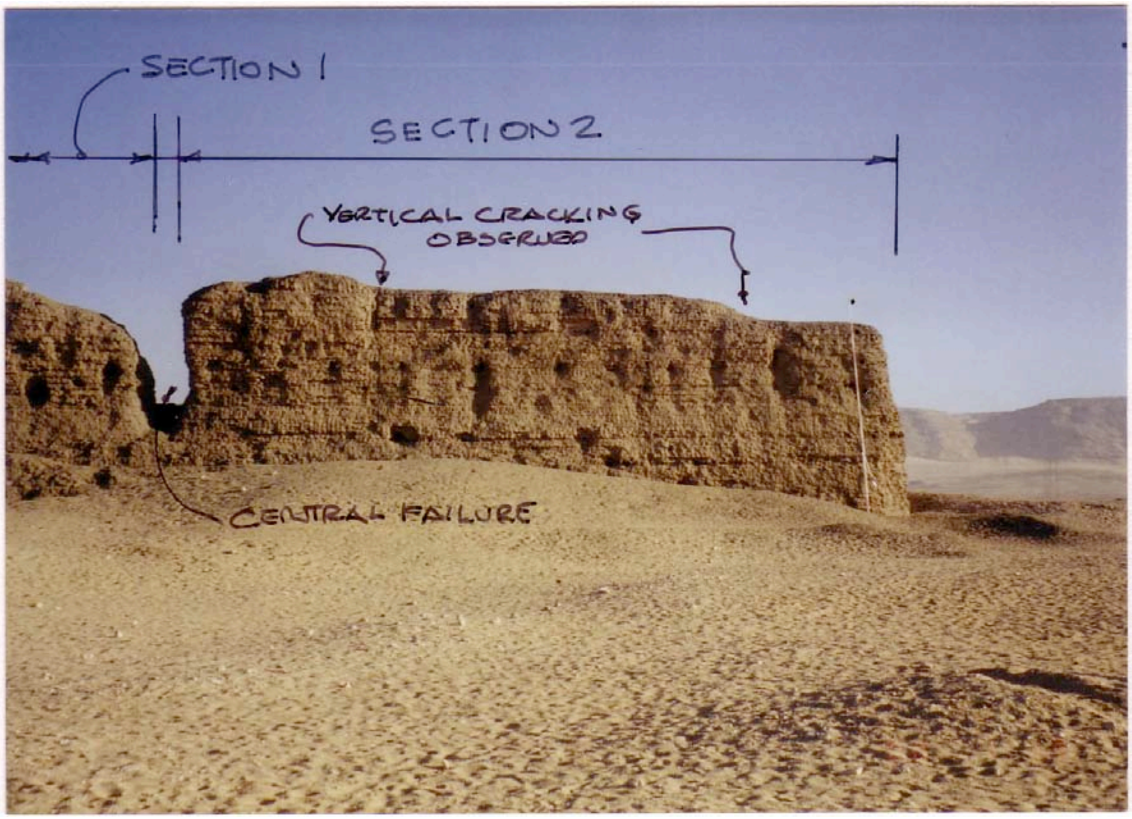


Figure 79. The western, exterior face of the north main enclosure wall (noted as section 2). (Photo: Conor Power 2000)

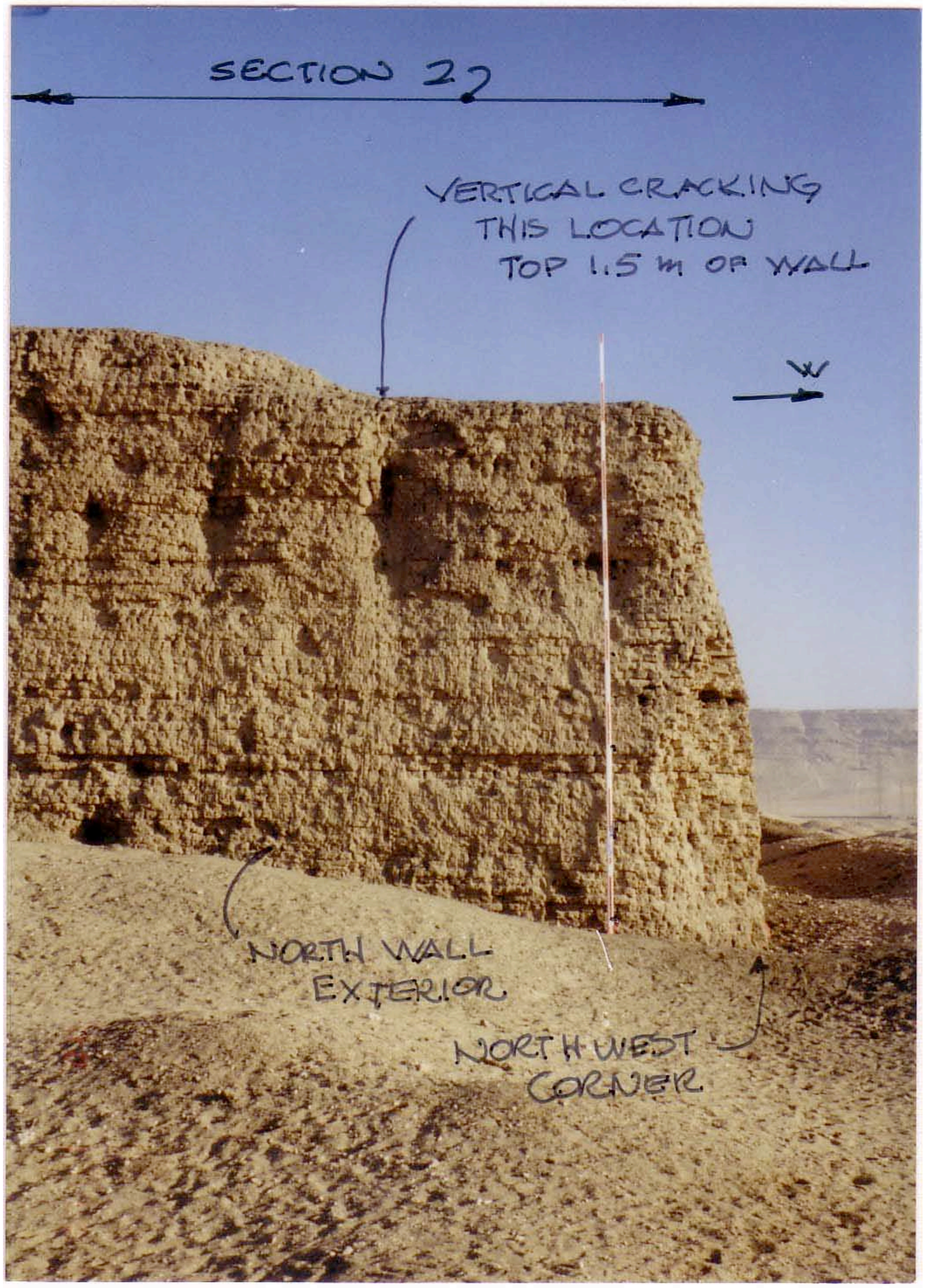


Figure 80. Detail of surface erosion and cracking at the western, exterior end of the north main enclosure wall. (Photo: Conor Power 2000)

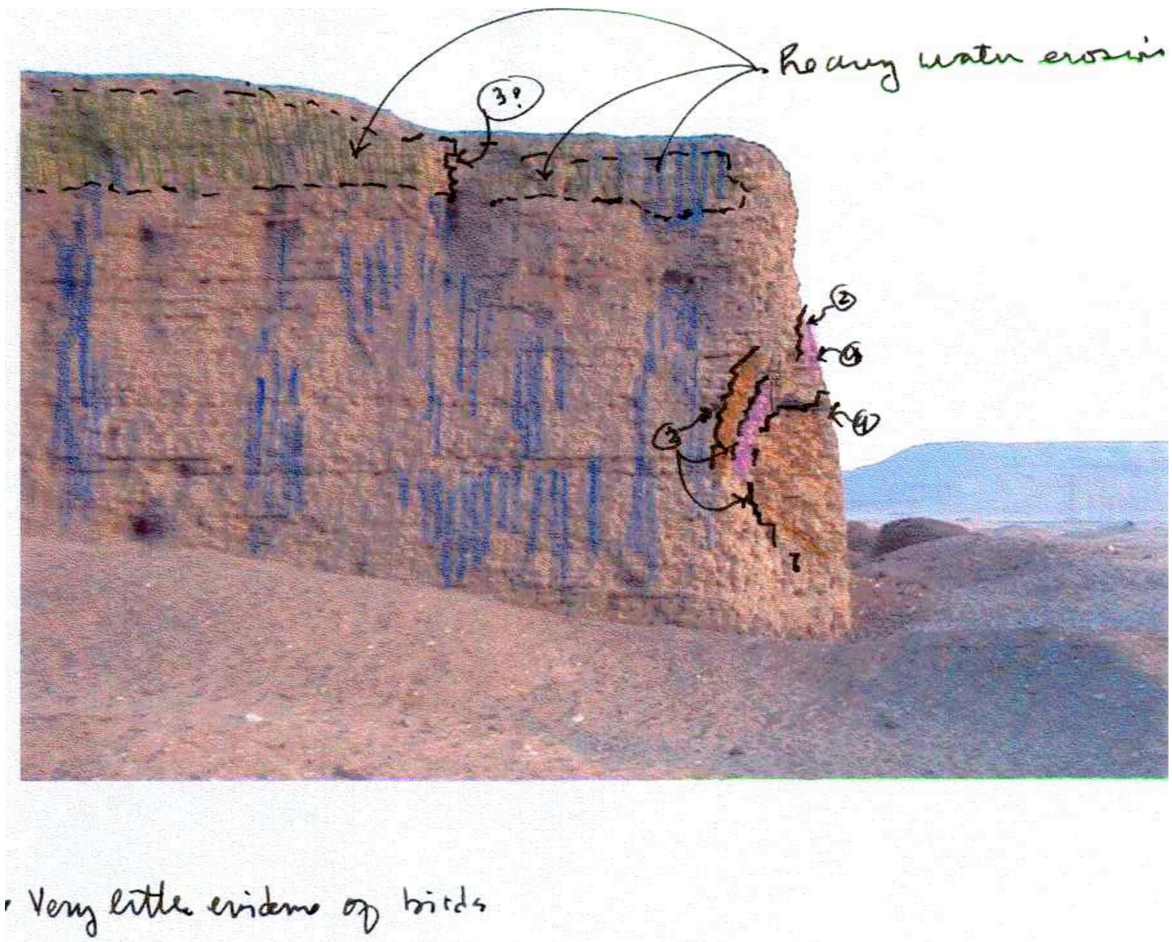


Figure 81. Locations of water erosion (noted in green) and mud drips (noted in blue) at the western, exterior end of the north main enclosure wall. (Photo/graphic: Anthony Crosby 2000)

Figure 82. Detail of a mud-drip concentration at the western, exterior end of the north main enclosure wall. (Photo: Conor Power 2000)

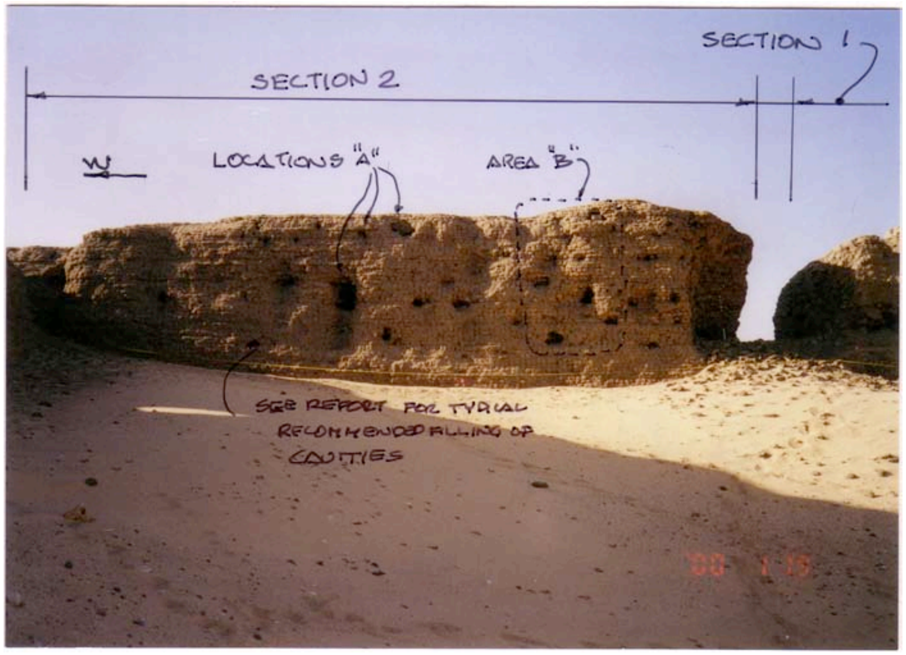


Figure 83. Urgent-priority cavitation caused by insect activity on the western, interior face of the north main enclosure wall (noted as section 2). (Photo: Conor Power 2000)

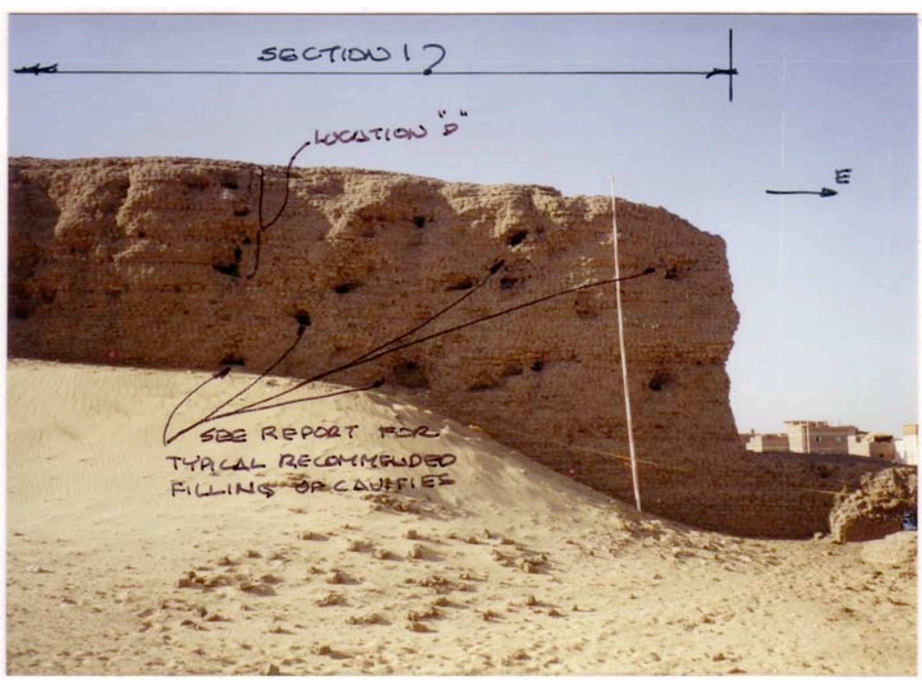


Figure 84. Normal-priority cavitation and surface detachment on the eastern, interior face of the north main enclosure wall (noted as section 1). (Photo: Conor Power 2000)

Structural Conditions on the East Main Enclosure Wall (2000)

The east main enclosure wall is characterized by the absence of the upper part of its central portion, which collapsed at an unknown time, leaving two standing piers on either side (to the north and south) of a long, low central section (Figures 85 and 86).

The southern, exterior face of the east wall exhibits five local conditions, illustrated as locations A through E in Figures 87-90, including an urgent-priority crack in the top three meters of the southern wall end, and specific locations of high to urgent-priority cavitation, erosion, loose brickwork and unstable brick masses. The southern, interior face exhibits distinct locations of urgent-priority undermining, cavitation, erosion, corbelling and cracking, and of normal-priority cavitation and loose and overhanging brickwork, illustrated as locations F through I in Figures 91-94.

The central, exterior side of the east wall is in remarkably good condition with low-priority pilaster detachment and cracking (Figures 95-98). However, the interior side of the low, central portion of the east wall is in extremely poor condition, exhibiting locations of urgent-priority undermining, cavitation, cracking and active surface detachment (illustrated as locations J and K in Figures 99-103), as well as a large, rotated wall mass (illustrated as location L in Figures 99 and 104). The undermining of the interior wall base in this area as a result of extensive animal burrowing is among the most critical of existing structural conditions at the monument.

The northern pier of the east wall generally exhibits extensive cavitation and surface friability as well as urgent-priority through-wall cracking, erosion, undermining, detachment, overhangs, nest accretions and loose brickwork at various locations on both the interior and exterior elevations (illustrated as locations M through O in Figures 105-111). Location M designates a major structural crack that threatens one end of the northern pier with collapse, and at the other (northern) end of this pier is a second structural crack, which has essentially isolated the vertical wall end at this location (see Figures 105, 107 and 111). This vertical segment of the east wall stands to near the original height of the enclosure in an extremely unstable condition, exhibiting a combination of cracking and detachment associated with the collapse of the adjacent gateway as well as the construction and decay of a monastic cell dug into the wall from the north interior gateway chamber (see Figures 17 and 18, above).

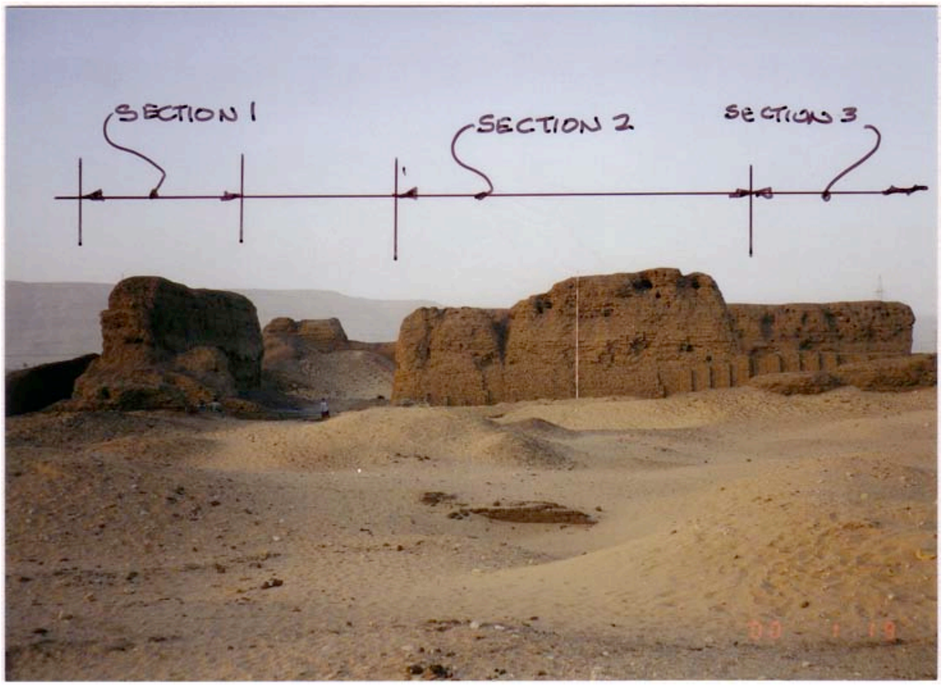


Figure 85. Southern and central, exterior faces of the east main enclosure wall (noted as sections 2 and 3, respectively). (Photo: Conor Power 2000)

Figure 86. Central and northern, exterior faces of the east main enclosure wall (noted as sections 3 and 4, respectively). (Photo: Conor Power 2000)

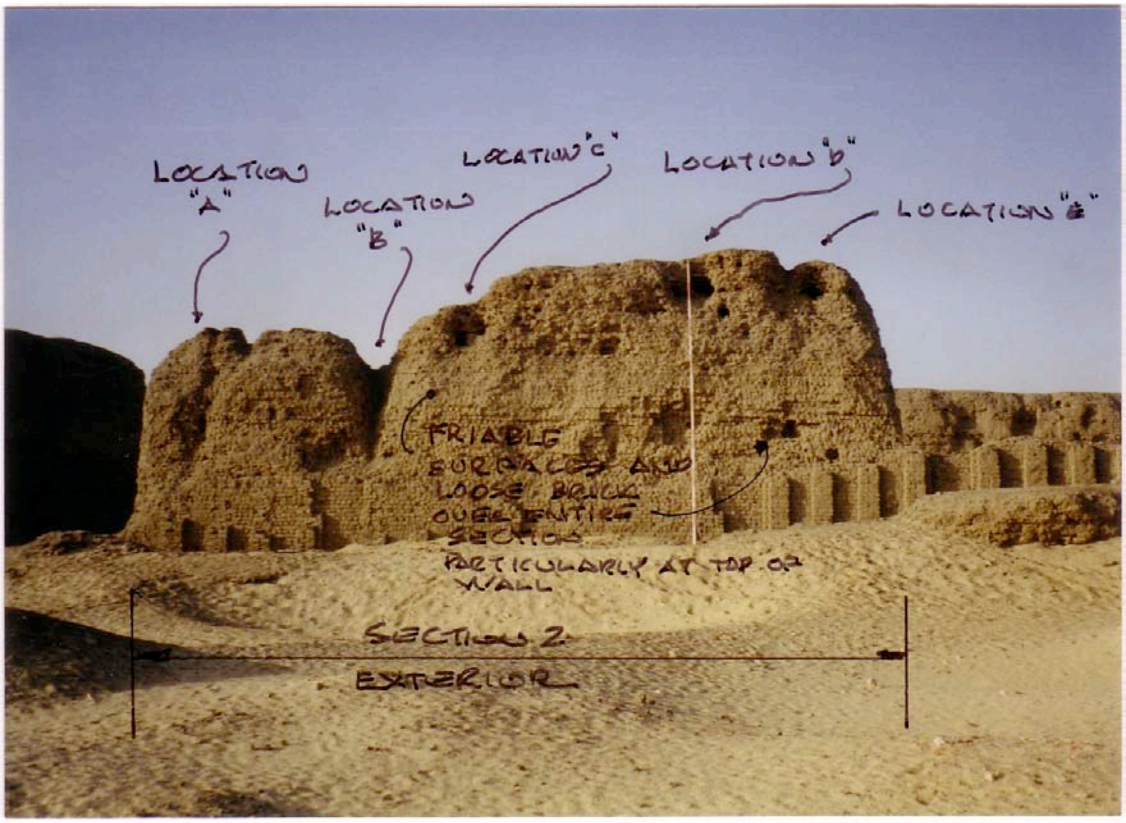


Figure 87. Specific structural conditions on the southern, exterior face of the east main enclosure wall, noted as locations A-E (see details, below). (Photo: Conor Power 2000)

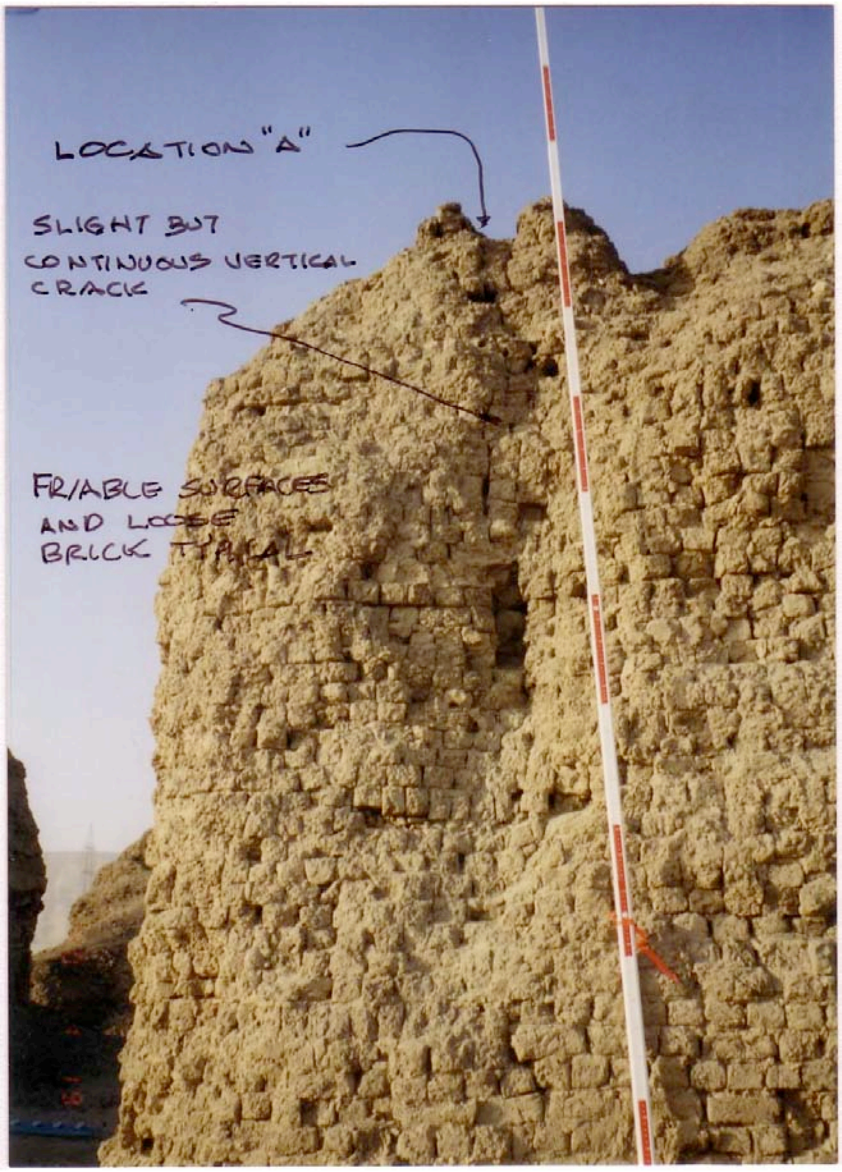


Figure 88. Detail of a vertical crack in the upper surface of the east main enclosure wall (noted as location A). (Photo: Conor Power 2000)

Figure 89. Detail of high-priority erosion in the upper surface of the east main enclosure wall (noted as location B). (Photo: Conor Power 2000)

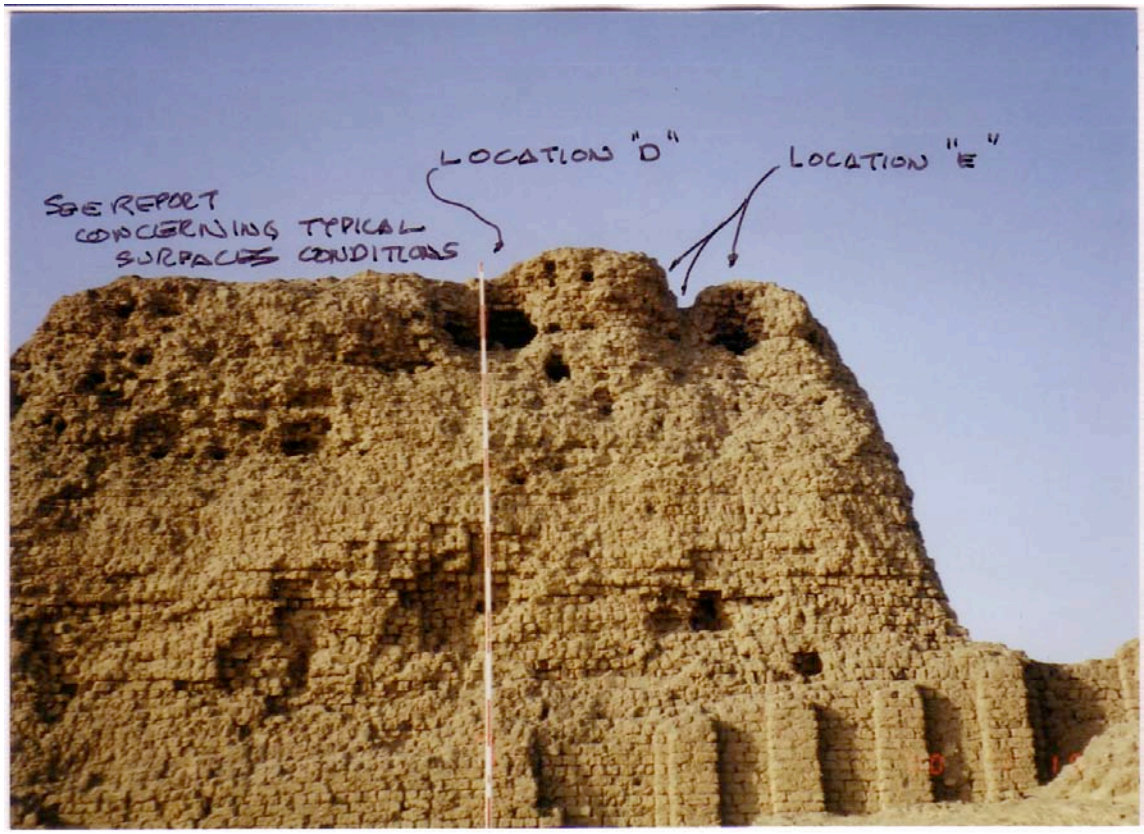


Figure 90. Details of urgent-priority cavitation and unstable brick masses on the exterior face of the east main enclosure wall (noted as location D) and urgent-priority cavitation, erosion and overhanging brickwork (noted as location E). (Photo: Conor Power 2000)

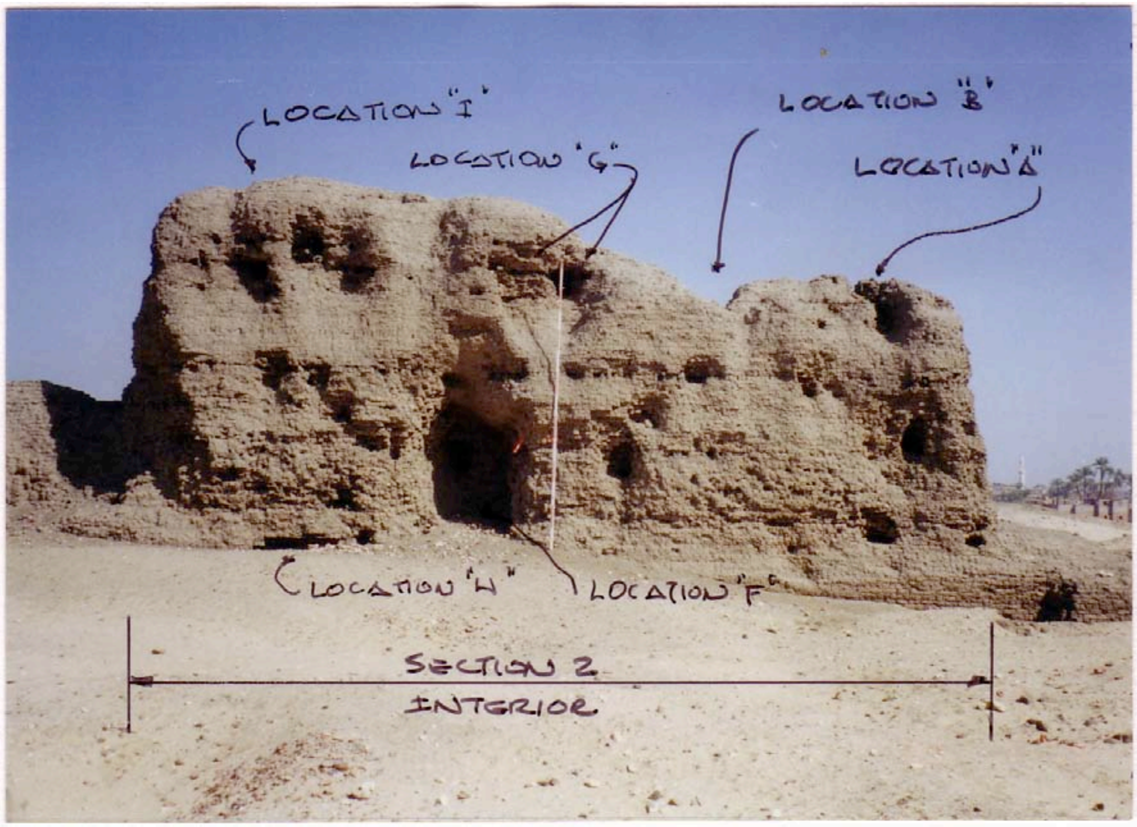


Figure 91. Specific structural conditions on the southern, interior face of the east main enclosure wall, noted as locations F-I (see details, below). (Photo: Conor Power 2000)

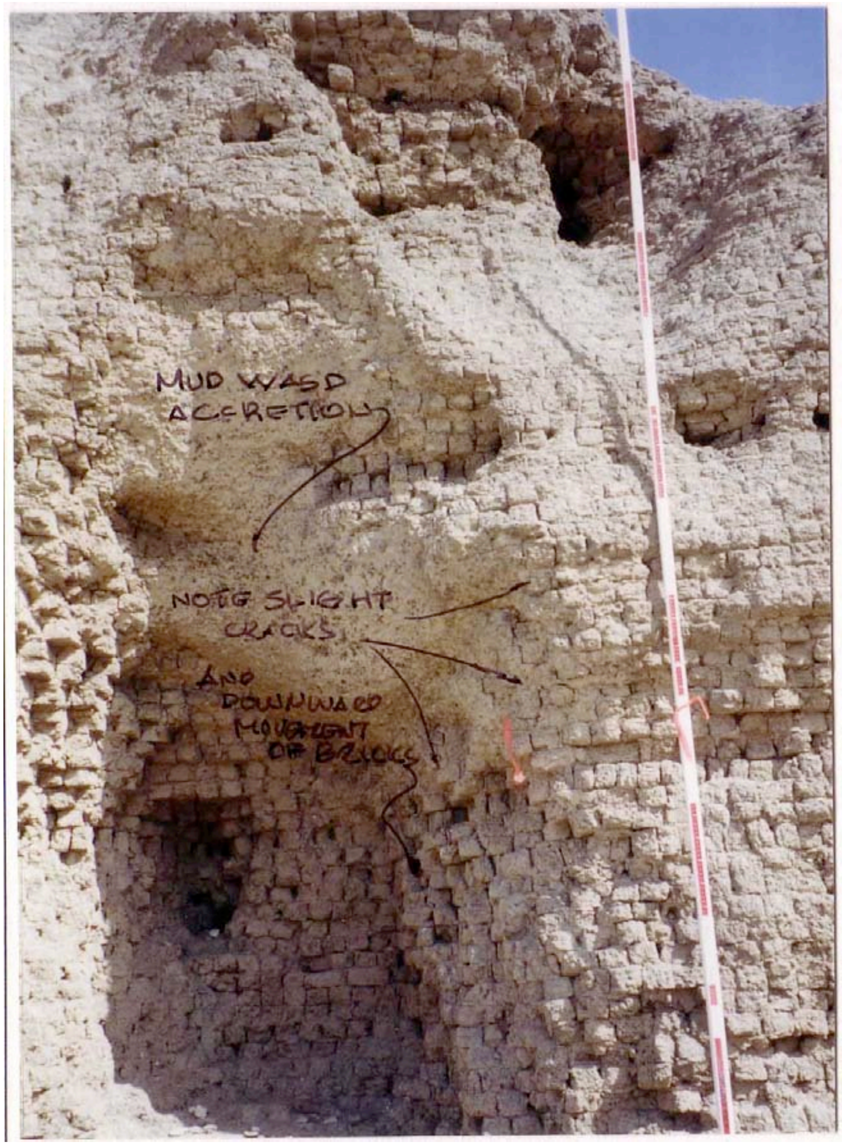


Figure 92. Detail of urgent-priority cavitation and cracking on the southern, interior side of the east main enclosure wall (noted as location F in Figure 91, above and Figure 93, below); note especially the large mud-wasp nest accretion on the upper surface of the wall cavity at lower left. (Photo: Conor Power 2000)

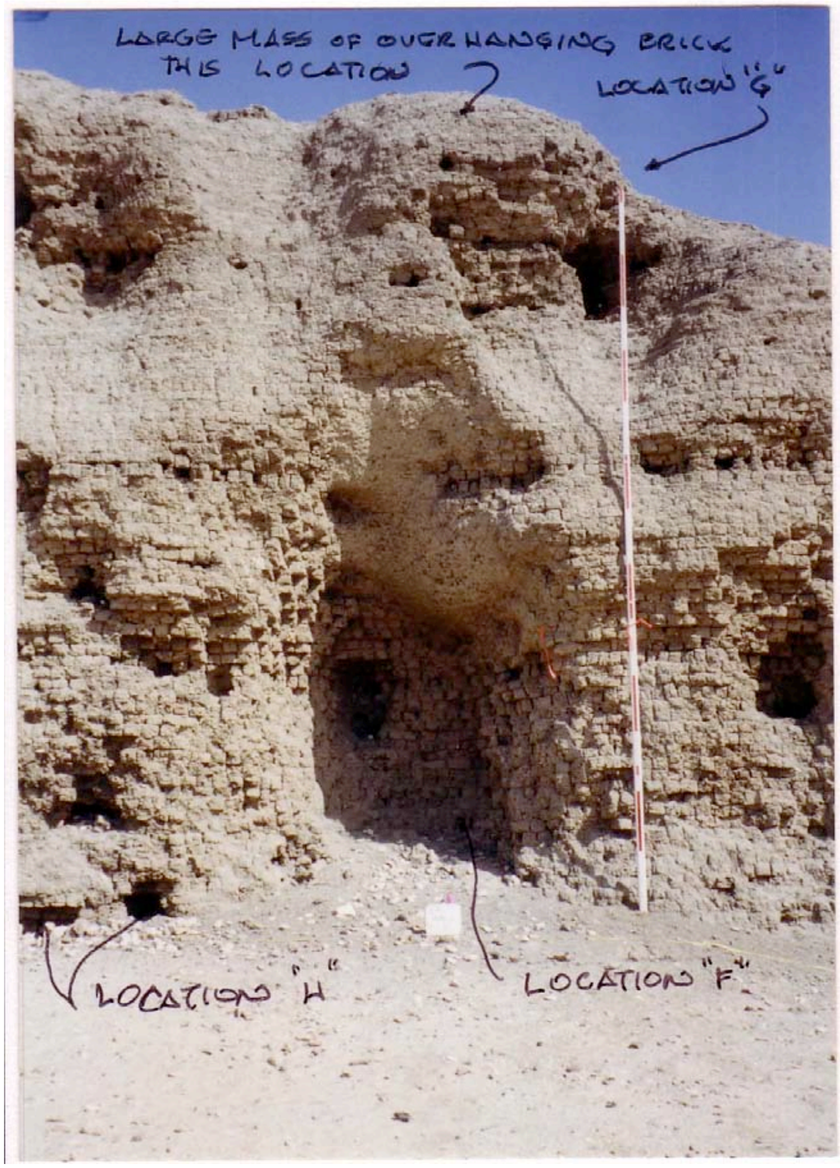


Figure 93. Detail of urgent-priority corbelling, cavitation and erosion on the southern, interior face of the east main enclosure wall (noted as location G). (Photo: Conor Power 2000)

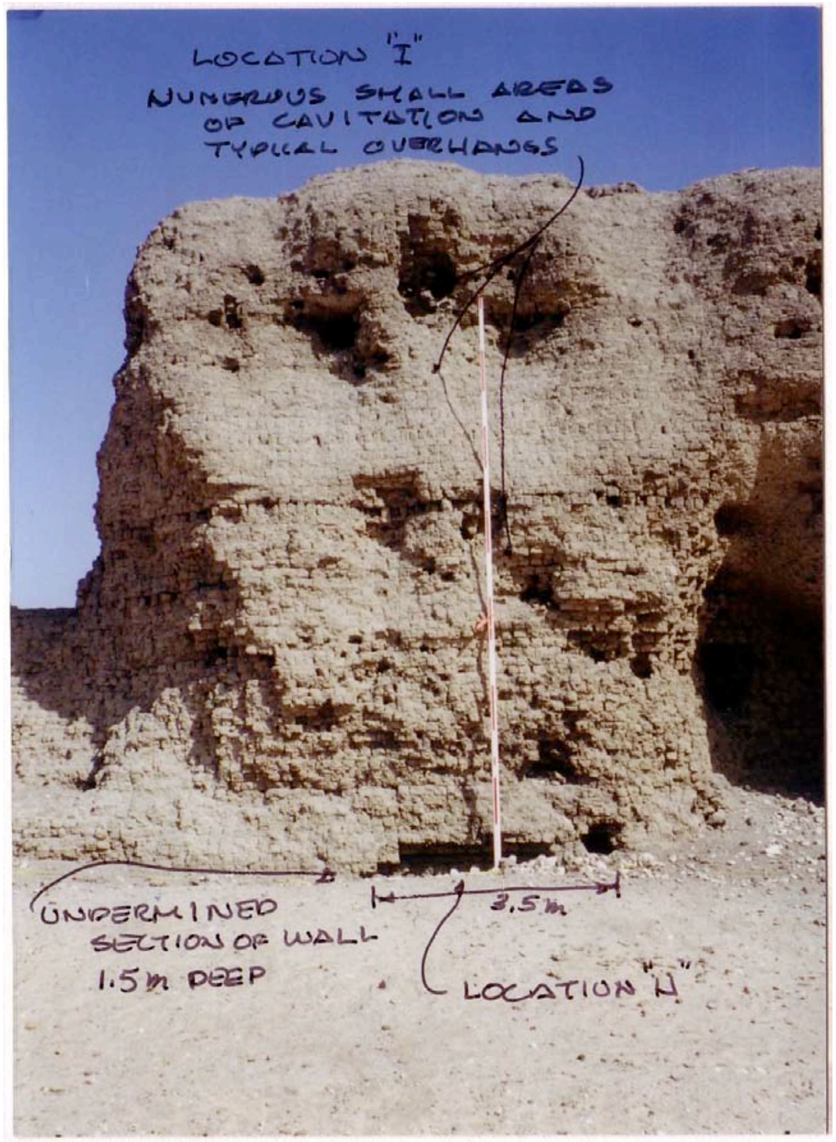


Figure 94. Details of urgent-priority undermining and cavitation on the southern, interior face of the east main enclosure wall (noted as location H) and normal-priority cavitation, overhangs and loose brickwork (noted as location I). (Photo: Conor Power 2000)

Figure 95. The central, exterior face of the east main enclosure wall (noted as section 3). (Photo: Conor Power 2000)

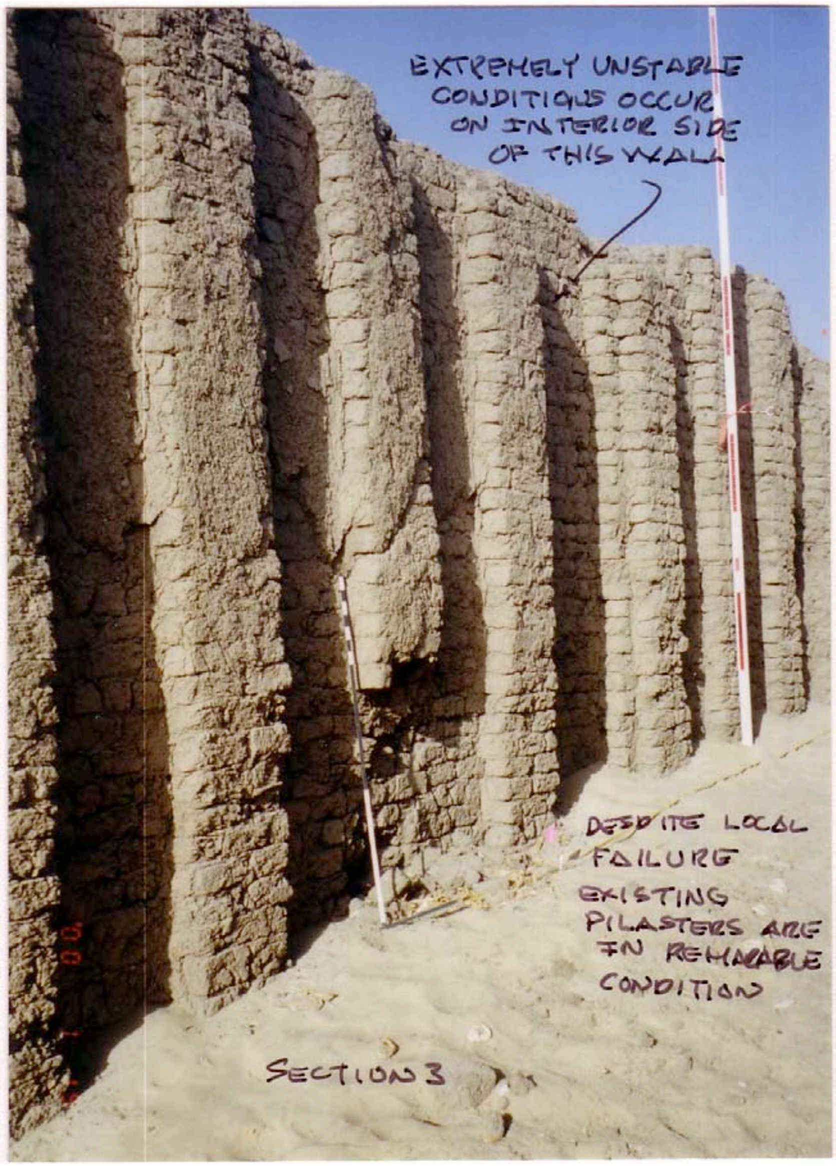


Figure 96. Detail of local failures on the central, exterior face of the east main enclosure wall. (Photo: Conor Power 2000)

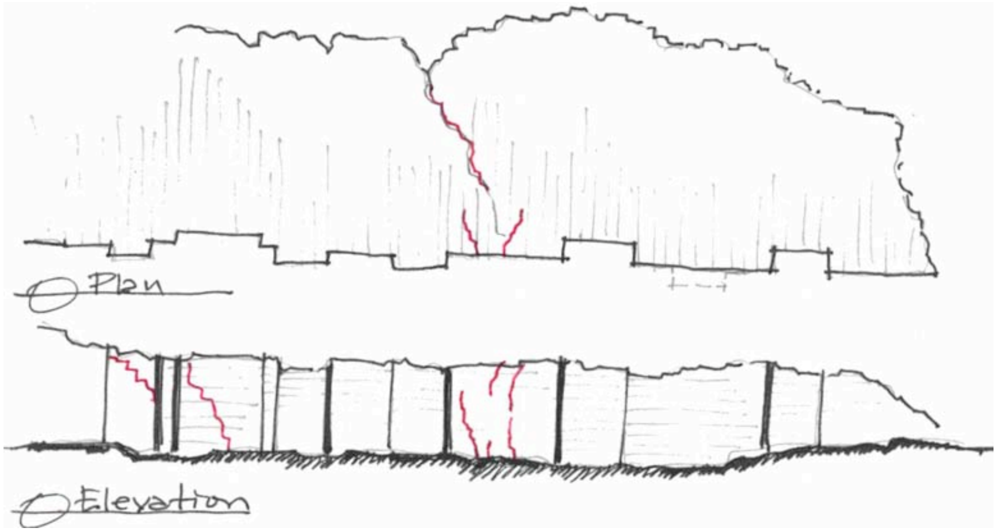


Figure 97. Relationships of pilasters and cracks (noted in red) on the central, exterior face of the east main enclosure wall. (Graphic: Anthony Crosby 2000)

Figure 98. Detail of cracking in the exterior face of the east main enclosure wall as depicted in the sketch elevation of Figure 97, above. (Photo: Anthony Crosby 2000)

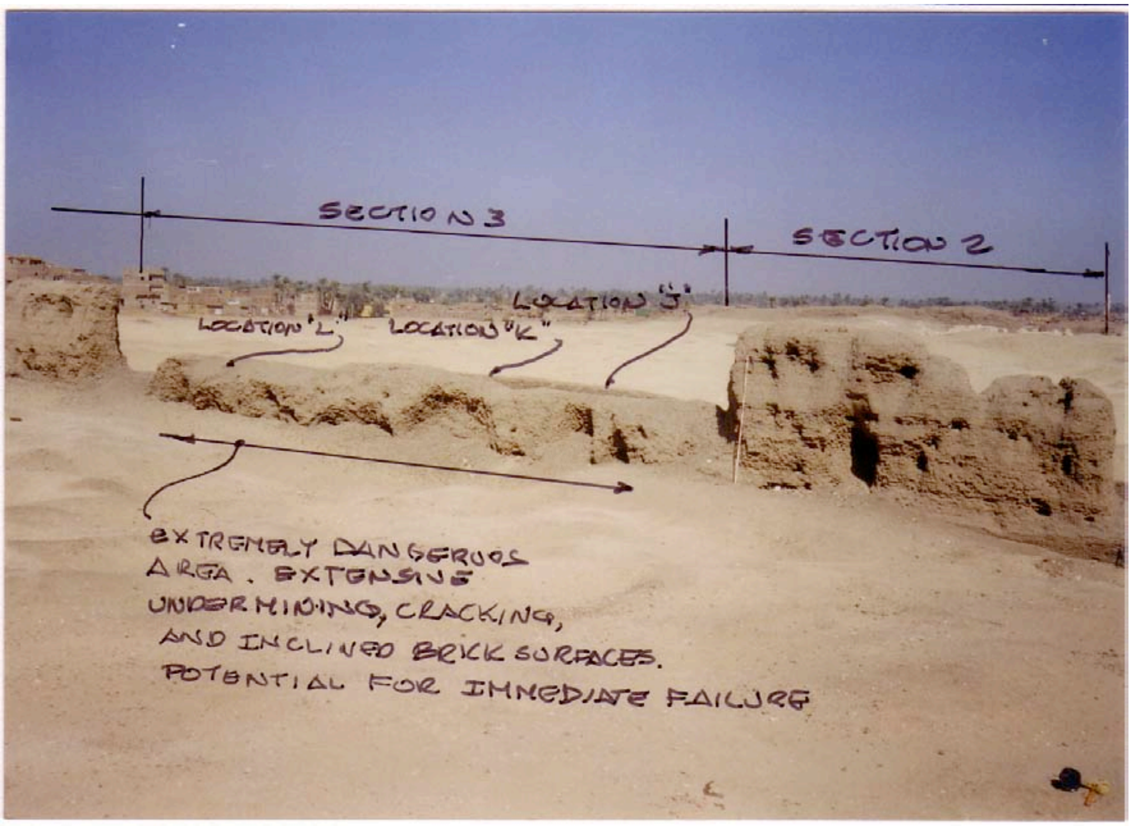


Figure 99. Specific structural conditions on the central, interior face of the east main enclosure wall, noted as locations J-L (see details, below). (Photo: Conor Power 2000)

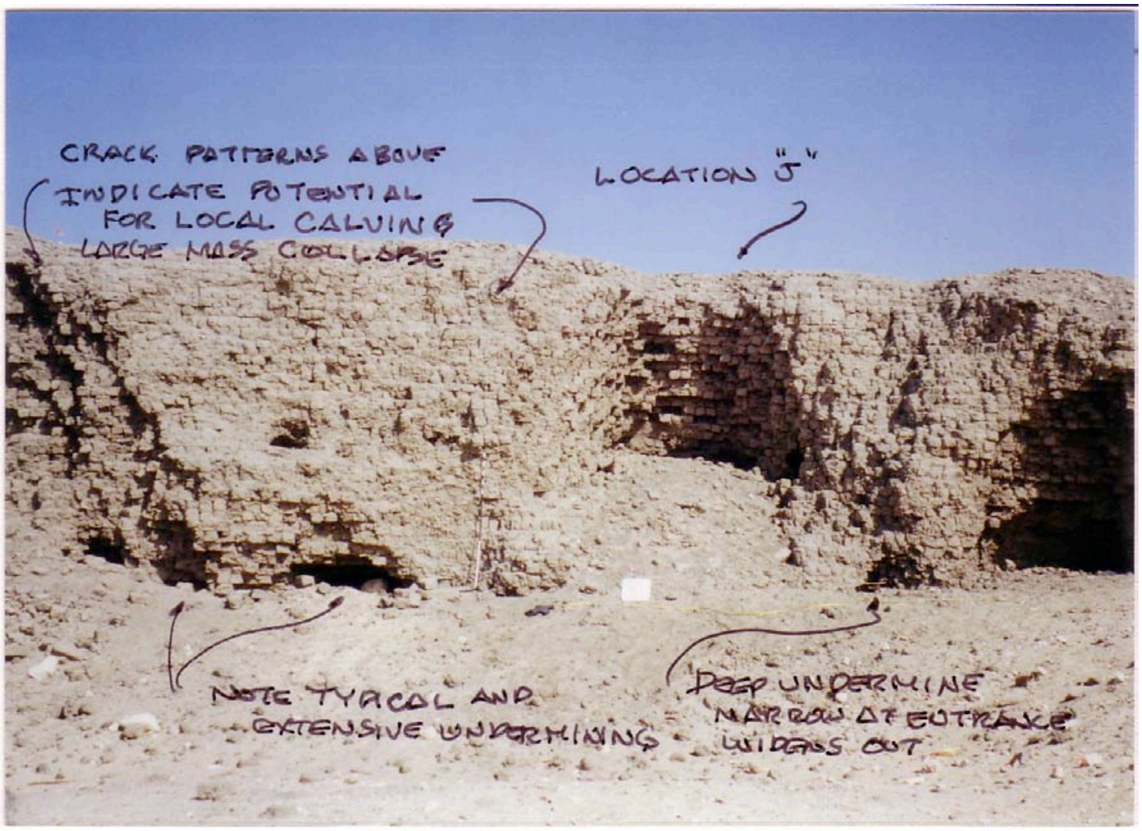


Figure 100. Details of undermining on the lower, interior side of the east main enclosure wall (lower left), as well as urgent-priority cavitation, cracking and calving (noted as location J). (Photo: Conor Power 2000)

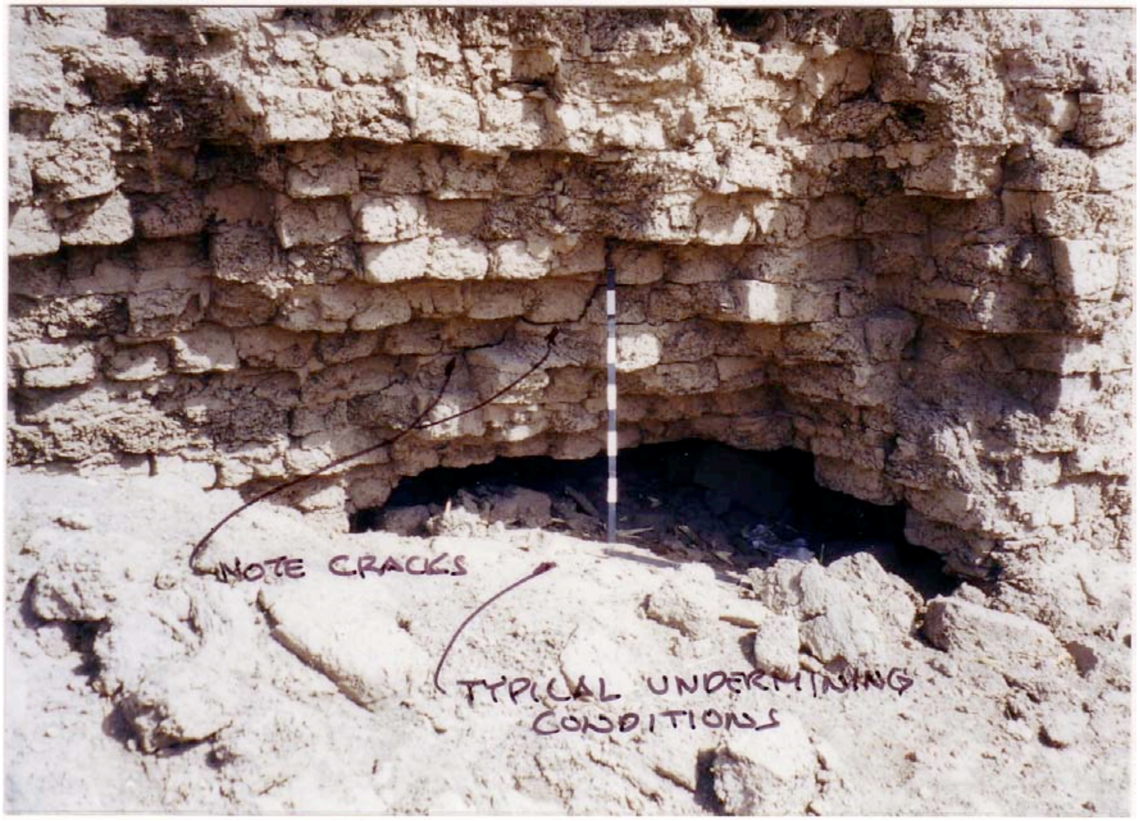


Figure 101. Detail of undermining to the interior base of the east main enclosure wall. (Photo: Conor Power 2000)

Figure 102. Detail of cracking and calving on the lower, interior side of the east main enclosure wall (noted as location K). (Photo: Conor Power 2000)

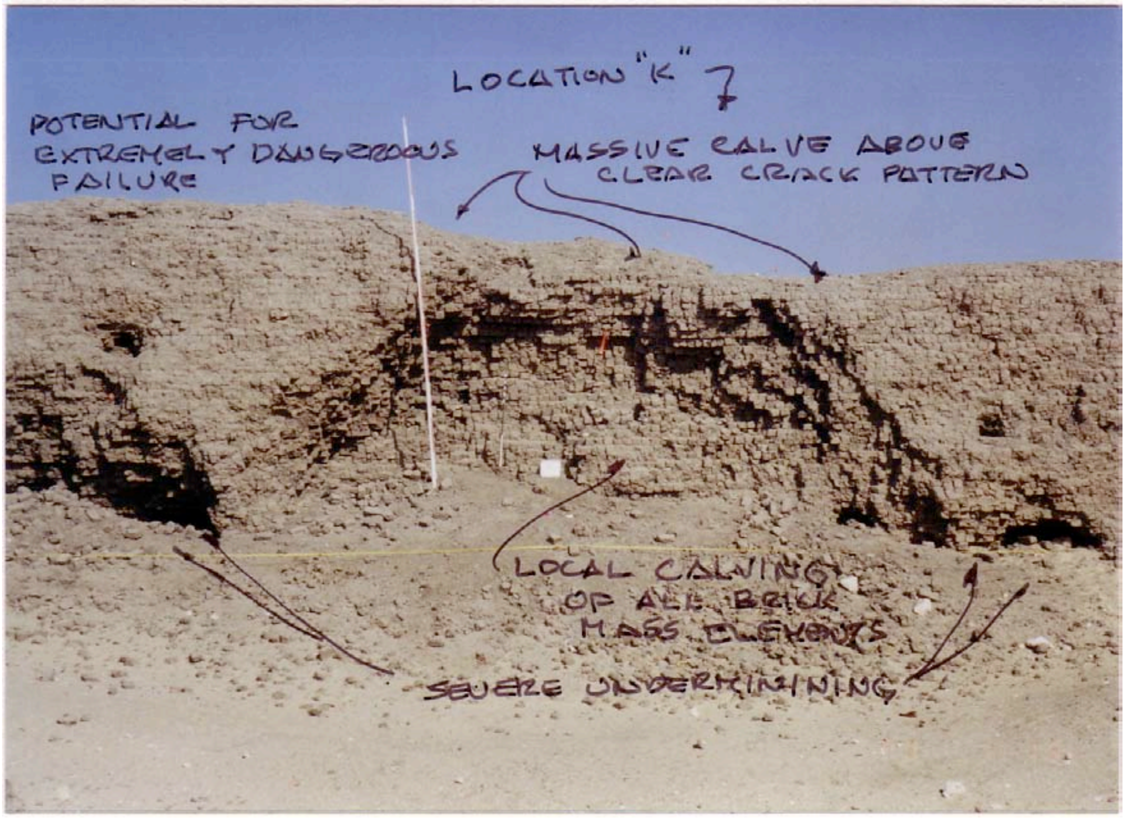


Figure 103. Detail of local undermining, cracking and calving on the interior side of the east main enclosure wall (noted as location K). (Photo: Conor Power 2000)

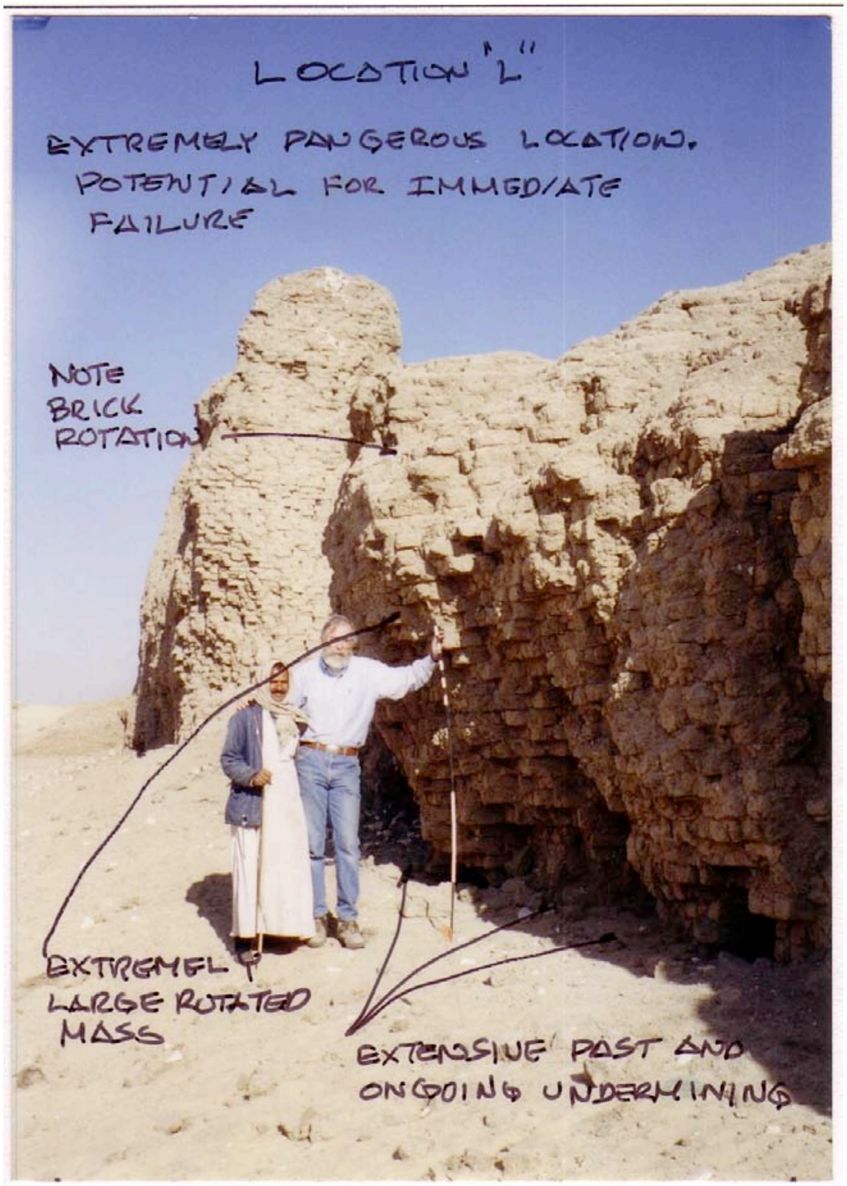


Figure 104. Detail of a large rotated wall mass on the interior side of the east main enclosure wall (noted as location L). (Photo: Conor Power 2000)

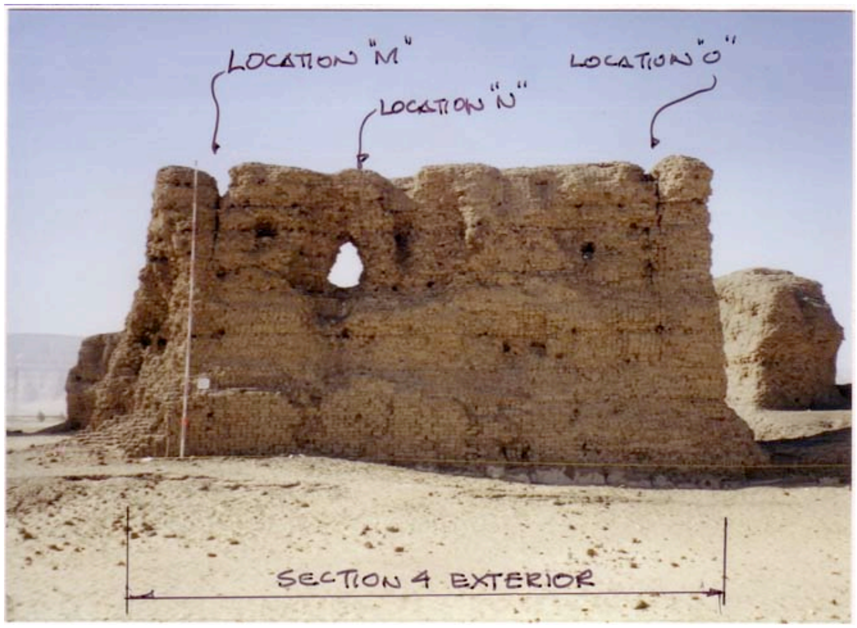


Figure 105. Specific structural conditions on the northern, exterior face of the east main enclosure wall, noted as locations M-O (see details, below). (Photo: Conor Power 2000)

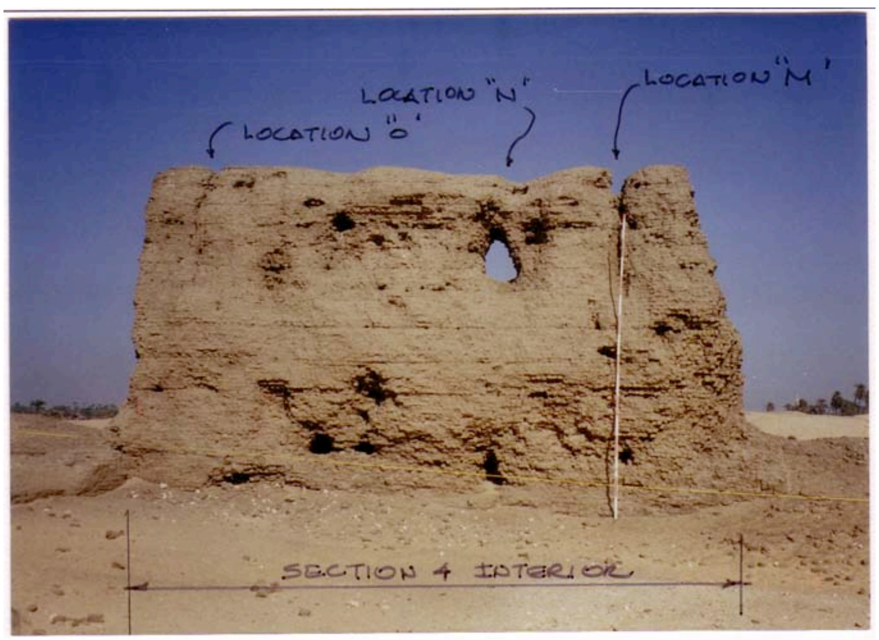


Figure 106. Specific structural conditions on the northern, interior face of the east main enclosure wall, noted as locations M-O (see details, below). (Photo: Conor Power 2000)

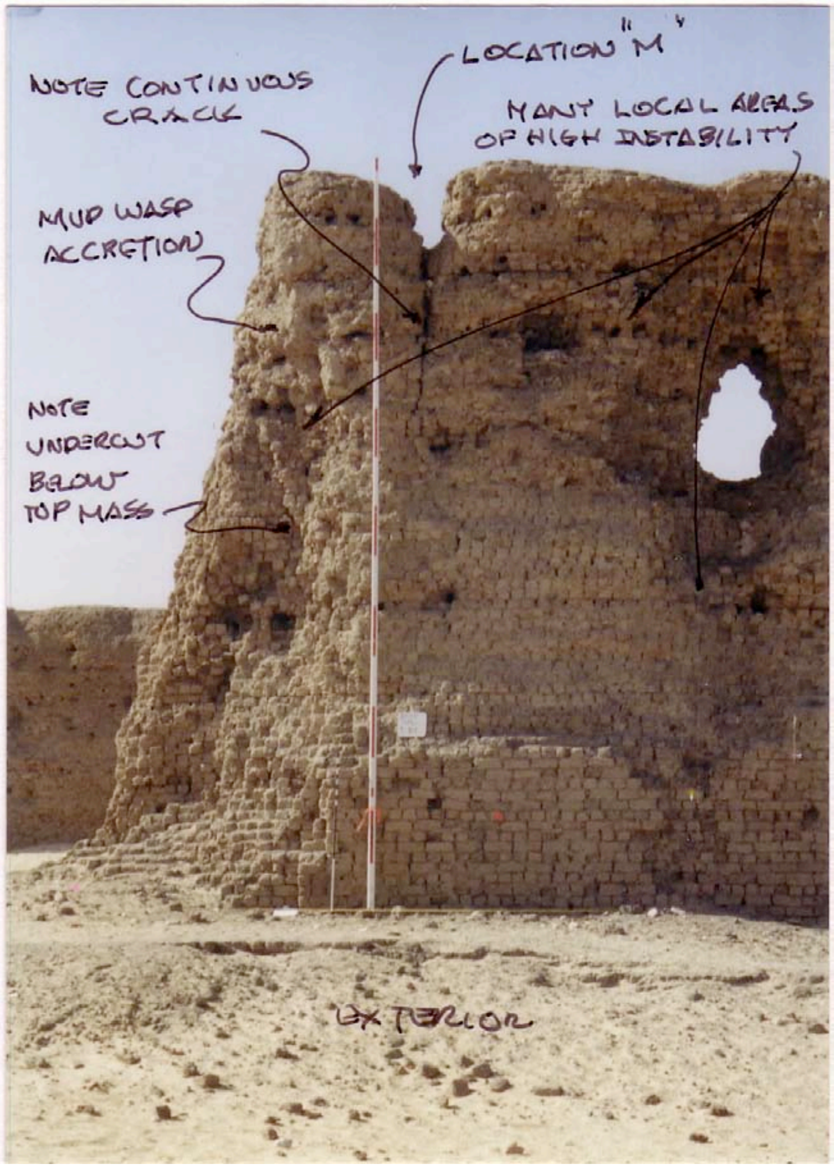


Figure 107. Exterior detail of an urgent-priority through-wall crack in the northern pier of the east main enclosure wall (noted as location M). (Photo: Conor Power 2000)

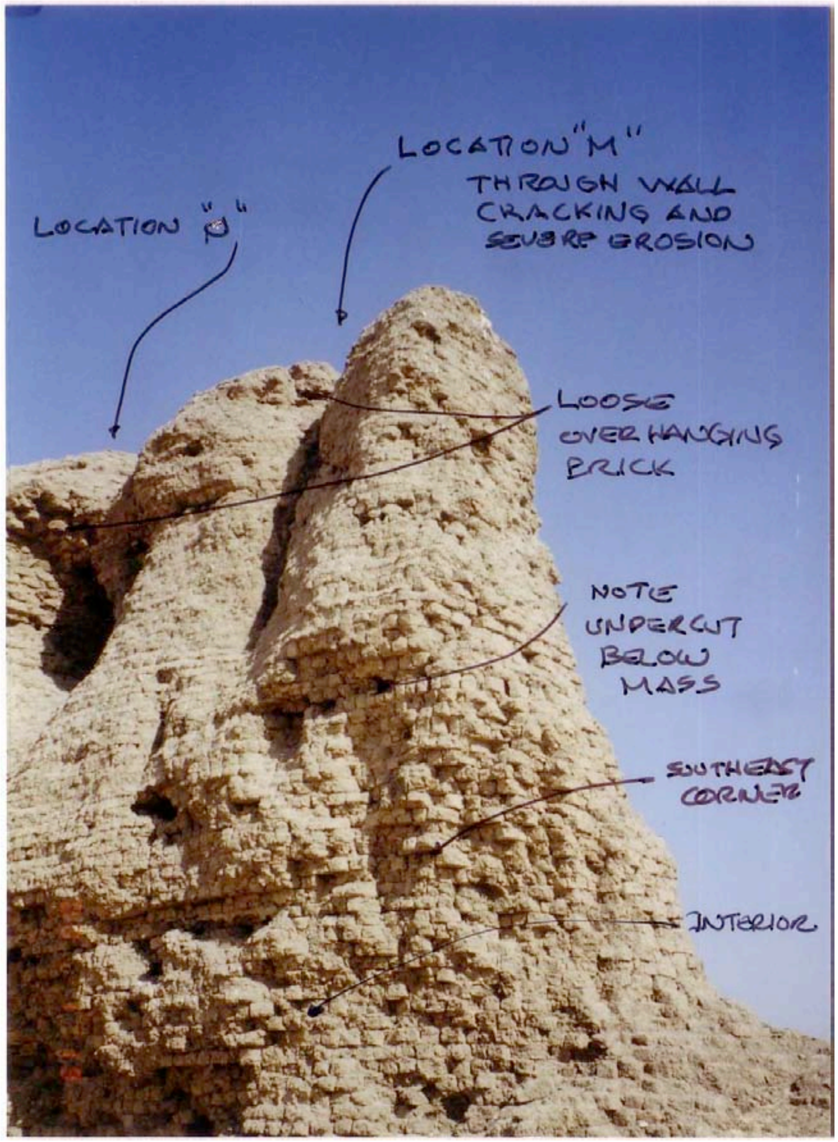


Figure 108. Details of cracking, erosion, detachment and overhanging brickwork on the northern, interior face of the east main enclosure wall (noted as locations M and N). (Photo: Conor Power 2000)

Figure 109. Exterior detail of through-wall cavitation in the northern pier of the east main enclosure wall (noted as location N). (Photo: Conor Power 2000)

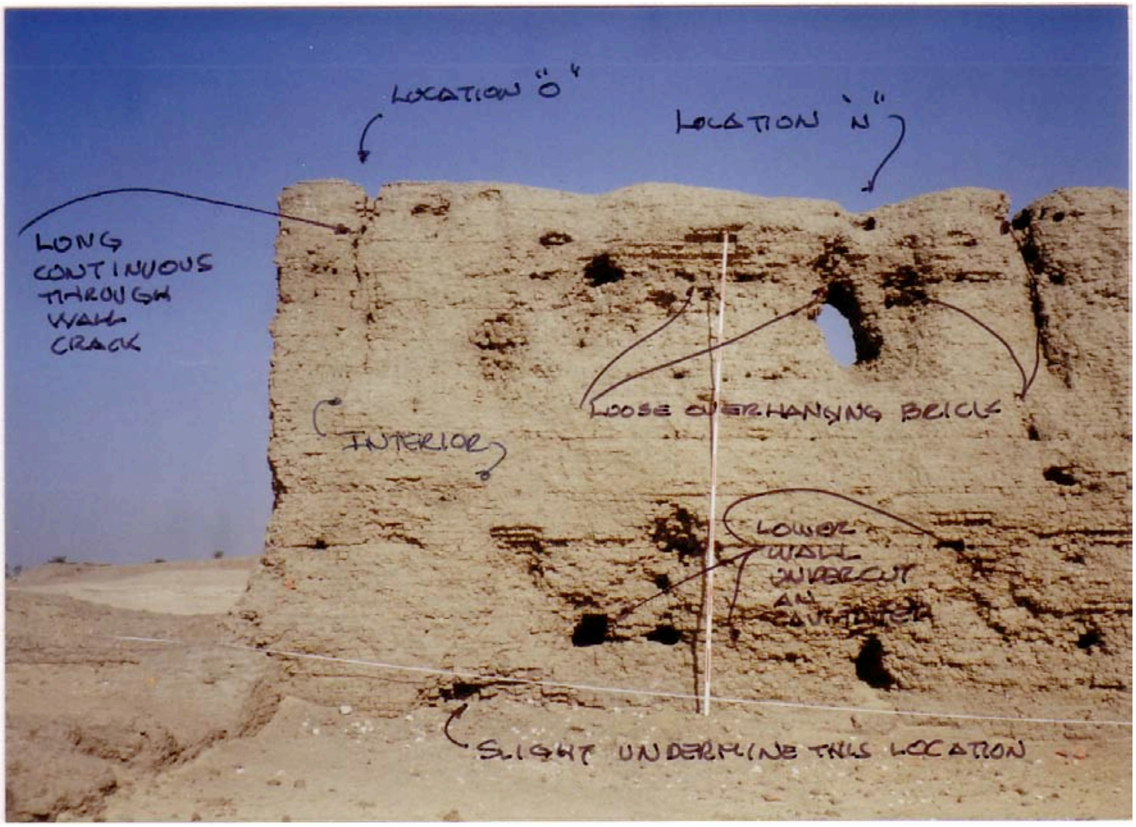


Figure 110. Structural conditions at the northern, interior end of the east main enclosure wall. (Photo: Conor Power 2000)

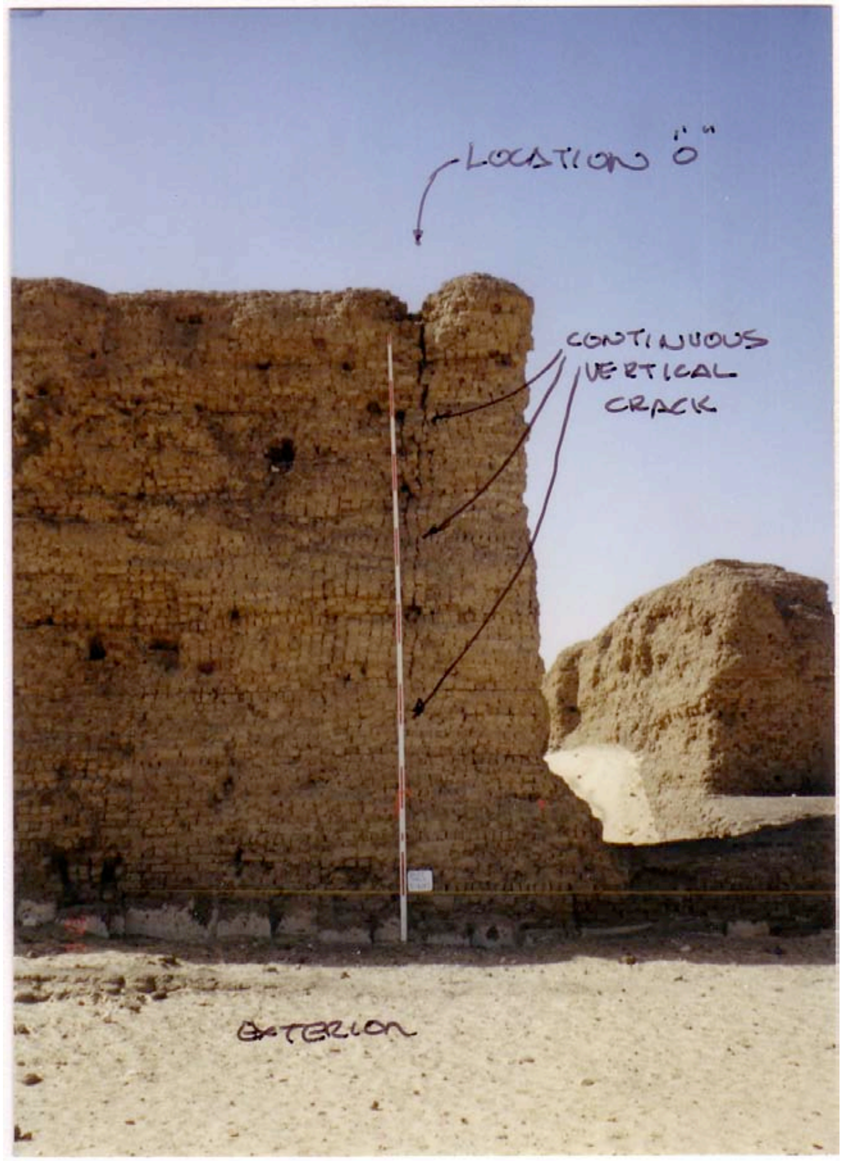


Figure 111. Exterior detail of a through-wall crack behind the highly unstable northern wall end of the east main enclosure wall (noted as location O). (Photo: Conor Power 2000)

Structural Conditions on the South Main Enclosure Wall (2000)

The core of the south main enclosure wall, which is essentially intact, is characterized by a distinctive texture on its interior side resulting from mud wasp and other animal activity, and by moderate surface loss on its exterior side (Figures 112 and 113).

The western, exterior corner of the south wall exhibits undermining, calving and loose brickwork associated with deep penetrations into the wall base, which are the result of both 19th Century archaeological activity and animal burrowing (Figures 114-116). Just east of this corner is a significant concentration of hornet burrows. On the interior side of this corner, a large sand dune/debris fan has built up against the surface, covering the full interior elevation of both the south and west walls at this intersection (Figure 117). The presence of this debris fan suggested that a massive failure may have previously occurred at this location, and just above the accumulation, a large mass of masonry was seen to be missing from the upper part of the south wall. Excavation in 2005-2006 revealed the extent and nature of the debris fan, which consisted of brick masonry collapsed from the wall above, and cleaning of the existing wall top at this location revealed the existence of a small monastic cell, which almost certainly contributed to the local failure of the wall (see Archaeological Investigation of the Monument, to follow).

The eastern corner of the south wall exhibits urgent-priority through-wall cracking, calving and erosion behind the vertical face of the eastern wall end. Primary and secondary detached brick masses and high-priority cavitation occur at this location, resulting in conditions of extreme instability (Figures 118 and 119).

Where accessible, the exterior surface of the south wall is in relatively good condition and generally exhibits normal-priority cavitation, erosion, surface friability, local cracking, and loose and overhanging brickwork (Figure 120). The central part of the exterior elevation is presently inaccessible due to the presence of a large sand deposit that fills the south corridor and extends some meters out from the exterior side of the south perimeter wall.

The interior surface of the south wall exhibits high-priority undercutting along the entire length of the lower wall face, primarily the result of long-term mud-wasp nest accretion and detachment. In addition, there is urgent-priority cavitation and loose brickwork at multiple locations along the wall base resulting from probable canid burrowing, moderate-to-severe head-joint erosion and loose brickwork at numerous locations along the upper wall surface, and one location of urgent-priority erosion in the wall top (Figures 121-123).

The area of the south gateway is in an unstable condition due to very significant cracking and calving behind the vertical wall end that forms the east side of the gateway opening in the main enclosure, as illustrated in Figures 124 and 125.

Figure 112. The exterior face of the south main enclosure wall. (Photo: Conor Power 2000)

Figure 113. The interior face of the south main enclosure wall. (Photo: Conor Power 2000)

Figure 114. Southwest corner of the perimeter and main enclosures, at the intersection of the west and south enclosure walls; note the area of the south gateway at upper right. (Photo: William Remsen 2000)

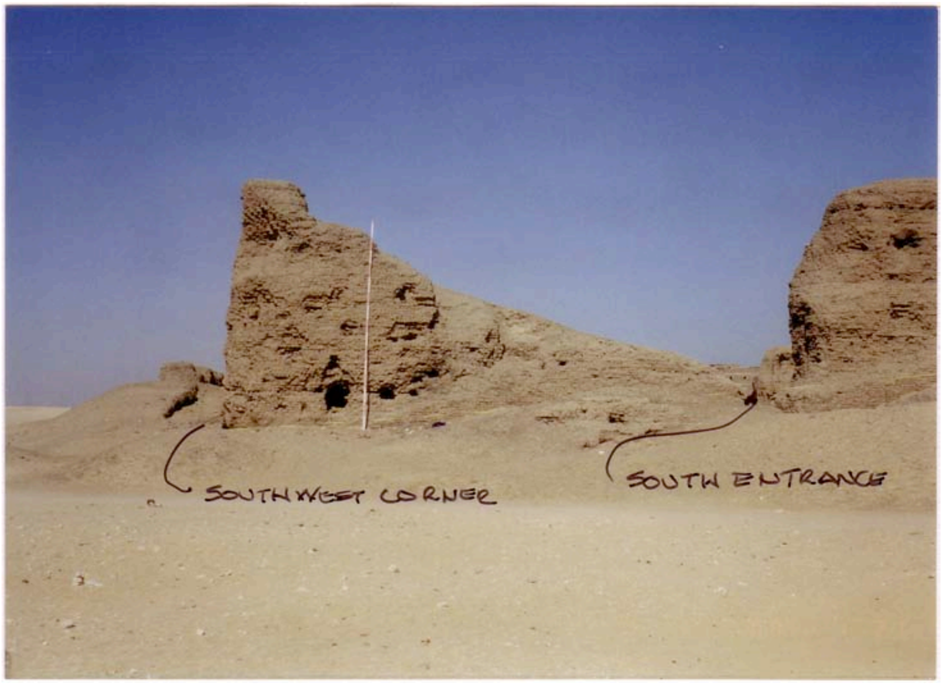


Figure 115. The western, exterior corner of the south main enclosure wall (adjacent to the south gateway). (Photo: Conor Power 2000)

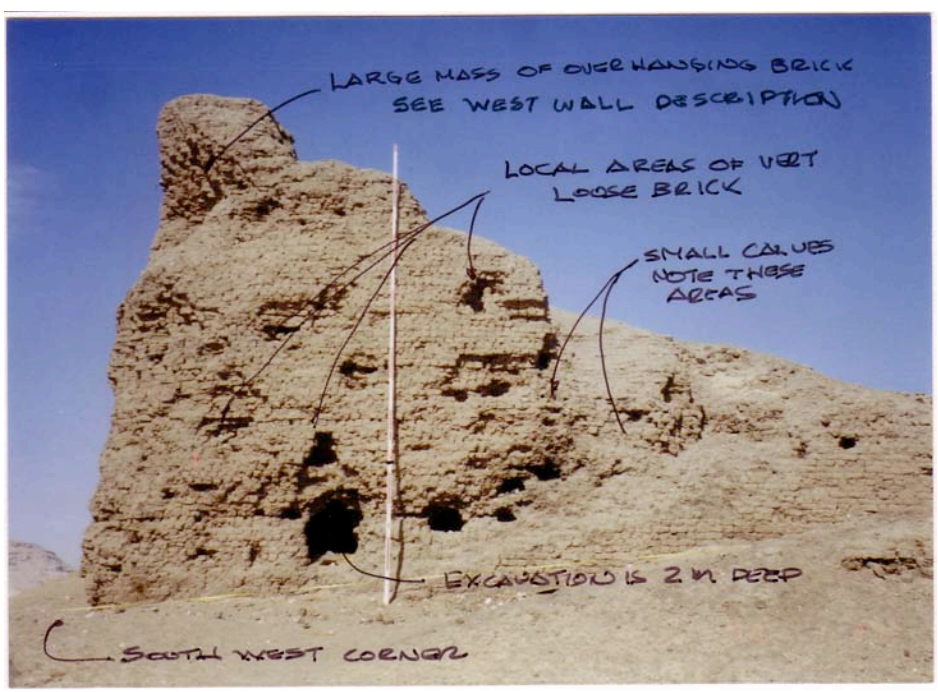


Figure 116. Detail of the large cavities at the western, exterior corner of the south main enclosure wall. (Photo: Conor Power 2000)

Figure 117. Detail of the large sand dune/debris fan that has built up against the southwestern, interior corner of the main enclosure. (Photo: Conor Power 2000)

Figure 118. Detail of the large detached brick mass at the eastern end of the south main enclosure wall. (Photo: Conor Power 2000)

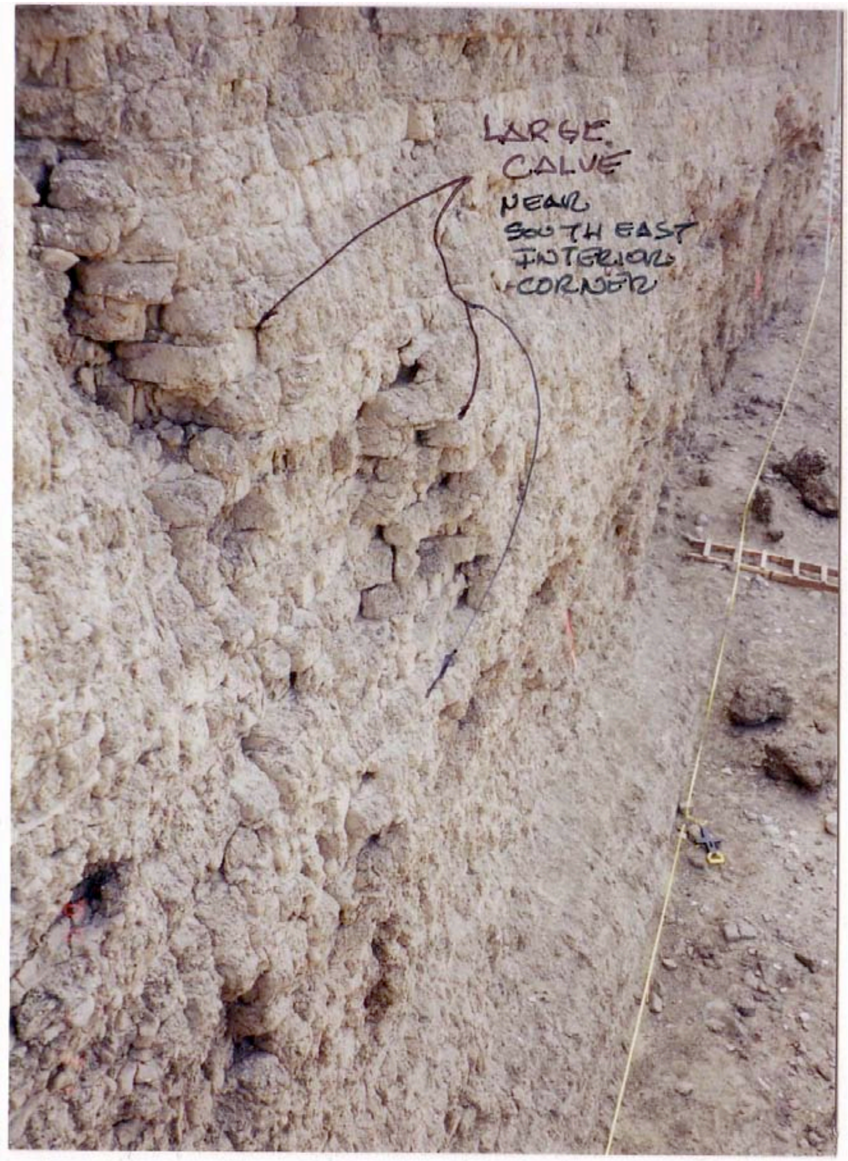


Figure 119. Detail of calving behind the eastern, vertical end of the south main enclosure wall. (Photo: Conor Power 2000)

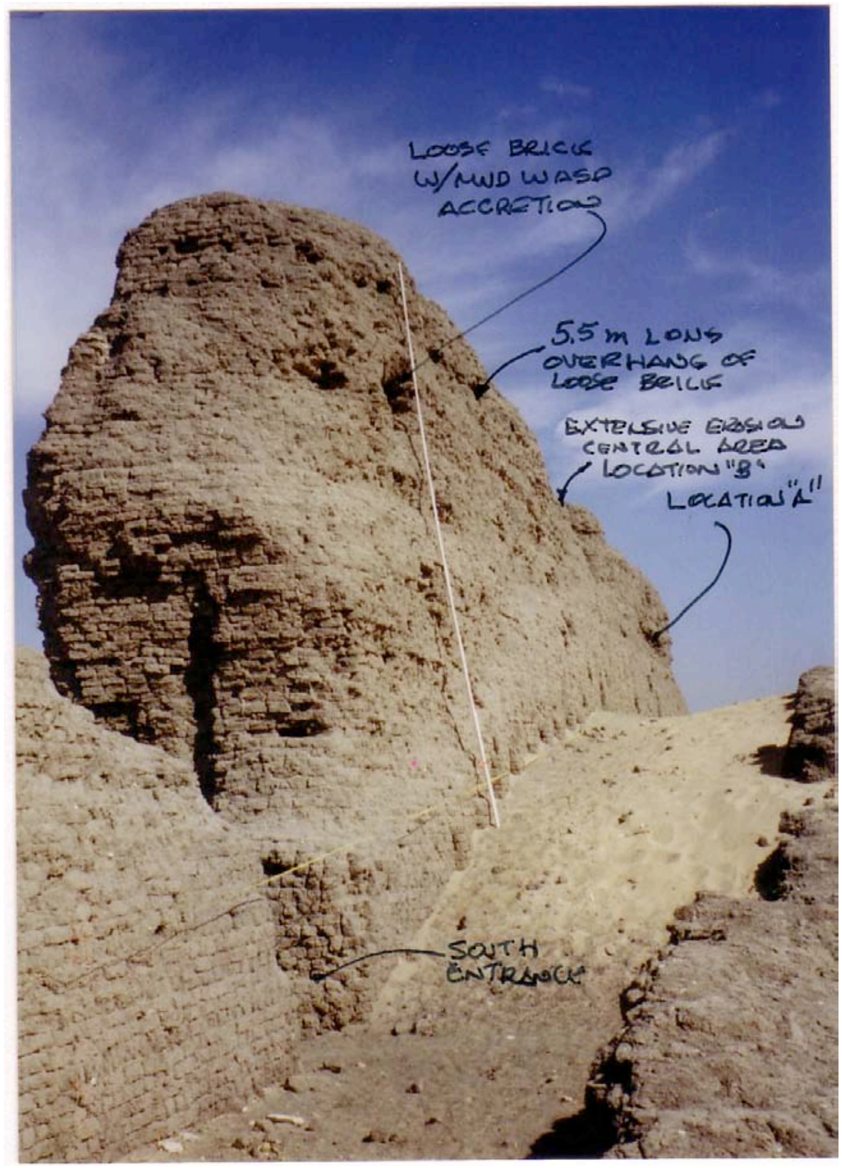


Figure 120. The exterior face of the south main enclosure wall, looking east from the south gateway. (Photo: Conor Power 2000)

Figure 121. The undercutting of the interior face of the south main enclosure wall is represented by a dramatic variation in surface texture below the mid-line of the wall (through center). (Photo: Conor Power 2000)

Figure 122. Detail of the undercut interior surface of the south main enclosure wall. (Photo: Conor Power 2000)

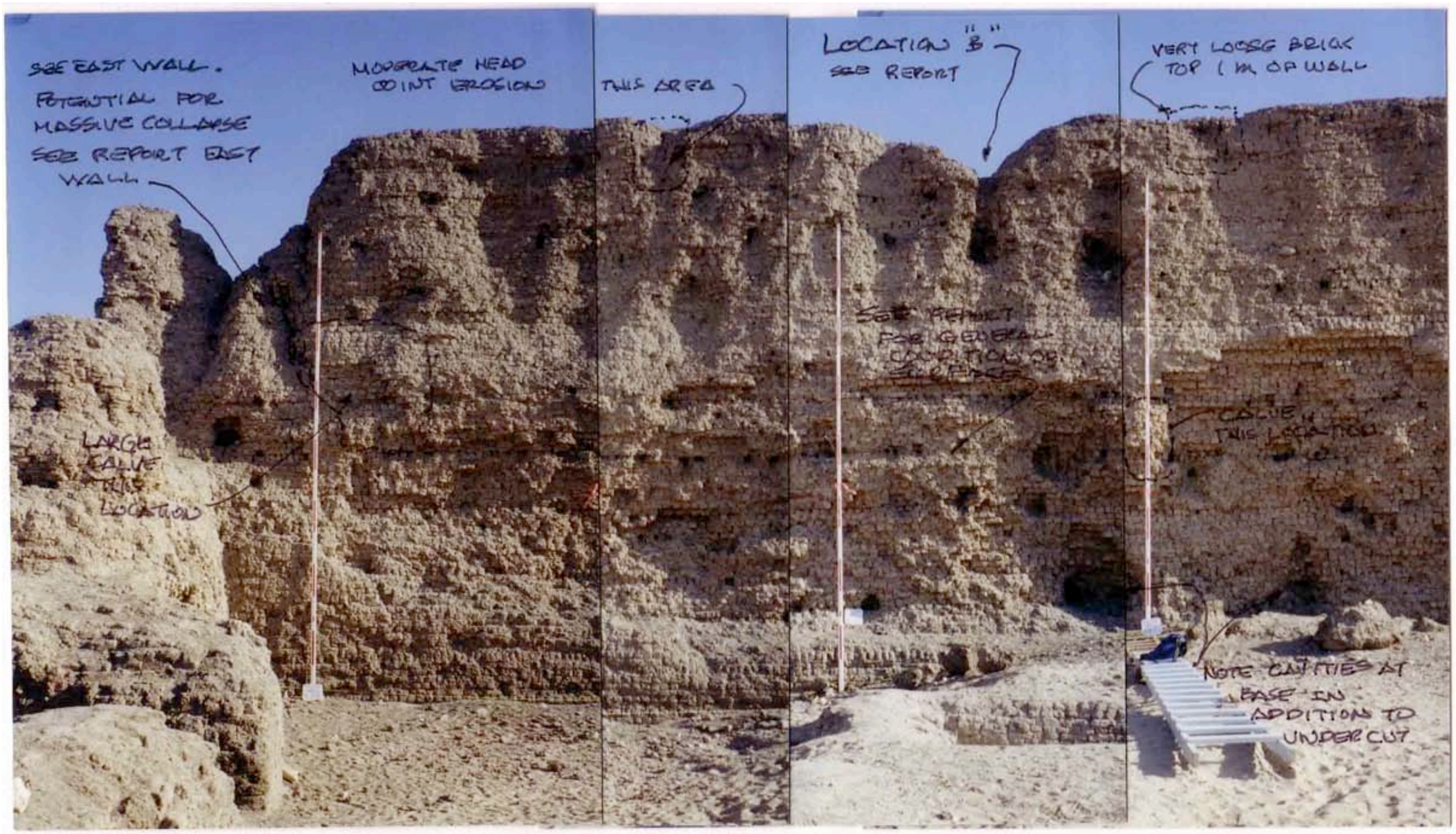


Figure 123. Details of undercutting, cavitation and erosion on the interior face of the south main enclosure wall, as well as urgent-priority erosion in the wall top, noted as location B (see also Figure 121, above); note the fallen mud-wasp nest accretion at lower right. (Composite photo: Conor Power 2000)

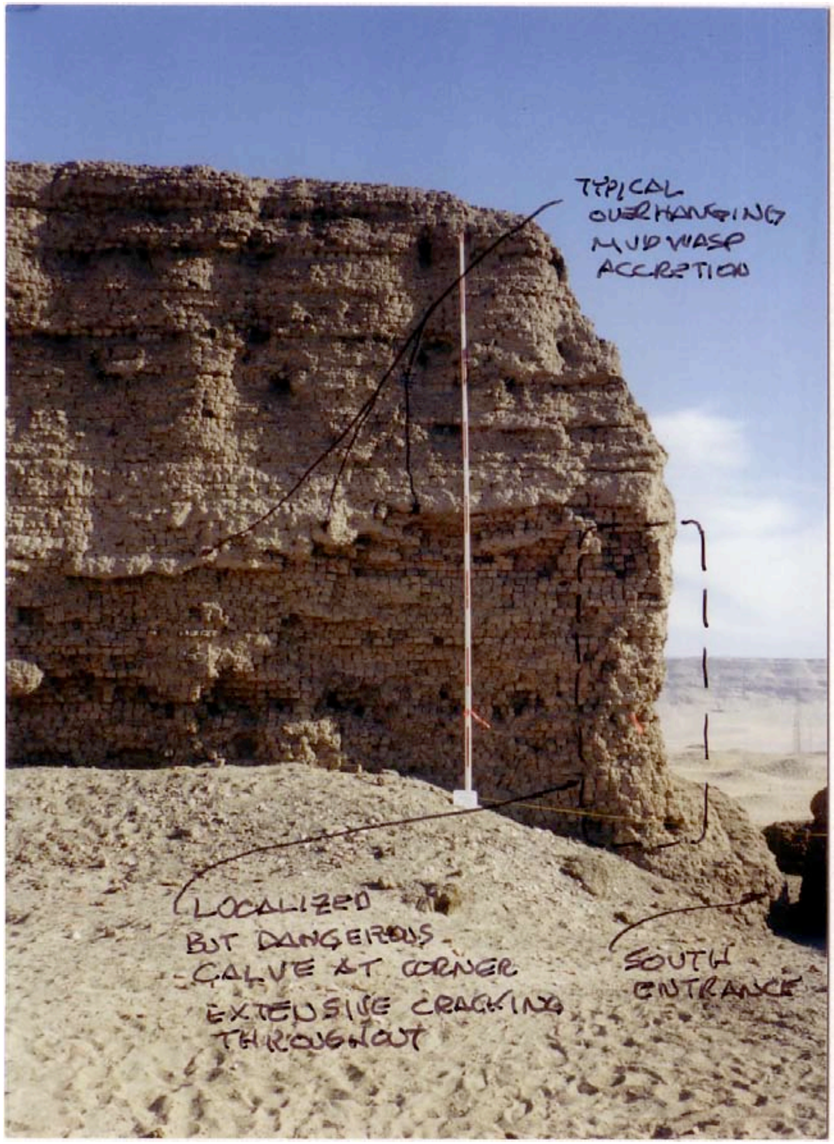


Figure 124. Urgent-priority cracking and calving behind the eastern, vertical end of the south gateway. (Photo: Conor Power 2000)

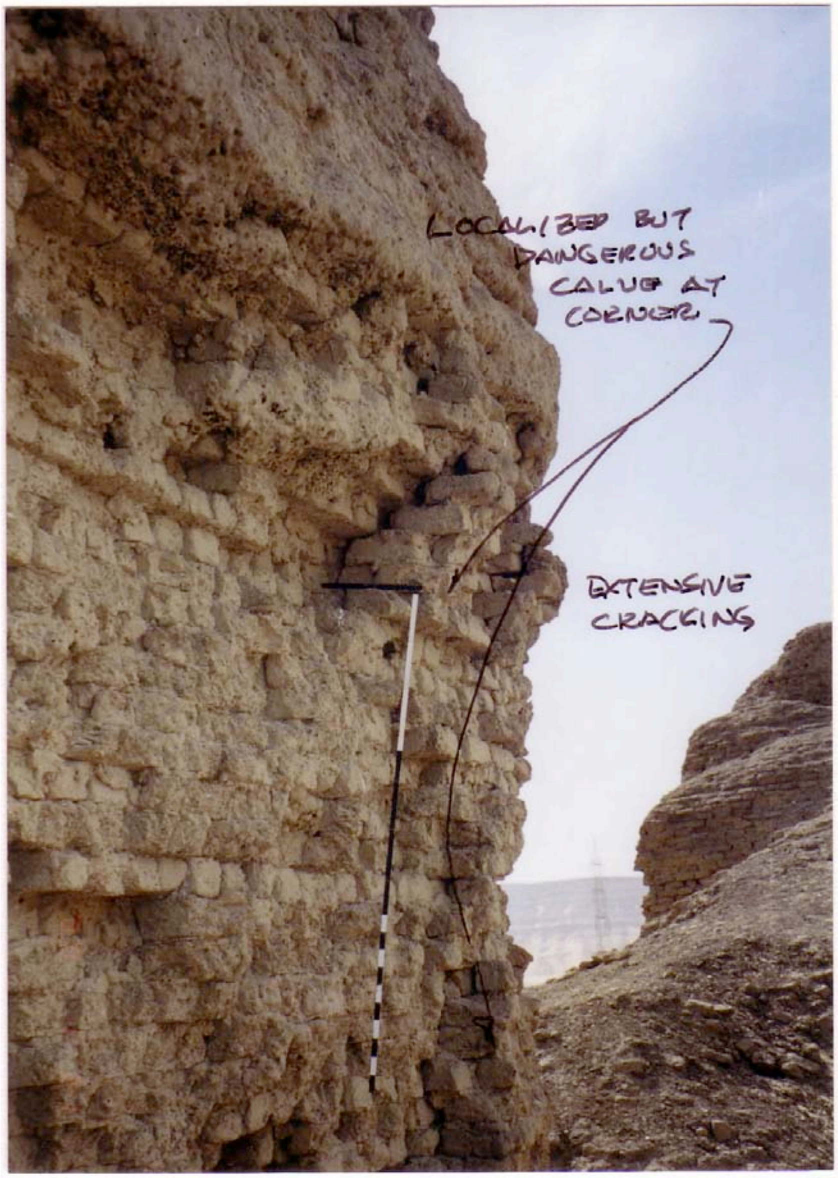


Figure 125. Interior detail of cracking and calving behind the eastern, vertical end of the south gateway. (Photo: Conor Power 2000)

Structural Conditions on the West Main Enclosure Wall (2000)

The opening where the west gateway originally stood divides the west main enclosure wall into roughly equivalent northern and southern sections, as depicted in Figure 126. The exterior face of the west wall is characterized by the presence of six large voids up to three meters deep, the result of late antique occupation of the monument, while the interior side is characterized throughout by especially severe undermining and cavitation as a result of long-term animal burrowing in the walls.

The southern portion of the west wall is characterized by a large gap in the upper masonry, illustrated as location A in Figures 126 and 127. The exterior surface adjacent to this location exhibits high-priority vertical cracking, mortar-joint erosion and surface detachment as well as a low-priority through-wall crack possibly resulting from differential settlement. Additionally, the southern, exterior face of the west wall exhibits severe undercutting, detachment, cracking, corbelling and loose and overhanging brickwork associated with the presence of four monastic cell cavities in this area, illustrated as locations B, C and D in Figures 128-135. The southern corner of the west wall exhibits cracking, erosion and loose and overhanging brickwork in the upper wall surface, as well as several undermined locations in the wall base, as depicted in Figures 136-140. This undermined area represents part of the highly unstable southwestern corner of the main enclosure, at the intersection of the south and west walls (see also the preceding discussion of the south main enclosure wall).

The northern portion of the west wall is generally characterized by excessive cavitation, cracking, erosion, surface friability and loose brickwork throughout (Figures 141-148). The northern, exterior face of the west wall exhibits deep undercutting, cavitation, detachment and loose brickwork extending nearly the full height of the wall from two former monastic cell cavities (illustrated as locations F and G). In addition, there are two large, through-wall voids in the upper masonry between the cell cavities (illustrated as cavities 1 and 2). The loss of wall fabric in this area has resulted in extremely unstable and hazardous conditions, particularly near the northern wall end.

The extent of cavitation resulting from both canid and insect activity on the interior side of the west wall is particularly significant (Figures 149-152). The southern, interior face exhibits deep undercutting, local undermining, joint erosion and loose and overhanging brickwork at numerous locations along the entire elevation of the wall (illustrated as locations H through K), and the northern, interior face is likewise extremely cavitated, friable and highly unstable throughout (see Figure 152).

The west gateway area of the main enclosure (illustrated as location E) is characterized by extremely unstable conditions (Figures 153-157). Urgent-priority structural cracks occur behind the vertical wall ends on either side of the gateway opening, and each vertical end exhibits undercutting, detachment, erosion, loose brickwork and unstable brick masses resulting from structural failure as well as from the construction of monastic cells into the wall ends on both sides of the gateway opening.

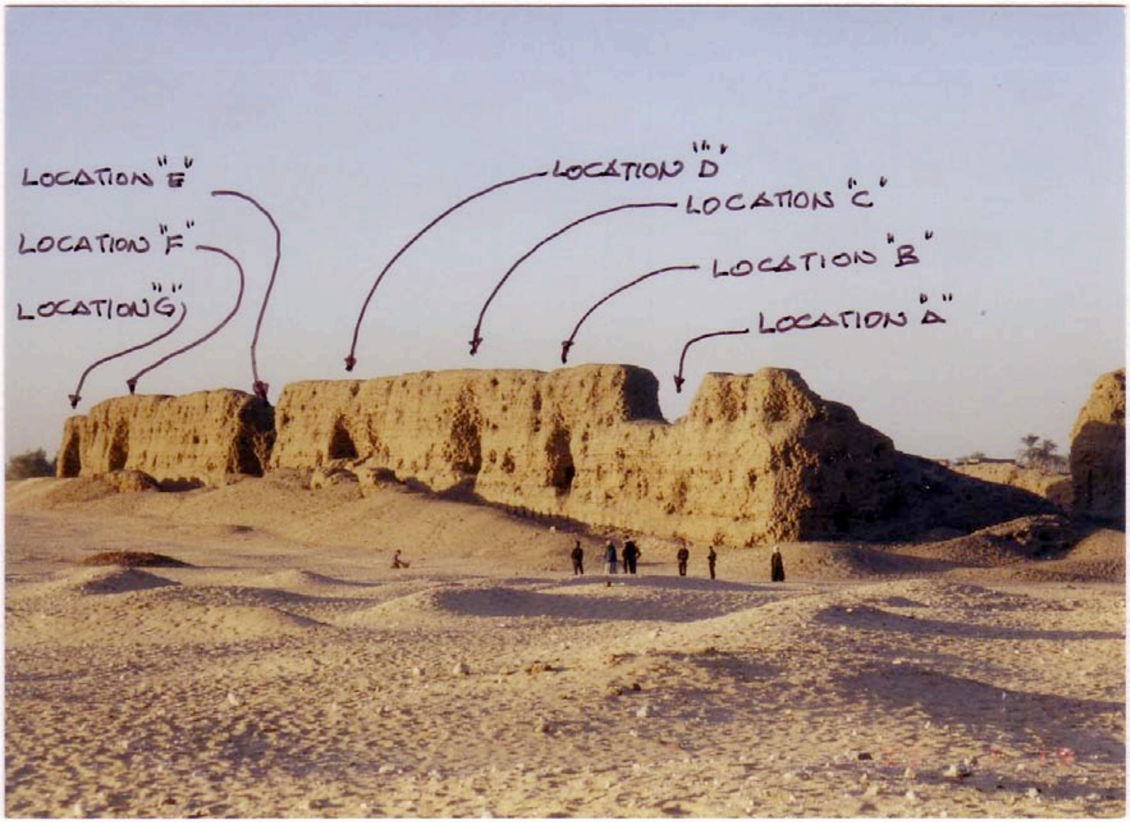


Figure 126. Specific structural conditions on the exterior side of the west main enclosure wall, noted as locations A-G (see details, below); location E represents the area of the west gateway, and the deep cavities visible at locations B, C, D, F and G are the remains of monastic cell locations from late antiquity. (Photo: Conor Power 2000)

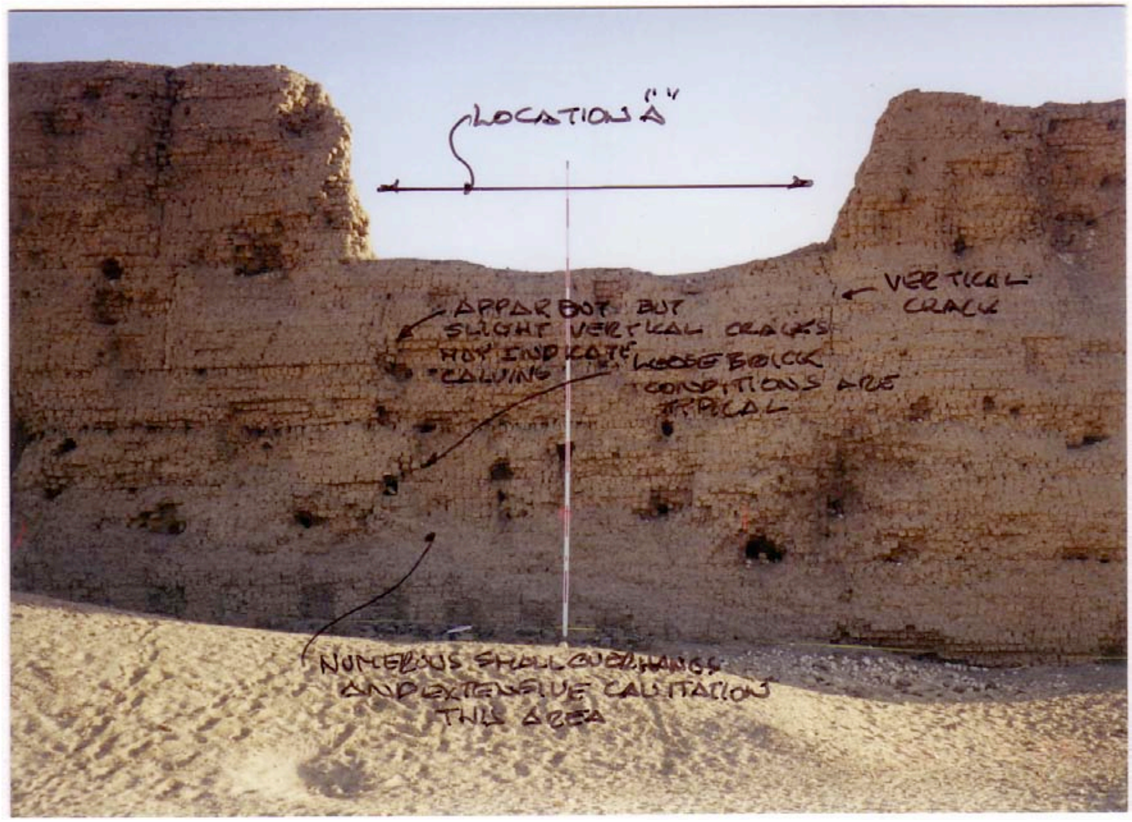


Figure 127. Detail of a large gap in the upper, southern portion of the west main enclosure wall (noted as location A). (Photo: Conor Power 2000)

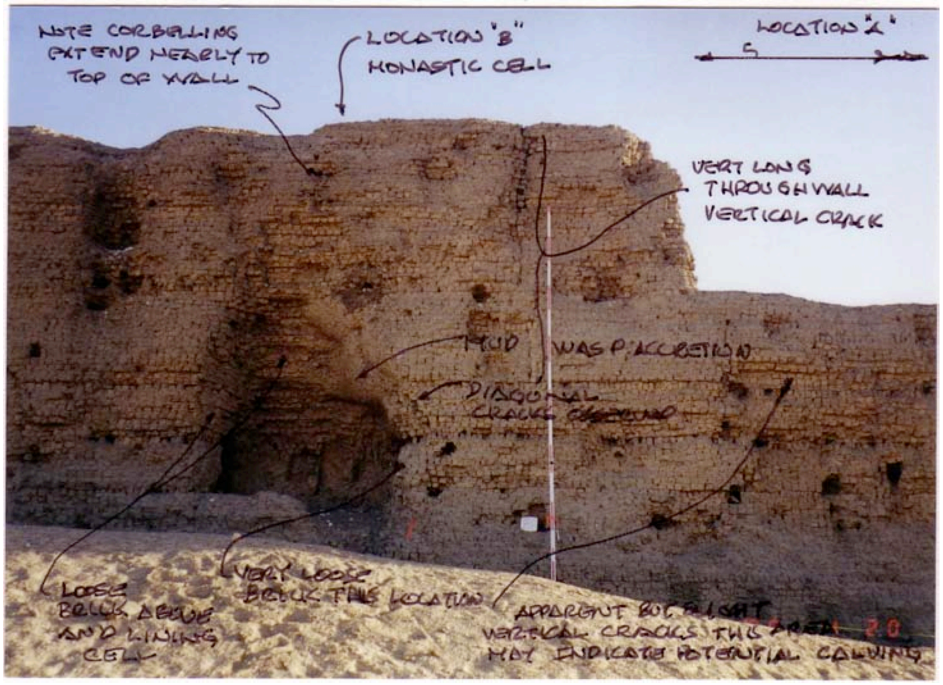


Figure 128. Detail of a monastic cell cavity and large mud-wasp nest accretion in the southern, exterior face of the west main enclosure wall (noted as location B). (Photo: Conor Power 2000)

Figure 129. Detail of the monastic cell cavity noted as location B in Figures 126 and 128, above; note the entrance to an ancillary chamber at left. (Photo: Conor Power 2000)

Figure 130. Detail of vertical cracking and cavitation near the cell void noted as location B in Figures 126 and 128, above. (Photo: Conor Power 2000)

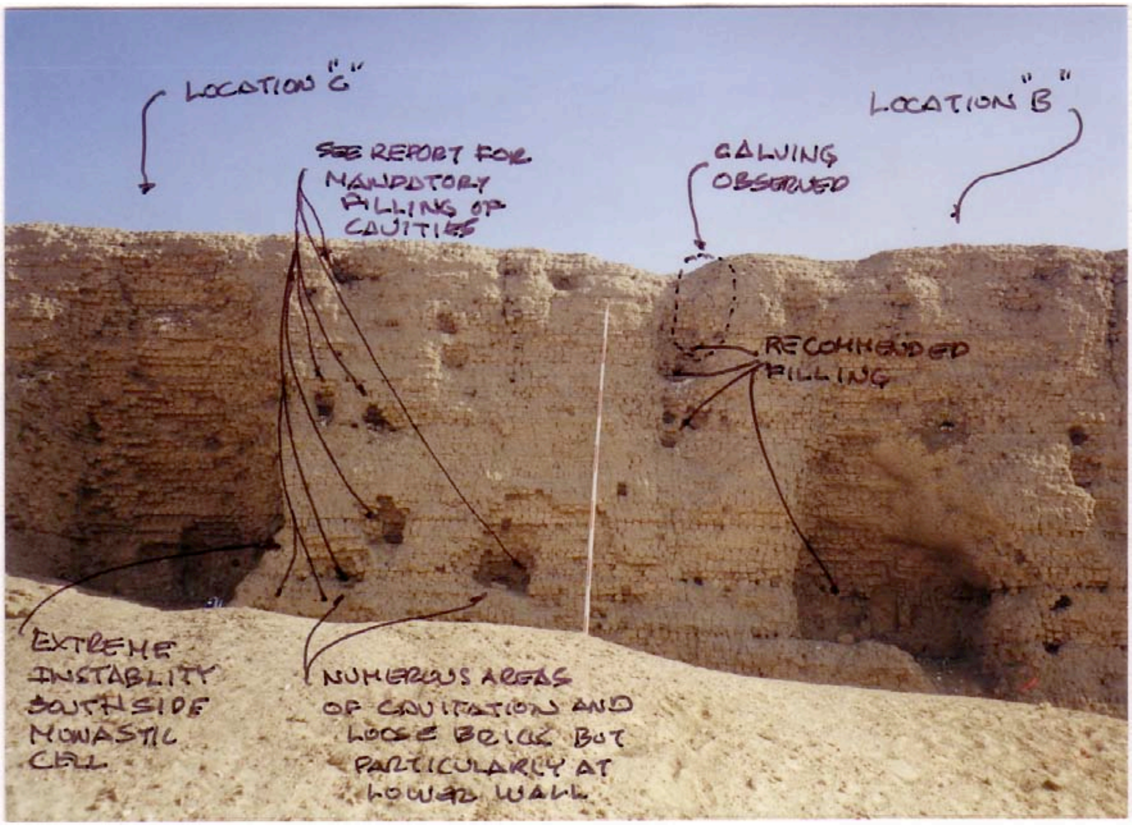


Figure 131. Detail of undercutting in the southern, exterior face of the west main enclosure wall resulting from the construction and decay of the two monastic cell cavities visible at right and at left (noted as locations B and C, respectively). (Photo: Conor Power 2000)

Figure 132. Detail of undercutting and corbelling near the monastic cell cavity noted as location C on the southern, exterior face of the west main enclosure wall. (Photo: Conor Power 2000)

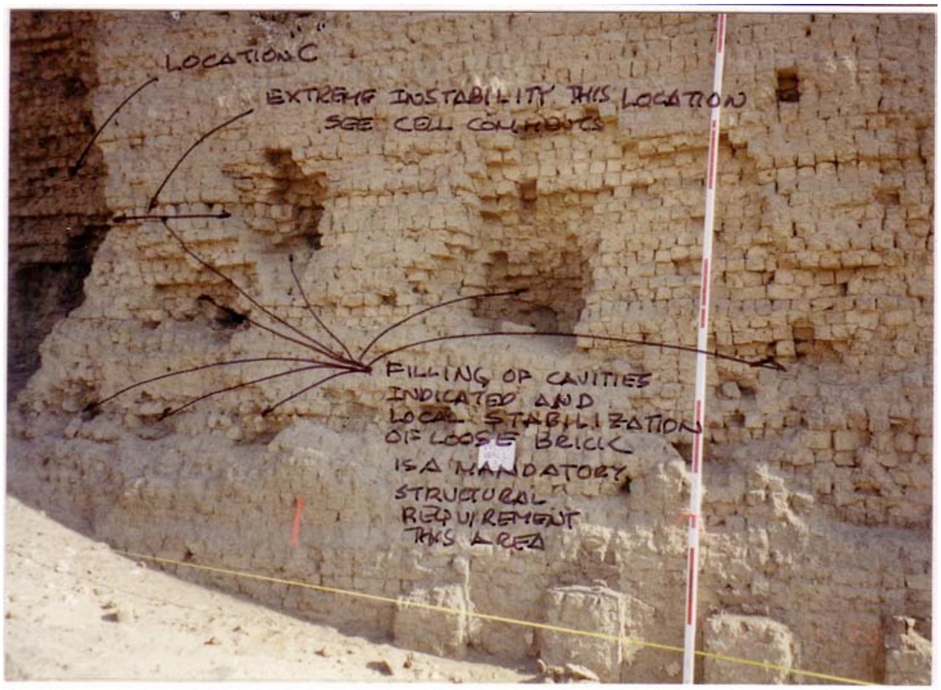


Figure 133. Detail of cavitation and loose brickwork near the monastic cell cavity noted as location C on the southern, exterior face of the west main enclosure wall. (Photo: Conor Power 2000)

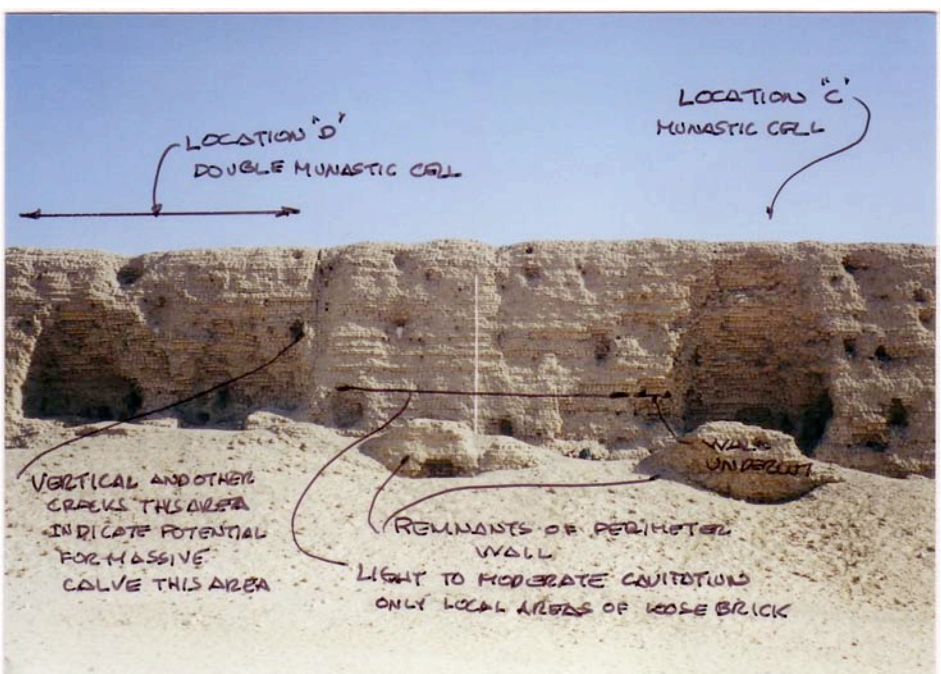


Figure 134. Details of monastic cell cavities in the southern, exterior face of the west main enclosure wall (noted as locations C and D); note that location D represents two adjacent cell voids. (Photo: Conor Power 2000)

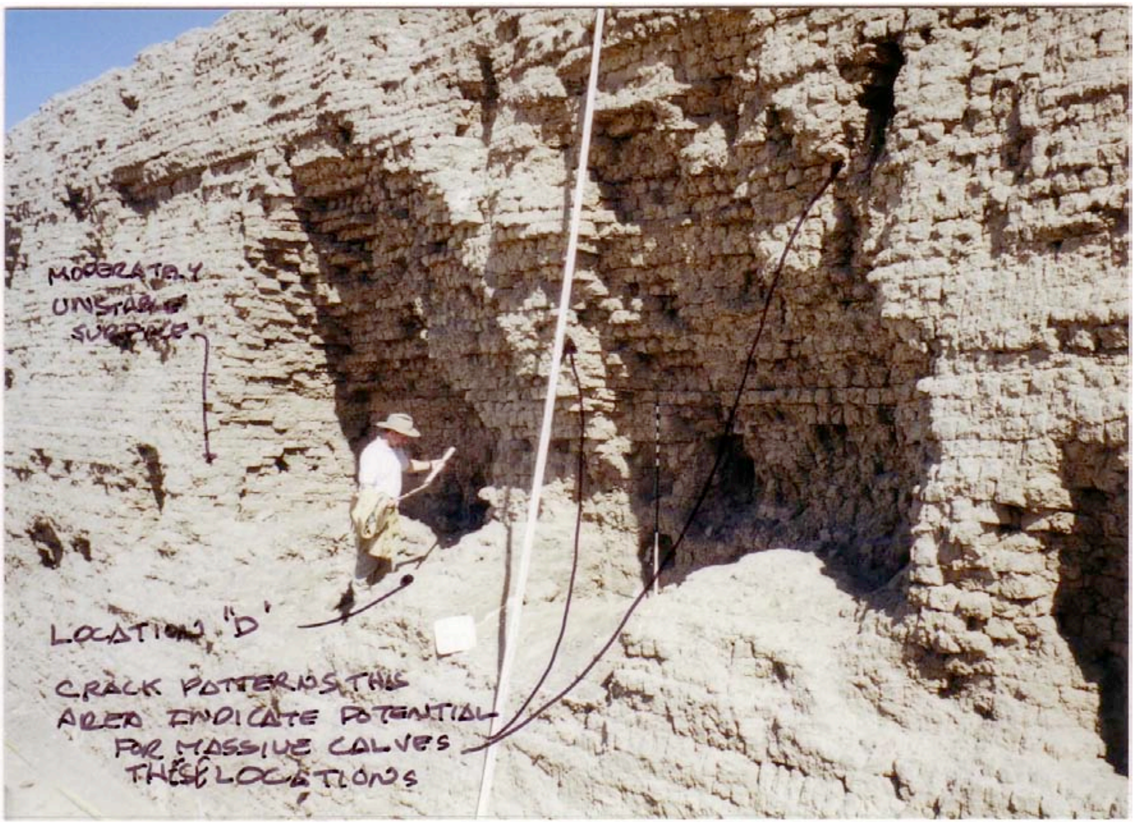


Figure 135. Detail of cracking, calving and local failures near two monastic cell cavities (noted as location D) on the southern, exterior face of the west main enclosure wall. (Photo: Conor Power 2000)

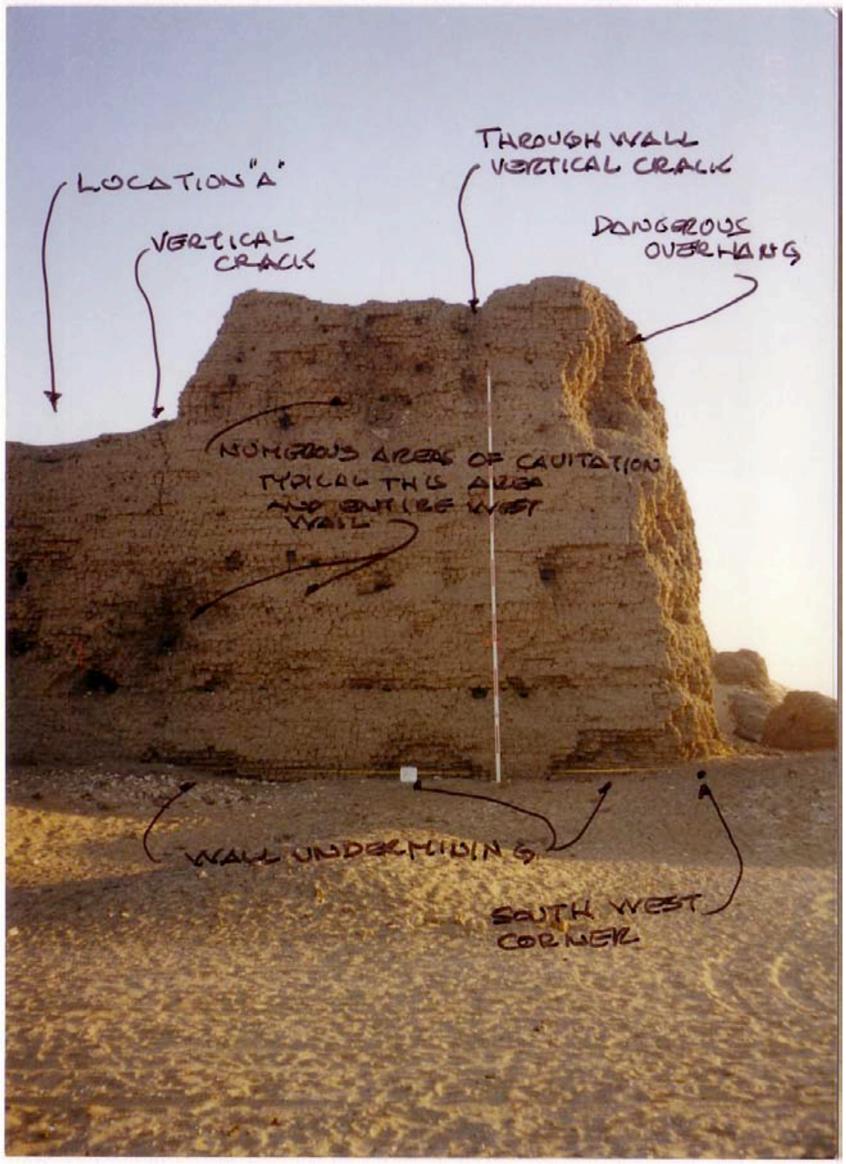


Figure 136. Structural conditions at the southern, exterior end of the west main enclosure wall. (Photo: Conor Power 2000)

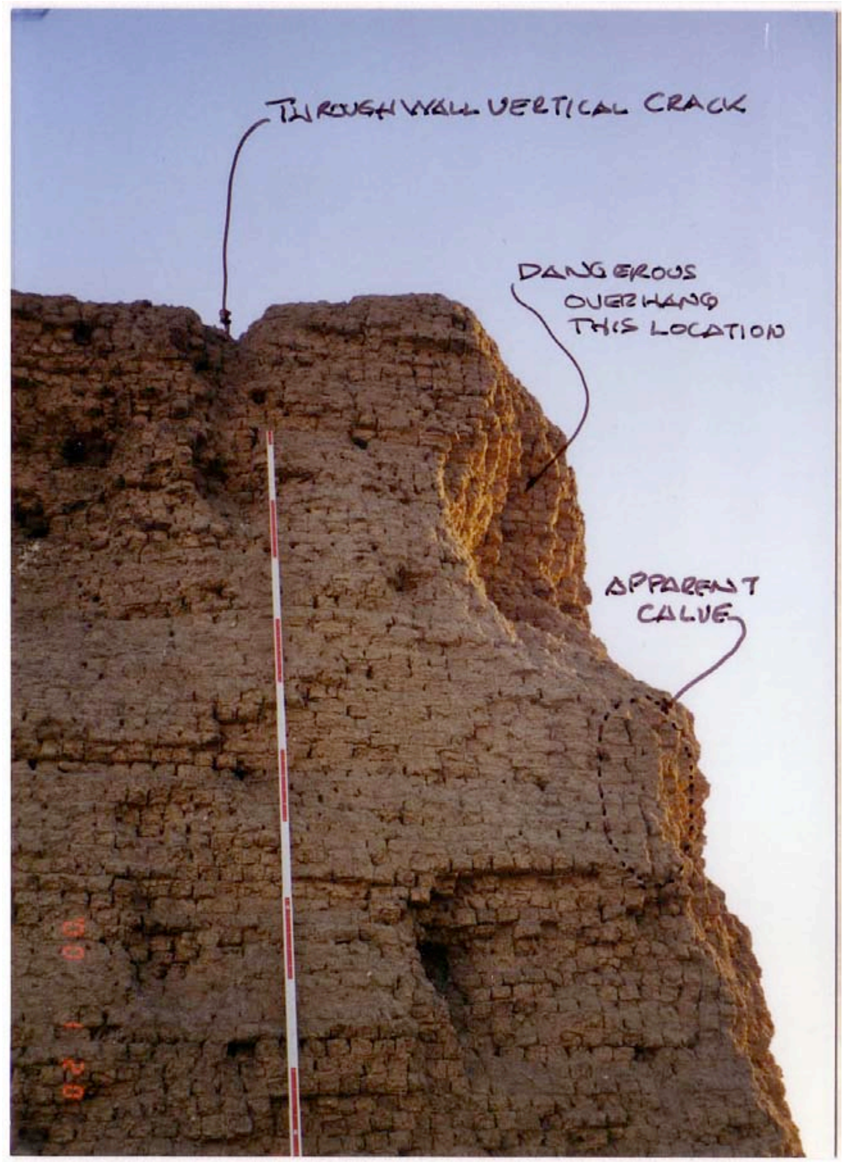


Figure 137. Detail of a through-wall crack and high-priority overhang at the top, southern corner of the west main enclosure wall. (Photo: Conor Power 2000)

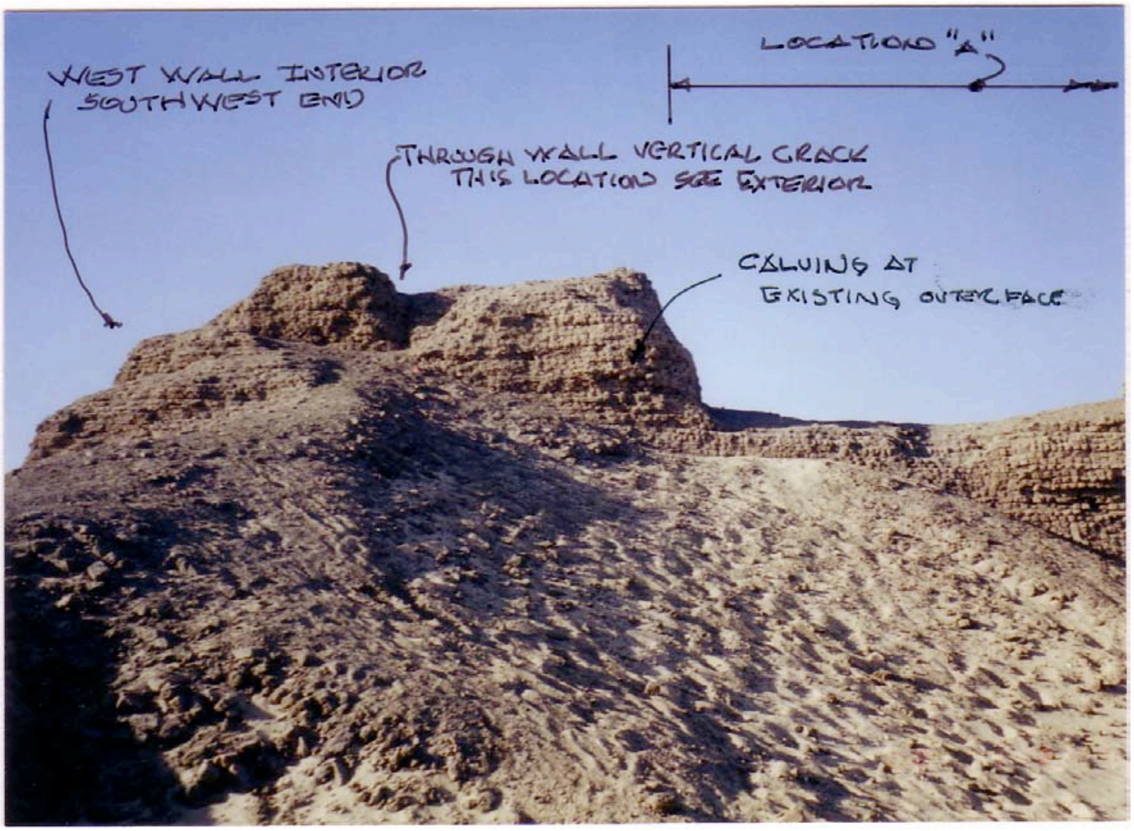


Figure 138. Interior detail of the through-wall crack pictured in Figures 136 and 137 (above) at the top, southern corner of the west main enclosure wall; note the reach of the sand dune/debris fan to the top of this interior elevation. (Photo: Conor Power 2000)

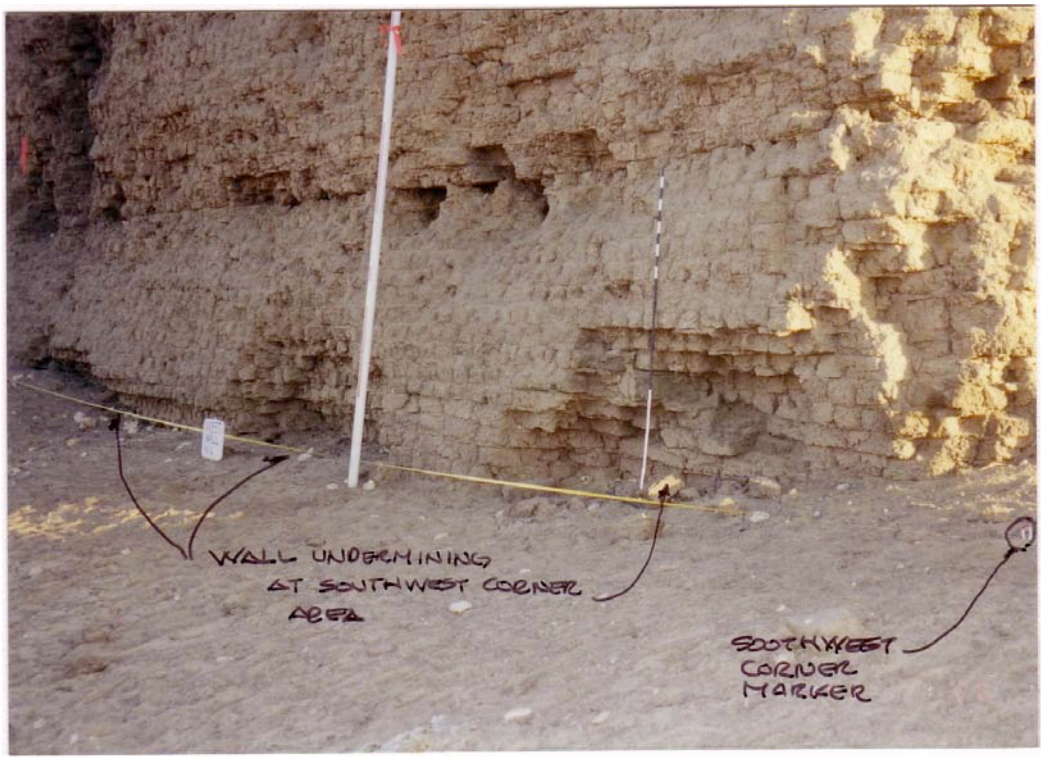


Figure 139. Detail of undermining at the southern, exterior corner of the west main enclosure wall. (Photo: Conor Power 2000)

Figure 140. Composite detail of the undercut wall base at the southern, exterior corner of the west main enclosure wall. (Photo: Robert Fletcher 2004-2005)

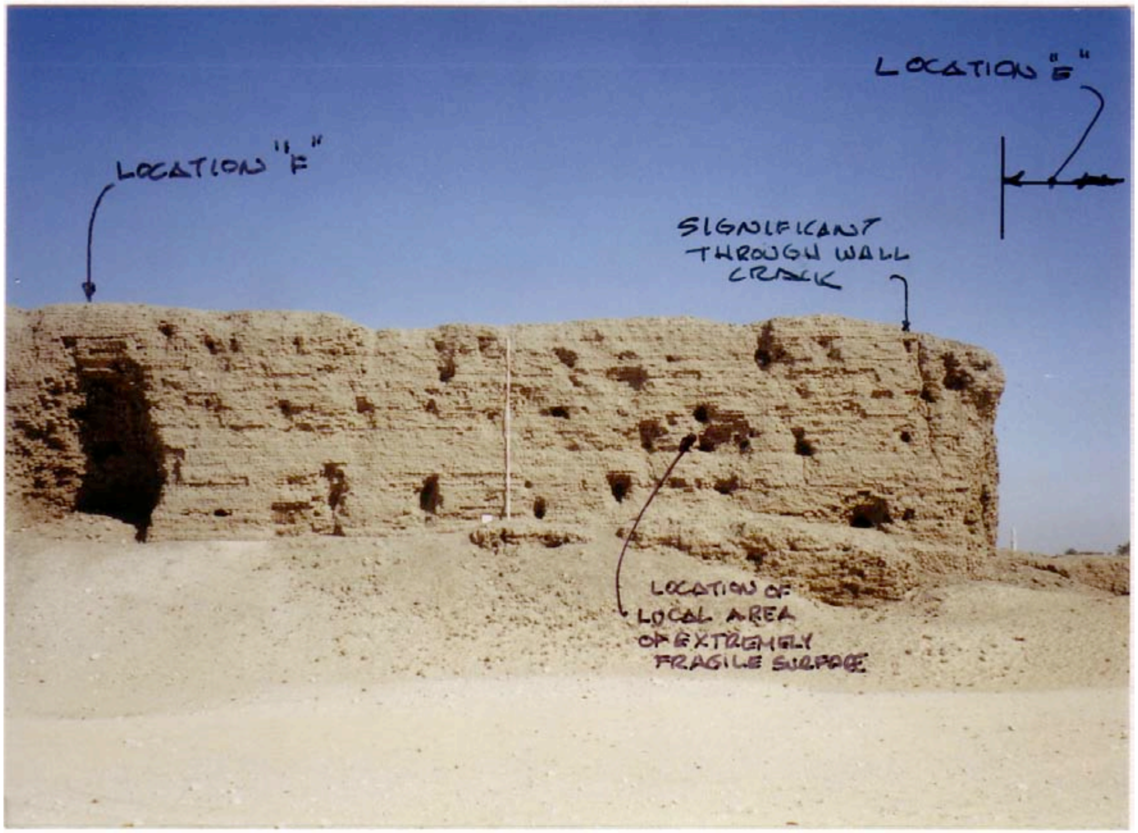


Figure 141. Structural conditions on the northern, exterior face of the west main enclosure wall. (Photo: Conor Power 2000)

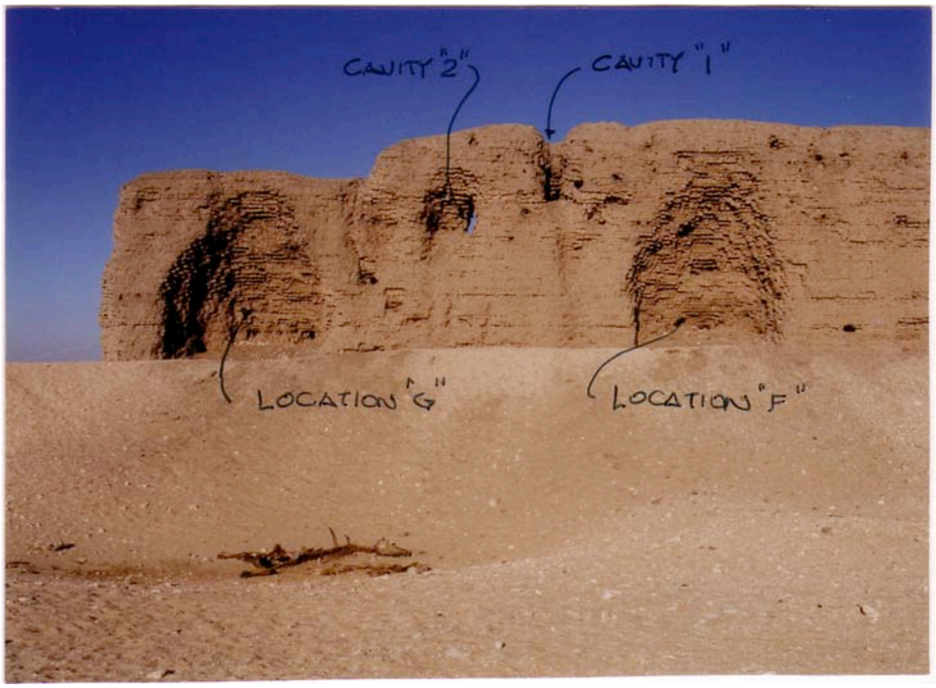


Figure 142. Monastic cell cavities and through-wall voids at the northern, exterior end of the west main enclosure wall, noted as locations F and G and cavities 1 and 2, respectively (see details, below). (Photo: Conor Power 2000)

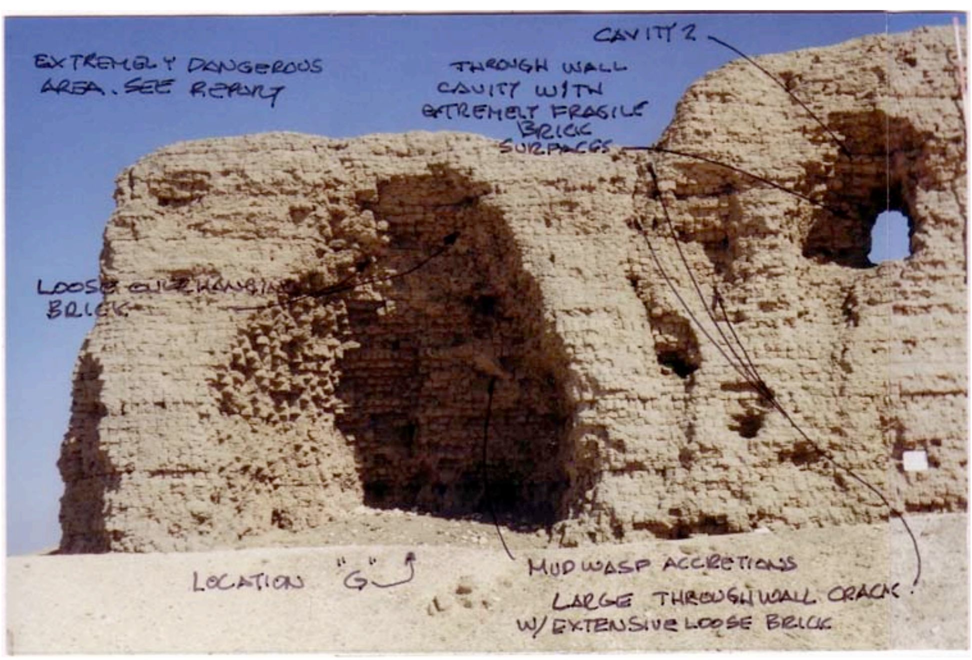
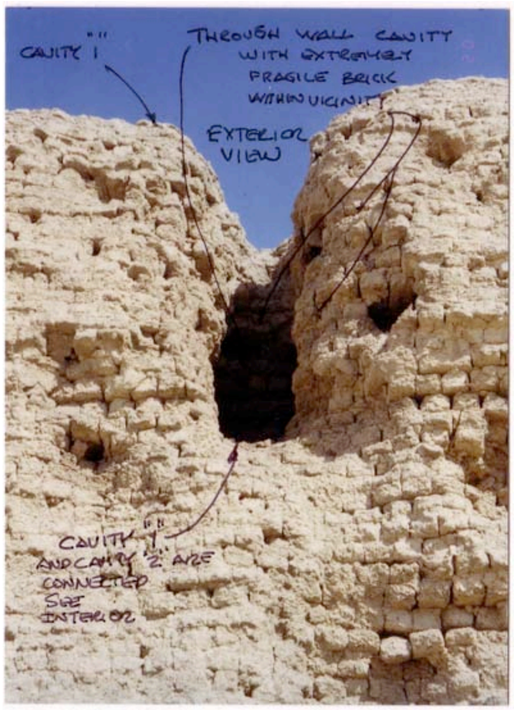
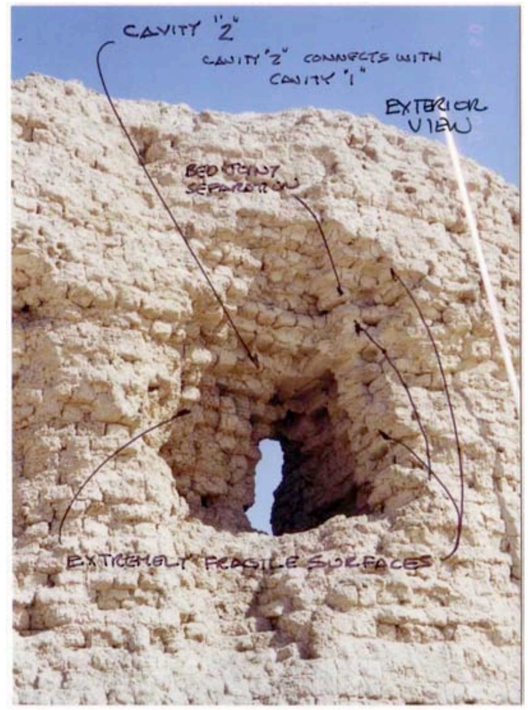
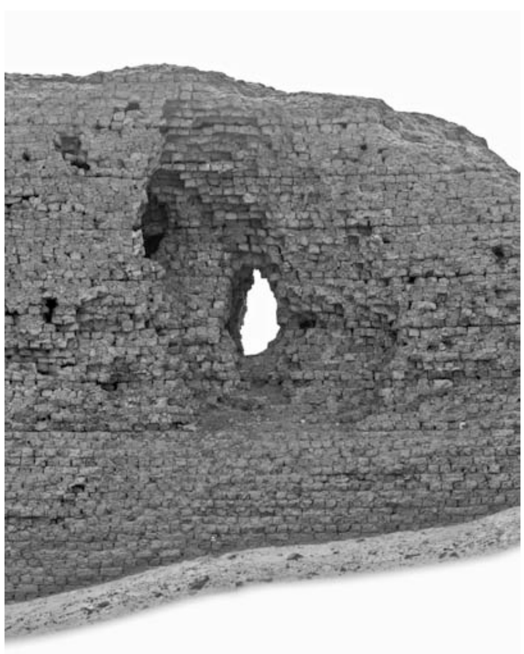


Figure 143. Details of extreme cavitation at and near the monastic cell cavity noted as location G and the through-wall void noted as cavity 2 at the northern, exterior end of the west main enclosure wall. (Photo: Conor Power 2000)





Figures 144, 145. Exterior details of the through-wall cavities in the upper, northern portion of the west main enclosure wall (noted as cavities 1 and 2). (Photos: Conor Power 2000)



Figures 146, 147. Interior and exterior details (at left and right, respectively) of the through-wall holes noted as cavities 1 and 2 in Figures 142-145, above; these large holes interact as a cavity system within the wall. (Photoelevations: Heritage 3D, Inc. 2001)

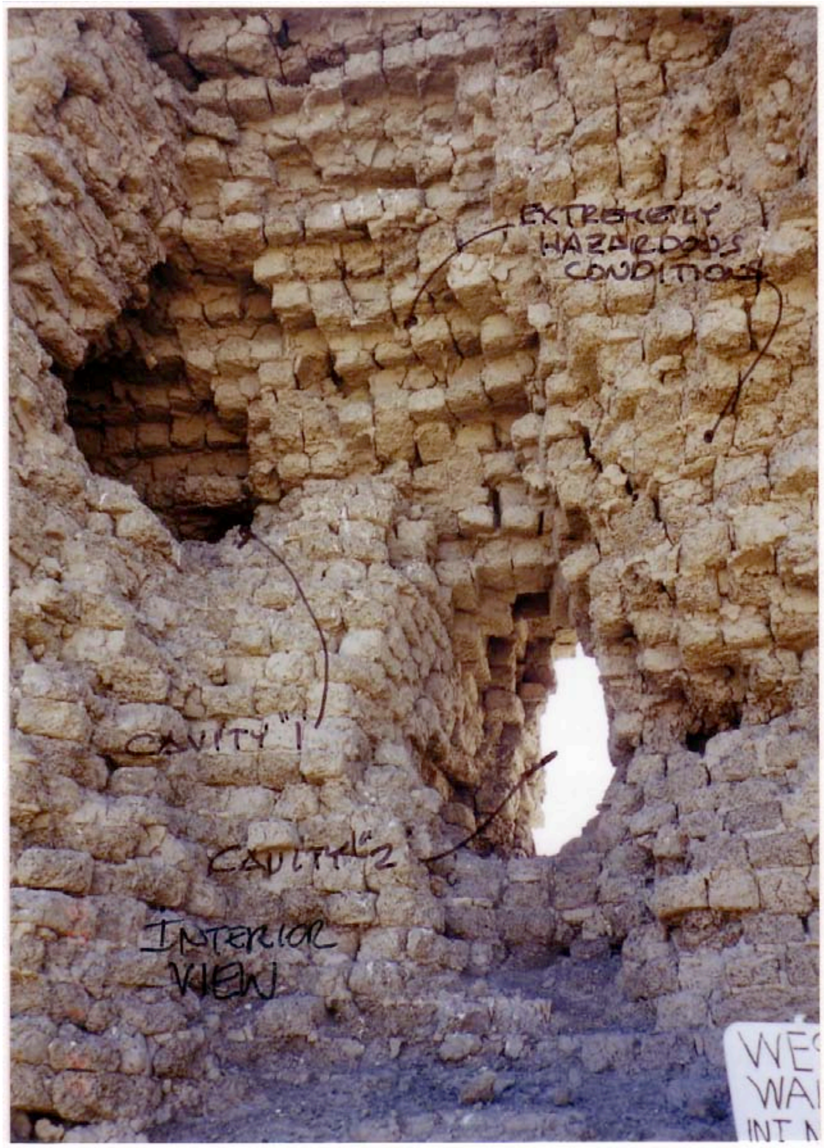


Figure 148. Interior detail of the through-wall cavity system in the upper, northern portion of the west main enclosure wall. (Photo: Conor Power 2000)

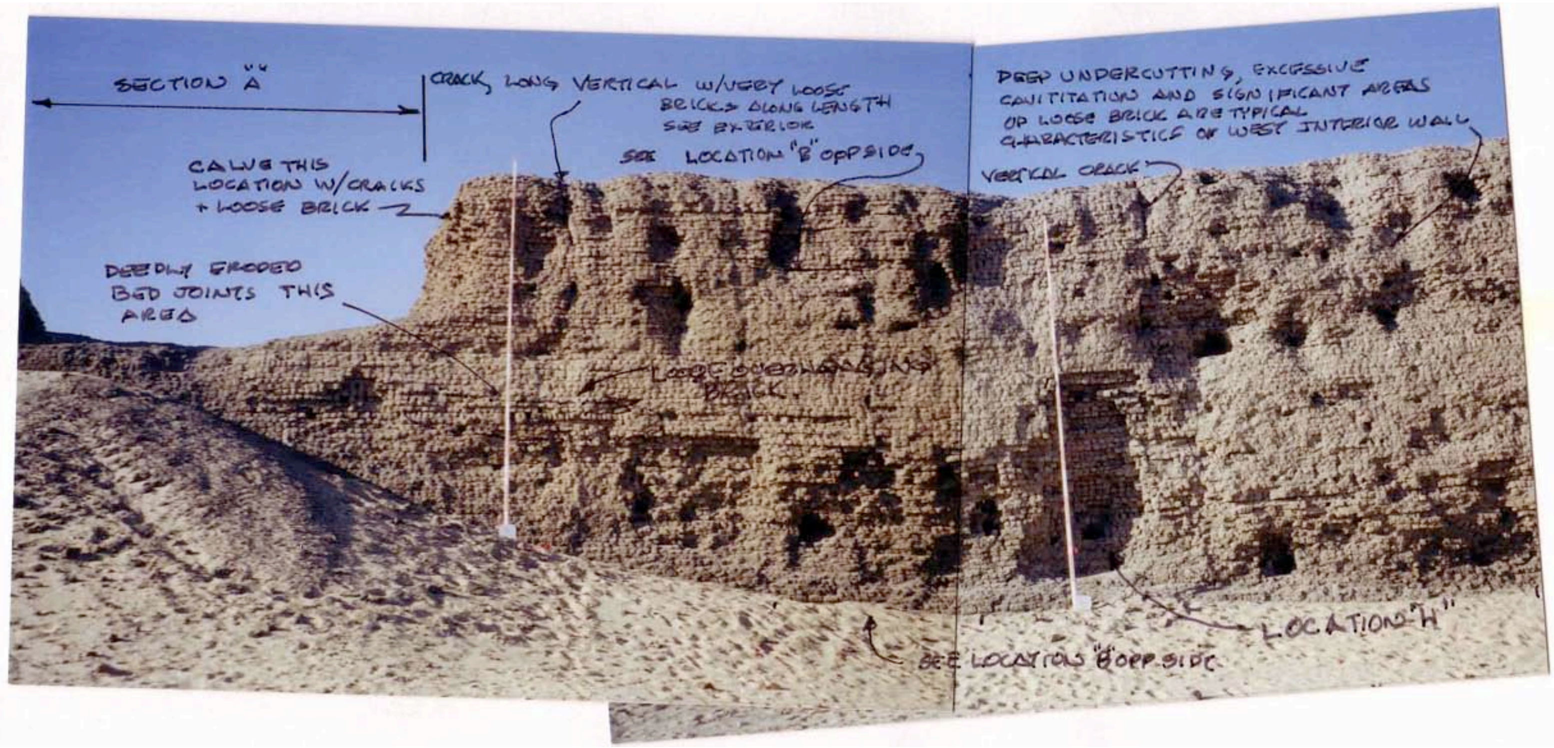


Figure 149. Structural conditions on the southern, interior face of the west main enclosure wall. (Composite photo: Conor Power 2000)

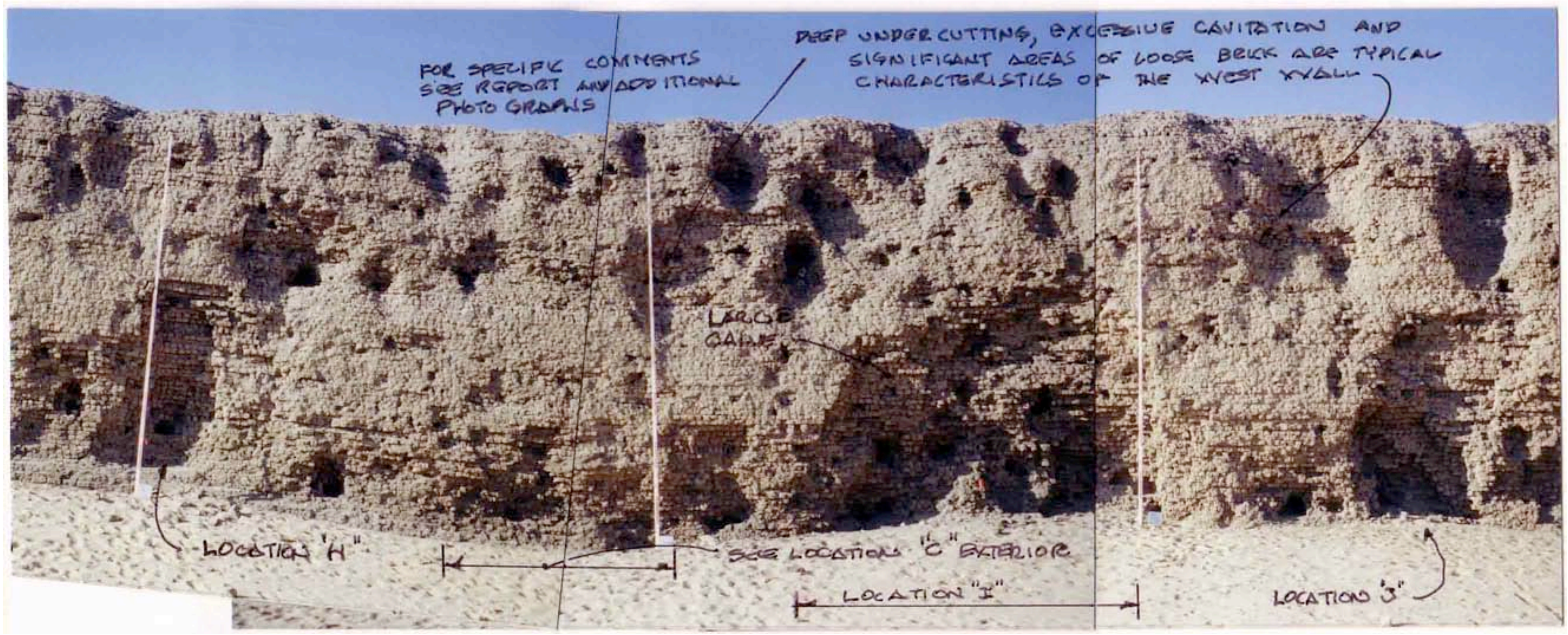


Figure 150. Detail of the deep undercutting and cavitation resulting from canine and insect activity on the southern, interior face of the west main enclosure wall (noted as locations H, I and J). (Composite photo: Conor Power 2000)

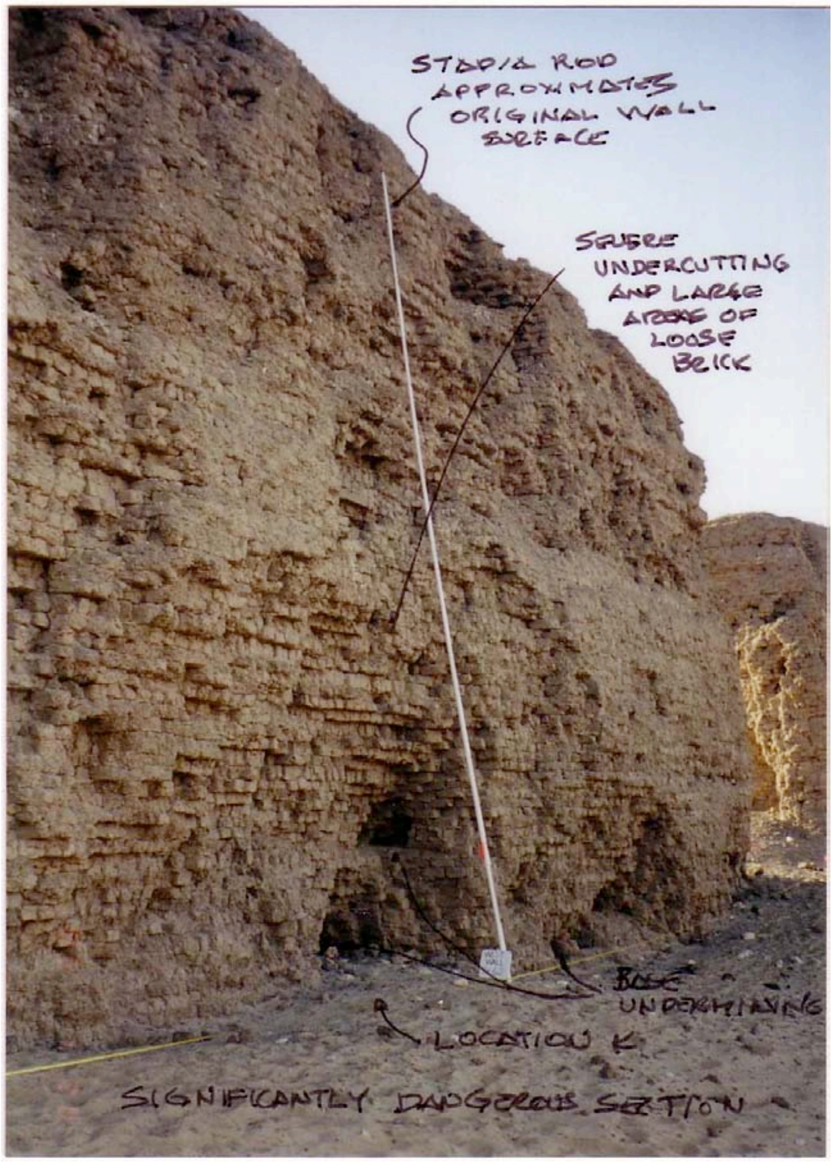


Figure 151. Detail of undercutting and loose brickwork on the southern, interior face of the west main enclosure wall (noted as location K). (Photo: Conor Power 2000)

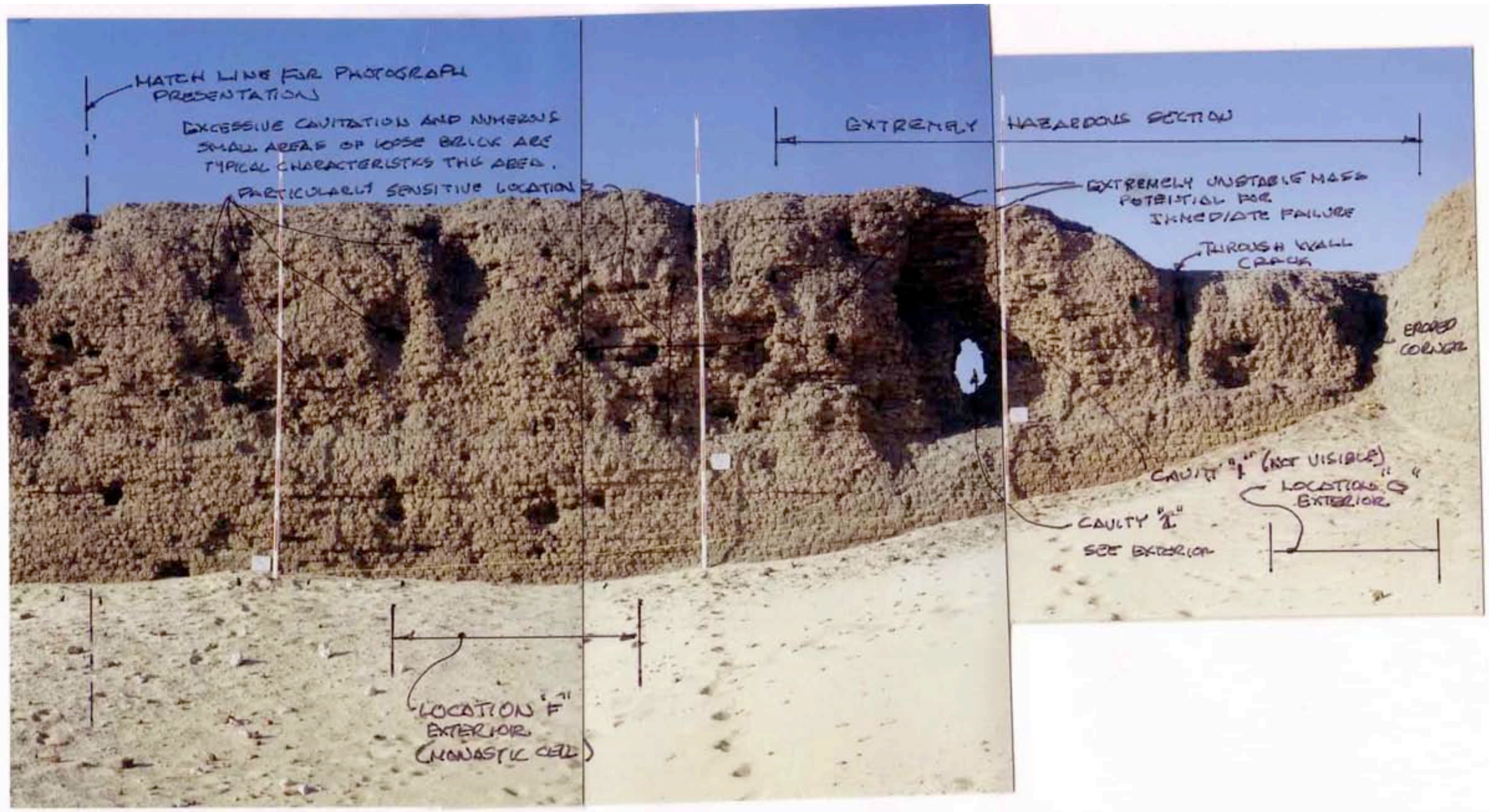


Figure 152. Structural conditions on the northern, interior face of the west main enclosure wall; note the interior detail of cavity 2 pictured in Figures 142-148, above. (Composite photo: Conor Power 2000)

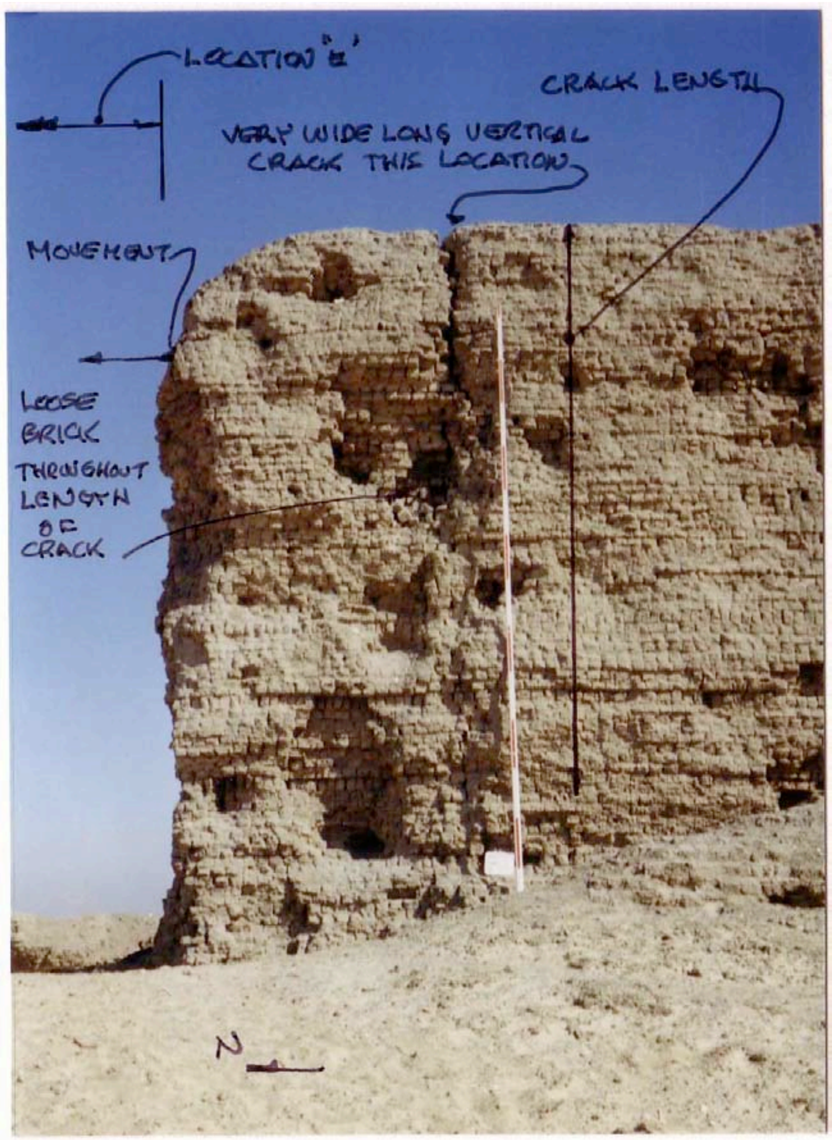


Figure 153. Exterior detail of a through-wall crack behind the southern, vertical end of the west gateway (noted as location E). (Photo: Conor Power 2000)

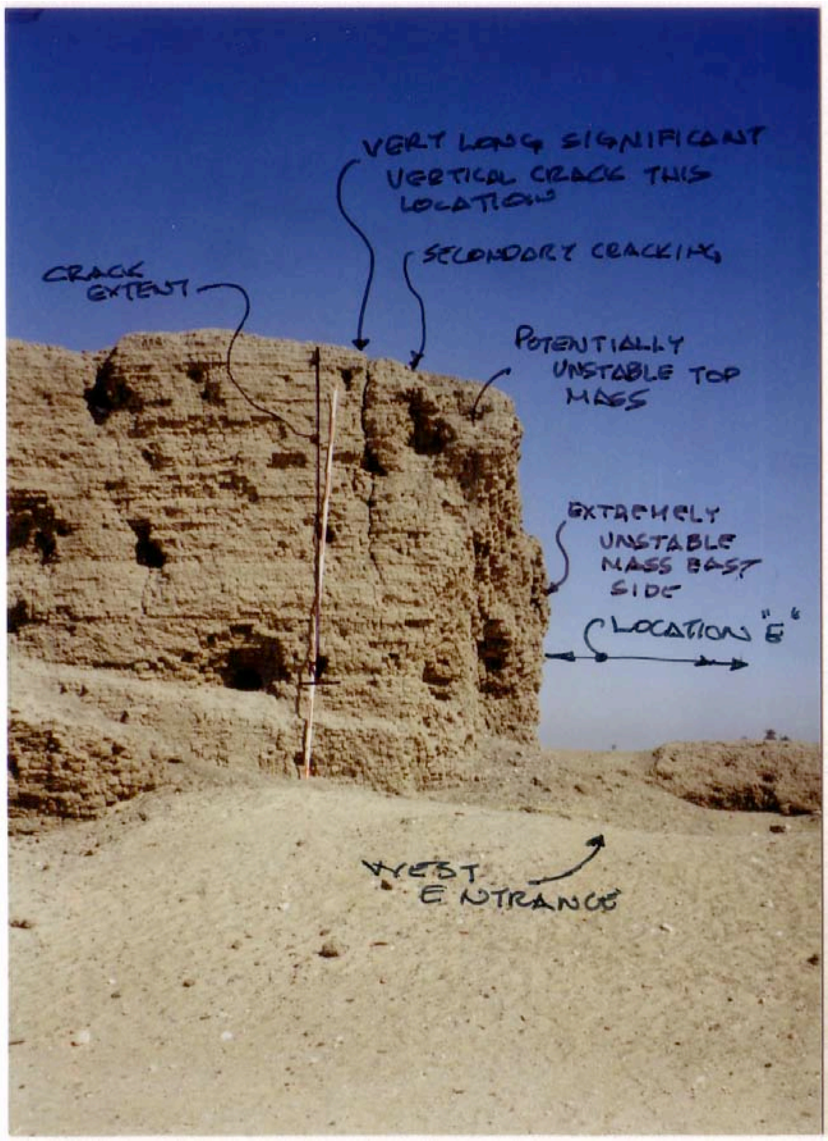


Figure 154. Interior detail of a through-wall crack behind the southern, vertical end of the west gateway (noted as location E). (Photo: Conor Power 2000)

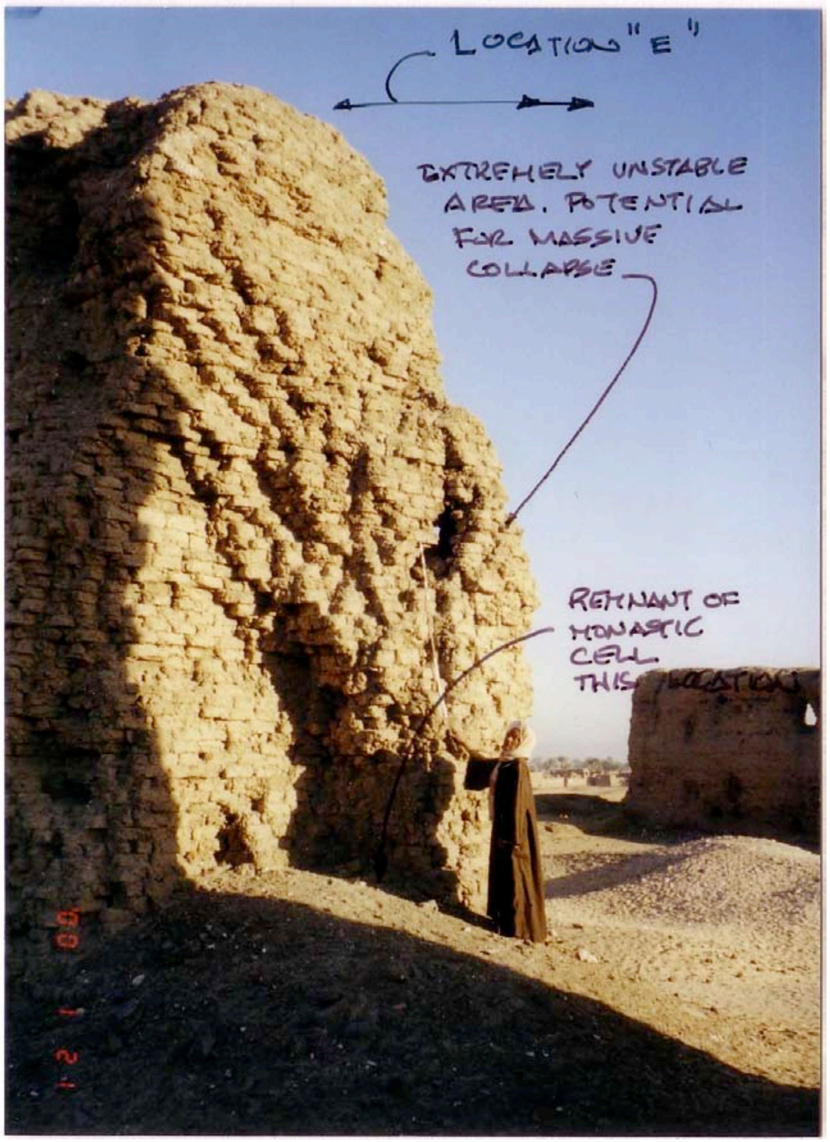


Figure 155. Detail of the undercutting and detachment resulting from monastic cell construction in the northern, vertical end of the west gateway (noted as location E). (Photo: Conor Power 2000)

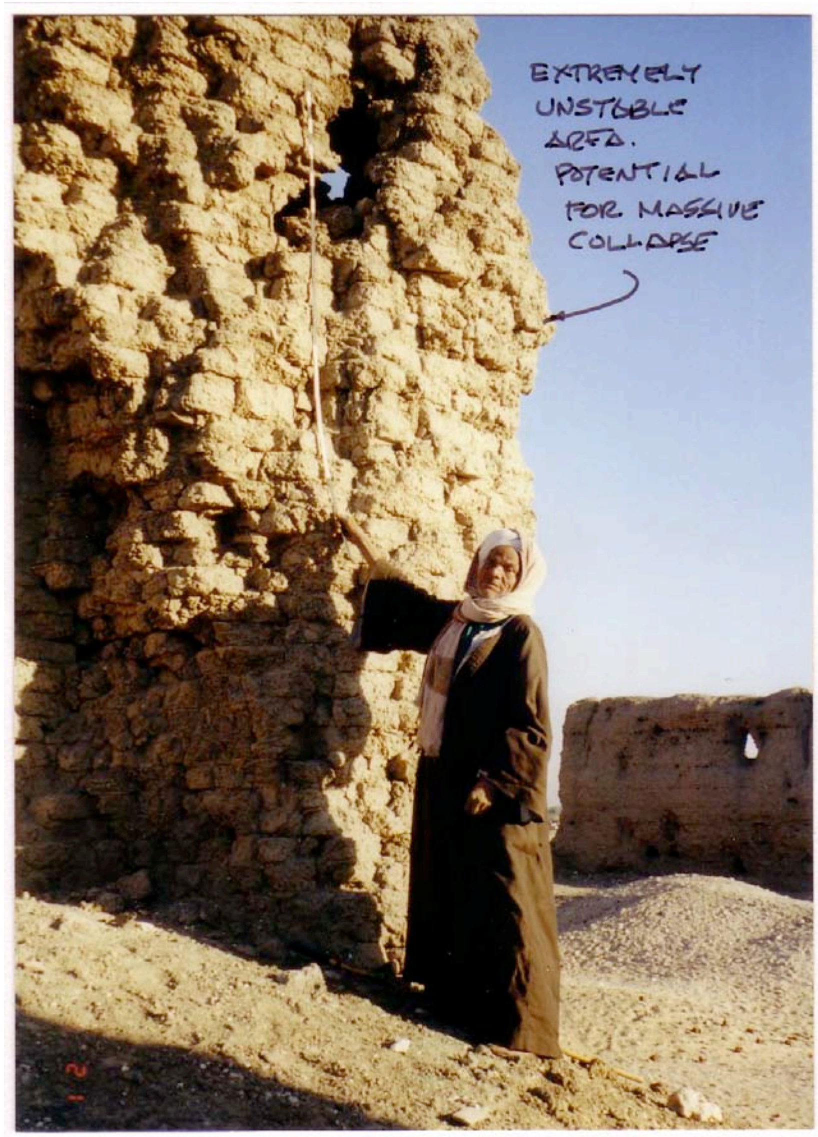


Figure 156. Detail of an unstable brick mass on the northern, vertical end of the west gateway. (Photo: Conor Power 2000)

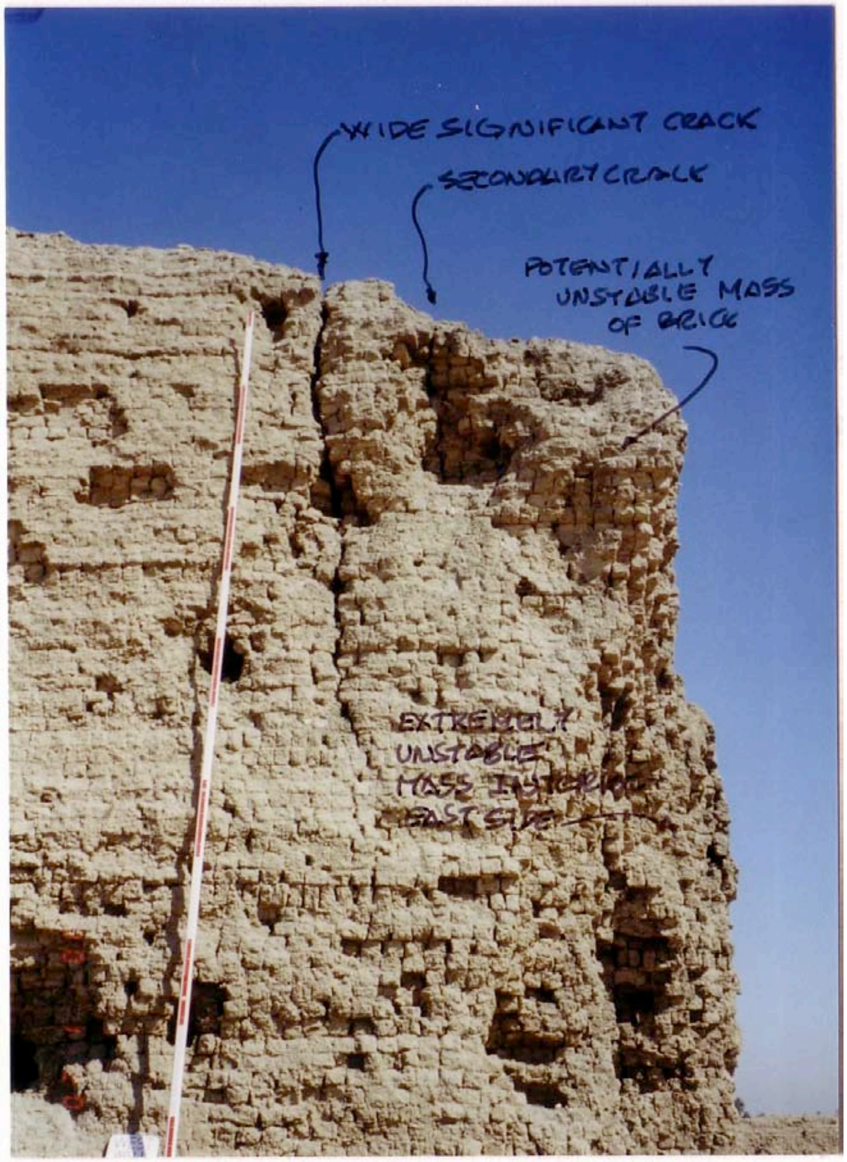


Figure 157. Exterior detail of a through-wall crack behind the northern, vertical end of the west gateway (noted as location E in Figures 153-155, above). (Photo: Conor Power 2000)

The specific structural conditions observed during the initial field survey were documented in relation to the overall stability of the monument, and based on this preliminary condition assessment, major threats to the monument were identified and actions were recommended that would mitigate risks of structural failure (Figure 158). In order of significance, actual extrinsic causes and threats of long-term deterioration at the Shuneh are wind (ongoing); adaptive building use (past); animal activity, including that of canids (possibly ongoing), hornets (ongoing), unidentified termite-like insects (past), mud wasps (ongoing) and birds (ongoing); and, finally, rain (past and ongoing). The past and ongoing effects on the monument resulting from these threats include undermining and cavitation (leading to other, more specific effects and general conditions of structural instability), erosion and loose brickwork. Potential extrinsic threats include ground motion, vehicular vibration, ground water, windstorms, high temperatures and aridity, and other possible undercutting or undermining disturbances, all of which are considered relatively unlikely in present conditions.

Certain intrinsic (that is, structural and material) properties of the monument have also been defined as threats to its stability and longevity. The most significant of these is the method of construction in the wall core, which has resulted in vertical lines of weakness and structural cracking, as well as the continuous, cascading collapse of unrestrained wall ends. Intrinsic causes and threats of decay, being essential characteristics of the structure, cannot be addressed by direct intervention without affecting fundamental and character-defining aspects of the monument. As causes of deterioration these properties therefore cannot be changed, but they can be managed with minimal intervention to prevent further decay. Documentation of the ways in which extrinsic conditions interact with the intrinsic features of material, structure and site at the Shuneh has informed both the immediate actions and long-range conservation planning undertaken by the project.

Recommended conservation actions based on observed conditions have generally involved cavity filling and local rebuilding, particularly in areas of high and urgent priority, stabilization of detached brick masses, bridging or rebuilding structural cracks, removing mud-wasp nest accretions, removing, resetting or consolidating loose brickwork, and reducing or eliminating sharp erosion junctures. In the case of cavity filling and local rebuilding, reversible and identifiable techniques for installing new mudbrick masonry were specified, with new construction to be set back slightly from existing wall surfaces, where feasible, and all new brickwork to be toothed to the existing masonry. Structurally, the treatment and repair of individual bricks was assigned a low priority.

Priority areas for stabilization and repair were identified as the central portion of the east main enclosure wall, both interior and exterior; the entire length, and particularly the northern, exterior area, of the west main enclosure wall; both sides of the west gateway area of the main enclosure; and the southwest corner of the main enclosure, at the intersection of the west and south walls. As part of the initial condition assessment, methods of scaffolding, buttressing and reinforcement were also suggested for structural rebuilding and stabilization operations.

It was recognized in the initial evaluation phase of the project that to achieve a completely safe structure would result in considerable alteration of the monument's present appearance, and conservation recommendations were developed in the interest of maintaining the building's archaeological character as well as ensuring the safety and stability of the standing walls. Conservation interventions based on this initial condition assessment are discussed in Conservation Work Completed at the Monument, to follow.

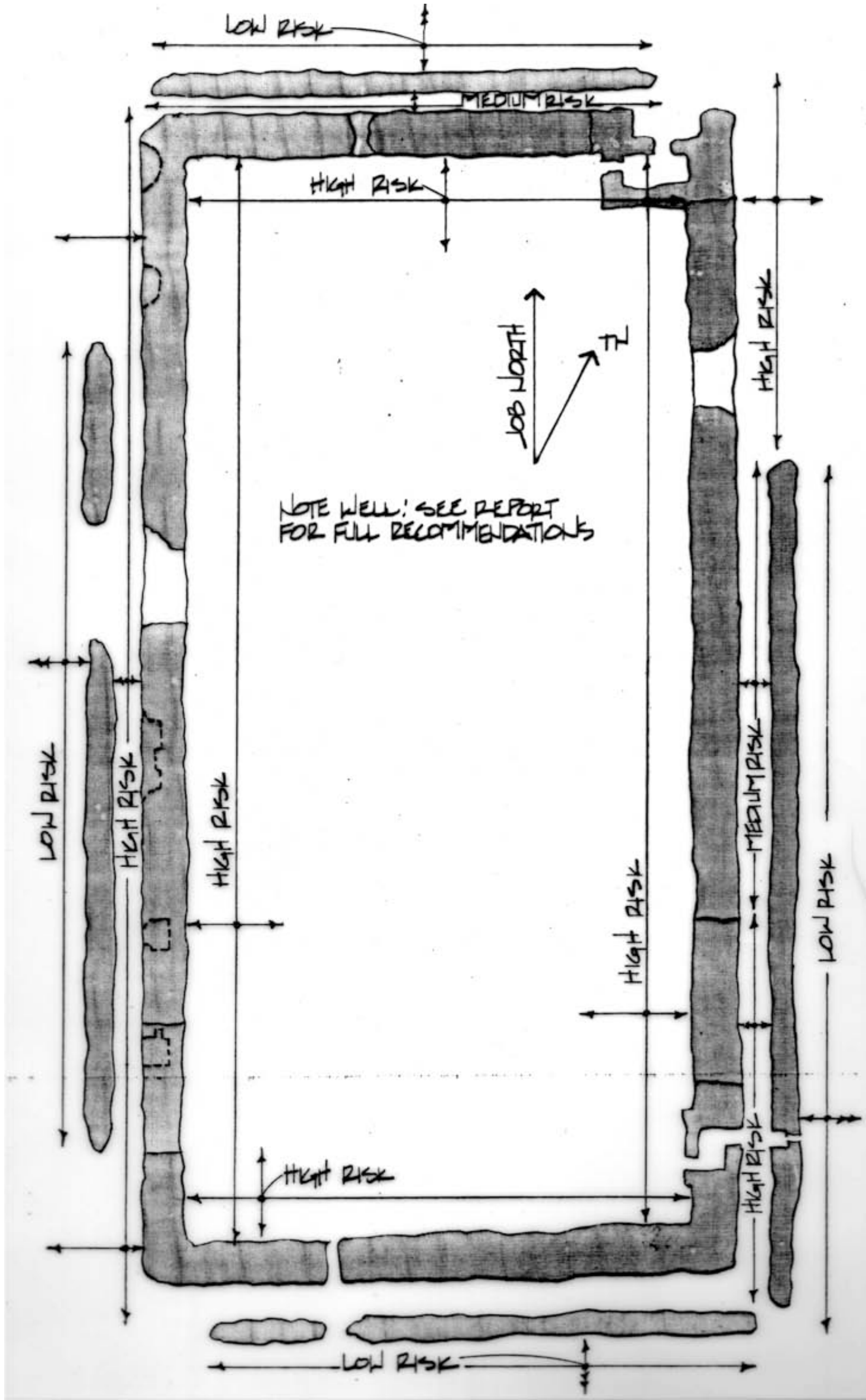


Figure 158. Plan of existing conditions and low to high-risk areas for structural failure at the enclosure of Khasekhemwy in 2000. (Conor Power 2000)

Conservation Work Completed at the Monument, 2001-2006

The basic approach to the conservation work undertaken at the Shuneh between 2001 and 2006 has emphasized preservation of the fundamental character of the monument as a grand ruin that reflects the 4700 years of its history. The primary goal of the conservation program has been to impede, insofar as possible, the processes that threaten the stability and survival of the monument, while maintaining its existing character and relationship to the surrounding environment. Specific interventions have been designed to address the most critical condition problems by re-establishing structural integrity where it is currently deficient. The primary methods and materials of conservation and stabilization replicate the mudbrick masonry that was used in the original construction. Structural interventions have been designed to blend visually with the existing fabric of the monument when viewed from a distance, maintaining the color, texture and basic geometry of the original walls, while at the same time being readily detectable upon close observation. It is not the intent of the conservation program to rebuild the monument as a whole or to return any part to its original state, even if this were known with certainty.

Based primarily on the initial condition assessment and architectural field report produced in 2000, a detailed set of technical specifications was developed by the project's mudbrick conservation specialist in 2001 (Anthony Crosby, Architectural Conservation, LLC), which has served as the basic manual for conservation operations at the monument to-date.[15] These specifications have been updated based on on-site experience following each field season, and were formally revised in 2007 to reflect current field conditions, completed work, and additional research. In addition to specifying methods and materials relating to mudbrick conservation at the Shuneh, the conservation specifications identify general guidelines for proposed interventions, including issues of safety, security, scheduling, mobilization, quality assurance, environmental conditions, crew size, tools and equipment. The specifications reflect the project's commitment to internationally established principles of heritage conservation and in particular to core values associated with king Khasekhemwy's funerary monument at Abydos. These values are comprised of the principal character-defining features of the monument, as well as the research potential of those features, which include the site of the monument and its relationship to the natural landscape, the texture and differentiation of individual mud bricks and mudbrick courses constituting the original fabric of the monument, and the visual rhythm of the preserved niches and pilasters as a reference to the original design. Both the general guidelines and specific interventions set out by the project's technical specifications reflect the significance of this character (Figures 159-163).

[15] The project's technical specifications, on file with the American Research Center in Egypt, are presented in the Master Format of the Construction Specification Institute (CSI).

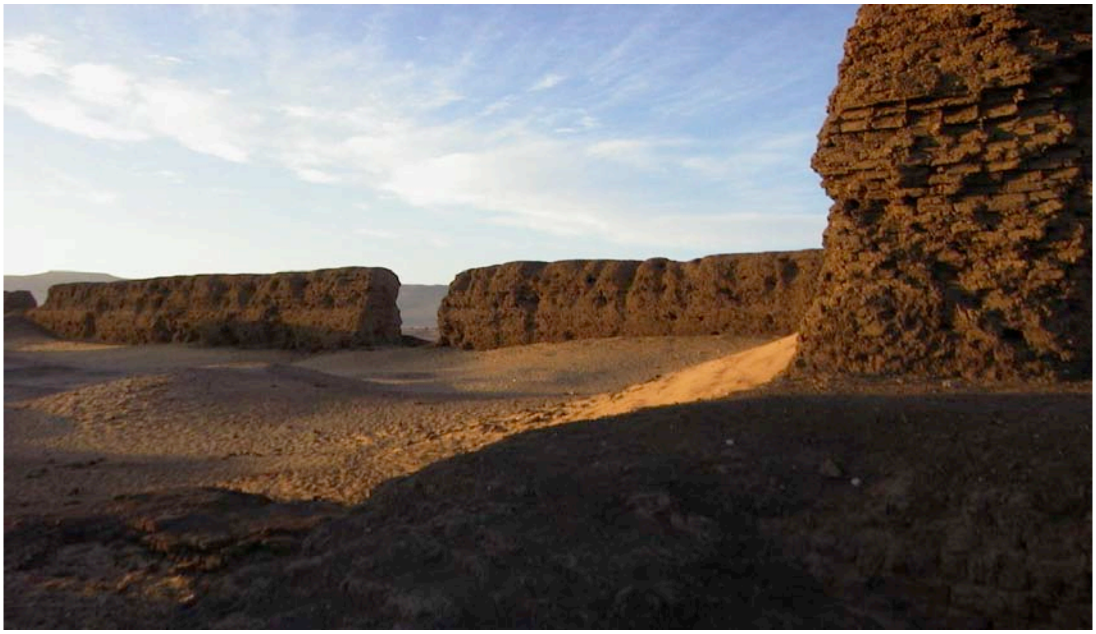


Figure 159. The relationship of the monument to the immediate environment of Abydos is a significant component of the overall conservation program at the Shunet el-Zebib. (Photo: Anthony Crosby 2000)

Figure 160. Characteristic features of the main enclosure that are protected by conservation measures include the massive mudbrick walls and remaining pilasters, pictured here at the south end of the monument. (Photo: Anthony Crosby 2000)

Figure 161. Detail of the characteristic patterns of a typical wall that are protected by conservation measures; although some changes are necessitated by the conservation work and have resulted in the reduction of holes and voids, the conserved walls retain this general character. (Photo: Anthony Crosby 2000)

Figure 162. Detail of the characteristic coursing patterns of the mudbrick masonry that are protected by conservation measures. (Photo: Anthony Crosby 2000)

Figure 163. The preserved niches and pilasters, pictured here on the lower façade of the east main enclosure wall (above grade), establish a visual rhythm that is characteristic of the monument's original design, and which represents a significant component of the overall conservation program. (Photo: Anthony Crosby 2000)

Conservation Implementation

After the initial evaluation phase of the conservation program at the Shuneh and the development of the technical specifications for conservation solutions, the implementation phase of the work commenced in field season 3 (spring 2001). The first major conservation activity undertaken in 2001 was the installation of four large sandbag buttresses against the central, interior portion of the east main enclosure wall (Figure 164). Given the highly precarious state of the interior side of this wall, which was critically affected by interrelated factors including undermining from animal activity, cavitation resulting from major, localized collapses, and concentric structural cracking around collapsed areas, immediate structural support was required. These buttresses, which are still in place as of 2007, represent a temporary solution to impede further calving and reduce the threat of catastrophic collapse, and a permanent solution in keeping with the overall conservation approach will be required to stabilize the east wall. The critical condition of the buttressed section of the east wall represents perhaps the greatest conservation challenge at the monument. Prior to adopting a permanent solution however, it was deemed necessary to obtain on-site experience at the monument regarding the specific conditions presented by the structure, the behavior of both the original wall fabric and the materials used in new construction, and the training of an appropriately skilled labor force. In addition to the sandbag buttresses, a number of other conservation methods were successfully tested in field season 3, including crack repair, pilaster reattachment, wall capping, and the in-filling of holes and voids, which represents the most common method of stabilization in the conservation program. Once these methods were tested and the results were determined to be successful, they became standards for subsequent conservation work.

Figure 164. Temporary sandbag buttresses installed in field season 3 against the interior side of the east main enclosure wall. (Photo: Robert Fletcher 2001)

The large-scale implementation of conservation solutions commenced in field season 5 (spring 2004) and has continued through field seasons 6 and 7 (2004-2005, 2005-2006). The primary method of stabilization in the conservation program at the Shuneh consists of adding new mudbrick masonry to support the original fabric of structurally unstable areas in the walls of the monument (Figure 165). Additional methods of stabilization outlined by the project's technical specifications include surface rendering, crack repair, plaster stabilization, mud grouting, mud-wasp nest removal, wall-base void repair, void and hole repair, mudbrick capping, and pilaster reattachment.

New mudbrick masonry that is added to support the original masonry where it has become unstable is keyed (or toothed) into the coursing of the original wall fabric to improve structural integrity (Figure 166). Missing segments of the wall that do not represent a threat to the monument's overall stability have not been reconstructed. The masonry materials used in conservation treatment are primarily those used in the original construction, and all new mud bricks are manufactured locally. The project's local brickmaker, Shabaan Alaam Abdelmagid, uses a rectangular, wooden hand mold to fabricate new bricks of the same shape and size as the original bricks. Approximately 80% of the new mud bricks measure 9 x 13 x 26cm, and 20% are in the range of 8-10 x 11-14 x 25-27cm to reflect the slight variability of sizing in the original mud bricks. The color and composition of the mud bricks match the original material as closely as possible, with an approximate 10% clay fraction. No non-traditional additives (such as cement, lime, asphalt emulsions, synthetic or natural plastisizers, consolidants or water repellents) are used. Soil for the mud mortar has a lower clay content, 5-10% by weight, and correspondingly more sand, and is composed of fine sand and silt originating from the same source as that used in the new bricks. All mud bricks and soils are free of alkali, acids, oils and organic material (either vegetable or animal); and the water used in fabrication is potable and free of injurious amounts of oil, soluble salts, alkali, acids and organic or other impurities that might impair brick strength.

All new bricks are stamped "PYIFA" (no deeper than 1cm, while wet) so as to be readily identified with the University of Pennsylvania Museum-Yale University- Institute of Fine Arts, New York University Expedition (Figures 167 and 168). New masonry is laid using mud mortar of specified sand-soil proportions, which is mixed on-site by local workmen. As the bricks are laid, the new masonry maintains the original coursing and the irregular texture of adjacent eroded wall surfaces so that the intervention will not be immediately apparent from a distance, but will be easily discerned through careful observation (Figure 169).

A local masonry team is responsible for all new construction under the supervision of the project's mudbrick conservation specialist, Anthony Crosby in close consultation with associate project director, Matthew Adams. A basic crew typically consists of 7 to 8 workmen, with an additional 8 workers for mortar preparation and transportation and 1 to 3 assistants to the local brickmaker, responsible for preparing and supplying mud bricks to the work site. The masonry team may consist of up to three 8-man crews, depending on the availability of staff and supplies. A team of masons from the nearby district of Girga was initially employed for part of the first season of large-scale conservation work (spring

2004), however in the interest of both efficiency and workmanship, this initial team was replaced in the same season by a more experienced and flexible team from Quft. The Qufti masons have since been thoroughly trained in the project's construction methods under the professional supervision of the project's mudbrick conservation specialist, and they have become key personnel in the architectural stabilization work.

Figure 165. Completed structural repair of the central void in the north main enclosure wall; this repair illustrates the basic approach to stabilization throughout the monument, with the addition of new mudbrick masonry to support the original fabric of the wall. (Photo: Matthew Adams 2004)

Figure 166. Detail of the toothing pattern used to integrate new and existing mudbrick construction. (Photo: Anthony Crosby)

Figure 167. New, formed mud bricks during initial drying. (Photo: Anthony Crosby)

Figure 168. A new mud brick stamped for identification with the Pennsylvania-Yale-IFA/NYU Expedition. (Photo: Anthony Crosby)

Figure 169. Detail of the texturing technique used to blend new mudbrick masonry with the surrounding, original wall fabric. (Photo: Anthony Crosby)

While the primary purpose of new construction at the monument is to re-establish structural integrity in critical areas, it has also been added in some locations to form a sacrificial layer against the effects of wind and water erosion, particularly on wall tops and other vulnerable surface areas. This method of intervention, known as "capping," involves the installation of new mudbrick caps to protect original fabric from further decay (Figures 170-175). Mudbrick caps compose a sacrificial layer that is expected to erode and be replaced over time. The purpose of this layer is to buffer the underlying bricks from erosion caused by wind, rain and human activity, such as walking and climbing. Mudbrick capping is a protective measure that does not significantly alter the overall massing of the walls, and that, insofar as possible, follows the existing contours of the walls. It is also closely related to crack repairs that involve the bridging of severe structural cracks. Eventually, all of the wall tops of the enclosure will be capped with a sacrificial layer of mud bricks.

Non-original materials are not generally employed in conservation treatments at the monument, however they have been used in specific circumstances (Figures 176-189). In areas where horizontal reinforcement is needed, high-density polyethelyne (HDPE) sheets in the form of an open grid, or "geogrid" (originally developed for the stabilization of earth embankments and roads), are used. In areas where the new mud bricks are under compressive loads, mechanical ties are not required, however where the new masonry is relatively thin or there is tension between the original fabric of the wall and the new construction, a system of mechanical ties is also necessary. These ties are used to anchor the geogrid, and the new masonry it reinforces, to the original fabric of the wall. In areas where access is difficult, holes and cracks have been filled with mud grout, and special techniques have also been developed for the reattachment of detached pilasters and delaminated areas of original plaster finish. The non-traditional materials used in the conservation program at the Shuneh are not left exposed in completed interventions and are not visible to visitors at the site.

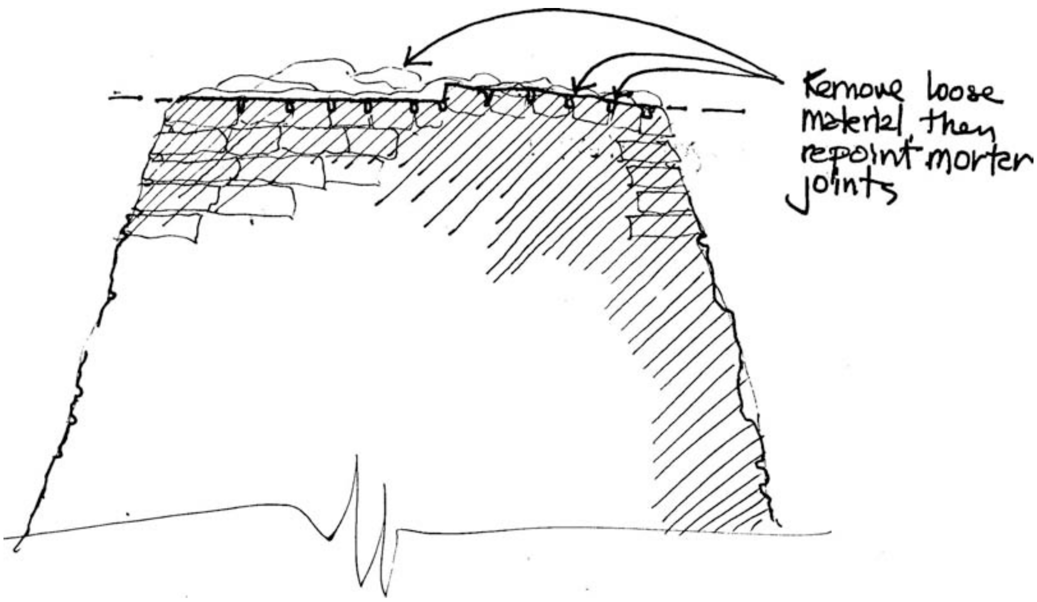


Figure 170. Sketch detail of the top of a wall in preparation for mudbrick capping. (Graphic: Anthony Crosby 2001)

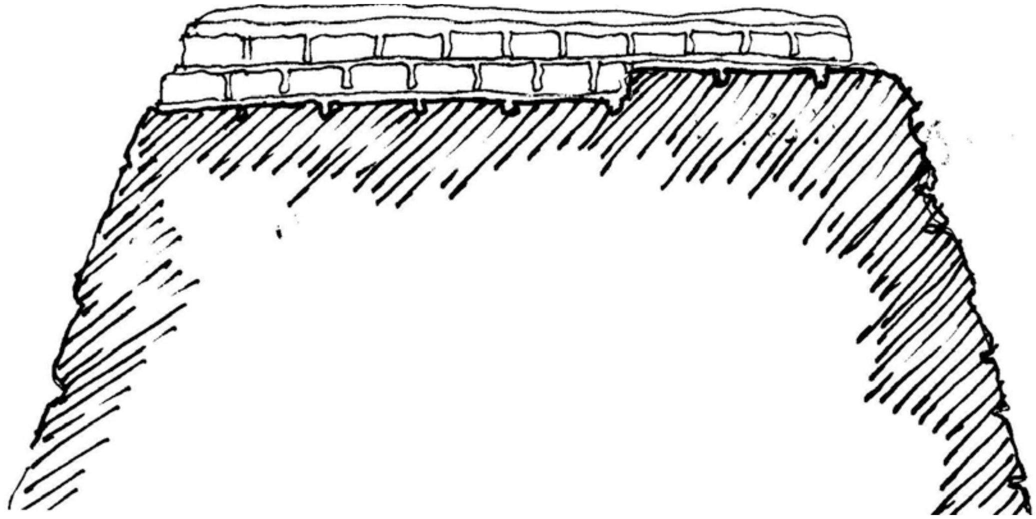


Figure 171. Sketch detail of a typical wall cap repair; note preservation of the existing wall profile in cap construction, which generally adds one to two courses of new mud brick to exposed original masonry. (Graphic: Anthony Crosby 2001)

Figures 172, 173. Details of a low section of the east perimeter wall before and after mudbrick capping (top and bottom, respectively). (Photos: Anthony Crosby 2001)

Figures 174, 175. Details of mudbrick capping in progress on the top of the east main enclosure wall; note how the capping reflects the general contours of the existing wall. (Photos: Anthony Crosby 2004)

Figure 176. Detail of an installation of geogrid horizontal reinforcement. (Photo: Anthony Crosby 2001)

Figure 177. Detail of the use of mechanical ties to secure the new masonry and geogrid to the original construction. (Photo: Anthony Crosby 2001)

Figure 178. A mechanical tie assembly consisting of threaded steel rod, toggle and eyebolt. (Photo: Anthony Crosby 2001)

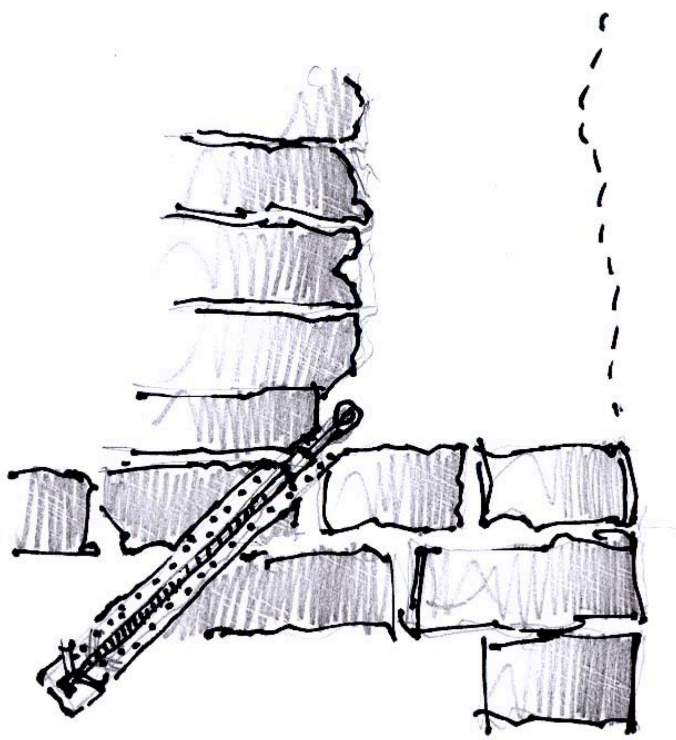


Figure 179. Sketch detail of a mechanical tie set into the wall; actual holes are drilled at an angle of approximately 30-45% from horizontal. (Graphic: Anthony Crosby 2001)

Figure 180. Mechanical ties are set into the wall approximately one meter apart, with only the eyebolts visible after placement. (Photo: Anthony Crosby 2001)

Figure 181. Detail of a crack repair on the east main enclosure wall that requires mud grouting because of its depth in the structure. (Photo: Anthony Crosby 2001)

Figure 182. Detail of a through-wall crack repair on the west main enclosure wall that requires a combination of mud grouting, structural ties and the addition of new mud bricks. (Photo: Anthony Crosby 2001)

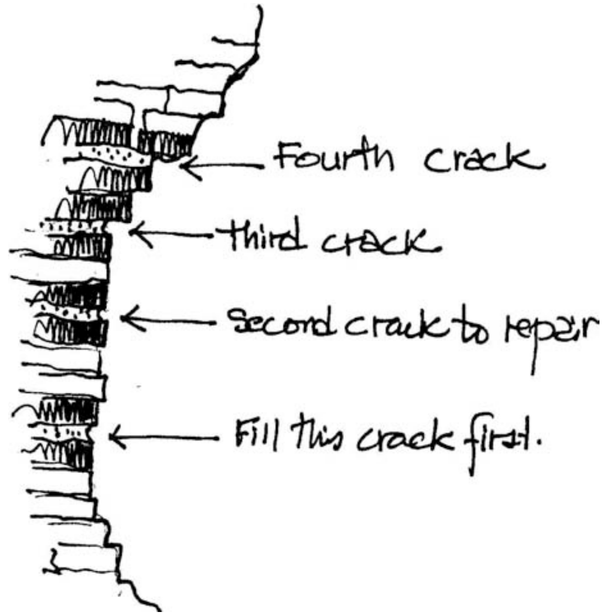


Figure 183. The sequence of mud-grout crack repair for multiple horizontal cracks in a wall section. (Graphic: Anthony Crosby 2001)

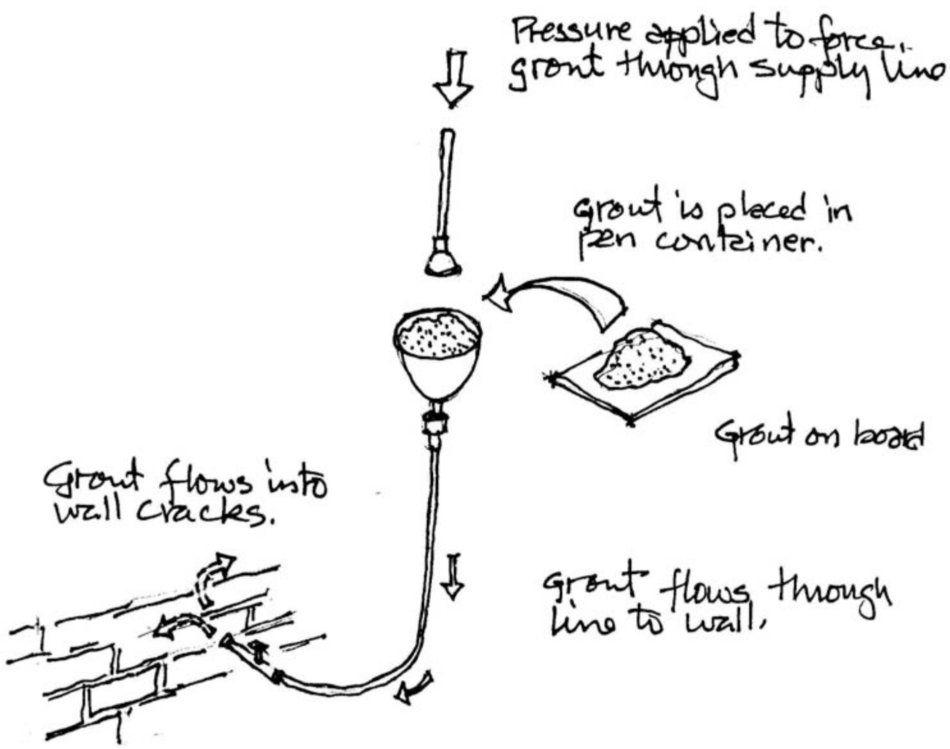


Figure 184. Schematic detail of the gravity-grout system and process used in mud grouting; 3-4m of line results in approximately 10-15psi. (Graphic: Anthony Crosby 2001)

Figure 185. Detail of a detached plaster fragment in preparation for reattachment; the unstable fragment has been removed from the wall and placed on a flat working surface, and the original mud plaster substrate has been partially removed. (Photo: Robert Fletcher 2004-2005)

Figure 186. Detail of geogrid attached with new mud plaster to the back of the original plaster fragment. (Photo: Robert Fletcher 2004-2005)

Figures 187, 188. Applying new mud plaster to the mudbrick substrate in preparation for plaster reattachment (top) and mud packing along the edges of the replaced plaster (bottom). (Photos: Robert Fletcher 2004-2005)

Figure 189. Detail of reattached plaster after it has cured. (Photo: Robert Fletcher 2004-2005)

The full implementation of conservation solutions began in field season 5 (spring 2004) and continued in field seasons 6 (2004-2005) and 7 (2005-2006). Large-scale solutions involving new mudbrick construction have been implemented at multiple locations throughout the monument. These include major work on all four walls of the main enclosure, as well as the west perimeter wall. In addition, a number of smaller-scale conservation and stabilization measures have been undertaken at many locations on all four walls of the main enclosure. The conservation work completed to-date is illustrated in Figure 190 and described below. Major work on the west gateway area of the main enclosure and in several monastic cell locations throughout the enclosure was incorporated into the work of field seasons 5 through 7, and these particular interventions are discussed in more specific detail to follow.

During field season 5 (spring 2004), the large gap in the central portion of the north main enclosure wall was filled in with new masonry to provide structural support for the original fabric on both sides of the gap and to reestablish the stability of this major wall section (Figures 191 and 192; see also Figure 165, above). The repair to this area represented the first full-scale example of the aesthetic that characterizes the conservation work at the Shuneh. The existing coursing of the original wall fabric on each side of the gap was followed in the installation of new masonry. The contours of the existing eroded wall top were used to define the line of the top of the new construction, which does not extend to the full height of the adjacent areas of the wall in order to reflect the major loss that occurred at this location. The new masonry was constructed to reflect the irregular texture of the surrounding eroded wall surfaces, and the joints between bricks were roughly pointed with mud mortar to reduce the visibility of sharp head joints that contrasted with the surrounding original fabric and to aid in blending the textures of the new and original work (Figure 193).

The eastern wall end of the north main enclosure wall (adjacent to the north gateway), which exhibited a high-priority overhang in danger of collapse, was buttressed in field season 5 by a supporting mass of new masonry (Figures 194-199; see also Figures 191 and 192). Careful examination of this area produced no evidence of post-Second Dynasty cultural features that may have contributed to the losses at this end of the wall, although both the flatness of the existing wall surface below the overhang and the existence of a monastic cell on the opposite side of the north gateway suggest that such a feature may once have been present.[16] The work at the eastern end of the north wall during field season 5 was only the first stage in the comprehensive stabilization of the entire north gateway area, which was continued during work on the northern end of the east wall in field seasons 6 and 7 (see below). The eastern end of this new construction was left untextured to allow it to be easily incorporated into the overall stabilization of the gateway, which will be completed in future seasons.

In contrast to the western side of the north gateway, definite but denuded remains of a late antique monastic cell were found in the northern end of the east main enclosure wall. The cell void would have been a source of significant structural weakness, and the ultimate

[16] Note the existence of a pair of monastic cells on the opposing sides of the west gateway opening in the main enclosure.

collapse of the wall above the cell void contributed to major losses of original fabric at this location (Figures 200 and 201). At some point in the past (probably during the 19th Century), a deep hole was cut through the floor of the cell and the underlying masonry of the wall, well into the sterile sand and gravel deposits beneath.[17] The void created in the sand deposits under the wall resulted in the localized collapse of several courses of masonry from the bottom of the wall. The base of the wall at the eastern end of the north interior gateway chamber had been undermined as well, possibly by an attempt to penetrate under the wall from the west at the same time the hole was dug through the wall nearby. Localized collapses associated with this undermining interacted with those associated with the hole, creating a significant area of instability at the base of the wall. The undermined, lower part of the wall at the eastern end of the interior gateway chamber was stabilized with new masonry during field season 6 (Figures 202 and 203). The new masonry that is below grade steps out slightly from the plane of the wall face to provide a stable base, but is not left visible. The new masonry above grade (which is visible) follows the original wall face. The void under the base of the wall at the bottom of the hole was filled with compacted sand to stabilize the area, and the shaft of the hole was filled with new masonry. Once the lower part of the wall was stable, work on the vertical wall end above could proceed.

A large section of new masonry was installed during field seasons 6 and 7 (2004-2005, 2005-2006) to support the unstable northern wall end of the east wall, and by the close of field season 7, this supporting masonry was brought to within two meters of the existing wall top (Figures 204-206). Sheets of geogrid were incorporated into the new construction to provide horizontal reinforcement (see Figure 205). As the work at this location is not yet completed, sections of these sheets remain visible as of 2007, protruding from the northern side of the new, still untextured, masonry. Like the new masonry at the eastern end of the north wall, the new masonry at the northern end of the east wall will be incorporated into the comprehensive stabilization of the entire north gateway area in future seasons.

[17] Similar holes were found cut into the southwest and northwest corners of the main enclosure, penetrating below the base of the wall into the sterile sand deposits below. These holes are the result of deliberate tunneling and are thought to represent the work of Mariette's agents in search of foundation deposits during the mid-19th Century.

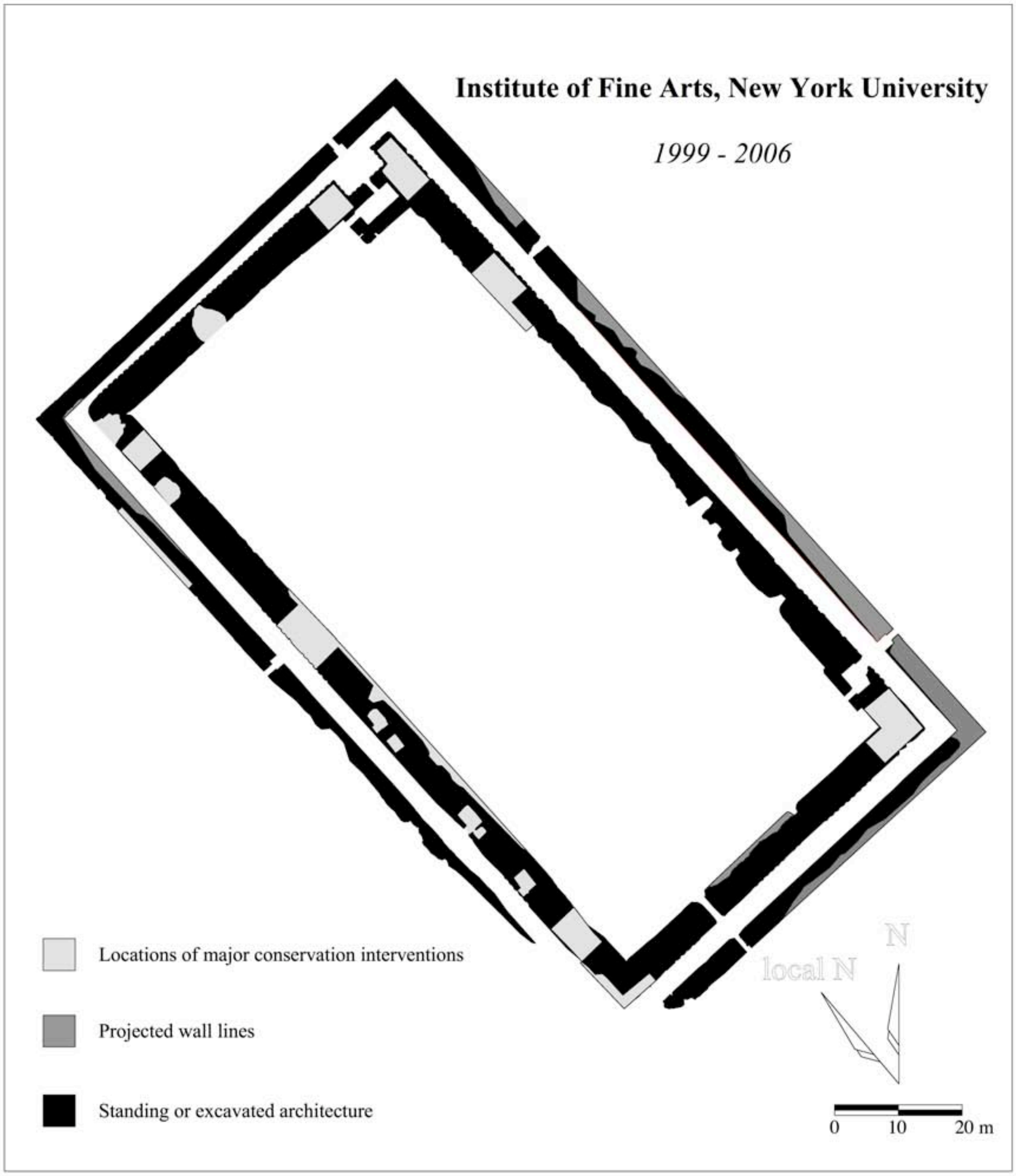


Figure 190. Plan of major conservation interventions at the enclosure of Khasekhemwy from 2001 to 2006. (Institute of Fine Arts, New York University 1999-2006)

Figure 191. The interior face of the north main enclosure wall, prior to conservation work. (Photo: Richard Barnes 2000)

Figure 192. The interior face of the north main enclosure wall, following reconstruction of the central void and stabilization of the eastern wall end (at right). (Photo: Matthew Adams 2004)

Figure 193. Pointing the joints of the new mud brick in the north main enclosure wall to aid in blending the texture of the new masonry with the original fabric of the surrounding wall. (Photo: Matthew Adams 2004)

Figures 194, 195, 196. Three details of the eastern, vertical end of the north main enclosure wall prior to architectural stabilization, facing north (top), west (bottom left), and south (bottom right). (Photos: Richard Barnes 1999)

Figure 197. Detail of the surface adjacent to the eastern end of the north main enclosure wall prior to architectural stabilization; no features relating to monastic occupation were detected at this location. (Photo: Robert Fletcher 2004-2005)

Figures 198, 199. Details of the eastern end of the north main enclosure wall during stabilization; once completed, the sharp ledges and vertical faces will disappear and the buttress will provide essential structural support for this side of the north gateway area. (Photos: Robert Fletcher 2004-2005)

Figure 200. The highly unstable northern end of the east main enclosure wall (left center, adjacent to the north gateway) prior to architectural stabilization; note the deep structural crack behind the vertical face of the wall end. (Photo: Robert Fletcher 2004-2005)

Figure 201. Detail of the north interior gateway chamber, facing east; note the remains of the monastic cell that was cut into the northern end of the adjacent east wall (rear center). (Photo: Robert Fletcher 2004-2005)

Figure 202. Detail of the north interior gateway chamber during stabilization of the northern base of the east main enclosure wall; the deep hole cut through the wall base at this location has been filled and new masonry is being installed to support reconstruction of the vertical wall end (see Figures 200 and 201, above). (Photo: Robert Fletcher 2004-2005)

Figure 203. Detail of the reconstructed wall base at the eastern end of the north interior gateway chamber (also the northern base of the east main enclosure wall); the two masonry courses projecting beyond the plane of the wall, which stabilize the wall base, are below grade and not visible in the completed intervention. (Photo: Robert Fletcher 2004-2005)

Figure 204. The northern end of the east main enclosure wall during architectural stabilization. (Photo: Robert Fletcher 2004-2005)

Figure 205. Detail of the new masonry support at the northern end of the east main enclosure wall at the close of field season 6; the use of geogrid at this location allowed the new masonry to be strongly keyed to the existing construction. (Photo: Robert Fletcher 2004-2005)

Figure 206. Stabilization of the northern end of the east main enclosure wall at the close of field season 7. (Photo: Matthew Adams 2005-2006)

Deep vertical cracks and heavy erosion at the eastern end of the south main enclosure wall (adjacent to the east gateway) have combined to create highly unstable, urgent-priority conditions, including significant calving and unstable brick masses, with one essentially freestanding column of masonry representing a particular area of concern (Figure 207). The features of greatest concern were stabilized during field season 6 (2004-2005) with the addition of new supporting masonry (Figure 208). The new construction follows the original coursing of the adjacent wall, and has been built so as to support unstable portions of the wall, while reflecting in its contours the highly eroded character of this corner area. The conservation work at this location will be incorporated into the comprehensive stabilization of the east gateway area in future seasons.

The southwest, exterior corner of the main enclosure, at the intersection of the west and south walls, was stabilized in field season 7 (2005-2006). This area was affected by significant cavitation along the base of the west wall, missing masonry and overhangs at the corner itself, hornet holes on both sides of the corner, and a deep man-made tunnel cut from the south side through the masonry of the wall into the underlying sand and gravel deposits (Figures 209 and 210). Like similar holes at the northwest and northeast corners of the main enclosure, this tunnel was probably dug by Mariette's workers in the 19th Century. The missing masonry along the wall base at this location was replaced, as illustrated in Figures 211 to 213. Below grade, the new masonry was constructed with a footing that extends slightly beyond the original line of the wall to provide a stable base for the new masonry, and above grade, the new construction follows the original wall line. Complete stabilization of the wall base also included filling the man-made tunnel and adjacent hornet-nest holes. The upper portion of the wall at the southwest corner, which exhibits highly unstable overhangs, will be repaired in a future season.

At the southern end of the west main enclosure wall, a large gap in the upper masonry posed high-priority structural risks (Figures 214 and 215). The sides of this gap were defined by opposing vertical wall ends, each associated with significant structural cracks. During field season 5 (spring 2004), a supporting section of new masonry was constructed against the northern side of the gap, and in field season 6 (2004-2005), the remainder of the gap was filled (Figures 216 and 217). The coursing of the original wall fabric was followed and the texture of the surrounding eroded wall surfaces was carried into the new construction, the top of which was contoured to follow the undulating lines of the existing wall top. The infilling of this large gap provides necessary structural support for the adjacent original fabric and eliminates the threat of further losses in this area. Because the new construction does not reach the full height of the wall, the slightly lower profile of the infilling makes a subtle but noticeable visual reference to the previous loss of fabric.

On the southern, interior face of the west main enclosure wall, new masonry was installed in stages along the lower wall face during field seasons 6 and 7 (2004-2005, 2005-2006). The lower portion of this interior elevation was heavily affected by cavitation, undermining and unstable overhangs, which threatened the stability of the upper wall (Figures 218 and 219). The urgent-priority condition of this wall was in large part the result of canid burrowing and insect activity, although ancient pitting associated with ibis burials may also have been a contributing factor. Excavation in field seasons 6 and 7 exposed the base of the wall, permitting its condition to be evaluated. All undermined areas, holes and voids were cleaned, and loose brickwork was removed prior to installing new masonry. A compacted sand base was prepared along the base of the wall, on which a footer was laid that extended slightly out from the original plane of the wall face, providing a solid base for the new construction above. This footer, as elsewhere, is below grade in the finished repair and will not be visible. Above grade, the new masonry followed the plane of the original wall face. The original masonry coursing was followed in the new work, and the finished wall surface was textured to reflect the eroded and undulating surfaces of the surrounding original wall. The new brickwork was built up to meet overhanging areas, providing structural support for the upper part of the wall (Figures 220-224). Because the upper parts of the new masonry in this area are relatively thin, mechanical ties were used in combination with geogrid to anchor the new work to the original fabric of the wall. The stabilization work along the lower, interior side of the west wall provides a particularly clear example of the approach being followed in the conservation program at the Shuneh. The texture of the new construction blends with that of the original masonry when viewed from a distance, but it is easily distinguishable upon close inspection (Figure 225). At the close of field season 7, a solid base of new construction had been established and the stabilization of the lower part of the southern, interior face of the west wall was complete.

In addition to the work completed on each of the main enclosure walls, part of the northern, exterior side of the west perimeter wall was stabilized with new masonry during field season 7 (2005-2006). This area was in an extremely unstable condition as a result of significant wind erosion, hornet nesting and extensive animal burrowing, some of which had penetrated completely through the thickness of the wall (Figure 226). In order to prevent further losses, new masonry was constructed to support the remaining original fabric in the most critical area, at the center of the northern portion of the wall (Figure 227). Because the new masonry is relatively thin in this area, geogrid and mechanical ties were used to anchor it to the existing wall. A temporary sandbag buttress was constructed to support a second highly unstable area, as depicted in Figure 228. The remainder of the northern, exterior side of the west perimeter wall (to the north and south of the repaired area) remains to be stabilized in a future season.

Figure 207. The southeastern corner of the main enclosure and perimeter walls, prior to architectural stabilization; the freestanding brick mass at the eastern end of the south main enclosure wall (upper right) was extremely unstable prior to conservation work. (Photo: Robert Fletcher 2004-2005)

Figure 208. The eastern corner of the south main enclosure wall completely stabilized at the close of field season 6; this work represents the first stage in the comprehensive stabilization of the east gateway area. (Photo: Robert Fletcher 2004-2005)

Figure 209. Detail of the southwest, exterior corner of main enclosure (adjacent to the south gateway) prior to conservation work; the large void (left center) is the result of deliberate tunneling in the mid-19th Century and the smaller holes nearby are the result of hornet nesting. (Photo: Robert Fletcher 2004-2005)

Figure 210. Detail of the large hole penetrating below the wall base at the southwest corner of the main enclosure, pictured in Figure 209 (above); this tunnel was likely excavated by agents of Auguste Mariette in the mid-19th Century. (Photo: Robert Fletcher 2004-2005)

Figure 211. New masonry courses were laid below grade and beyond the wall plane at the base of the southwest corner of the main enclosure to provide a stable base for new construction in field season 7. (Photo: Robert Fletcher 2005-2006)

Figure 212. Stabilization work in progress at the southwest corner of the main enclosure; the extent of missing original masonry can be judged by the thickness of the new construction, which follows the original line of the wall above grade. (Photo: Robert Fletcher 2005-2006)

Figure 213. Completed area of stabilization on the lower, exterior portion of the southwest corner of the main enclosure at the close of field season 7. (Photo: Jason Goodman 2005-2006)

Figure 214. Interior detail of the gap in the upper, southern portion of the west main enclosure wall prior to architectural stabilization. (Photo: Matthew Adams 2004)

Figure 215. Detail of brick loss on the northern, vertical end of the gap in the upper west main enclosure wall pictured in Figure 214 (above); the arrow shows a hornet in flight to an active nest opening at this location. (Photo: Robert Fletcher 2001-2002)

Figure 216. Detail of the buttress constructed against the northern side of the gap pictured in Figure 214 (above), representing the unfinished state of intervention at the close of field season 5. (Photo: Matthew Adams 2004)

Figure 217. Interior detail of the gap in the upper, southern portion of the west main enclosure wall following architectural stabilization; note how the new construction is contoured to follow the lines of the existing wall top. (Photo: Robert Fletcher 2004-2005)

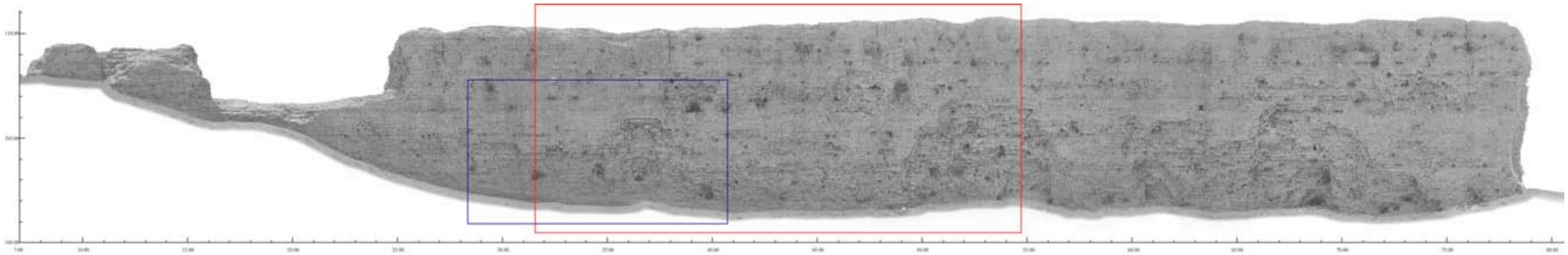
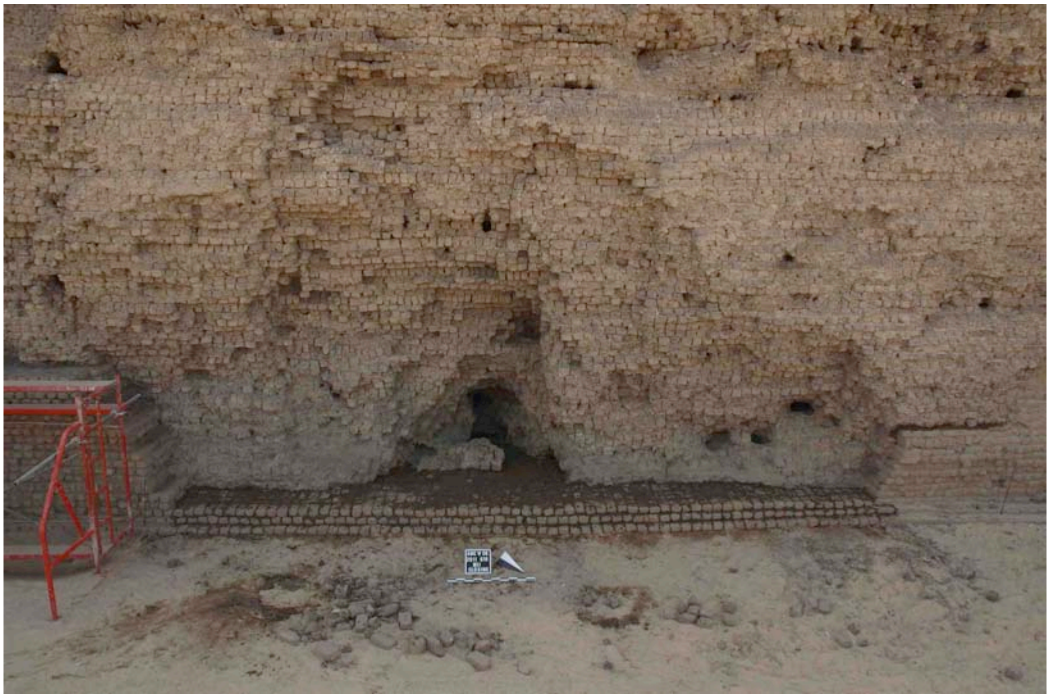


Figure 218. Rectified photoelevation of the southern, interior face of the west main enclosure wall, illustrating the condition of the wall in 2001 prior to conservation work; the details noted in red and blue are pictured in Figures 221 and 222 (respectively), below. (Photoelevation: Heritage 3D, Inc. 2001)

Figure 219. Detail of the typical undercutting caused by animal burrowing on the interior side of the west main enclosure wall. (Photo: Robert Fletcher 2004-2005)

Figure 220. Installing new masonry along the southern, interior side of the west main enclosure wall; note the original line of the wall in the background and overhanging masonry in the foreground. (Photo: Robert Fletcher 2004-2005)

Figures 221, 222. Two details of stabilization work in progress on the undercut areas outlined in Figure 218, above. (Photos: Robert Fletcher 2004-2005)



Figures 223, 224. Stabilization work in progress at the undercut location pictured in Figure 219 (above), on the southern, interior side of the west main enclosure wall; the lowest course of new mud brick extends beyond the line of the wall below grade, and the above-grade masonry is built up as high as necessary to fill existing voids and to provide structural support for the large and irregular overhangs above. (Photos: Robert Fletcher 2004-2005)

Figure 225. Stabilization work near completion on the lower portion of the southern, interior face of the west main enclosure wall. (Photo: Jason Goodman 2005-2006)

Figure 226. The northern, exterior portion of the west perimeter wall prior to architectural stabilization; the outer surface of this wall has been heavily damaged by wind erosion, animal burrowing and insect activity. (Photo: Robert Fletcher 2005-2006)

Figure 227. Stabilization work in progress on the northern, exterior face of the west perimeter wall. (Photo: Jason Goodman 2005-2006)

Figure 228. Following stabilization of part of the northern, exterior face of the west perimeter wall in field season 7, a temporary sandbag buttress was constructed to support a remaining unstable area (lower right). (Photo: Anthony Crosby)

Several additional interventions, both large and small-scale in nature, were implemented in field seasons 5 through 7, and these included crack repair, mudbrick capping, void and hole repair, and plaster stabilization. A large number of small to medium-sized holes primarily the result of hornet nesting were filled in on the interior and exterior sides of both the north and west main enclosure walls, as well as on the interior side of the east main enclosure wall, during field seasons 5, 6 and 7 (2004, 2004-2005, 2005-2006). Extensive scaffolding was often required to provide efficient access to large sections of these wall faces (Figure 229). The treated holes, which had led to severe cavitation and surface erosion in these areas, were cleaned, documented and filled with new mudbrick masonry (Figures 230-245). A particular area of concern in these void and hole repairs was the large through-wall hole system that existed in the upper, northern portion of the west main enclosure wall between the two large cell voids in the exterior face of the wall (discussed below). The combination of the unstable cell voids and this through-wall hole system created extremely unstable conditions in this part of the main enclosure (see Figure 230). The interior and exterior regions around these large cavities were stabilized with new brickwork in field season 6, and the two sides of the new construction were anchored together with geogrid that extended through the holes (see Figures 242-245).

An urgent-priority through-wall crack in the central portion of the east main enclosure wall was stabilized and reinforced with new brickwork and geogrid during field season 5, and a second, related crack was opened and mended at this location in the following season (Figures 246-250). In association with these crack repairs, a large-scale mudbrick capping operation was implemented along the top of the east main enclosure wall in field season 5 and carried into field season 6 (see Figures 247 and 250). Finally, during work on the northern end of the east main enclosure wall in field season 6, a large section of delaminated, original wall plaster was successfully reattached to its original location in the north interior gateway chamber (Figures 251-254; see also Figures 185-189 and 201-203, above).

Figure 229. Scaffolding was erected against the northern, interior face of the west main enclosure wall to allow full access to the wall surface during stabilization of the many holes and voids throughout the masonry. (Photo: Robert Fletcher 2004-2005)

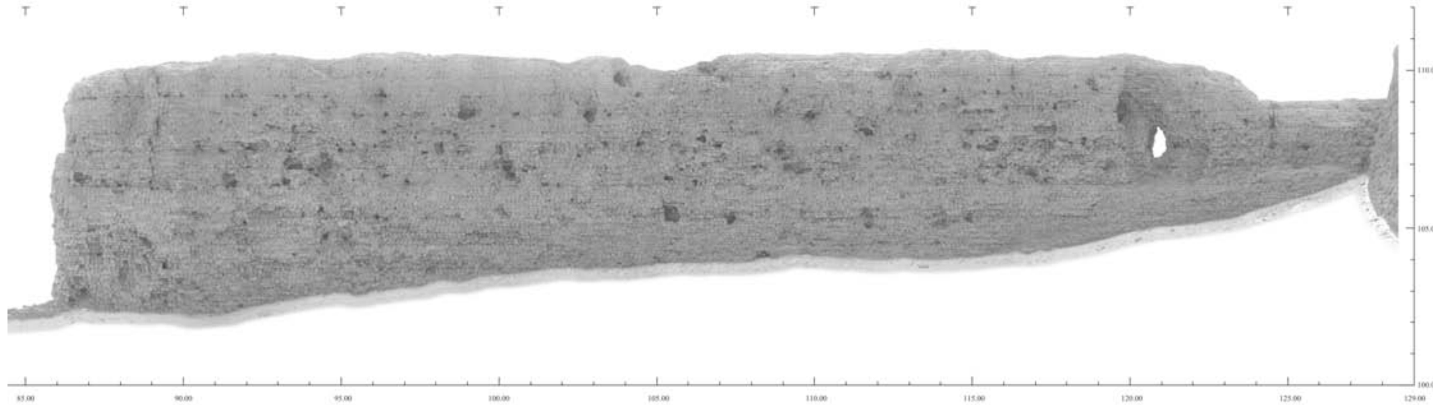


Figure 230. Rectified photoelevation of the northern, interior face of the west main enclosure wall prior to conservation work; note the through-wall hole system at far right. (Photoelevation: Heritage 3D, Inc. 2001)

Figure 231. The northern, interior face of the west main enclosure wall following stabilization of the numerous holes and voids throughout the masonry. (Photo: Robert Fletcher 2004-2005)

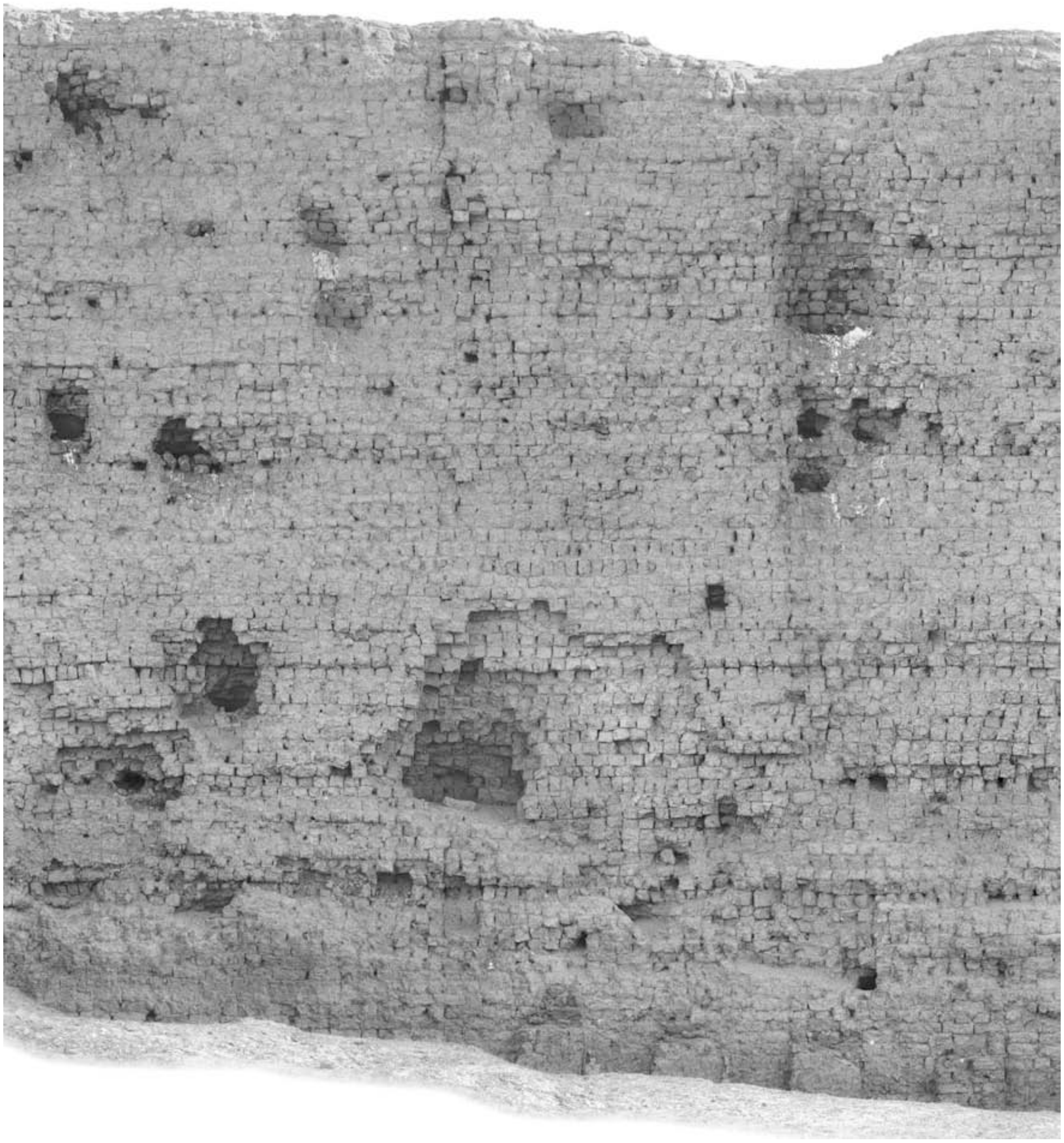
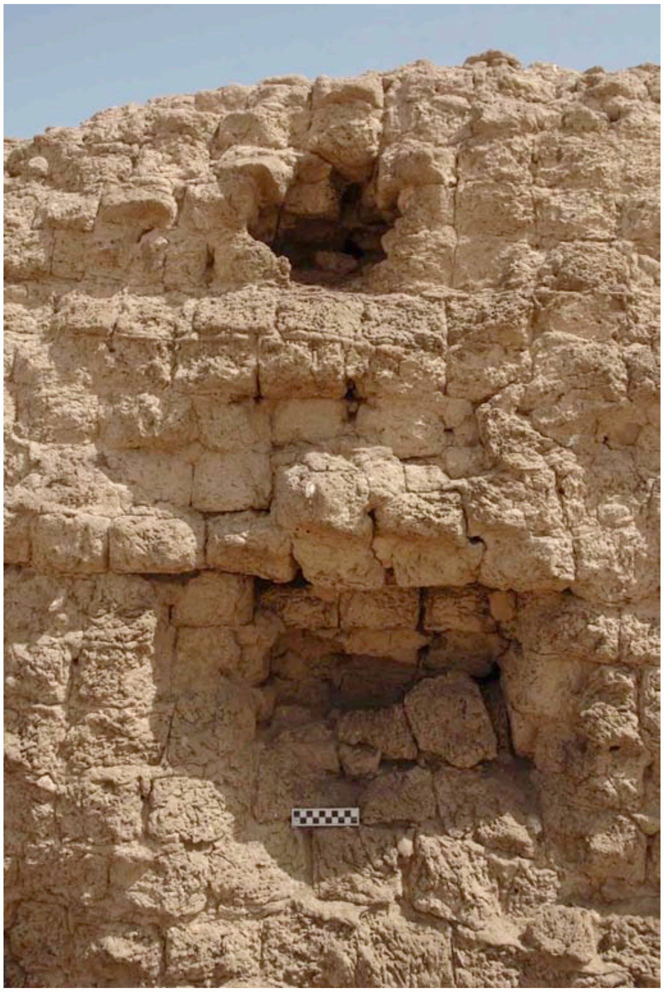
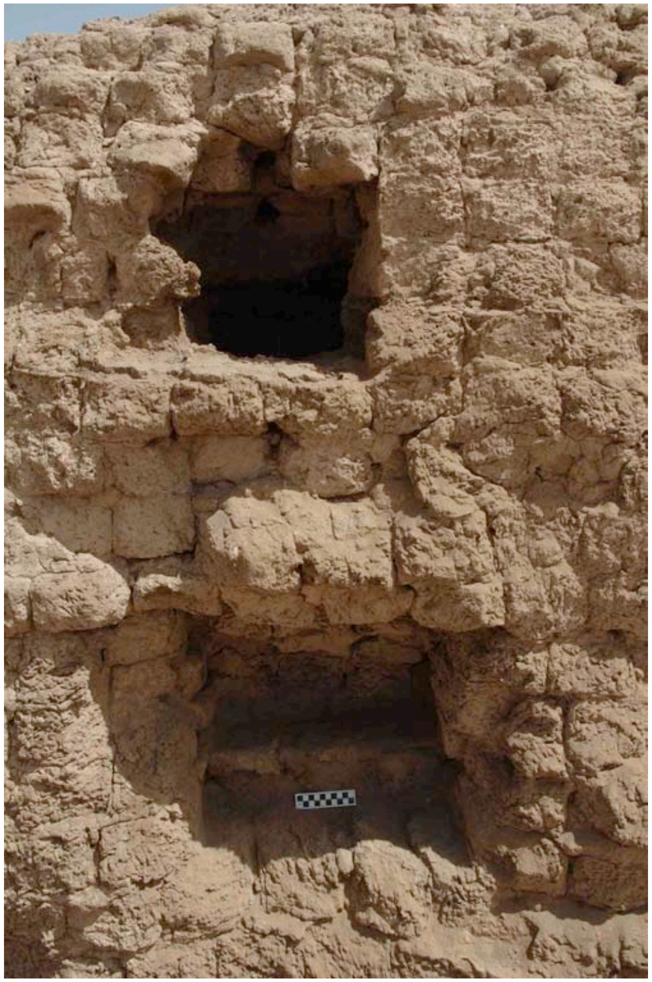


Figure 232. Detail of the typical distribution of small to medium-sized holes resulting from hornet activity in the exterior face of the west main enclosure wall, prior to stabilization. (Photoelevation: Heritage 3D, Inc. 2001)



Figures 233, 234, 235. Details of two small holes in the upper, exterior face of the west main enclosure wall prior to stabilization (top) and during cleaning and repair (bottom, left and right); note that the actual extent of hornet-nest excavation into the wall is greater than the full extension of a man’s arm (bottom right). (Photos: Jason Goodman 2005-2006)



Figures 236, 237. Details of the two small holes pictured in Figure 233, above, after cleaning (left) and with stabilization work complete (right); the work at this location illustrates the basic method of small to medium-sized hole repair undertaken on the north, west and east main enclosure walls in field seasons 5-7. (Photos: Jason Goodman 2005-2006)

Figure 238. Detail of the same section of the west main enclosure wall pictured in Figure 232, above, following stabilization of the holes and voids in the masonry. (Photo: Jason Goodman 2005-2006)

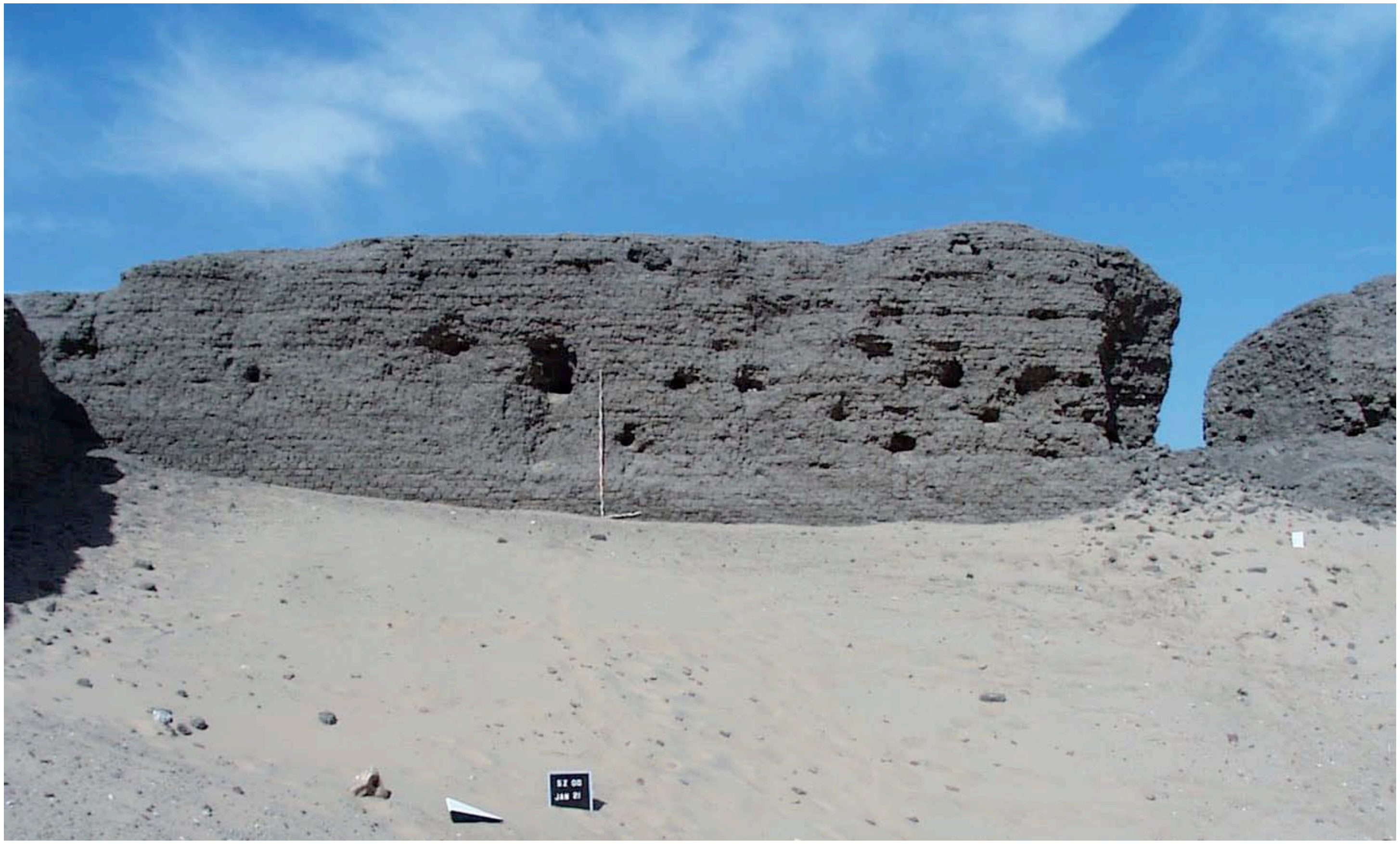
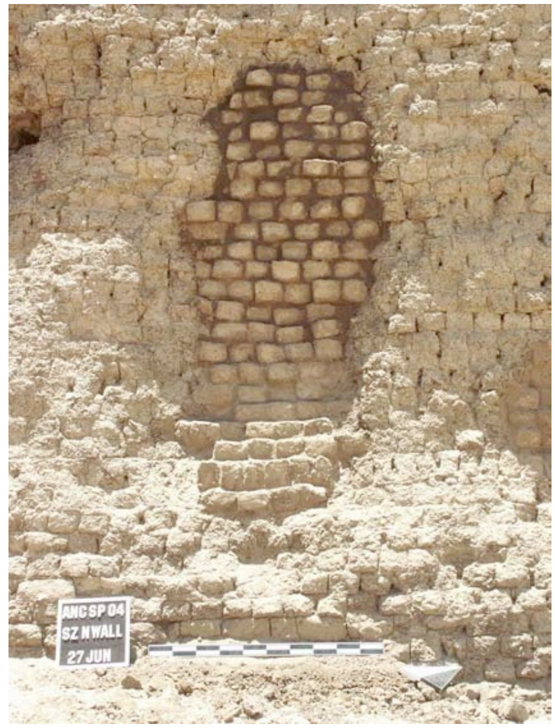


Figure 239. The western, interior face of the north main enclosure wall prior to architectural stabilization. (Photo: Richard Barnes 2000)



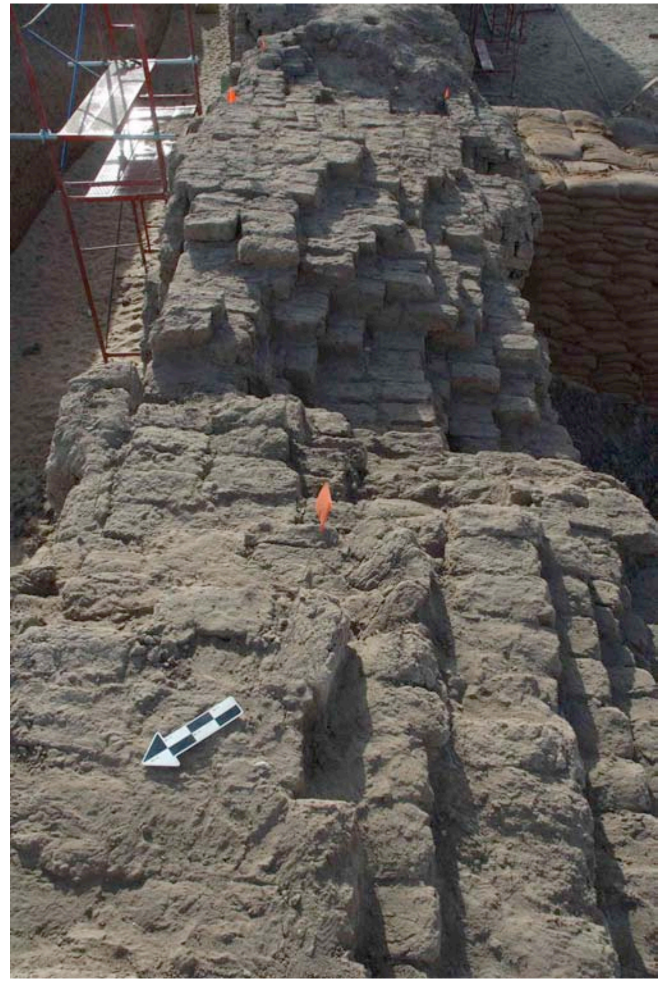
Figures 240, 241. Details of the largest hole on the interior face of the north main enclosure wall (pictured at center in Figure 239, above), during and after stabilization; loose and decayed bricks were removed below the hole (left) to allow the construction of a stepped base for additional masonry to be added above (right). (Photos: Matthew Adams 2004)

Figure 242. Interior detail of the through-wall hole system pictured in Figure 230, above, prior to stabilization. (Photo: Robert Fletcher 2004-2005)

Figures 243, 244. Details of stabilization work in progress on the through-wall cavities in the upper part of the west main enclosure wall; the brick infilling on the interior and exterior sides of the wall (top) were structurally connected with geogrid during stabilization (bottom). (Photos: Robert Fletcher 2004-2005)

Figure 245. Exterior detail of the west main enclosure wall following stabilization of the through-wall hole system pictured in Figure 230, above; the concave profiles of new masonry visible at left and right are the result of additional architectural stabilization in this area (see below). (Photo: Robert Fletcher 2004-2005)

Figures 246, 247. Details of stabilization work in progress on the top, central portion of the east main enclosure wall; note the structural crack prior to repair (top, lower left) and following stabilization (bottom), which included mudbrick capping of the adjacent area. (Photos: Matthew Adams 2004)



Figures 248, 249. Details of stabilization work in progress on the top, central portion of the east main enclosure wall; the flagged area in the background (left and right) represents the structural crack that was stitched and capped in field season 5 (pictured in Figures 246 and 247, above) and the eroded area in the foreground represents the top of another deep structural crack in preparation for repair. (Photos: Robert Fletcher 2004-2005)

Figure 250. Detail of the area pictured in Figures 248 and 249, above, following crack repair and mudbrick capping; once the new masonry was in place, mudbrick crumble was spread over the wall top to blend the repaired section with the original, eroded wall top. (Photo: Robert Fletcher 2004-2005)

Figure 251. Detail of detached plaster in the north interior gateway chamber prior to removal and stabilization. (Photo: Robert Fletcher 2004-2005)

Figure 252. Detail of geogrid reinforcement cut to size and set into fresh mud on the back of the detached plaster fragment pictured in Figure 251, above. (Photo: Robert Fletcher 2004-2005)

Figure 253. Repositioning the stabilized plaster into its original position in the north interior gateway chamber, pictured in Figure 251, above. (Photo: Robert Fletcher 2004-2005)

Figure 254. Detail of the wall base in the north interior gateway chamber with plaster stabilization and reattachment complete; the cracks around and between the individual plaster fragments were filled with mud mortar. (Photos: Robert Fletcher 2004-2005)

Conservation Implementation: West Gateway

While general methods of local rebuilding have been used to stabilize many areas throughout the enclosure affected by undermining, cracking and masonry losses, the complex structural conditions associated with both gateway failure and monastic cell construction warrant particular consideration. Vertical wall ends and major structural cracks associated with the collapsed gateways require stabilization, but given the spatial relationship of the wall ends to the original gateways, in most instances it is not possible to provide the necessary structural support without spanning the gateway openings. Although the project's basic conservation approach is to avoid reconstruction of the monument to its Second Dynasty appearance, neither is it desirable to obscure the presence of the gateways and their fundamental significance as defining architectural features of the original structure.

At its most basic level, the enclosure of Khasekhemwy, like the enclosures of his predecessors at Abydos, was constructed to create an interior ritual space that was defined by the walls as both visually and physically separated from the outside. The archaeology of these enclosures indicates that this space was the setting for ceremonial associated with the cult of the king. Prior to the collapse of the masonry surrounding the four gateways of the Shuneh, there would have been very limited visibility into the interior from outside (and vice versa). Originally, lines of sight through the gateway openings may have been blocked by wooden doors. The sense of the total boundedness of the interior space and of its complete physical separation from what lay outside was lost when large voids were created in the walls, as the gateways progressively collapsed.

The solution adopted by the project for treatment of these important features attempts to strike a balance between the minimum requirements of structural stabilization and the aesthetic considerations of the presence and original configuration of the gateways, through *partial* reconstruction. Such treatment involves reconstruction of the original lines of the gateway opening itself, as well as the immediately adjacent niches and pilasters. The gateway opening is spanned with a lintel and supporting members of reinforced concrete that are shaped, colored and textured to evoke the wood that would have been used originally (actual wood was not considered due to the risk of destruction by termites and vandals). The reconstructed design elements are reduced with distance from the gateway proper and gradually blend into the type of textured surface that reflects the eroded character of the surrounding original masonry, which characterizes most of the new masonry involved in gateway stabilization. This approach has been successfully implemented for the west gateway area of the main enclosure, illustrated in Figures 255 through 275. A similar approach is projected for the comprehensive stabilization of the north, east and south gateways as the conservation work continues in future seasons.

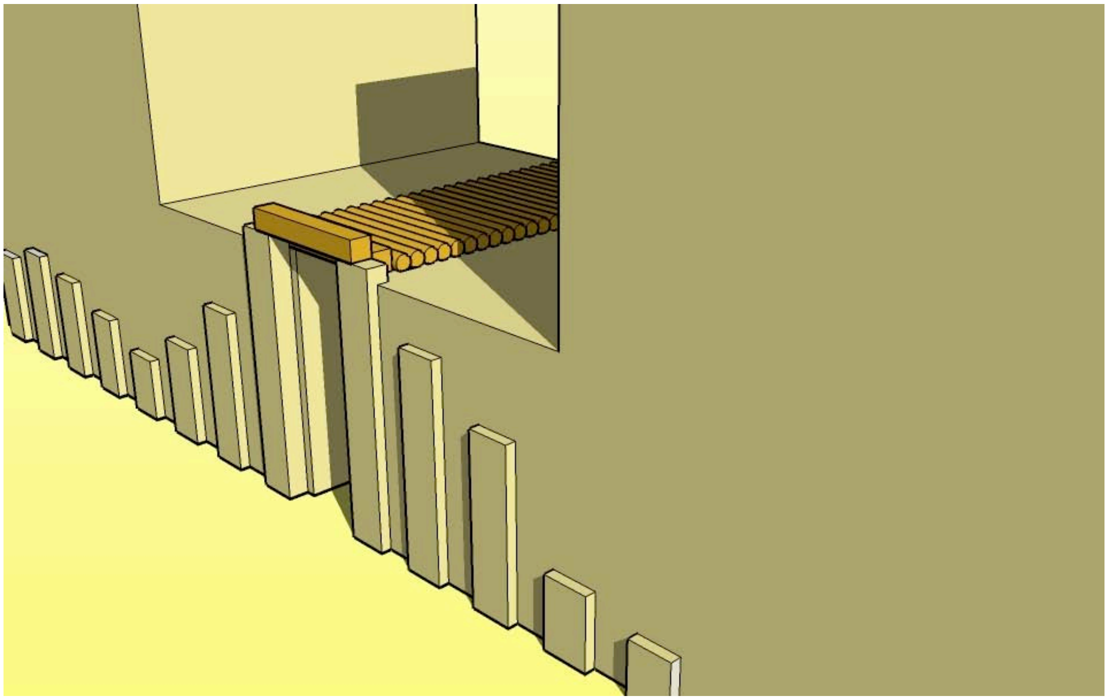
Stabilization of the west gateway began in field season 6 (2004-2005) and continued in field season 7 (2005-2006). As documented in early field seasons, the condition of the west gateway was extremely unstable. Inherent structural weakness and the loss of its original, presumably wooden, lintels had led to the collapse of the masonry above the gateway opening, which probably initiated the gradual cascading losses of additional original fabric over time. The construction of monastic cells in both sides of the gateway introduced significant new structural weakness to each side of the opening and contributed to the large-scale losses that characterize this area. The instability of the unsupported vertical wall ends is greatly increased by the presence of major structural cracks that extend completely through the thickness of the wall behind each end and penetrate nearly the full, vertical height of the existing wall (see Figures 153-157, above). Archaeological excavation and complete architectural documentation of both the remains of the monastic cells and the existing condition of original gateway elements was completed in field season 6 in advance of the conservation work. The design and building specifications for gateway reconstruction were developed through collaboration between the project's directors and architectural consultants (see Figures 256 and 257). After consideration of the gateway's existing dimensions (approximately two royal cubits, or 104cm, in width), as well as the gateway design of the Netjer-khet complex at Saqqara (which represents the next major royal construction in Egypt, separated in time from Khasekhemwy's enclosure by perhaps only 20 years), and architectural representations in Early Dynastic and Old Kingdom iconography, the original dimensions of the west gateway were estimated to have been 6 royal cubits high and 2 royal cubits wide, for a height to width ratio of 3: 1.

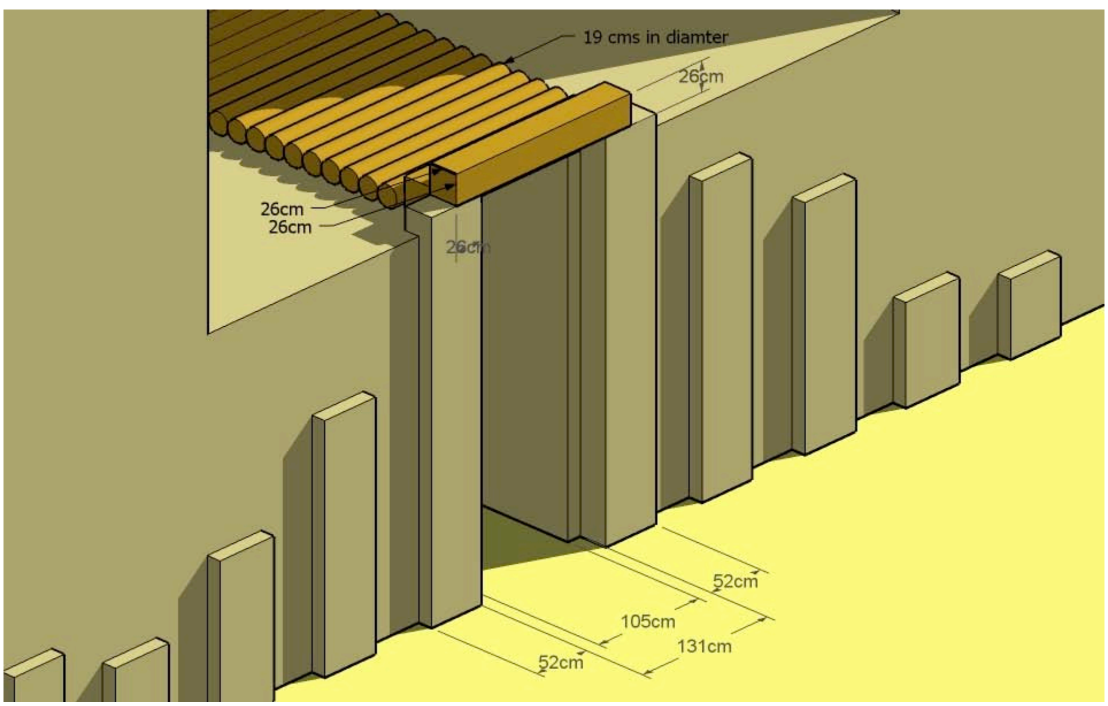
The stabilization of the west gateway has been undertaken in stages. The masonry comprising the side walls of the gateway opening, as well as the design elements of the façade that defined the opening (i.e., the niches and pilasters), were reconstructed during field season 6 (see Figures 258-265). This work included the protective treatment of all preserved features of the adjacent monastic cells (see also below). The initial stages incorporated full reconstruction of the two pilasters immediately flanking the entrance, which were built up from their preserved, original bases to the estimated height of the opening. The adjacent pilasters were reconstructed to a much lower level, capped by only a few courses of new masonry. Pilaster reconstruction was designed to create a transition in texture from the orthogonal lines of the reconstructed gateway opening to the rough eroded masonry of the adjacent original wall fabric.

Preparatory to spanning the gateway opening in field season 7, a series of architectural mock-ups were constructed in wood and dry-laid bricks, in order to evaluate the proposed design and proportions of the spanned opening. In addition, a series of color test panels were fabricated to aid in the selection of the most appropriate color for the reinforced concrete elements used in the gateway reconstruction (see Figure 266). The opening was spanned with two types of reinforced concrete members (see Figures 267-270). At each end of the gateway opening, a rectangular lintel cast in a wooden mold was set with its outer, vertical face in line with the plane of the reconstructed pilasters adjacent to the gateway opening. These rectangular lintels approximate the wooden lintels that would almost certainly have been used in the original construction. The remainder, i.e., interior, of the gateway was roofed with pole-shaped members designed to evoke the wooden poles most likely used in original construction. These pole-shaped members are inspired by the representation of a wooden pole roof in the gateway ceiling of the Netjer-khet complex at Saqqara (see Figures 271 and 272). They were cast in lengths of heavy plastic pipe and once the pipe was removed, they were textured using a mild acid wash to reduce the smoothness created by the interior surface of the pipe. The rectangular lintels were cast atop the new construction, but the pole elements were cast nearby and manually raised into position. Once the roofing of the gateway was completed, construction continued above the opening (see Figures 273 and 274). Geogrid was used to provide horizontal reinforcement to the masonry above the gateway opening. During field season 7, the new masonry reached a height of approximately one meter above the roof of the gateway, significantly below the projected top of the finished repair (see Figure 275). In a future season, the new masonry above the gateway will come within 1-2m of the existing wall tops on either side. This masonry will provide necessary structural support for the upper parts of the adjacent, vertical wall ends and will eliminate the risk of further significant losses in the gateway area. A gently sloping "dip" in the projected profile of the wall top will make a visual reference to the collapse of this part of the original wall.

Although it is not the project's intention to recreate or reinterpret the original monument, the effect of the partial reconstruction of the west gateway on the potential perception of the monument should be noted. By closing the wide gap in the west wall around the gateway, thus blocking the line of sight between the interior and the exterior of the monument on this side, something of the original boundedness of the interior space has been reestablished. This conveys a greater sense of the separation of that space, and that it should be seen as "other" or distinct from what is outside. In addition, by reconstructing the orthogonal gateway opening and its defining features, something of the original formality of the monument is recaptured. Observing the eroded wall masses today, it is very difficult for non-specialists to gain much sense of the highly formal, original character of the structure. In the quite limited area of the partial reconstruction of the west gateway, this formality of design is suggested and a recognizable human element is introduced into the perception of the monument, which may not be otherwise evident in its eroded character. While these considerations are not the primary reasons for gateway conservation, they have informed aesthetic and design choices and should be explicitly acknowledged in discussing the effects of the conservation program.

Figure 255. Exterior detail of the west gateway area prior to excavation or conservation work. (Photo: Robert Fletcher 2001)





Figures 256, 257. Rendered elements and dimensions of the partial reconstruction of the west gateway. (Graphics: William Remsen 2004-2005)

Figure 258. The first stage in comprehensive stabilization of the west gateway area included the installation of new masonry around the edges of the two sides of the gateway opening. (Photo: Robert Fletcher 2004-2005)

Figure 259. Stabilization work in progress on the west gateway. (Photo: Robert Fletcher 2004-2005)

Figure 260. Detail of the base on the northern side of the west gateway opening, prior to stabilization. (Photo: Anthony Crosby 2004-2005)

Figure 261. Detail of the northern side of the west gateway during stabilization; the original walls and floor of the monastic cell at this location were covered by clean, compact sand during architectural stabilization. (Photo: Robert Fletcher 2004-2005)

Figures 262, 263. Condition of the vertical wall end on the northern side of the west gateway prior to conservation (left) and following partial reconstruction (right). (Photos: Anthony Crosby 2000, 2005)

Figure 264. The overall effect of initial gateway stabilization in the west main enclosure wall following the first phase of reconstruction. (Photo: Anthony Crosby 2005)

Figure 265. The partially reconstructed west gateway area at the close of field season 6. (Photo: Robert Fletcher 2004-2005)

Figure 266. Testing to match the color of reinforced concrete, for use in partial gateway reconstruction, to the surrounding, original brickwork. (Photo: Robert Fletcher 2005-2006)

Figure 267. Wooden forms constructed for the roof lintels on the interior and exterior sides of the west gateway. (Photo: Anthony Crosby 2005)

Figures 268, 269. Spanning the west gateway with reinforced-concrete poles, which were first cast in segments of heavy plastic pipe until fully set and then raised manually, maneuvered into place above the gateway opening and set into mud mortar; geogrid was placed under the poles on each side of the opening to provide a secure base for the mortar, which was also used to seal the seams between poles. (Photos: Jason Goodman 2005-2006)

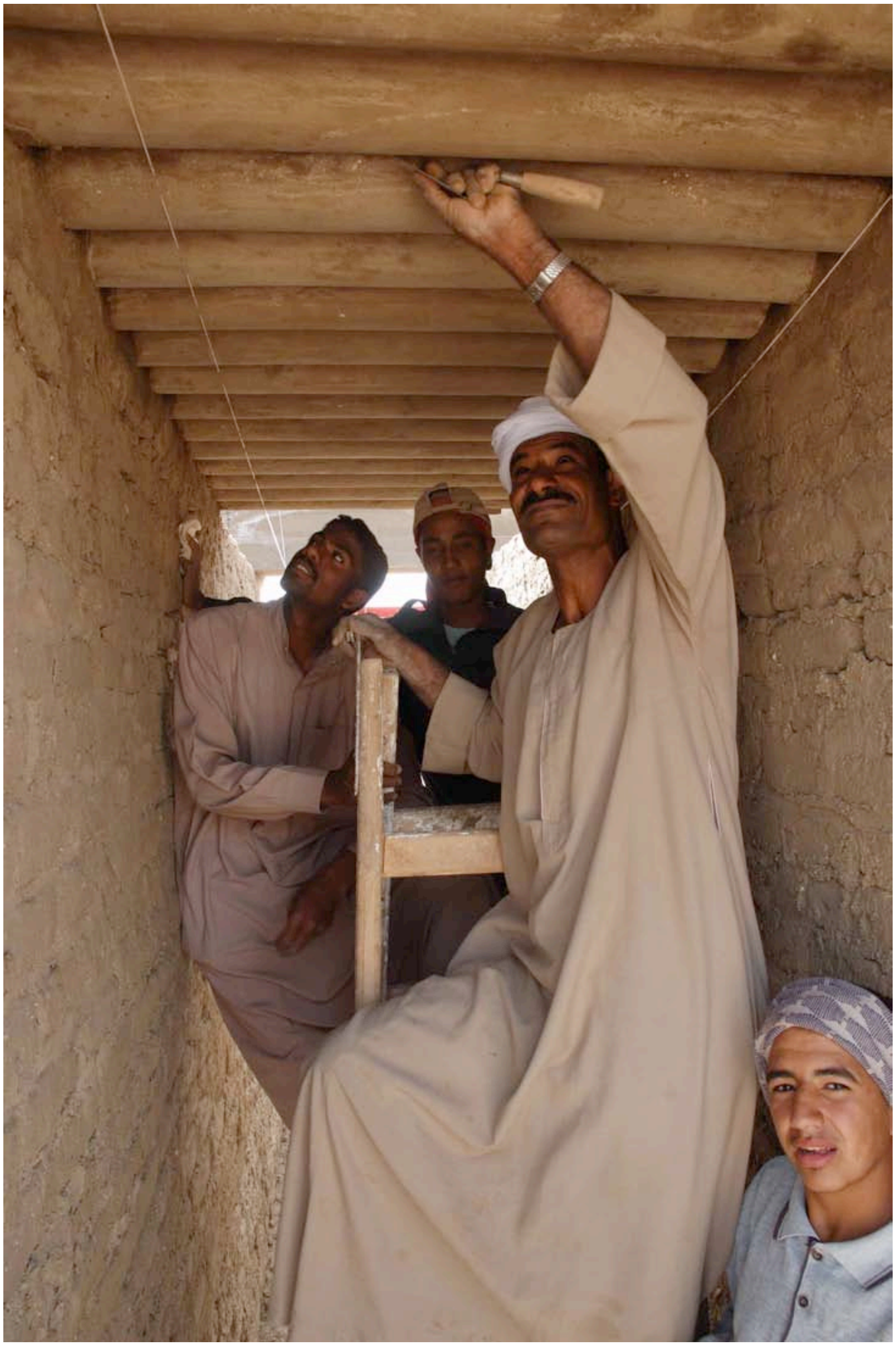


Figure 270. Pointing the underside of each seam in the roof of the west gateway during partial reconstruction. (Photo: Jason Goodman 2005-2006)

Figures 271, 272. Elevation and detail of the reconstructed gateway and stone roofing beams at the Netjer-khet complex in Saqqara (left and right, respectively). (Photos: Anthony Crosby)

Figure 273. Stabilization in progress above the fully roofed west gateway opening, with geogrid installed for horizontal reinforcement. (Photo: Jason Goodman 2005-2006)

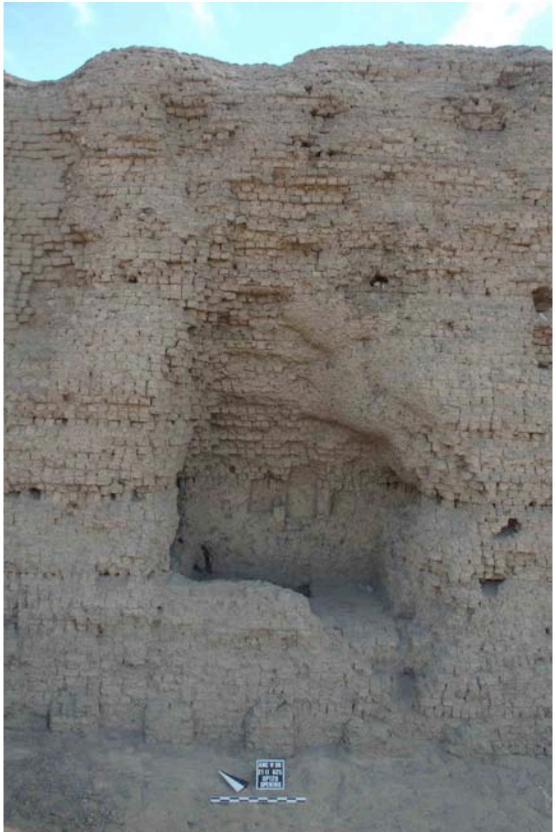
Figure 274. The top of the new construction above the west gateway opening at the close of field season 7. (Photo: Jason Goodman 2005-2006)

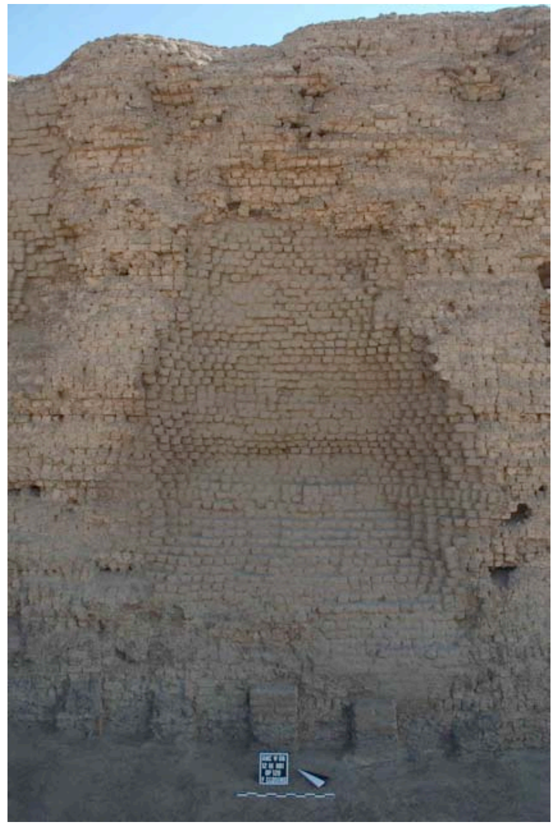
Figure 275. Exterior detail of the west gateway area following initial stabilization and partial reconstruction, pictured at the close of field season 7. (Photo: Jason Goodman 2005-2006)

Conservation Implementation: Monastic Cell Cavities

Much like the original gateways, the remnants of the late antique occupation of the monument represent both important aspects of the monument's history and significant threats to its structural stability. The component of late antique activity that most directly affects the condition of the monument is represented by the rooms, or cells, that were excavated into the masonry of the walls. In some cases, the upper parts of these cells have collapsed completely, as in the west gateway and in the east and south main enclosure walls (see Operations 102 and 136, below), leaving nothing in position of the masonry that once existed above them. In other cases, as in the exterior face of the west main enclosure wall and the interior side of the east wall, the wall above the cell voids has partly collapsed, creating a corbel in the remaining masonry. The stabilization of collapsed cells is represented by the work at the west gateway (discussed above) and in the lower, central portion of the east main enclosure wall (described as Operation 102, below), as well as in the major area affected by cell voids on the exterior side of the west main enclosure wall (described as Operations 100 and 101, below).

The voids in the west wall created by the creation and subsequent collapse of two monastic cells in the northern area represent the greatest threats to the general stability of this wall. The original fabric of the wall above and adjacent to these voids was in danger of collapse and required structural support. The most practical means of providing this support in keeping with the project's basic conservation approach is to replace the missing masonry from the voids, thereby providing support for the original wall fabric that is at risk and reestablishing the local stability of affected areas. This treatment involves the installation of new brickwork in the cell voids, which is built up to support the surrounding original fabric above and adjacent to the cavities (Figures 276 and 277). Although reconstruction of the missing masonry in these areas does not destroy the remains of the cells, and the interventions are ultimately reversible, the new masonry does obscure the cells indefinitely. As such, all monastic features that are to be altered by conservation work are systematically documented as part of the monument's archaeological record, which includes photography and detailed architectural illustration in plan, elevation and section. In this way, although the features themselves become inaccessible, their archaeological and architectural detail is captured and preserved. In addition, significant features of the cells, such as plastered surfaces, receive conservation treatment as needed, and all original features are covered prior to new construction by a protective layer of clean, sieved sand (approximately 5cm thick) that separates them from the new, infilled masonry. As the level of new construction rises in a cell, the new masonry is held back approximately 5cm from preserved vertical surfaces and other original features, and clean sand is deposited between these features and the new brick masonry (Figures 278-283). The finished exterior surface of the new brick infilling is held back from the existing wall face and is constructed with a slightly concave profile to create a visual reference to the presence of the cells and to thus preserve the significance of their phase in the history of the monument (see Figure 277).





Figures 276, 277. Details of a monastic cell cavity on the exterior face of the west main enclosure wall before and after intervention (left and right, respectively), illustrating the general method of cell-void stabilization. (Photos: Jason Goodman 2005-2006)

Figure 278. Preliminary stabilization of the wall base adjacent to a monastic cell in the west gateway. (Photo: Anthony Crosby 2005)

Figures 279, 280. Adding a layer of clean sand to protect the plastered floor and walls of the monastic cell pictured in Figure 278, above, prior to installing new masonry. (Photos: Anthony Crosby 2005)

Figure 281. Detail of partially infilled masonry above the protected floor of a monastic cell cavity in the west main enclosure wall. (Photo: Robert Fletcher 2005-2006)

Figure 282. Detail of the typical 5cm gap left between new brick infilling and preserved cell walls. (Photo: Jason Goodman 2005-2006)

Figure 283. Adding clean sand to the protective gap left between the brick infilling and the original wall plaster of a monastic cell. (Photo: Anthony Crosby)

Stabilization of the cell voids in the exterior side of the west main enclosure wall began in field season 5 (spring 2004), and by the end of field season 7 (2005-2006), work in all six of the cell voids on this side of the wall had been completed. Stabilization of the northernmost cell void on the west wall, excavated as Operation 100, began in field season 5 (Figures 284-287). The first stage of this operation was to fill a deep pit that had been dug (probably in the mid-19th Century during Mariette's work at the site) through the floor of the cell and the original masonry of the wall to a depth of more than 1.5m below the base of the wall into the underlying sand deposits. Following excavation and documentation of the hole (see Archaeological Investigation of the Monument, to follow), three new mud bricks (stamped "PYIFA") were placed at the bottom of the pit, which was then filled with compacted sand. The purpose of the sand bed was to re-establish support for the wall base, which had been significantly undercut by the pitting, and to provide a stable base for new masonry that would fill both the hole and the cell void above. At the close of field season 5, the infilling of the hole had been completed and new masonry was built up approximately 1m in the cell void (see Figure 287). As work continued in field season 6 (2004-2005), the remainder of the cell void was filled with new masonry and the stabilization of this cell was completed (Figures 288 and 289).

Immediately south of Operation 100, a second cell void, excavated as Operation 101, was stabilized during field season 6 (Figures 290 and 291; see also Figure 284). The finished condition of both Operations 100 and 101 illustrate the general method and outcome of cell-void treatment at the monument. The new masonry filling the wall cavities supports the original wall fabric above and adjacent to the cells, thus re-establishing structural stability in the surrounding areas, but is slightly recessed to create a concave profile (see Figures 289 and 291). This profile is a visual reference to the presence of the cell, as an important phase in the history of the monument.

Figure 284. The remains of two collapsed monastic cells in the northern, exterior face of the west main enclosure wall, prior to excavation or conservation work; these cell voids, which were excavated as Operations 100 and 101 (left and right, respectively), were stabilized during field seasons 5 and 6. (Photo: Robert Fletcher 2001)

Figure 285. Detail of the cell void excavated as Operation 100, during architectural stabilization; the first stage of stabilization was to fill the void at the bottom of the hole (below the wall base) with clean sand and to then fill the hole itself with new masonry. (Photo: Matthew Adams 2004)

Figure 286. Detail of the cell void excavated as Operation 100, during architectural stabilization; the pit cut through the cell floor has been filled in and stabilized. (Photo: Matthew Adams 2004)

Figure 287. The cell void excavated as Ooperation 100, during architectural stabilization; the cell void has been filled in with new masonry to an approximate height of 1m. (Photo: Matthew Adams 2004)

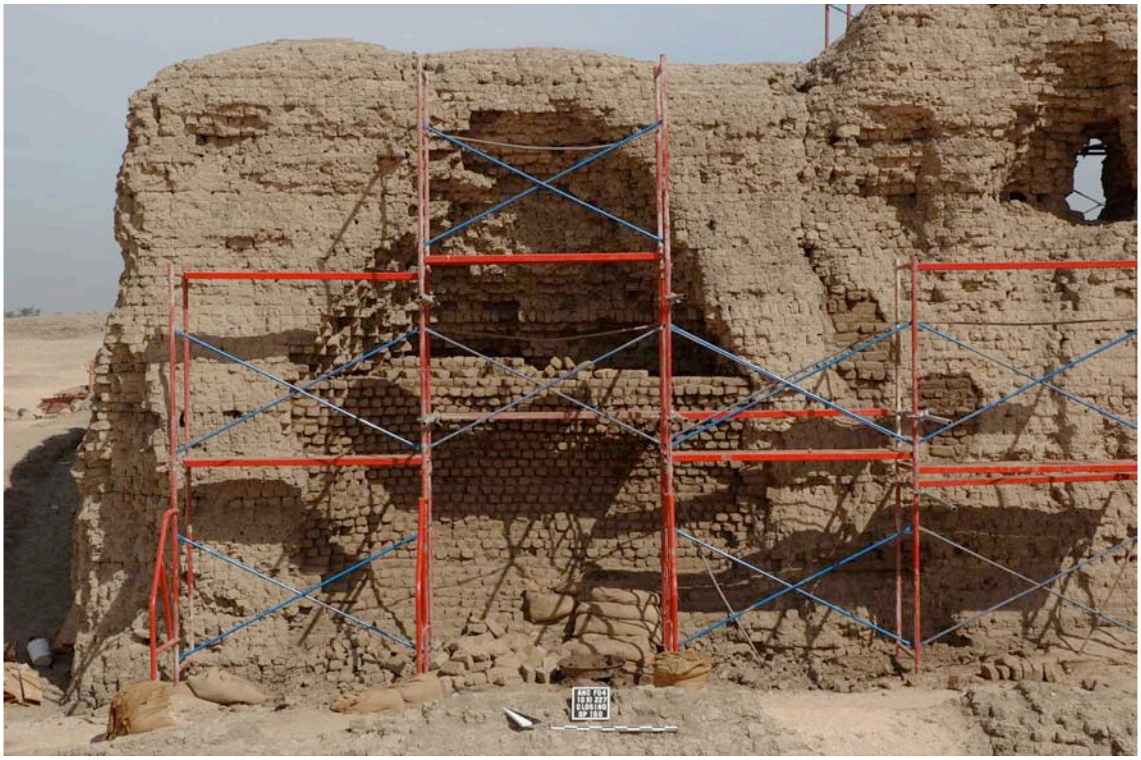


Figure 288. Continued stabilization of the northernmost cell void on the west main enclosure wall in field season 6. (Photo: Robert Fletcher 2004-2005)

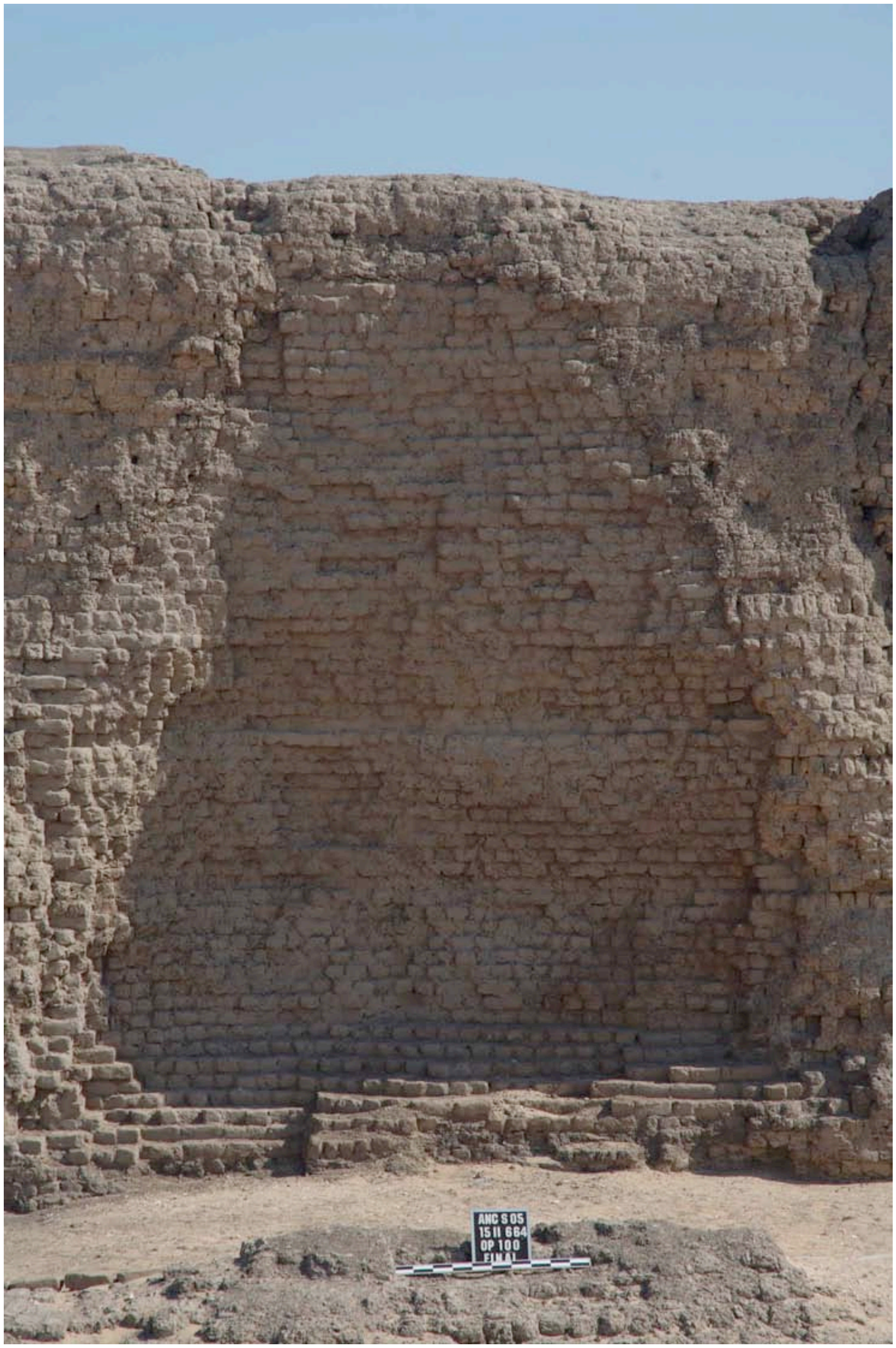


Figure 289. The cell void excavated as Operation 100, completely stabilized; note especially the concave profile of the reconstructed area, which creates a visual reference to the now-concealed monastic features. (Photo: Robert Fletcher 2004-2005)

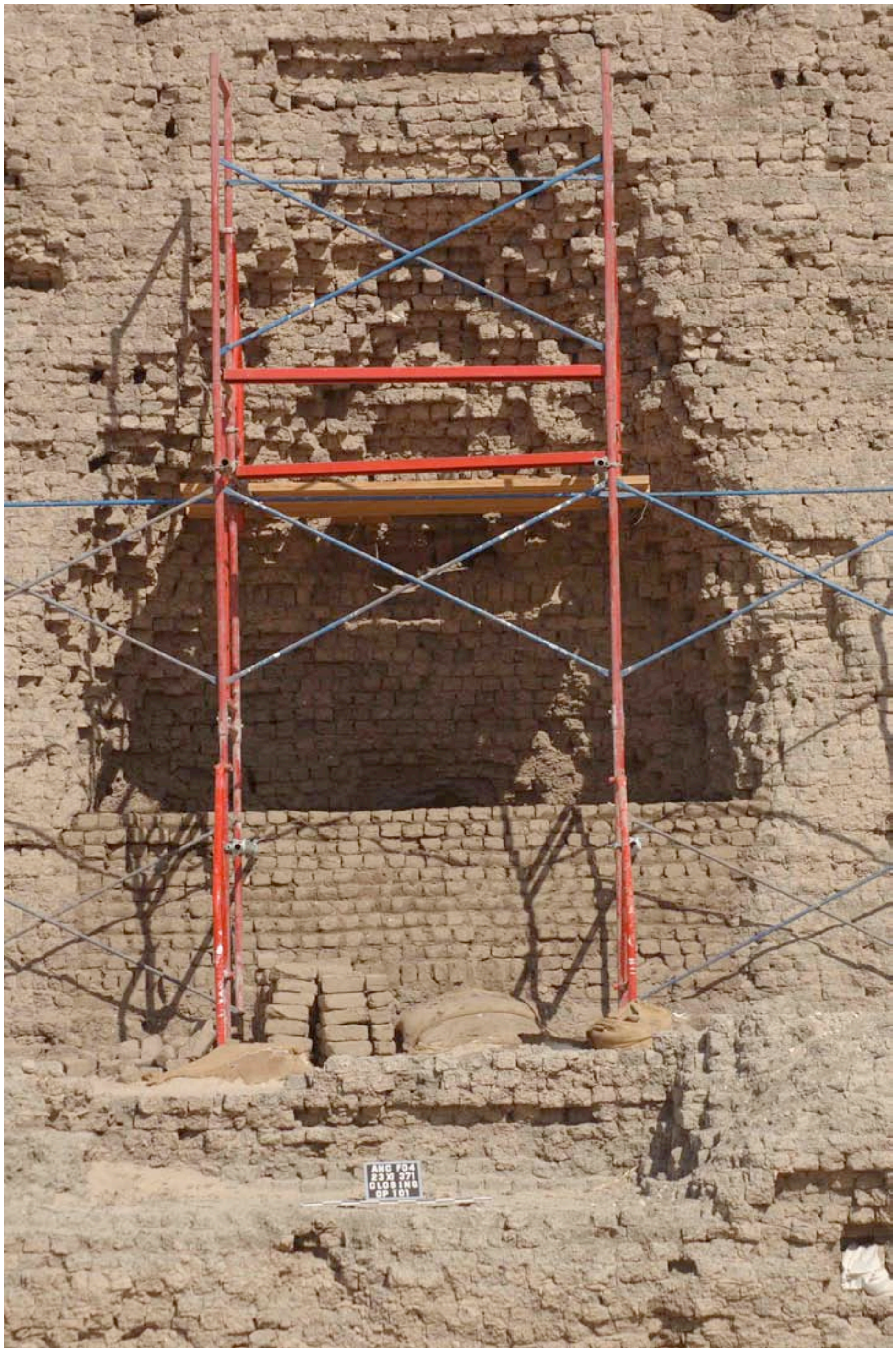


Figure 290. Stabilization work in progress on the cell void excavated as Operation 101 on the northern, exterior face of the west main enclosure wall. (Photo: Robert Fletcher 2004-2005)

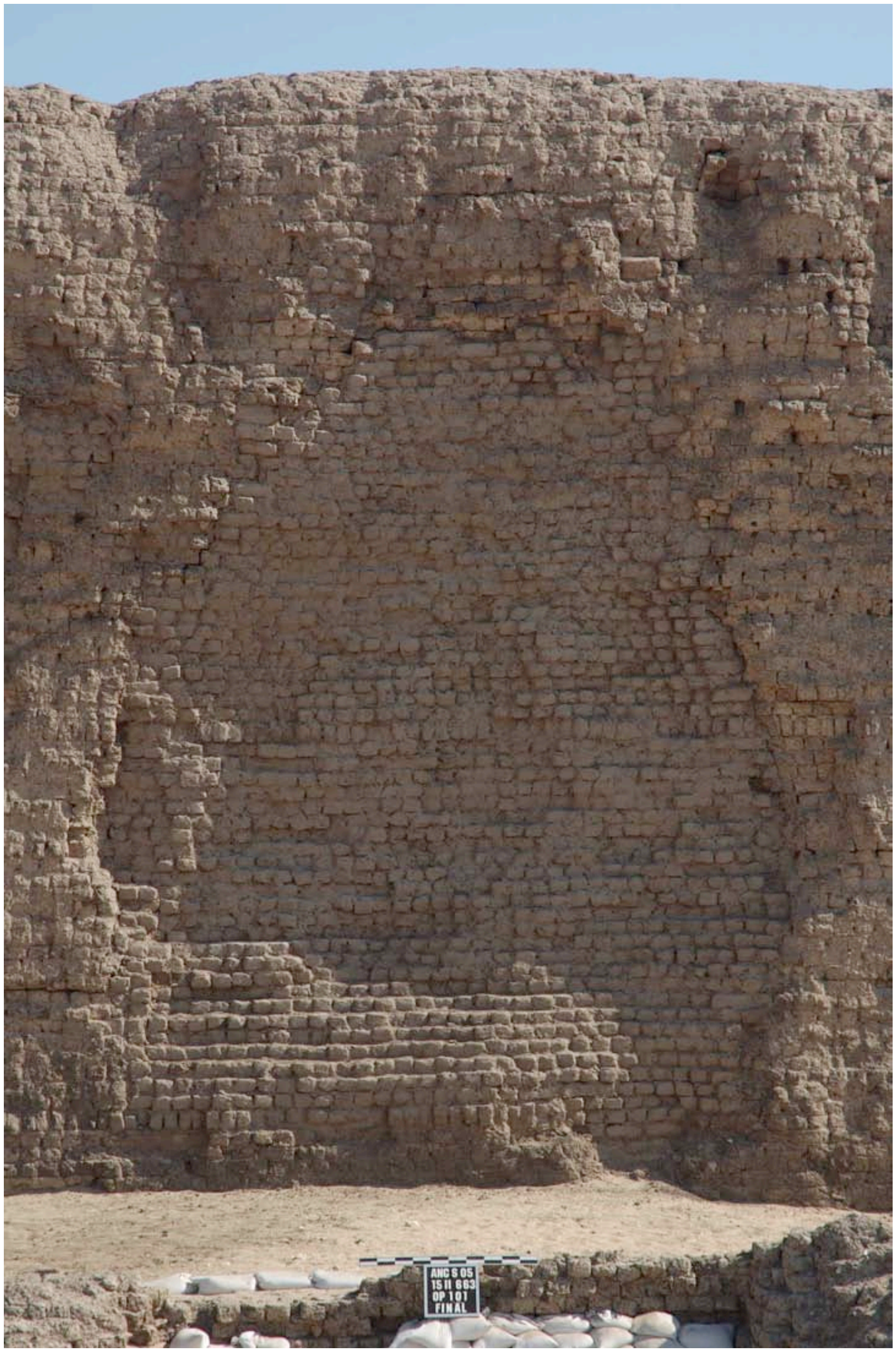


Figure 291. The cell void excavated as Operation 101, completely stabilized. (Photo: Robert Fletcher 2004-2005)

Four additional cell voids in the southern, exterior face of the west main enclosure wall, excavated as Operations 119, 120, 121 and 122, were stabilized during field season 7 (Figure 292). The cell void filled in Operation 119, located in the middle of the southern wall face, consisted of a main cell and smaller ancillary chamber (Figures 293 and 294). This cell was excavated in field season 6 and architecturally documented and stabilized in field season 7 (Figures 295-300). The stabilization work at this location began with filling a series of shallow pits in the floor of each chamber with new brickwork and covering all original surfaces with a protective barrier layer of clean, sieved sand. The sand was then wetted and compacted to provide a level base for the first course of new masonry. Both the main and side chambers were filled in with new mudbrick masonry. As the level of new construction was raised, it was set back 3-5cm from the original finish of preserved vertical surfaces and sand was added to this space to protect these features. Layers of geogrid provided horizontal reinforcement for the new masonry. As the level of new construction reached the upper part of the concavity, eroded bricks in the overhanging original masonry were removed and these spaces were used to key the new masonry with the original wall fabric. As with all such cell-void locations, the brick infilling was held back from the outer face of the wall to indicate the presence of late antique monastic features (see Figure 300).

The monastic cell excavated as Operation 120 was not as large as a number of others in the west wall, and the void it created in the wall was consequently relatively small (see Figure 292). The cell void was excavated in field season 6 and architecturally documented in field season 7 (see Archaeological Investigation of the Monument, to follow). The basic process of stabilization was the same as in other cell voids, including the use of a sand barrier to protect preserved original features and the use of geogrid for horizontal reinforcement in the new construction. In the course of infilling, a large and apparently inactive mud-wasp nest was removed from the upper part of the cell void to allow the new masonry to key with the original fabric of the wall (Figures 301 and 302). Loose and overhanging brickwork at the upper edge of the cell void was also removed, and a large hornet nest hole adjacent to the northern, top end of the void was filled. The before and after condition of this cell void is illustrated in Figures 276 and 277, above.

The cell voids excavated as Operations 121 and 122 represent two adjacent cells (see Figure 292). The more northern of these cells, Operation 121, was the substantially larger of the two. Both of these cells were excavated in field season 6 and documented in field season 7, prior to architectural stabilization. The plaster floors in both cells were covered with a protective barrier layer of sand, and a large pit that had been cut through the floor at the northern end of the cell chamber in Operation 121 was filled with new brick masonry (Figures 303-305). Unlike the pits in the cells at the northern ends of the east and west main enclosure walls, this pit did not penetrate through the base of the wall. The original masonry that was left to form a wall between the two cells at this location had collapsed long ago, and, as the infilling of both cells rose, the new masonry spanned the space between them (Figures 306 and 307). As in other operations, horizontal reinforcement was provided by layers of geogrid, which spanned between the two cells to securely anchor the new masonry of each cell together. The finished, fully stabilized cells at this location are illustrated in Figure 308.

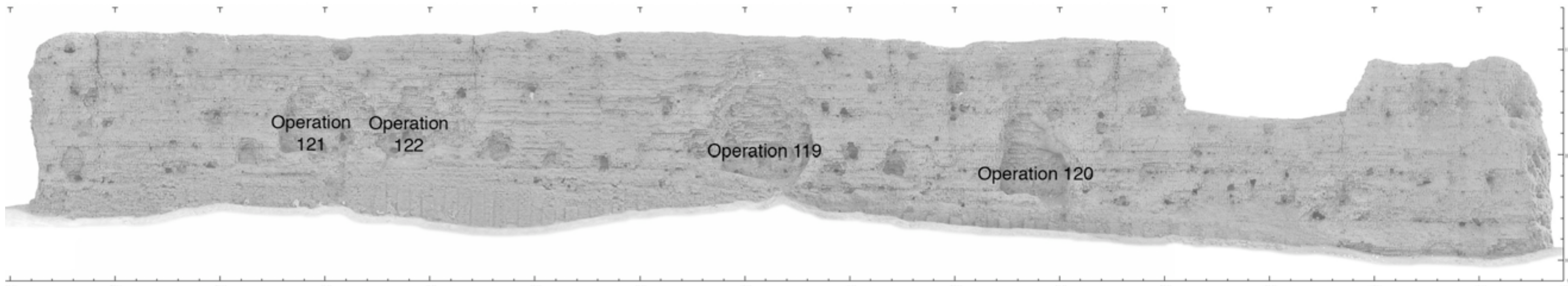


Figure 292. Rectified photoelevation of the exterior, southern face of the west main enclosure wall, indicating the locations of the cell voids excavated as Operations 119, 120, 121 and 122, all of which were architecturally documented and stabilized in field season 7 (see details below). (Photoelevation: Heritage 3D, Inc. 2001)

Figure 293. Detail of the cell void noted as Operation 119, prior to excavation or conservation work. (Photo: Robert Fletcher 2004-2005)

Figure 294. Interior detail of the main chamber (at left) and smaller ancillary chamber (at right) in the cell void excavated as Operation 119, prior to architectural stabilization; unlike the main chamber, the secondary chamber was finished in mud plaster only; the inward notch at the bottom of the frame represents the main entrance to the cell from the exterior side of the west main enclosure wall. (Composite photo: Robert Fletcher 2005-2006)

Figure 295. Detail of the cell void excavated as Operation 119, during stabilization; the holes in the floor of the main chamber have been filled with new mud bricks. (Photo: Robert Fletcher 2005-2006)

Figure 296. Detail of the cell void excavated as Operation 119, during stabilization; original surfaces have been covered by a protective barrier layer of finely sieved sand, which was then wetted and compacted prior to the installation of new masonry. (Photo: Robert Fletcher 2005-2006)

Figure 297. Detail of the cell void excavated as Operation 119, during stabilization; the first course of new mud brick has been laid and the protective space around the edges of the infilling has been filled with clean sand to aid in preserving the original surfaces and features of the cell. (Photo: Robert Fletcher 2005-2006)

Figure 298. Detail of the cell void excavated as Operation 119, during stabilization; layers of geogrid were placed between new masonry courses to provide horizontal reinforcement. (Photo: Robert Fletcher 2005-2006)

Figure 299. Detail of the cell void excavated as Operation 119, during stabilization; the depth of infilling was gradually reduced as the level of new construction reached the upper part of the wall cavity, and loose bricks in this area were removed to create spaces for toothing the new masonry to the existing fabric of the wall. (Photo: Jason Goodman 2005-2006)

Figure 300. Detail of the cell void excavated as Operation 119, completely stabilized; note again the concave profile of the new construction to provide a visual cue to the presence of the cell in the wall. (Photo: Jason Goodman 2005-2006)

Figure 301. Detail of the cell void excavated as Operation 120, during stabilization; as the level of infilling reached the upper part of the void, the large mud-wasp nest (seen at upper right) was removed. (Photo: Jason Goodman 2005-2006)

Figure 302. Detail of the cell void excavated as Operation 120, during stabilization; the gradual removal of the mud-wasp nest accretion (upper center) allowed the new brick masonry to key sufficiently with the surrounding, original wall fabric. (Photo: Jason Goodman 2005-2006)

Figure 303. Detail of the cell voids excavated as Operations 121 (left) and 122 (right), prior to conservation work; note the deep vertical crack to the upper right of Operation 122, which is structurally related to the cell voids. (Photo: Jason Goodman 2005-2006)

Figure 304, 305. Details of the cell void excavated as Operation 121, during stabilization; a large pit cut through the floor of this cell is being filled with new brick masonry (top) and a barrier layer of clean sand has been laid on the plaster floor to protect the preserved original features of the cell (top, at right, and bottom). (Photos: Jason Goodman 2005-2006)

Figure 306. Detail of the cell voids excavated as Operations 121 and 122, during stabilization; because the original masonry dividing these two cells had collapsed previously, the infilling of this area comprised a single construction. (Photo: Jason Goodman 2005-2006)

Figure 307. Detail of the cell voids excavated as Operations 121 and 122, during stabilization; layers of geogrid are being installed between new masonry courses to provide lateral reinforcement across the length of the new construction. (Photo: Jason Goodman 2005-2006)

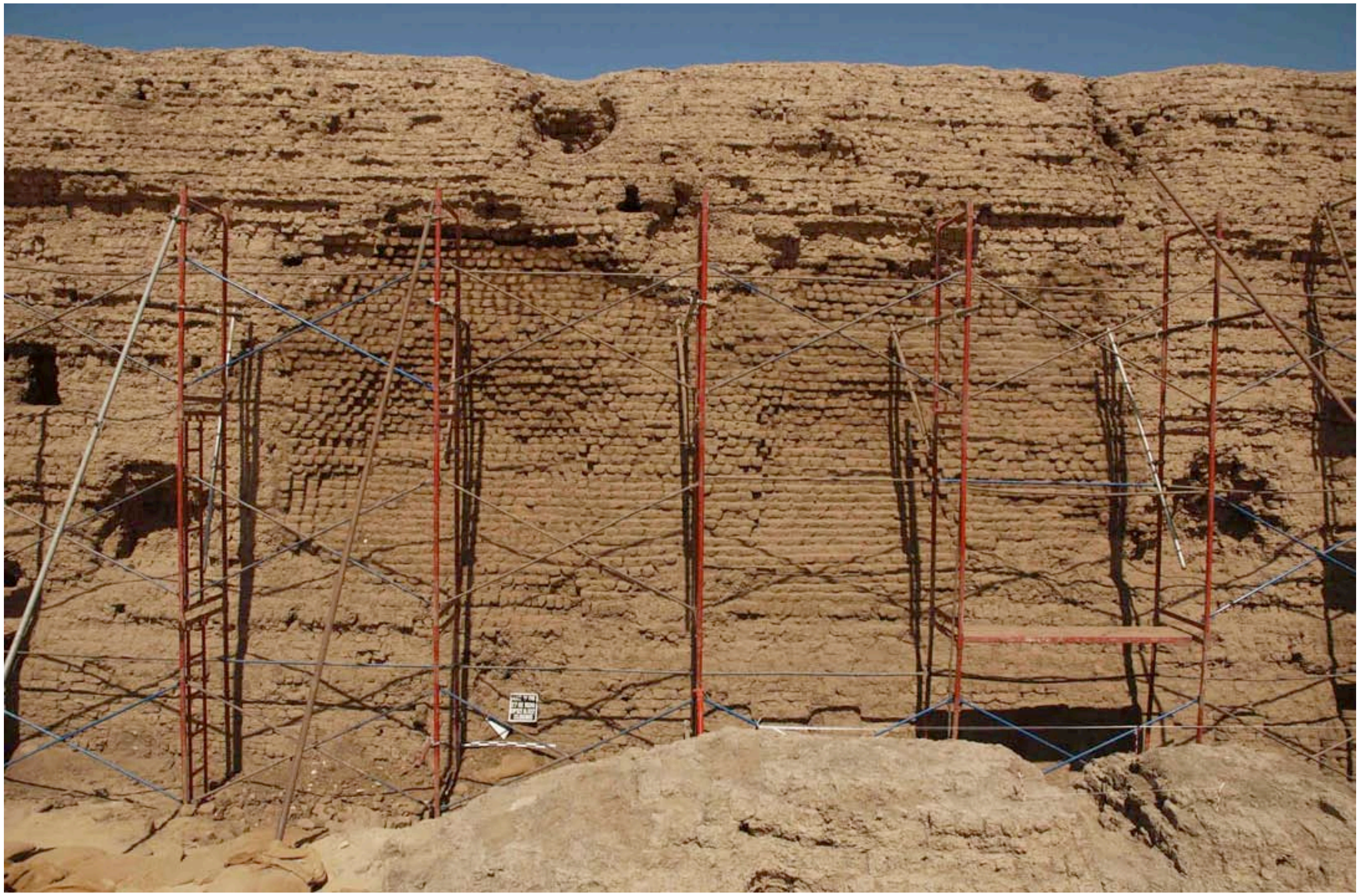


Figure 308. Detail of the cell voids excavated as Operations 121 and 122, completely stabilized. (Photo: Jason Goodman 2005-2006)

Another type of condition created by the collapse of a monastic cell is represented by a suite of features in the lower, central portion of the east main enclosure wall, adjacent to the tall northern pier (Figures 309 and 310). This area was excavated as Operation 102 in field season 6 (2004-2005), and architecturally documented and stabilized in field season 7 (2005-2006). The suite consisted of a white-plastered, main interior chamber, a small side chamber, and a mud-plastered forecourt. The main and side chambers were excavated into the wall from the interior side, and the forecourt was built up against the wall face. From a conservation standpoint, the set of conditions at this location were distinct from those in which the cell is represented by a void in a still-standing wall. Here, nothing remained of the original masonry that once stood above the cell. On the northern side of the cell is an unstable vertical wall end, affected by structural cracks and a large through-wall hole. The base of the wall in this area has been signficantly undermined by activities associated with the adjacent cell. On the east (exterior) side, the original fabric of the wall adjacent to the main cell chamber was also unstable, as the cell had penetrated almost completely through the wall, leaving less than one meter of original masonry intact on this side. This is of particular importance, because the exterior side of the east wall incorporates a well-preserved section of the original façade that represents a defining feature of the monument. In addition, the wall to the south of the cell is heavily undermined and affected by large-scale cavitation and extensive networks of structural cracks. The animal burrows under the wall base penetrate into the smaller side chamber of the main cell, and have destroyed the southern wall of this ancillary chamber. The conditions affecting the area of Operation 102 were of urgent priority and required immediate stabilization.

The initial step in Operation 102 was to install new masonry to support the undermined wall base on both sides of the monastic suite (Figures 311 and 312). This step was also critical to reducing the general instability of the tall northern pier, and to reinforcing the overall stability of the central portion of the east wall, as dangerously undermined as it has been by animal burrows that contributed to the collapse of the mid-upper wall portion. The method used to buttress these wall base locations with new construction will eventually be used to stabilize the full length of the central, interior portion of the east wall. A platform was excavated slightly below the level of the original wall base in the sand adjacent to the wall. This sand was wetted, compacted and reinforced with geogrid to provide a stable base for the new construction, which was then built up to meet and support the original fabric of the wall. Once the base of the wall was stabilized on both sides of the cell, infilling proceeded in the interior chambers (Figures 313 and 314). This infilling was necessary to provide a base for the large masonry section that will be required to support the adjacent vertical wall end on the northern pier of the east wall. Prior to new construction inside the cell, all plastered surfaces and significant features were covered by a protective barrier layer of finely sieved sand, and as the level of infilling rose, a 3-5cm gap was left adjacent to all finished surfaces and filled with clean sand (Figures 315 and 316). Because the floor and walls of the forecourt lay beyond the original line of the enclosure wall, this area was left unencumbered by new masonry. The new brickwork was recessed adjacent to the doorway and window between the forecourt and interior cell chamber to provide visual references to these features. The walls and mud floor of the forecourt, as well as other related features that lay outside the line of the enclosure wall, were reburied with sand.

Figure 309. Interior detail of the tall, standing pier at the northern end of the east main enclosure wall; the low area at right, adjacent to the vertical wall end, was excavated as Operation 102 in field season 6, and was architecturally documented and stabilized in field season 7 (see details, below). (Photo: Matthew Adams 1999)

Figure 310. The suite of monastic features excavated as Operation 102 in the lower, central portion of the east main enclosure wall, prior to conservation work; note here that the walls and floor of the forecourt were artifically truncated by early archaeological excavations at the monument. (Photo: Jason Goodman 2005-2006)

Figure 311. Detail of stabilization work in progress on the northern, interior side of the east main enclosure wall, adjacent to the monastic cell noted as Operation 102; a layer of geogrid was used to provide a secure base for the new masonry in this heavily undermined area. (Photo: Jason Goodman 2005-2006)

Figure 312. Detail of the stabilized wall base on either side of the monastic cell noted as Operation 102, prior to infilling the interior cell chambers. (Photo: Jason Goodman 2005-2006)

Figures 313, 314. Interior and exterior details of the monastic cell area noted as Operation 102, completely stabilized at the close of field season 7 (top and bottom, respectively); the solid base of new construction created at this location will support additional masonry required to stabilize the adjacent vertical wall end. (Photos: Jason Goodman 2005-2006)


Figures 315, 316. A protective barrier layer of clean sand covers the plaster floor and walls of the monastic cell noted as Operation 102, prior to infilling (left) and clean sand is added to the protective gap between original surfaces and new masonry (right). (Photos: Jason Goodman 2005-2006)

To date, more than 247,000 mud bricks have been laid as part of the comprehensive conservation of the funerary monument of king Khasekhemwy at Abydos. This represents around 47% of the estimated total that will be required to complete the major structural stabilization in future seasons. Approximately half of the walls of the main enclosure have been stabilized as of 2007, and the conservation interventions so far completed have resulted in greatly improved stability and overall conditions at the monument. As detailed above, the large gaps in the north and west main enclosure walls have been filled and all of the large voids resulting from monastic cell construction in the exterior side of the west main enclosure wall have been stabilized. An extensive system of interconnected holes that penetrated completely through the upper part of the west wall between two of these cell voids has also been filled. Unstable vertical wall ends adjacent to the north and west gateways are now supported by new mudbrick masonry, and work will continue in future seasons on the comprehensive stabilization of each gateway area in the main enclosure. A broad, heavily undercut segment on the interior face of the west main enclosure wall has successfully been stabilized, and work has begun on the highly unstable interior side of the east main enclosure wall. The lower part of the wall at the southwest corner of the main enclosure, which was riddled with hornet nesting holes, penetrated by a man-made tunnel, undercut and eroded, is now supported by new masonry. New brickwork has also stabilized the upper part of the wall at the east corner, which exhibited deep structural cracks and was heavily eroded. Small and medium-sized holes, representing localized areas of structural weakness and cascading collapse, have so far been cleaned and filled on the interior and exterior faces of the west and north main enclosure walls, as well as on the interior side of the east wall and in the region of the southwest corner of the main enclosure. In addition to the major areas of the main enclosure that have received attention, stabilization work has begun on the exterior side of the west perimeter wall, which had been seriously undermined by animal burrows, weakened by hornet nests and denuded by severe wind scouring.

Perhaps most importantly, in the course of the seven field seasons of documentation and conservation at the Shuneh to date, conservation methods have been developed and refined, major presentation issues have been resolved, and a capable labor force has been thoroughly trained in the conservation treatments employed by the project. In future seasons, stabilization of the remaining tall walls will continue, along with the filling of additional cell voids and the partial restoration of the north, east and south gateways. Eventually, all of the walls will be capped with a protective layer of mud bricks to prevent further decay to the original fabric of Khasekhemwy's enclosure.

Archaeological Investigation of the Monument, 1999-2006

Investigation of the Interior

Excavations inside the main enclosure, during field seasons 1, 3, 5, 6 and 7, have revealed significant evidence for the original Dynasty 2 configuration and use of the structure, as well as for its post-Second Dynasty history. To date, approximately 35% of the total area of the interior has been excavated as part of the archaeological component of this project. The excavation work is intended to expose the lower parts of the walls of the monument, both to permit condition assessment and stabilization, where necessary, and to investigate the original design, construction and use of the monument.

Excavation in the northwestern area of the interior was undertaken in field season 3 (spring 2001), consisting of nine units at the base of the large sand deposit against the north main enclosure wall excavated as Operations 1, 2, 4, 5, 6, 8, 9, 14 and 16 (Figures 317-319). This area provided significant new information about the condition of the walls and the nature of the interior of the enclosure during Dynasty 2, as well as its later history. Excavation in this area exposed the lower portion of the west main enclosure wall, revealing a distinct erosion line along the inner face of the wall (Figure 320). This erosion line indicates the top of the long-stable sand deposits that were in place against the west wall prior to the first excavations of the 19th Century. At the base of the wall excavated in Operations 14 and 16, small areas of original finish were preserved, which demonstrates conclusively that the interior of the monument was plastered and whitewashed, as was known to have been the case for the exterior. Despite the erosion of the original plaster that implies exposure to the elements for a substantial period of time, the brick masonry of the lower part of the wall (below the erosion line in this area) appears to be in relatively good condition, with no major holes or voids.

In the units excavated as Operations 5 and 8, a large area of the original Dynasty 2 floor was revealed adjacent to the west wall, which extended some meters from the wall to the edge of a large oval basin feature (Figure 321). The original floor consisted of a layer of mud plaster of variable thickness put down on top of the naturally occurring sterile sand at this location. The interior of the large basin was coated with grey-white plaster, similar to the finishing plaster of the wall faces. Adjacent (on the east) to the white plaster basin was another large basin feature, somewhat irregular in shape, the edges of which were defined by bricks set at an angle into the mud plaster floor of the enclosure. A similar section of a basin feature with angled brick edges was encountered in the unit excavated as Operation 2, and it is likely that this represents the southeastern portion of the same feature seen in Operations 5 and 8. The interior surface of the basin consisted of dried brown mud, characterized by finger marks and other impressions, ridges and irregularities that indicate the mud had been worked while wet. The basin was filled with broken mudbricks, brick debris, sand and gravel (Figure 322). Areas of mud plaster floor were also preserved in the units excavated as Operations 6, 8 and 9. In Operation 8, near the northwestern corner of the unit, a large deposit of dark brown alluvial soil was found piled up in a depression in the mud plaster floor. In Operation 16, in the northwestern portion of the unit, a small area of loosely arranged mudbricks was found, which may represent the remains of brick stacks left over from the construction of the enclosure.

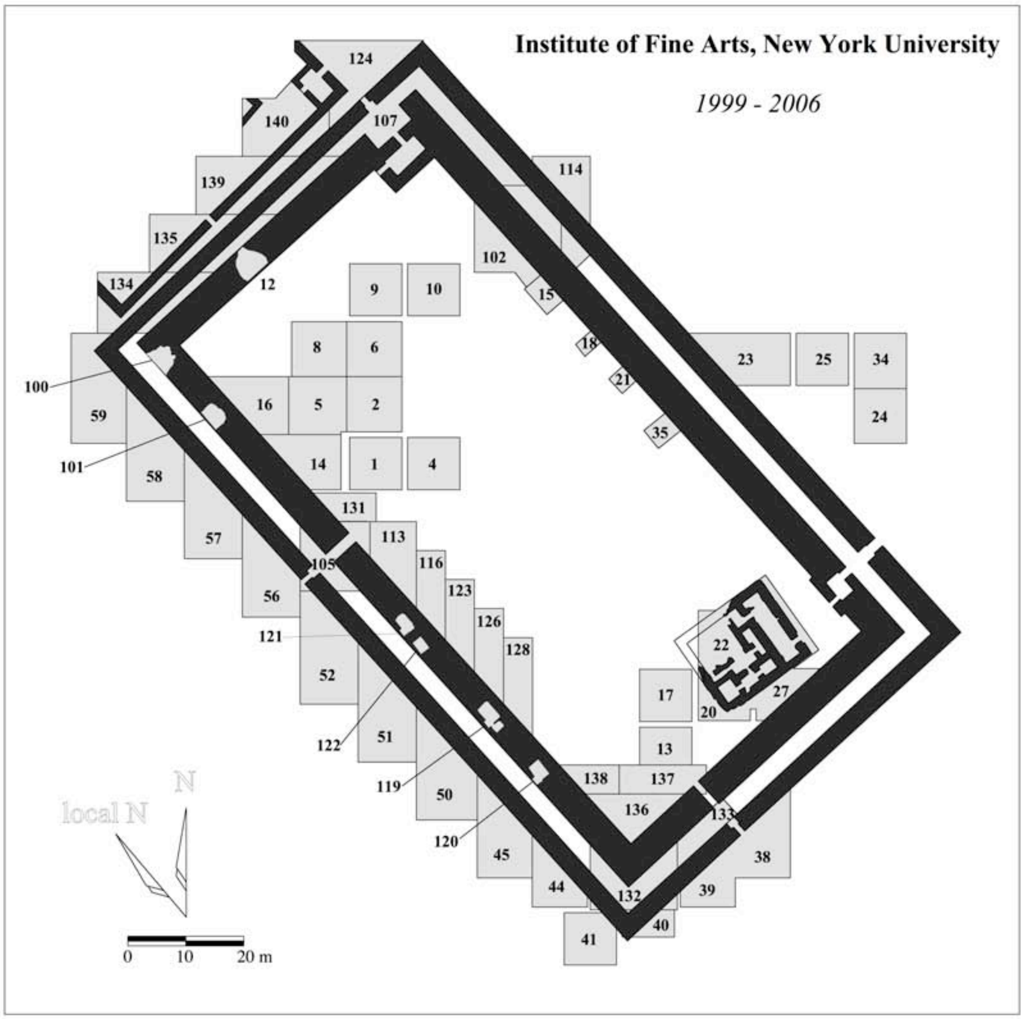


Figure 317. Plan of excavation units at the enclosure of Khasekhemwy from 1999 to 2006. (Institute of Fine Arts, New York University 1999-2006)

Figure 318. The northern, interior area of the enclosure, prior to excavation. (Photo: Matthew Adams 1999)

Figure 319. Excavation in progress in the northwest, interior area of the main enclosure (facing north); a portion of the preserved Dynasty 2 floor of the enclosure (left center) and two large basin features (right center) were exposed at the base of the large sand deposit against the north wall in field season 3. (Photo: Robert Fletcher 2001)

Figure 320. Excavation in progress in the northwest, interior area of the main enclosure (facing west); note the erosion line on the interior face of the west main enclosure wall, which represents the long-term stable position of sand deposits in this area. (Photo: Robert Fletcher 2001)

Figure 321. Detail of the units excavated as Operations 5 and 8 (facing south); these excavations revealed the original, mud-plaster floor of the enclosure (right center), as well as two large, white-plaster basin features set into the floor at an angle (noted in blue). (Photo: Robert Fletcher 2001)

Figure 322. Detail of the units excavated as Operations 5 and 8, with part of the deposit of brick, sand and gravel in the larger of the two basins pictured in Figure 321, above. (Photo: Robert Fletcher 2001)

The combination of features excavated in the northwestern area of the main enclosure suggests that the interior of the monument may not have been formally finished and may have retained the character of a construction site until original activity ceased. The basin features appear, in one case, to have been used for mixing mud plaster and/or mortar and, in the other case, for mixing the facing plaster used to finish the interior and exterior surfaces of the enclosure. The pile of alluvial soil and the remains of brick stacks almost certainly relate to construction activities as well.

Significantly, the interior character of Khasekhemwy's enclosure differs from other Early Dynastic royal enclosures at Abydos, in which the interiors (where excavated) were characterized by continuous, smooth mud-plaster floors. The unfinished interior of the enclosure may relate to evidence found during the work of the German Archaeological Institute in Khasekhemwy's tomb at Umm el-Qa'ab, where it appears that a major expansion was planned but not executed.

An additional discovery in the northwest, interior area of the main enclosure may relate to the original Dynasty 2 use of the monument. In the excavated area of Operation 3, a deep pit was discovered that appears to have possibly been cut down from the level of the original floor. A stack of cut timbers was found in the bottom of this pit, some of which appear to be as large as 6m long by 50cm wide. The wood appears to be ancient and is in poor condition, similar to the condition of the wooden boats discovered east of the Shuneh (see the Early Dynastic Boat Graves at Abydos, to follow). The timbers appear to be straight, with no detectable curves, mortises or other features that might be expected if they were the dismantled remains of a wooden boat (C. Ward, pers. comm.). If this deposit should prove to belong to Dynasty 2, the presence of these timbers may be highly significant for understanding the way in which the open space of the northern part of the enclosure may have been used. Judging from their size, they may have been part of a wooden structure of some kind, dismantled and buried inside the enclosure. Support for this suggestion may be found in a discovery made inside one of the two secondary enclosures of king Aha of Dynasty 1, where a dismantled construction of wooden poles was found deposited on the floor of the open interior space (Bestock 2007:221-222). If this discovery were paralleled by a dismantled wooden structure in the Shuneh, it is likely that the open spaces inside all of the royal enclosures at Abydos may have once contained shrines or chapels built in organic materials. Early Dynastic iconography includes depictions of shrines made of reeds or other organic materials. Such structures could have been dismantled and deposited inside their respective enclosures once their ritual functions had been met.[18]

The only evidence found for activity at the monument between the Second Dynasty and the Third Intermediate Period was a single human burial excavated in Operation 8 (Figure 323). The individual was buried in a rectangular wooden coffin, without decoration, of a type commonly found in the surrounding North Cemetery and probably dating to the Middle Kingdom. The wood of the coffin had been almost entirely reduced to frass by insects, however this frass retained the coffin’s shape. This discovery was the first human burial found inside the enclosure by the Pennsylvania-Yale-IFA/NYU project. Ayrton et al. (1904:4) refer to a child burial of Dynasty 12 found in the great sand deposit against the north main enclosure wall. Each of these instances appears to be exceptional, however, and it seems that the interior of the enclosure was for the most part respected during the Middle Kingdom and following periods, up to its use in the Third Intermediate Period as a burial site for sacred ibises.

[18] At the time of discovery, the project did not have adequate conservation staff to meet the substantial and particular challenges presented by this large-scale deposit of wood. After basic documentation, the timbers were reburied and will await full excavation, conservation and analysis in a future season.

Figure 323. Detail of the single human burial excavated in Operation 8 in the northwest, interior area of the main enclosure (facing east); this burial in a rectangular wooden coffin, probably dating to the Middle Kingdom, is unusual in that it was situated inside the enclosure. (Photo: Robert Fletcher 2001)

In the Third Intermediate Period, probably (based on the ceramic forms) during the first half of the first millennium BCE (cf. Ayrton et al. 1904:Pls. 34-35), many large and small pits were cut within the interior of the enclosure, into which were placed ceramic jars containing sometimes a single and sometimes multiple ibis mummies. It is clear that in the approximately two thousand years between its construction and its use for ibis burials, a significant amount of wind-deposited sand had accumulated against the north wall of the main enclosure, as ibis burial jars were found in situ in this sand during 1988 excavations. In most cases, however, the burial pits penetrated the original floor and other features of the interior. It appears that the enclosure was used for this purpose for a significant length of time and that later burial pits commonly disturbed earlier pits, as in many instances deposits were found with broken jars and displaced remains. Large deposits of ibis jars were excavated in Operation 4, and smaller groupings were excavated in Operations 6, 8, 9 and 14 in the northern, interior area of the main enclosure (Figures 324 and 325).

The excavations in this area also produced evidence for two major episodes of pitting unrelated to either original Dynasty 2 activity or the later Third Intermediate Period burials. Rather, these pitting episodes are likely related to early archaeological excavation inside the enclosure. One set of roughly parallel pits, or trenches, was oriented north-south, and generally penetrated only as deep as the Dynasty 2 surface and associated features. The other set was oriented east-west and cut through all Dynasty 2 and later features, penetrating quite deeply into the sterile, underlying substrate. In the units excavated as Operations 7, 10 and 11, virtually nothing of the Dynasty 2 interior was preserved. Although the publication record of early excavations inside the enclosure is poor, it is tempting to identify those pits that did not cut through the floor and associated features with the work of Ayrton for the Egypt Exploration Society (Ayrton et al. 1904) and the more destructive pitting with the agency of Auguste Mariette in the mid-19th Century. Aryton (1904) notes that Mariette's workers concentrated on the eastern part of the interior, and this appears to be confirmed by both the results of the excavation in this area and the modern interior topography, in which the area along the interior side of the east wall is much lower than other areas of the interior and lower even than the base of the adjacent east wall, which is one reason for its precarious state.

Figure 324. Detail of the unit excavated as Operation 4 in the northwest, interior area of the main enclosure (facing north), which revealed a large deposit of ibis burial jars from the Third Intermediate Period; the “torpedo-shaped” vessels pictured here are the most characteristic form found in association with ibis burials. (Photo: Robert Fletcher 2001)

Figure 325. Detail of the unit excavated as Operation 6 (facing west), which revealed small groupings of ibis burial jars deposited in pits that were cut through the floor and basin features pictured in Figure 321, above. (Photo: Robert Fletcher 2001)

A series of units were excavated in field seasons 6 and 7 (2004-2005, 2005-2006) along the interior side of the west main enclosure wall, adjacent to and south of the west gateway, as Operations 113, 116, 123, 126, 128 and 131 (see Figure 317, above).

The excavated area of Operations 113 and 116, just south of the west gateway, revealed the denuded remains of a dry-laid mudbrick structure built up against the enclosure wall, which are the remnants of a small field house built by W. M. F. Petrie during his 1921-1922 season at Abydos (Figures 326-328). A number of artifacts were found in or near the remains of the house that had been labeled in pencil or ink by Petrie. The finds also included one letter and two postcards, apparently written by his wife Hilda to Professor Petrie before his arrival on-site. The documents had been torn into pieces and were found loose in sand near a hearth at the northwest corner of the house. They appear to have escaped being burned only by chance. The house was built on the existing ground level in 1921. Under the house, the deposit consisted primarily of a thick layer of a highly disturbed mixture of sand and mudbrick debris. This deposit overlay at least two large pits cut into the natural "gebel" substrate in which were found the broken remains of ceramic vessels containing the burials of sacred ibises.

The area of Operation 113 was characterized by a series of intercut pits originally dug for the deposition of ceramic vessels containing the remains of sacred ibises, and an additional number such vessels were found in a portion of the area left unexcavated in field season 6, during the work of field season 7 (Figures 329 and 330). The results of Operation 113 and adjacent areas excavated in field season 6 suggest that there were multiple pitting episodes and that later pits were cut into earlier ones, with the result that many of the jars were dislodged from their original positions, cracked or completely broken, and the remains of the ibises they contained disturbed. Nothing remained of the original Dynasty 2 floor or any interior features in this area. One large pit dug along the interior face of the west wall had a ramp of dry-laid bricks at its northwest end that may have provided a stable surface for entry and egress, since the soft sand substrate into which the pit was cut collapses easily underfoot.

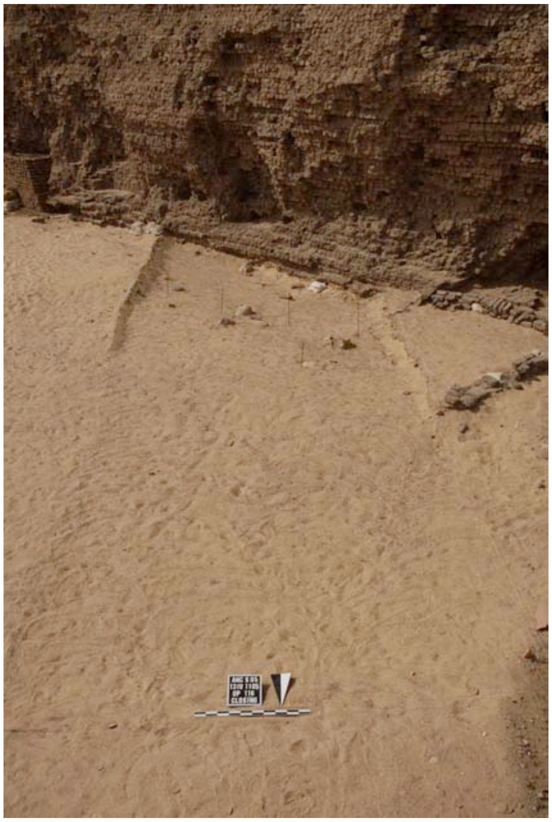
The excavated area of Operations 123, 126, 128 and 131, along the interior side of the west main enclosure wall (south of the Petrie house), produced no Dynasty 2 features, and the encountered remains related almost exclusively to the burials of sacred ibises (Figures 331-334). In the area of Operation 123, a small wooden box was found in a niche cut into the base of the wall. The box contained a well preserved mummy, the wrappings of which had been coated in resin (Figures 335 and 336). The size and shape of the unwrapped mummy suggest it is that of an animal (probably an ibis), however this has not yet been confirmed. In the area of Operation 131, immediately north of the west gateway, traces were found of the original mud plaster floor of the enclosure, which had been heavily damaged by later intrusive pitting (Figure 337). The unit excavated as Operation 131 also produced ample evidence for the burials of sacred ibises in ceramic vessels, but, exceptionally, one of these was covered in an ink inscription in demotic script (Figure 338 [a, b]).[19]

[19] The text is being analyzed by Dr. Jennifer Wegner of the University of Pennsylvania Museum's Egyptian Section and will be published separately.

Figure 326. Detail of the excavated area in Operations 113 and 116 along the southern, interior face of the west main enclosure wall; the clean yellow sand adjacent to the exposed wall base in the foreground is the natural geological deposit underlying the site, into which pits were cut at this location for the burial of large numbers of ceramic vessels containing ibis mummies; the bricks lying against the enclosure wall in the background are the remains of W. M. F. Petrie's 1921-1922 field house. (Photo: Robert Fletcher 2004-2005)

Figures 327, 328. Details of the excavated area in Operations 113 and 116, with the remains of Petrie's 1921-1922 field house before and after excavation in field season 6 (top and bottom, respectively); the walls of two rooms could be defined, consisting primarily of reused ancient bricks, and two hearth areas were located (bottom, upper right and lower left) with postcards and a letter found loose in the sand beside the hearth at upper right. (Photos: Robert Fletcher 2004-2005)

Figures 329, 330. Details of the excavated area of Operation 113, during and after the excavation of additional ibis burial pits found in field season 7. (Photos: Robert Fletcher, Jason Goodman 2005-2006)



Figures 331, 332. Details of units excavated in Operations 116 and 123, along the southern, interior face of the west main enclosure wall (left and right, respectively), which revealed a number of ceramic jars containing ibis burials, but no original interior features. (Photos: Robert Fletcher 2004-2005)

Figure 333. Detail of units excavated in Operations 126 and 128, along the southern, interior face of the west main enclosure wall (at center and left, respectively), which revealed a number of ceramic jars containing ibis burials, but no original interior features. (Photo: Robert Fletcher 2004-2005)

Figure 334. Detail of the unit excavated in Operation 126, with a typical deposit of ibis burial jars. (Photo: Robert Fletcher 2004-2005)

Figures 335, 336. Details of the unit excavated in Operation 123, which revealed a niche in the base of the west main enclosure wall containing the remains of a wooden box (top) that was found to contain an object wrapped in cloth, presumably an ibis mummy (bottom); burial in a box coffin such as this is exceptional at the Shuneh. (Photos: Robert Fletcher 2004-2005)

Figure 337. Detail of the excavated area in Operation 131, on the northern, interior side of the west gateway, which revealed traces of the original mud plaster floor of the enclosure, as well as a number of ibis burials. (Photo: Robert Fletcher 2004-2005)

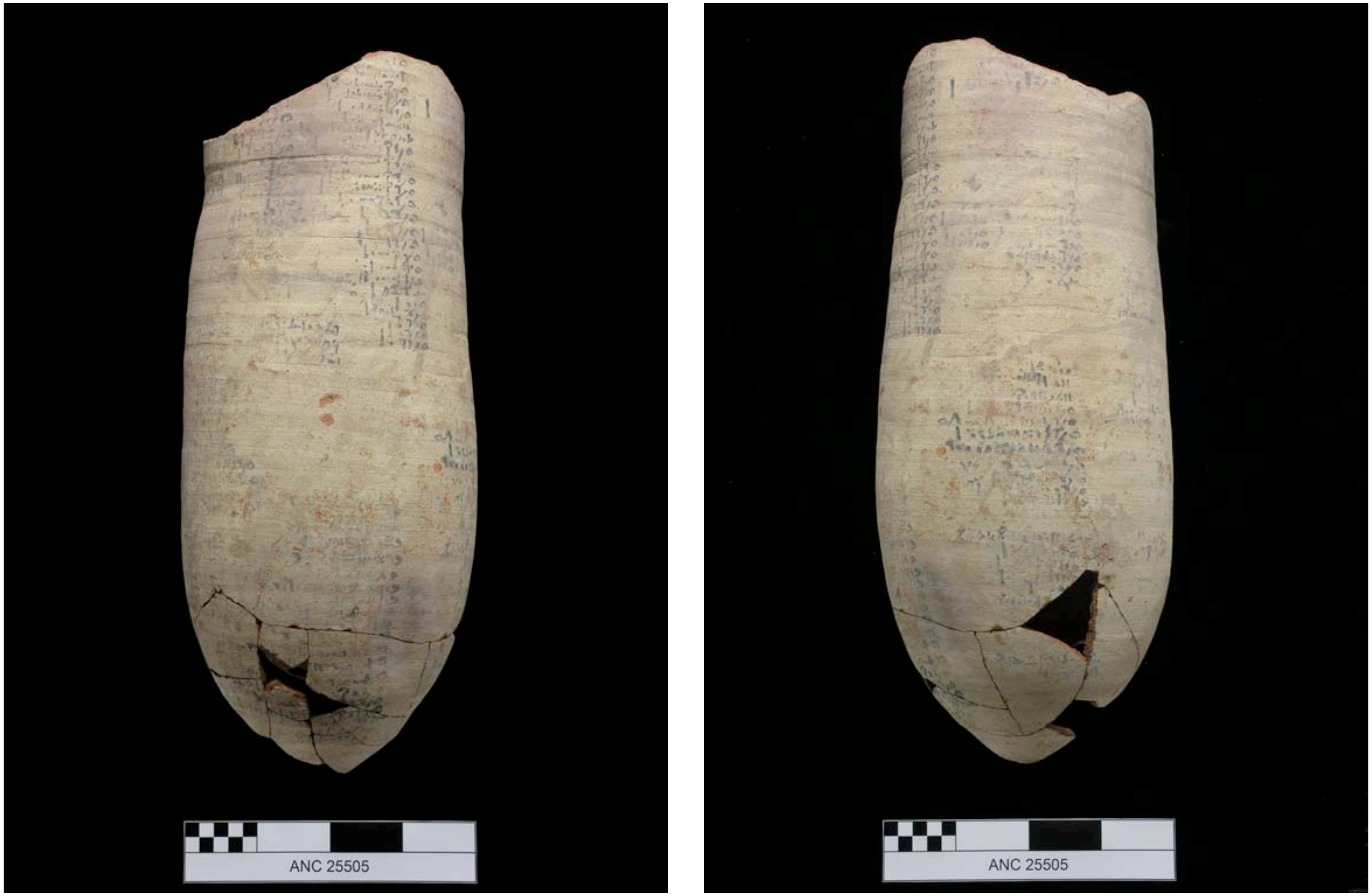


Figure 338 (a, b). Two details of ANC25505, an inscribed ibis burial jar excavated in Operation 131 on the northern, interior side of the west gateway; the demotic text, which is in black ink covering all sides of the vessel, is the longest ever found at the monument associated with the ibis cult. (Photos: Jason Goodman 2004-2005)

At the southwest, interior corner of the enclosure, where a large sand dune had accumulated over the centuries to a height of over seven meters, three units were excavated as Operations 136, 137 and 138 (see Figure 317, above). The stratigraphic sequence encountered during the excavation of this area in field season 7 (2005-2006) very clearly illustrates what is known of the monument's history and use over time.

A feature excavated in Operation 136, near the top of the sand deposit in this area, represents the latest phase of ancient activity inside the enclosure. During the Late Roman/Byzantine period, a small room was built into this corner of the enclosure, on top of what was, by that time, already a considerable mound of sand (Figures 339 and 340). Two thin, dry-laid mudbrick walls were built perpendicular to the west and south main enclosure walls, and comprised the northwest and northeast sides of the room. The interior of the room had a thick mud plaster floor. The northwest wall contained a painted block of wood that had been used just like a brick. This wall was dismantled during the course of excavation, allowing for removal and closer examination of the block. It appears to have been originally a stand or base for some type of object, perhaps a statuette. Associated with this room were two ceramic amphorae, one of which was found stoppered, with its contents intact (Figures 341 and 342). Upon removal of the stopper, the vessel was found to contain a mass of woven fiber, and fragments of similar material were found loose in the sand during the excavation (Figure 343). At some point the front wall of the corner room collapsed down the sand slope along the face of the adjacent south wall (Figure 344).

In the sand under the late antique room excavated at the southwest corner of the enclosure, a series of pits dating to the first millennium BCE that contained deposits of ceramic ibis burial jars were also excavated in Operation 136. These deposits represent the preceding major phase in the history of the monument (Figure 345). One of these deposits was unusual in its association with a small mudbrick chapel containing a painted limestone stela (Figures 346 and 347). Although the stela had been covered with a thick coating of mud and its decoration was poorly preserved as a consequence, the depiction of two opposing pairs of figures is clear. One of the figures is the god Osiris, who is also named in the partially preserved text. The stela and chapel were the first such finds associated with ibis cult activity at the monument. Unusually, some of the jar deposits excavated in this area contained the remains of canids (Figure 348), and one deposit not associated with any ceramic vessels consisted of bovine remains. Although many of the excavated deposits contained the typical "torpedo-shaped" ibis burial jars, others contained atypical forms and in one case, the ibis remains were placed without jars in a single layer at the bottom of a rectangular pit (Figures 349 and 350). Some of these atypical forms appear to be earlier than the forms most commonly found with ibis burials elsewhere in the Shuneh and to relate more closely to the Egyptian ceramic corpus of the late New Kingdom. Judging from the ceramics, the activity in the southwest corner may represent the earliest incidence of animal cult activity in the enclosure. The occurrence of species other than ibises in this area may demonstrate that initially, a wider range of cults were practicing ritual animal burial at the monument than was the case later.

Figure 339. Interior detail of the southwest corner of the enclosure, prior to its excavation in Operations 136, 137 and 138 (see details, below). (Photo: Robert Fletcher 2005-2006)

Figure 340. Detail of the small room constructed into the southwest, interior corner of the enclosure, which was excavated as Operation 136 in field season 7; based on the ceramics, this room appears to be contemporary with the monastic occupation of the monument in late antiquity. (Photo: Jason Goodman 2005-2006)

Figures 341, 342. Two details of a ceramic amphora excavated in the area of Operation 136 at the southwest, interior corner of the enclosure; the amphora was stoppered with the broken base of another vessel, which was removed to allow observation of the contents, consisting of a mass of woven fiber in the form of what appeared to be strings, ringlets and bands. (Photos: Jason Goodman 2005-2006)

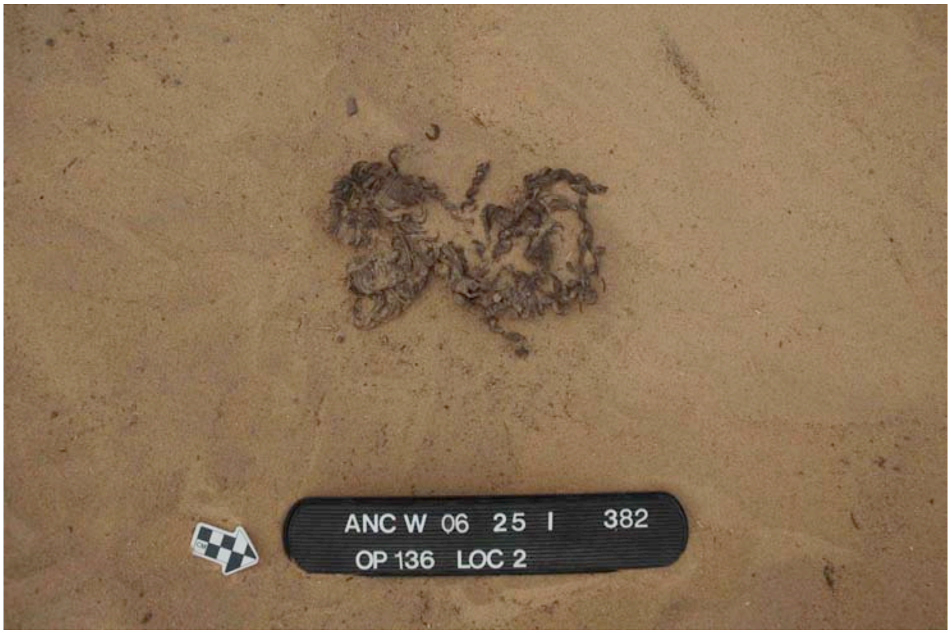
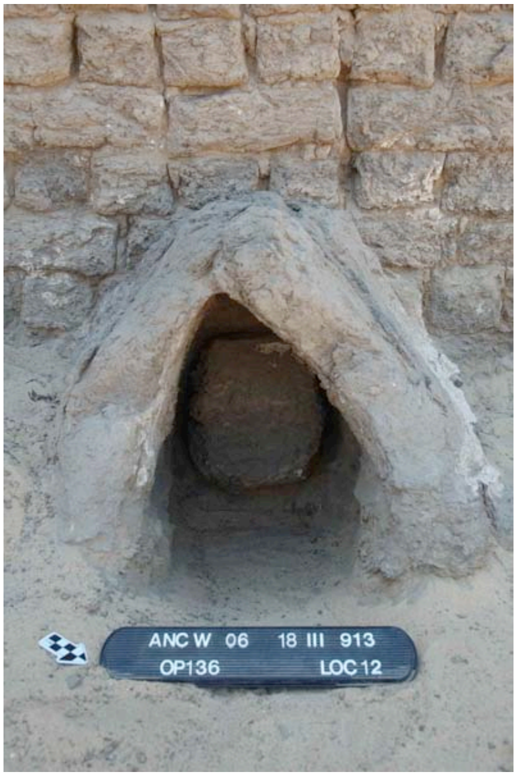


Figure 343. Detail of woven fragments found loose in the excavated area of Operation 136. (Photo: Jason Goodman 2005-2006)

Figure 344. Interior detail of the corner room excavated as Operation 136; the dry-laid, front wall of the room collapsed in antiquity down the slope of the underlying sand deposit. (Photo: Jason Goodman 2005-2006)

Figure 345. Detail of the excavated area of Operation 136, beneath the floor of the late antique room pictured in Figure 340, above; ceramic vessels relating to the sacred ibis cult were found deposited along a shallow trench dug along the face of the wall (at left), and a small mudbrick chapel was found contemporary with the vessel deposit (at right). (Photo: Jason Goodman 2005-2006)



Figures 346, 347. Detail of the small mudbrick chapel excavated in Operation 136 (left), which was found to contain a limestone stela *in situ* (right); traces of the stela's painted decoration were revealed during cleaning to depict two opposing pairs of standing figures and the god Osiris, second from left. (Photos: Jason Goodman 2005-2006)

Figure 348. Detail of a jar deposit excavated in Operation 136; a number of the jar forms found in this area are atypical of the types of ibis burial jars found elsewhere in the enclosure, such as this form containing the remains of a canid. (Photo: Jason Goodman 2005-2006)

Figure 349. Detail of atypical burial jar forms excavated in Operation 136. (Photo: Jason Goodman 2005-2006)

Figure 350. Detail of ibis remains excavated in Operation 136, which appear to have been wrapped in reed matting and deposited without jars in this rectangular pit. (Photo: Jason Goodman 2005-2006)

Near the deposits of ibis burials excavated at the southwest corner of the enclosure, but not directly associated with them, another type of ritual deposit was found. Eight small figurines modeled in beeswax were also excavated, along with eight mud bases, in the area of Operation 136 (Figures 351 and 352 [a-h]). Each of these figurines appears to represent a deity, two with hawk or falcon heads and one with a jackal head. Two of the figurines may represent female deities. Several of the figures show evidence for heat discoloration. Given the low melting point of wax, it is possible that some additive was present in the wax to make it less susceptible to heat. These are the first examples of such figurines found at the monument, and they appear to be evidence for additional ritual activities in the enclosure contemporary with the burial of sacred ibises.

In the areas excavated as Operations 137 and 138 at the southwest corner of the enclosure, the original Dynasty 2 floor was reached in field season 7 (Figure 353). The features revealed by these excavations represent the original construction phase and royal use of the enclosure. As with other exposures of Dynasty 2 floor in the enclosure, the floor in this area consisted of a somewhat irregular layer of mud plaster. A number of broken beer jars were found on the floor, probably the result of cultic ritual carried out in the enclosure. Only a small section of the original plaster finish of the wall was preserved at this location.

The excavated area at the southwest, interior corner of the enclosure is illustrated in Figure 354, at the close of field season 7. Additional excavation will be required in a future season to reach the Dynasty 2 floor level over the entire area. This will permit evaluation of the adjacent south main enclosure wall, prior to the comprehensive and large-scale stabilization of the south gateway area.

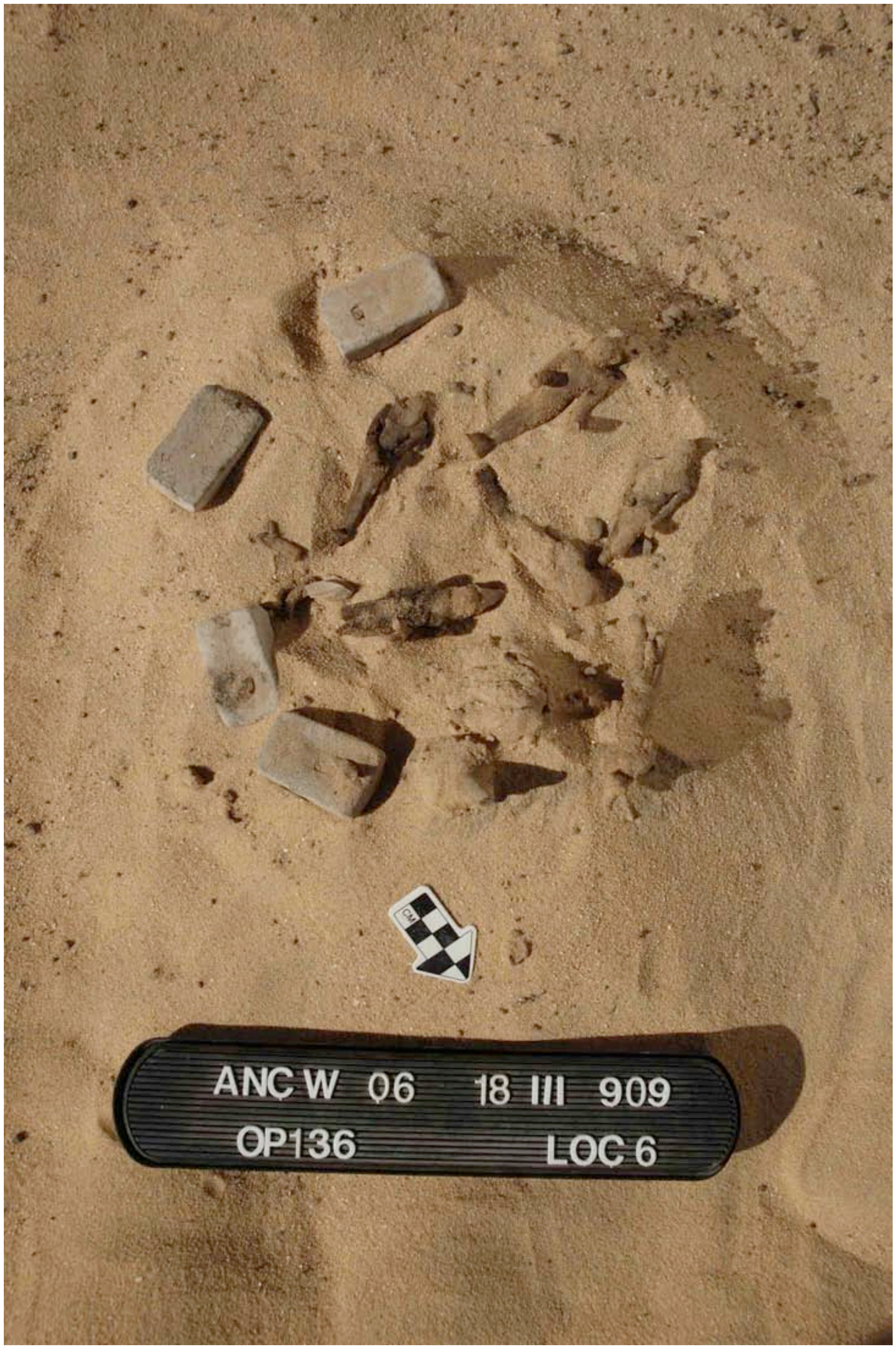


Figure 351. Detail of a deposit of wax figures with mud bases excavated in Operation 136 at the southwest, interior corner of the enclosure; many of the figures had been removed from their bases, and the arrangement appears to have been deliberate. (Photo: Jason Goodman 2005-2006)

Figure 352 (a-h). Details of the eight wax figures excavated in Operation 136, after cleaning and consolidation. (Photos: Jason Goodman 2005-2006)

Figure 353. Detail of the original mud plaster floor of the enclosure, excavated in Operations 137 and 138 at the southwest corner of the enclosure; note the deposit of broken offering pottery of the “beer jar” type. (Photo: Jason Goodman 2005-2006)

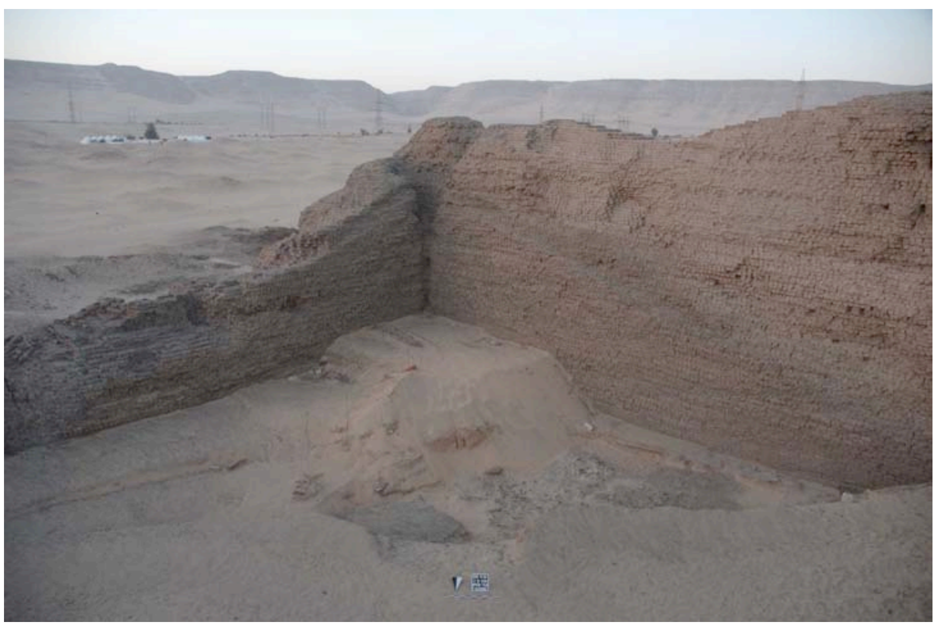


Figure 354. Interior detail of the southwest corner of the enclosure at the close of excavation in field season 7; note the erosion line of the adjacent wall face, which indicates the profile of long-stable sand deposits in this area. (Photo: Jason Goodman 2005-2006)

Five units on the interior side of the south main enclosure wall were excavated as Operations 13, 17, 20, 22 and 27 in field season 3 (see Figure 317, above). In the unit excavated as Operation 13, just inside the south gateway, two large areas of grey-white plastered mud were found, the surfaces of which appear identical to the large plastered basin excavated in Operation 5 to the north (see Figure 321, above). These areas, which probably represent similar basin features, had also been cut through by ibis burial pits and a large deposit of ceramic jars containing ibises was excavated in the northeast corner of Operation 13 and into the southeast corner of Operation 18.

Operations 22 and 27 concentrated on the re-excavation and documentation of the interior cult chapel at the southeast corner of the enclosure (Figures 355 and 356), which was originally excavated by E. R. Ayrton in 1902-1903 (Ayrton et al. 1904) and again by John Garstang in 1909 (Garstang 1909). Published discussions of the earlier work at this location are extremely summary in nature, and the results of re-excavation in 2001 were significant. In a number of the interior rooms, the original mud plaster floor, as well as the original plaster and whitewash on some wall surfaces, was found in a well-preserved condition. The mud plaster floor of the chapel appears to have been renewed several times. In the southern corner room, labeled "J" on Ayrton's plan (see Figure 2, above), brown stains on the walls and floor that are suggestive of some organic material (perhaps from the pouring of some liquid), as well as the remains of what appear to be incense found on the floor, may relate to cultic ritual carried out in the chapel. Similar staining has been found on the floors and walls of the interior chapels in the Dynasty 1 enclosures of king Aha. The excavated area of Operations 22 and 27 also revealed that the cult building had a niched "palace" façade on at least three of its four sides (east, south and west). Plastered and whitewashed niches on the front of the east wall were known from the work of Ayrton and from the unpublished 1986 work of the Pennsylvania-Yale Expedition. Excavation in field season 3 revealed the remains of plastered niches on the exterior of the south and west walls. The north wall of the cult building is partly destroyed and the preserved portion is highly denuded, and no evidence of niching was detected. On the south and west sides there were only simple niches, whereas on the east wall, the pattern was of three simple niches, one complex niche. This pattern corresponds with that of the niching on the façade of the main enclosure and on the other known Dynasty 1 and 2 funerary enclosures at Abydos.

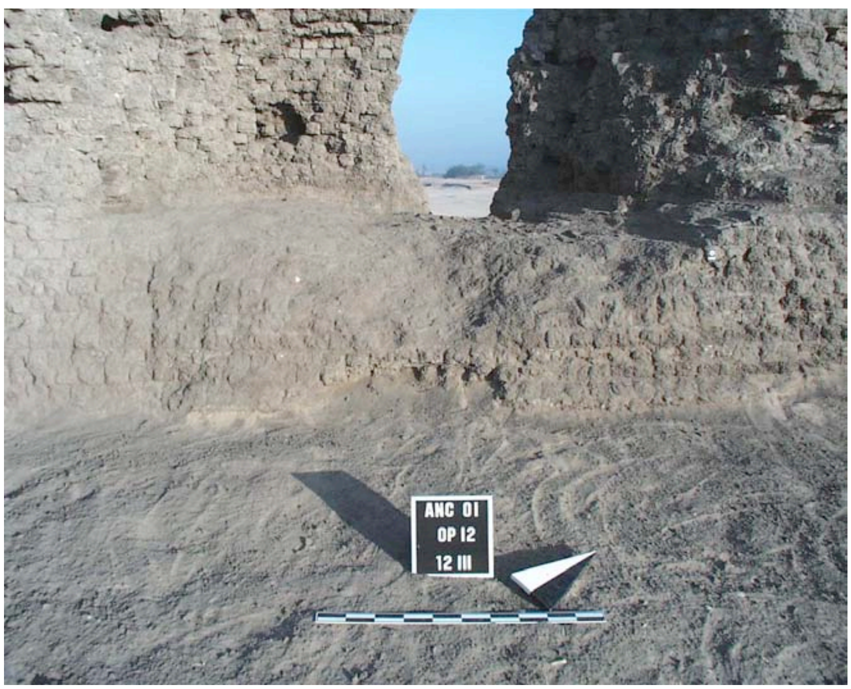
In the excavated area of Operation 27, between the southern wall of the cult building and the south main enclosure wall, patches of the original mud plaster floor of the enclosure were preserved. The preserved floor in this area was covered by deposits containing numerous fragments of uninscribed mud sealings and jar stoppers, as well as a few bearing the impressions of seals. Several were found with the name of king Khasekhemwy, and one was found with a serekh of Netjer-khet, the Horus-name of king Djoser of Dynasty 3. The presence of the name Netjer-khet in the enclosure is of considerable historical significance, as it corresponds with the discovery by the German Archaeological Institute of Netjer-khet sealings in Khasekhemwy's tomb. The evidence from both the tomb and the enclosure demonstrates that Netjer-khet conducted the funeral ceremonies of Khasekhemwy and was responsible for his entombment. The obvious implication is that Netjer-khet was Khasekhemwy's direct successor.

Figure 355. The interior cult chapel at the southeast corner of the enclosure (facing northwest); the entrance to the chapel is at lower right and the room in which possible evidence of cultic practice was found is at lower left (Ayrton’s room “J”). (Composite photo: Robert Fletcher 2001)

Figure 356. The interior cult chapel at the southeast corner of the enclosure (facing southwest); note the well-preserved mud plaster floor of the chapel in and around the entranceway (lower left), as well as the preserved lower portions of the simple and complex niches, with traces of white plaster, on the exterior face of the east chapel wall. (Photo: Robert Fletcher 2001)

A number of smaller excavations were also undertaken inside the enclosure in field season 3 (spring 2001). Mudbrick debris in the large gap at the center of the north main enclosure wall was excavated as Operation 12 (Figures 357 and 358). Although this gap had existed in the wall for a long period of time (see Ayrton et al. 1904:Pl. 5[1, 3]), additional brickwork collapsed in 1996 or 1997 as a result of torrential rainstorms. The debris from these recent collapses, as well as underlying sand and debris, were removed, and the area was cleaned and examined. No remains of plastering or other direct evidence of use during the late antique occupation of the Shuneh was detected, although the relatively flat surface left in the masonry at the bottom of the gap suggests that the gap may have been, in origin, a cut for a monastic room or cell.

In preparation for the construction of temporary sandbag buttresses against the interior side of the east main enclosure wall, four small test units were excavated as Operations 15, 18, 21 and 35 in field season 3 (Figure 359). Excavation revealed that the entire area along the central, interior portion of the east wall is highly disturbed. Much of the modern grade is below the elevation of the adjacent wall base. Ayrton (1904:1) notes that Mariette's workers concentrated on the east side of the interior, and both the low ground level and the disturbed nature of the deposits are probably the result of the large sondages in which they normally worked. The damage to late antique features excavated in this area in field season 6 (see Operation 102, below) is almost certainly the result of their digging as well.



Figures 357, 358. Detail of the central void in the north main enclosure wall before and after excavation as Operation 12 in field season 3 (top and bottom, respectively); the relatively level surface of the gap in the wall may be the result of efforts to create a chamber or cell in late antiquity. (Photos: Robert Fletcher 2001)

Figure 359. Detail of the unit excavated as Operation 18 on the interior side of the east main enclosure wall in field season 3; three other test units such as this were also excavated in this area in field season 3, and these four local excavations permitted the installation of temporary sandbag buttresses to stabilize the east wall. (Photo: Robert Fletcher 2001)

Investigation of the Exterior

The excavated area of Operation 107 encompassed the north gateway area of the main enclosure and the adjacent areas of the north and east corridors (see Figure 18, above). This area had been partially excavated by the Pennsylvania-Yale Expedition in 1988. The north gateway is the most complex of the four gateways and consists of a number of elements. There is an opening in the north perimeter wall that provides access to the corridor in front of the gateway into the main enclosure. The floor of the gateway through the perimeter wall was partly preserved and consisted of compacted mudbrick debris (see Figure 9, above). The façade of the main enclosure is set back some meters in this area, to create an open court in front of the gateway opening through the main wall (see Figure 16, above). The forecourt had a floor of mud plaster laid down over mudbrick debris, which was probably left over from construction. The niching and pilaster pattern of the main façade continues into the setback defining the court, and the gateway itself is essentially an enlarged niche. The opening is slightly more than one meter wide, or two Egyptian cubits. Along the lower part of the main enclosure wall that defines the setback sides of the court (on the east, south and west), the original plastered and whitewashed finish of the wall is preserved.

The north gateway through the main enclosure opens into an interior gateway chamber, which measures approximately 3.25 x 6.75m (see Figure 17, above). A deposit of approximately 200 rough, ceramic beer jars was found in this chamber, apparently just beneath the original Dynasty 2 floor level (Figure 360). These vessels date to the Second Dynasty and are contemporary with the original period of use of the enclosure during the reign of Khasekhemwy. The jars along the northern side of the gateway chamber, along the traffic path between the entrance through the main enclosure and the exit through the chamber's west wall into the open interior of the enclosure, are in relatively poor condition as a result of trampling. The mud floor of the gateway chamber is only preserved in one small area in the northern corner, but it does appear to run *over* the jar deposit, thereby establishing the early date of that deposit. In the eastern corner and along most of the eastern end of the gateway chamber, the jar deposit is almost entirely missing, apparently due to an intrusive pitting episode that also appears to be represented in a large section of masonry that is missing from the base of the wall in this area. This pitting episode may relate to a deep hole dug through the adjacent wall.

In the flat surface at the northern end of the east wall, adjacent to the vertical wall end, the remains of a poorly preserved monastic cell were excavated in Operation 107 (Figure 361). The cell had probably been cut into the wall from the gateway chamber. The lines of its north and east side walls could be defined, and traces of white plaster were preserved on the east wall and on the floor. Two large holes had been cut through the remains of the cell into the underlying masonry of the wall. The larger of the two holes penetrated straight down through the wall and well into the sterile sand and gravel substrate beneath (Figures 362 and 363). Like a similar hole excavated in Operation 100 at the northern end of the west wall (see below), this hole was probably the result of a search for foundation deposits, likely by Mariette, in an early attempt to identify the date and purpose of the enclosure. The damage to the base of the wall along the east side of the gateway chamber may be the result of a related attempt to get under the base of the wall. Because the sand and gravel substrate in this area is rather soft, it may be that the attempt made from the gateway chamber was unsuccessful due to collapses, necessitating the much more labor-intensive tunneling through the wall from above.

Figure 360. Detail of the Second Dynasty deposit of offering pottery, consisting of rough “beer” jars, excavated in the north interior gateway chamber. (Photo: Robert Fletcher 2004-2005)

Figure 361. Detail of monastic cell remains excavated adjacent to the north interior gateway chamber, at the northern end of the east main enclosure wall (see also preceding sections). (Photo: Robert Fletcher 2004-2005)

Figure 362. Detail of one of two large holes cut through the wall adjacent to the north interior gateway chamber, at the northeast corner of the main enclosure, in the mid-19th Century. (Photo: Robert Fletcher 2004-2005)

Figure 363. Detail of the underside of the main enclosure wall from within the hole at the northeast corner, pictured in Figure 362, above. (Photo: Robert Fletcher 2004-2005)

The excavation of the east corridor as part of Operations 102 and 107 in field season 6 revealed well-preserved areas of the original finish on both the main enclosure and perimeter walls in this area. The niched or "palace" façade of the main enclosure, as well as the interior side of the perimeter wall, had been plastered and whitewashed. For the first 13 or so meters of the east corridor, the original Dynasty 2 mud plaster floor was not preserved, with the exception of a small patch in the middle of this area. From the 13-meter point southward, however, the floor was essentially preserved.

In the part of the east corridor excavated as Operation 102, the niched façade and original plastered and whitewashed finish of the main wall were well preserved. In several locations, drips and runs of red paint were found on the lower parts of the wall (Figures 364 and 365). This demonstrates that red color was used to decorate some part of the wall above, although the decoration itself is no longer preserved. Similar evidence was found in field season 7 in the south corridor (see below). The use of red color is also attested in the Peribsen enclosure (see below), as well as in the main enclosure of king Aha of Dynasty 1.

The north corridor and northern exterior area of the enclosure were excavated as Operations 124, 134, 135, 139 and 140 in field seasons 6 and 7. In the north corridor, excavation revealed that the original Dynasty 2 mud floor of the corridor had been systematically trenched by earlier excavations, presumably those of Ayrton (Figure 366). The façade of the north main enclosure wall, as revealed in the perimeter corridor, retained a significant amount of its original plaster finish, although this appears to have suffered significant losses after exposure by the earlier excavations (Figure 367). The plastered surfaces of the pilasters and niches show numerous horizontal sand lines, which probably illustrate the gradual buildup of wind-deposited sand and mudbrick erosional debris in the north corridor (Figure 368). These sand lines are either not present at all or else are not nearly as pronounced in other locations. Given that they are probably related to the moisture content of the sand surface, they may be more pronounced here given the length of time each day that the lower part of the north perimeter corridor is in shade, which may have allowed the sand surface to remain moist longer than was possible elsewhere.

Operation 124 explored the exterior area of the gateway through the north perimeter wall and also exposed part of the adjacent east gateway of the Peribsen enclosure (Figure 369). Situated between the Peribsen gateway and the north perimeter wall of the Khasekhemwy enclosure was a very large deposit of offering pottery, almost exclusively consisting of "beer" jars. Many seal impressions were found in this deposit, some with the Dynasty 2 royal names Peribsen and Sekhem-ib, which indicate that the deposit is to be associated with Peribsen's, rather than Khasekhemwy's, enclosure. The exterior side of the north perimeter wall has a thin mud plaster floor that extends 1-2m out from the wall. This floor runs *over* the south margins of the pottery deposit, confirming that the deposit predates the enclosure of Khasekhemwy, or at least the construction of the perimeter wall. As found, the top of the pottery deposit is more than one meter higher than the adjacent exterior floor of the Shuneh. Thus, the upper part of the deposit must have been at least partially visible at the time of the construction and use of Khasekhemwy's enclosure.

Figure 364. Detail of the excavated area in Operation 102 at the base of a niche on the façade of the east main enclosure wall; note especially the drops of red-orange pigment on the white plaster at bottom, which indicate original red-painted decoration on the wall above. (Photo: Robert Fletcher 2004-2005)

Figure 365. Detail of the red paint revealed in Operation 102 on the east main enclosure wall. (Photo: Robert Fletcher 2004-2005)

Figure 366. The excavated area of the north corridor in field season 7; the regular pitting appears to be the result of earlier excavations in this area. (Photo: Jason Goodman 2005-2006)

Figure 367. Detail of the niched design and preserved plaster finish on the lower portion of the north main enclosure wall during excavation of the north corridor; one section of the Dynasty 2 floor appears to have been left intact at this location, covered by mudbrick erosional debris. (Photo: Jason Goodman 2005-2006)

Figure 368. Detail of sand lines on the preserved finish of the north main enclosure wall, during excavation. (Photo: Jason Goodman 2005-2006)

Figure 369. The excavated area of Operation 124 outside the north gateway area of the enclosure; note the large deposit of offering pottery situated between the north perimeter wall (at left) and the east gateway area of Peribsen's enclosure (at right). (Photo: Robert Fletcher 2004-2005)

Excavation in field season 7 reached the level of the exterior mud floor of Khasekhemwy's enclosure in the corridor-like space between the north perimeter wall and the south wall of the Peribsen enclosure. This floor was found trenched in a manner similar to the adjacent north corridor (Figure 370). In a number of instances, lines of bricks had been dry-laid between the north perimeter wall and the south Peribsen wall, presumably to keep sand from pouring into the trenches during Ayrton's excavations. Although they damaged this important original feature of the Khasekhemwy complex, the cuts through the floor revealed important information about the construction of the floor and perimeter wall, as well as the stratigraphic relationship between the north perimeter wall and the Peribsen enclosure (Figure 371). The mud floor associated with the perimeter wall was laid down atop a layer of sand and brick debris as much as 25cm thick that had itself been deposited over the original exterior floor of the Peribsen enclosure, which appears to have consisted primarily of thin brown mud plaster laid directly on the hard-packed natural sand surface.

Like all known Early Dynastic royal cultic enclosures at Abydos, the enclosure of Peribsen had a niched façade and a gateway at the southeast corner. This part of the Peribsen enclosure was previously excavated by Ayrton in 1902-1903, as well as by the Pennsylvania-Yale Expedition in 1988. Careful examination of the walls of this enclosure in field seasons 6 and 7 revealed that, unlike all earlier known enclosures, that of Peribsen was whitewashed. The whitewash appears to have been thinly applied directly on grey-brown mud plaster. This differs from the Shuneh in that the latter has a thin coat of buff-colored gypsum plaster as a base for its white finish, which was applied over a thicker layer of grey-brown mud plaster. The exterior side of the Peribsen enclosure wall and the interior side of the gateway chamber bear clear traces of a 10cm wide horizontal red stripe, slightly less than one meter above the base of the wall. The red painted stripe was applied on top of the wall's whitewash. The use of red in wall decoration is paralleled in the traces red pigment found in the enclosure of Khasekhemwy. Peribsen's enclosure is unusual in that its walls, on average only 1.5m thick, are significantly thinner than those of any of the other known royal enclosures at Abydos.

The Peribsen enclosure, like that of Khasekhemwy, had a gateway in its southeast wall. Ayrton's 1904 plan shows an opening in the southeast wall, but it was not certain until the excavations of field season 7 (2005-2006) whether this was an original feature or a gap in the masonry resulting from damage to the wall. The enclosures of Khasekhemwy and Peribsen are the only two known to have such gateways, and this feature may have been an innovation of Dynasty 2, when other modifications were made to the design of the royal enclosures.

In the interior of the Peribsen enclosure, excavation revealed large deposits of brick debris against the wall. This debris is clearly the result of the deliberate demolition of the enclosure wall. All other known enclosures at Abydos, apart from the enclosure of Khasekhemwy, appear to have been deliberately demolished, and the situation at the Peribsen enclosure generally fits this overall pattern.

The relationship between the Khasekhemwy and Peribsen enclosures may be illuminating as to the history of the later monument. Figure 317 (above) demonstrates that the line of the north perimeter wall is slightly askew from the adjacent north main enclosure wall. It appears that the line of the north perimeter wall was shifted to fit it into the space between the main enclosure and the south wall of the Peribsen enclosure. Excavations in Operations 102 and 114 in field season 6 (see Figure 317, above) found evidence that the perimeter wall of Khasekhemwy's enclosure may have been a secondary feature added to the monument some time after construction began on the main enclosure. The arrangement of the walls on the north side of the monument appears to support this suggestion.

Figure 370. The excavated area of the north corridor and northern exterior area adjacent to the enclosure of Peribsen (facing northeast); note the trenching of the corridor between the north perimeter wall and the Peribsen enclosure (at center). (Photo: Jason Goodman 2005-2006)

Figure 371. Stratigraphic profile of the preserved deposits in the area between the north perimeter wall and the south wall of the Peribsen enclosure (at right); the perimeter wall was constructed in a foundation trench, which was subsequently filled with brick debris (noted as location A, at lower left); the exterior floor level of the Shuneh is noted as location B (at left) and the top of the exterior mud floor of the Peribsen enclosure is located just below the sand and gravel lens noted as location C (at right). (Photo: Jason Goodman 2005-2006)

The two northernmost monastic cell voids in the west main enclosure wall were excavated in field season 5 as Operations 100 and 101 (see Figure 317, above). Work in Operation 100 revealed that, while the primary void in the masonry of this area was created by the removal of brickwork to create a cell in the wall during the late antique occupation of the Shuneh, very little of the fabric of that cell remains. Only a pivot stone for a wooden door, a very small area of lime plaster, and a slightly larger area of mud plaster floor are preserved in what would have been the south interior corner of the cell, adjacent to the position of the entrance to the cell (Figure 372). They indicate that this cell was originally similar in layout to other cells in the west main enclosure wall, with a doorway in the front and a floor covered in fine lime plaster. Judging from the present size of the void in the masonry of the wall, its original size was approximately 3.5 x 2m in plan. The cell appears to have been mostly destroyed by the excavation of a large pit that removed the floor of the cell and the underlying brick masonry of the main enclosure wall (Figures 373-376). This pit cut not only through the wall, but more than one meter into the sterile natural sand and gravel deposits under the wall of the enclosure. The pit was filled with a deposit consisting of a mixture of brick debris and sand, with a large number of pieces of lime plaster that almost certainly represent fragments of the destroyed floor and side walls of the cell. After the pit stood open for some time, a horse was buried in it, covered by a layer of loose mudbricks (see Figure 373). No artifacts were found in the pit or with the horse skeleton to determine the date of either the cutting of the pit or the interment of the horse. It is highly likely, given similar pits at the northeast and southwest corners of the enclosure, that the pit was cut in the 19th Century by one of the early excavators at the site of Abydos (most likely Mariette), who, lacking information about the date or purpose of the monument, may have been looking for foundation deposits under the corners.

Work in Operation 101 revealed the remains of a second late antique cell in this area (Figure 377). Measuring approximately 3.75 x 2m in plan, the basic outline of this cell was better preserved than the cell that was excavated in Operation 100. Though completely collapsed, the ceiling of this cell can be estimated from traces of wall plaster to have been approximately 1.9m high. The front wall of the cell was formed by original masonry that was left in place when the void for the cell was excavated into the mass of the wall. Like the cell excavated in Operation 100, access to the interior of cell excavated in Operation 101 was gained by means of an entrance at its southern end. At this entrance was a door pivot, and just inside, a small ceramic bowl was set into the floor. The floor and the lower parts of the walls were covered in a smooth white lime plaster, and, where preserved, the upper parts of the cell's walls were finished in a light brown mud plaster. At the northwestern end of the cell, there was once a raised sleeping platform, similar to one excavated in field season 4 in the west perimeter wall (see below). The platform has been completely destroyed, but its position and size could be determined from the preserved plaster on the floor and adjacent wall. On the inner face of the exterior, southwest wall of the cell, some of the original finish of white lime plaster was preserved. Its upper edge, which bore traces of red line decoration, was found to be extremely fragile and was delaminating. Because of the significance of the traces of decoration, measures were taken to stabilize the edge of the plaster. After careful cleaning, a solution of Acryloid B-72 was injected into the mud-plaster backing of the lime-plaster finish, and, finally, a putty consisting of a mixture of lime and sand was applied to provide physical protection to the exposed plaster edge (Figures 378 and 379).

Excavation in Operation 101 also revealed fragments of fallen wall plaster mixed into the decayed mudbrick and mudbrick debris on the floor of the cell, some of which bore traces of black line decoration. This deposit was left *in situ* in field season 5 to be consolidated in field season 6 by the project's archaeological conservators, after which it was removed for further cleaning and conservation in the field lab (Figures 380 and 381). Most of the decoration appears to be abstract, rather graffito-like in character, although some recognizable design elements are present, including what appears to be a representation of the sun with rays emanating from it. The decorated plaster almost certainly fell from the interior face of the front wall of the cell, just above where it was found. Once the fallen, decorated wall plaster was removed, the remaining original features of the cell, including the plastered floor and walls, were fully revealed, permitting full architectural documentation preparatory to stabilization (Figure 382). The configuration of the cell excavated in Operation 101, which is paralleled in other cells throughout the enclosure, provides very clear evidence for the process of cell construction. Removal of the fabric of the wall began with the cell doorway. Working through this narrow entrance, additional masonry was removed until the entire space for the cell was created. A bench of original masonry was left at the northwestern end of the cell, to form the sleeping platform. The entire cell was then smoothed with a coating of mud plaster, and the floor, bench and lower part of the walls were finished with fine lime plaster.

Figure 372. The excavated area of Operation 100, on the northern, exterior side of the west main enclosure wall; the only preserved monastic features at this location are the small fragments of lime plaster and underlying mud plaster visible at lower right, along with a circular depression in the floor that once held a small ceramic bowl. (Photo: Matthew Adams 2004)

Figure 373. The excavated area of Operation 100, which revealed a horse burial in the fill of the pit that was cut into the main enclosure wall below the monastic cell cavity at this location. (Photo: Matthew Adams 2004)

Figure 374. The fully excavated area of Operation 100, which exposed the sterile sand deposits below the base of the wall. (Photo: Matthew Adams 2004)

Figures 375, 376. Two details of the base of the main enclosure wall, and the compact sand deposit upon which it was constructed, from below the hole at the northwest corner pictured in Figure 374, above. (Photos: Matthew Adams 2004)

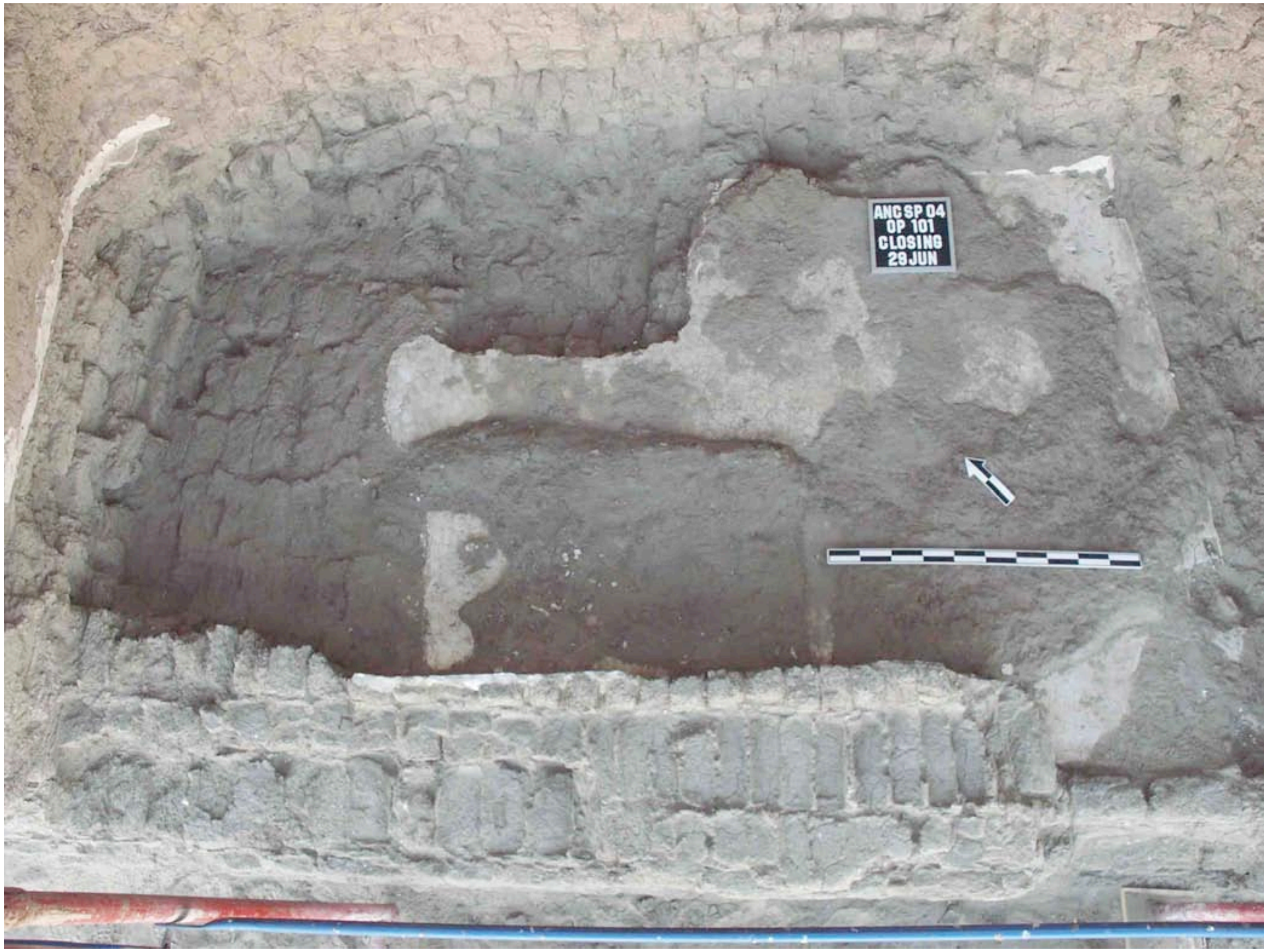


Figure 377. The excavated area of Operation 101, on the northern, exterior side of the west main enclosure wall. (Photo: Matthew Adams 2004)

Figure 378. Stabilizing the mud plaster behind the lime wall plaster of the monastic cell excavated in Operation 101 with a solution of Acryloid B-72. (Photo: Jennifer Lavris 2004)

Figure 379. Backing the delaminated edge of the wall plaster in the monastic cell excavated in Operation 101 with a lime-sand mixture. (Photo: Matthew Adams 2004)

Figure 380. The excavated area of Operation 101; note the deposit of mudbrick debris on the floor of the cell, which contains fragments of fallen, decorated wall plaster. (Photo: Matthew Adams 2004)

Figure 381. Fragments of decorated wall plaster excavated in Operation 101, after consolidation and removal; the decoration was in black line, probably charcoal, and was primarily abstract in design. (Photo: Robert Fletcher 2004-2005)

Figure 382. The fully excavated area of Operation 101, in preparation for architectural stabilization; the line of white plaster on the wall at left marks the rear of a bench or platform, probably for sleeping. (Photo: Robert Fletcher 2004-2005)

The west gateway area of the main enclosure was excavated as Operation 105 in field season 6 (Figures 383-390). Like the other gateways, the west gate consisted of an opening through the main enclosure wall and a corresponding opening through the perimeter wall. The opening in the main wall was integrated into the niched façade, and, with set back reveals on each side, was designed like the more elaborate "complex" niches on the northeast façade of the main enclosure. The opening itself was approximately 1.05m wide, or two cubits. Damage on the interior side of the gateway makes it impossible to be certain whether there was any elaborate treatment of the opening on that side (see Figure 390), although the design of the other gateways in the enclosure, as well as examples in other earlier enclosures at Abydos, suggest there probably was not. Two stones found on the southern, interior side of the gateway may have together served as a pivot for a wooden door.

In the corridor area adjacent to the west gateway, the lines and original finish of the façade were well preserved along the wall base excavated in Operation 105 (see Figure 389). The west corridor was found to have intact floor-level deposits dating to Dynasty 2, which consisted of very thin mud plaster over a mixed sand and brick debris deposit- very different from the heavy mud plaster floor in the east corridor. Only fragments of the mud plaster floor were preserved in the gateway opening, along the southern side, although the underlying deposit of sand and brick debris was preserved throughout. Inside the gateway, this deposit was put down over the brick footing of the wall, which ran continuously under the gateway (see Figure 388). On the interior side of the enclosure, adjacent to the west gateway, very little of the Dynasty 2 floor was preserved due to heavy disturbance by later pitting for sacred ibis burials (see discussion of the interior, above).

Monastic cells had been cut into the main enclosure wall on both sides of the west gateway opening, during the late antique occupation of the monument (see Figures 384 and 387). These were mostly destroyed, but the lime plaster floor and lower portions of three of the walls in the northern cell were preserved. The preserved plaster surfaces were covered by a deposit of brick debris, and fallen wall fragments were found that bore inscriptions in Coptic (see Figure 385). As in other cells, the edges of the preserved plaster were very fragile, and these were consolidated by the project's archaeological conservators to protect the plaster during the excavation and architectural documentation of the area. Traces of white plaster at the northern end of this cell indicate a niche with a sleeping platform (see Figure 386). A low bench was built against the bottom of the west side wall. The configuration of the plaster at the southern end of the preserved part of the floor indicates that the entrance to the room may have been from the southwest side, through the exterior face of the enclosure wall. The cell on the southern side of the gateway had been almost entirely destroyed. All that remained was a patch of thick mud plaster that had been applied to the floor of the hole dug into the wall for the cell, which represents either the floor surface or a base onto which a finish layer of white plaster would have been applied. The construction of these cells adjacent to the gateway created significant structural weakness and contributed to the loss of a large segment of the main enclosure wall in this area.

Figure 383. The west gateway area of the enclosure, prior to excavation as Operation 105 (see details, below). (Photo: Robert Fletcher 2004-2005)

Figure 384. The northern side of the west gateway area excavated in Operation 105, which revealed the plastered floor and walls of a monastic cell in this area. (Photo: Robert Fletcher 2004-2005)

Figure 385. Detail of wall plaster fragments with Coptic inscriptions excavated in Operation 105. (Photo: Robert Fletcher 2004-2005)

Figure 386. The northern side of the west gateway area fully excavated in Operation 105. (Photo: Robert Fletcher 2004-2005)

Figure 387. The southern side of the west gateway area excavated in Operation 105, which revealed the mud plaster floor of a second monastic cell in this area. (Photo: Robert Fletcher 2004-2005)

Figure 388. The interior passage of the west gateway area excavated in Operation 105, which revealed that the base course (foreground) was laid continuously, with the gateway opening laid out in the second course; the small patches of mud along the southern side of the passage (at left) represent the Dynasty 2 mud floor. (Photo: Robert Fletcher 2004-2005)

Figure 389. The exterior side of the west gateway area fully excavated in Operation 105, which reached the level of the Dynasty 2 floor in the west corridor (through center) and revealed what remains of the original façade of the enclosure in this area. (Photo: Robert Fletcher 2004-2005)

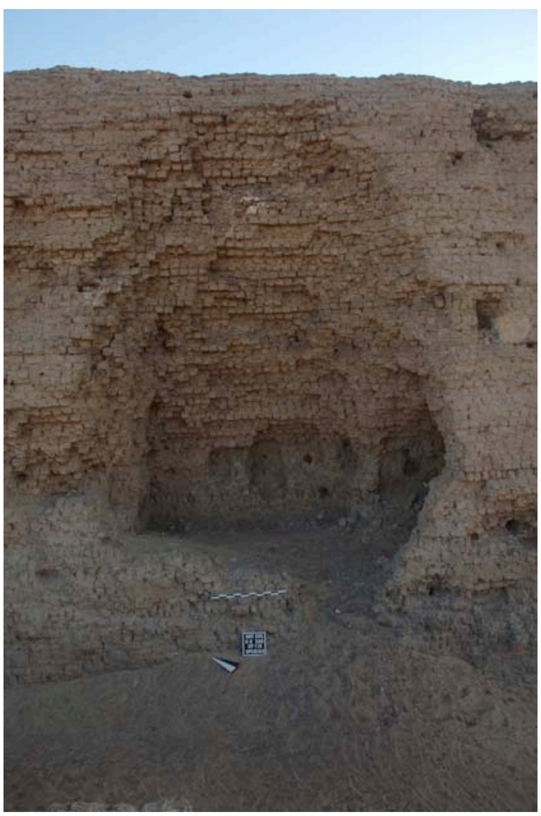
Figure 390. The interior side of the west gateway area fully excavated in Operation 105; note the two stones on the southern side of the gateway passage (lower left), slightly displaced from their original position, which, together, may have acted as a pivot for a wooden door. (Photo: Robert Fletcher 2004-2005)

The remains of four monastic cells cut into the southern, exterior side of the west main enclosure wall were excavated as Operations 119, 120, 121 and 122 in field season 6 (see Figure 317, above). The largest of these cells, excavated as Operation 119 (Figure 391), consisted of a main chamber and smaller ancillary chamber on the southeast side. The larger main chamber had a floor and walls finished in white lime plaster. There was a set of three niches in the northeast wall, a larger central one, with two smaller niches on each side, and a single small niche in the northwest wall. It had low lime-plastered benches along three sides (northwest, southwest, and southeast) but does not appear to have had a bed niche. Like the cells excavated in Operations 100 and 101, the entrance was at the southeastern end of the southwest side, and the front wall was original masonry left in place when the cell was dug into the main enclosure wall. The use of a wooden door is confirmed by the presence of a small stone door pivot set into the floor. The smaller chamber on the southeast side was entered by a doorway in the side wall of the cell. This doorway had a raised threshold, covered in mud plaster, and the floor and walls of the room were finished in mud plaster as well. There was a small niche in the northeast wall of the smaller chamber and a larger niche in the southeast wall.

The cell excavated as Operation 120 (Figures 392-394) also consisted of two chambers, but in this instance the side chamber was quite small, and its floor was elevated above the floor level of the main chamber. The main chamber in Operation 120 originally had a white, lime-plaster floor, but only a small area in the northwestern half of the room was still preserved. The walls appear to have been finished in brown mud plaster. There were three niches in the rear, northeast, wall, a larger central niche, with smaller ones on each side (see Figure 394), as well as a small niche on the northwest side, adjacent to the opening into the small side chamber. Like the cells excavated in Operations 101 and 119, the front wall consisted of original masonry left in place at the time the cell was constructed. The door was at the southeast end of the southwest side of the cell. A low bench, covered in lime plaster, was constructed along the southwest side. There does not appear to have been a bed niche. The small side chamber, cut into the wall on the northwest side, does not appear large enough to have functioned as a sleeping or living space and may have been for storage.

The excavated area of Operations 121 and 122 represents two adjacent cells (Figure 395). The larger of the two, excavated as Operation 121, consisted of a single chamber with lime-plastered floor and walls (Figures 396-398). The white plaster appears to have been applied only to the lower parts of the walls, and, where the edge is preserved, there are traces of a red painted border, a feature also seen in the cell group excavated in the west perimeter wall (see below). The floor plaster in the southeast end of the cell appears to have been patched at some point, and the boundary between the original floor plaster and the patch is easily distinguishable. Remains of a raised sleeping platform were found at the northwest end, and low benches along the southwest and southeast sides. A set of three niches, one larger and two smaller, were cut into the rear, northeast, wall, and there were traces of two other small niches in the southeast wall. The front, southwest, wall consisted of original masonry, and the door was at the southeast end of the southwest side of the cell. At the southeast end of the northeast side of the cell were traces of drawing in black line on the white wall plaster. The drawing does not appear to be figural, but rather a geometric hatching design. A large pit had been dug through the floor of the cell and well into the masonry below, destroying the sleeping platform and half of the floor of the cell. It is unknown whether this pit relates to those found in the excavated areas of Operations 100 and 108.

The cell excavated as Operation 122 was much smaller than the cell excavated in Operation 121 (Figures 399 and 400). It does not appear to have had a sleeping platform, and the arrangement of several small niches in the rear, northeast wall is unusual, with the addition of two smaller niches below the eroded remains of the set of three. The white plastered floor was well preserved, and there was a low bench along the southeast side. This cell did not penetrate as deeply into the thickness of the enclosure wall as most others, and nothing was preserved of its front wall, which may have been constructed in front of the cell cavity in the west corridor, rather than consisting of original masonry. Adjacent to both cells excavated in Operations 121 and 122, deep niches were cut into the masonry of the enclosure wall. These probably represent the rear parts of ancillary spaces associated with the two cells that were built up against the face of the wall in the west corridor.



Figures 391, 392. Two monastic cells in the southern, exterior face of the west main enclosure wall, prior to excavation as Operations 119 (left) and 120 (right); note the remains of three niches in the eroded rear wall of the cell at left. (Photos: Robert Fletcher 2004-2005)

Figure 393. Remains of the cell floor excavated in Operation 120. (Photo: Robert Fletcher 2004-2005)

Figure 394. Set of three niches in the northeast wall of the cell excavated in Operation 120. (Photo: Robert Fletcher 2004-2005)

Figure 395. Rectified photoelevation of two monastic cells in the southern, exterior face of the west main enclosure wall, prior to excavation as Operations 121 (left) and 122 (right). (Photoelevation: Heritage 3D, Inc. 2001)

Figure 396. Detail of the cell area excavated in Operation 121 on the exterior side of the west main enclosure wall, facing northeast; note the preserved remains of three niches in the rear wall. (Photo: Robert Fletcher 2004-2005)

Figure 397. Interior detail of the monastic cell excavated in Operation 121; note the doorway to the cell at lower right, where the original masonry of the west wall was removed to create a space for the cell within. (Photo: Robert Fletcher 2004-2005)

Figure 398. Interior detail of the monastic cell excavated in Operation 121; note the preserved area of wall plaster, with a red upper border, at lower right, above which the cell was finished in brown mud plaster, and the preserved patch of mud plaster at upper left, which likely indicates the original height of the cell. (Photo: Robert Fletcher 2004-2005)

Figure 399. Detail of the cell area excavated in Operation 122 on the exterior side of the west main enclosure wall, facing northeast; note the preserved edges of the plastered floor and walls, and the niches in the rear wall (Photo: Robert Fletcher 2004-2005)

Figure 400. Interior detail of the monastic cell excavated in Operation 122; this cell is smaller than most others and is also unusual in the number of niches in the rear wall, with two small niches below the usual set of three. (Photo: Robert Fletcher 2004-2005)

The exterior side of the west perimeter wall was excavated in Operations 45, 50, 51, 52, 56, 57, 58 and 59, during field season 4 (see Figure 317, above). The excavated area of Operations 45 and 50 revealed a general denudation along the exterior side of the wall, however a thick deposit of fallen mudbrick was found immediately adjacent to the wall (see Figure 61, above). This debris represents the ancient collapse of a large section of the upper part of the west perimeter wall. Removal of this deposit revealed that the perimeter wall in this area was constructed on top of rather loose wind deposited sand, rather than on the compact desert substrate or “gebel,” as in other parts of the monument, which may have contributed to the early collapse of this portion of the perimeter wall.

Excavation in Operations 50 and 51 determined that the stability of a significant section of the west perimeter wall, between the brick deposit mentioned above and the suite of rooms described below, has been seriously compromised by animal burrows and localized collapses relating to these burrows. Due to the instability of the wall, it was determined that excavation should not proceed in this area, and that a temporary stabilization solution would be required before the lower part of the perimeter wall may be exposed and studied. This area remains unexcavated and will be addressed in a future season.

Excavation in Operations 51 and 52 revealed a well-preserved suite of small rooms that had been partly excavated into and partly built up against the exterior face of the west perimeter wall (Figures 401 and 402). Based on the associated ceramics, the construction of these rooms dates to the Late Roman/Byzantine period, indicating that they are contemporary with other modifications to the Shuneh during the monastic occupation of the monument.

There was a single entrance to the preserved part of the complex, at its west corner. The entrance opened onto the largest of the spaces, noted as Room 1. The northwest part of Room 1, comprising a well-defined path between the entrance and the opening to Room 2, was paved with flat pieces of limestone. At least two of these bore traces of hieroglyphic inscriptions and appear to be reused fragments of stelae or architectural elements from an earlier period. The remainder of Room 1 was floored with mud plaster. A small window in the wall separating Room 1 from Room 3 may indicate that Room 1 functioned as an unroofed, walled courtyard leading into the complex.

A special function for Room 2, perhaps involving liquids, is probably to be seen in the stone paving of the approach, the stone threshold at its entrance, and the stone paving of the room itself. A low mud curb at the northwest edge of the stone paving in Room 2 divides the main part of the room from two small bin-like features, floored in mud, built against the rear wall. There was a small niche in the northeast wall of Room 1 adjacent to the entrance to Room 2. The floor of Room 2 was found covered in broken pottery. In the southwest wall of Room 2, just inside the entrance, was a blocked doorway, indicating that earlier in its use this space connected with another room to the southwest, of which little is preserved.

The main room of the complex, noted as Room 3, was entered from Room 1 via an elaborate doorway. The walls on either side of the doorway were covered in the fine white lime plaster frequently seen in features of this period at the Shuneh, while the remaining walls of Room 1 were coated in brown mud plaster. In front of the doorway opening was a high curb, also covered in lime plaster (Figure 403). The floor between this curb and the lime-plastered threshold of the doorway opening was paved with pieces of limestone. Inside Room 3, the floor and the lower parts of the walls were covered with fine white lime plaster, while the upper parts of the walls were covered in brown mud plaster (Figures 404 and 405). The border of the lime plaster was marked with a single red painted band. In the rear (northeast) wall of this room, a small niche had been cut into the wall, which had also been covered in the same fine white lime plaster as the walls and floor. On the rear wall of this niche were traces of black paint, and at the front (just at the transition from the horizontal floor of the niche to the vertical face of the wall below) was a band of decoration with a red floral or garland motif between two thicker red lines. Below the niche is a small red cross with a short Coptic inscription just above it (Figure 406), which reads:

ⲡⲓ̈ⲱⲧ ⲡϣⲏⲣⲉ ⲡⲉⲡ̅ⲡ̅ⲛ̅ⲁ ⲉⲧ ⲟⲩⲁⲁⲃ ⲡⲥ̅ⲱⲧⲏⲣ ⲓ̅ⲥ̅ ⲡⲉⲭ̅ⲥ̅ ⲡⲉ̅ⲛ̅ϫ̅ⲥ̅

“The Father, the Son, the Holy Spirit, the Savior, Jesus Christ, our Lord.” It may be significant that the window in the southwest wall of Room 3 is directly opposite this niche.

Two other small niches were present in the walls of Room 3. One was cut into the east corner, and the other into the southeast wall. Both of these niches were well above the top of the white lime plaster and were themselves mud plastered.

On the northwest side of Room 3, a large niche had been cut into the brickwork of the west perimeter wall, and the walls and floor of the niche were covered in brown mud plaster (Figure 407). The niche appears to have functioned as a sleeping platform, and there is a raised mud plaster “pillow” at the southwest end. This bed niche was a secondary feature in the room. Earlier in its use, the northwest wall of Room 3 appears to have been at the line of the lime plaster front of the bed platform. Originally, this wall had a much smaller lime-plastered niche built in it, outlined with bands of red paint, as were other lime-plastered features in the room. This earlier niche appears to have been for a seat, and the three sides, as well as the bottom surface, all show stains on the plaster that recall the shape of cushions. The stains might be from some adhesive used to attach cushions or pads to make sitting in the niche more comfortable. In the reconfiguration of Room 3, the original seat niche was filled with dry-laid bricks, the upper part of the wall was cut back, and the entire area was covered with mud plaster to create the finished bed niche or sleeping platform (Figures 408-410).

Against the bases of the southwest and southeast walls of Room 3, low flat-topped benches were built and plastered apiece with the floor and walls (see Figures 402 and 405). The lime wall plaster above each of these benches was heavily discolored, and it is tempting to see this as the result of people sitting on the benches and leaning back against the adjacent wall. The general configuration of the room in its initial phase, with an elevated seat in the northwest wall and lower benches along the southwest and southeast walls, may relate to the authority structure of the monastic community occupying the Shuneh. The floor of Room 3 was found covered by brick debris from the collapse of the roof and the upper parts of the walls, but was virtually clean of artifacts. There was a stone door pivot just inside the doorway, indicating the presence of a wooden door.

Southeast of Rooms 1 and 3 were two smaller chambers, noted as Rooms 4 and 5 (see Figure 402). Room 4 served as an anteroom to Room 5, and both were entirely finished in brown mud plaster. Room 4 had a low bench covered in mud plaster built along its southeast wall, and Room 5 had a small niche in the southeast wall, into which a large ceramic vessel was set. This room also had a stone door pivot just inside the doorway, indicating the location of a wooden door. Another small store, noted as Room 6, opened off from Room 4.

The denuded remains of additional spaces, perhaps two or three more rooms, were found on the exterior side of the southwest wall of Room 1. The suggestion of additional rooms is supported by evidence that the wall between Rooms 1 and 4 appears to have extended beyond the face of the outer wall of Room 1, dividing additional spaces on the southwest. These spaces may have been floored in mud plaster, which is now mostly eroded away, leaving only the compact mudbrick debris that appears to have been put down as a base for those parts of the complex external to the perimeter wall. There is fire discoloration on both the southwest and southeast exterior sides of Room 4, suggesting that there were hearths or ovens in these locations. In addition, two small features or additional rooms were built against the face of the west perimeter wall southeast of Rooms 4 and 6.

The suite of rooms excavated in Operations 51 and 52 were apparently abandoned for some time before the collapse of the original masonry that would serve as the ceiling in Rooms 3 and 5. The floors in both rooms were relatively clean of artifacts, and a thick deposit of wind-blown sand, containing a significant amount of probably wind-borne organic material, had accumulated in both spaces prior to the collapse of the brickwork above. This sand deposit, which was capped by dense mudbrick debris, along with the surrounding mass of the perimeter wall, served to seal and protect the underlying strata and features resulting in an excellent state of preservation. The spaces built up against the exterior face of the west perimeter wall (Rooms 1, 2 and 4) were much more exposed to the strong northerly and westerly winds that blow much of the year along the west side of the enclosure, and were consequently much more denuded than the inner rooms.

Figure 401. The excavated area of Operation 52 on the exterior side of the west perimeter wall, which revealed a suite of rooms dating to the Late Roman/Byzantine period of monastic occupation at the Shuneh. (Photo: Robert Fletcher 2001-2002)

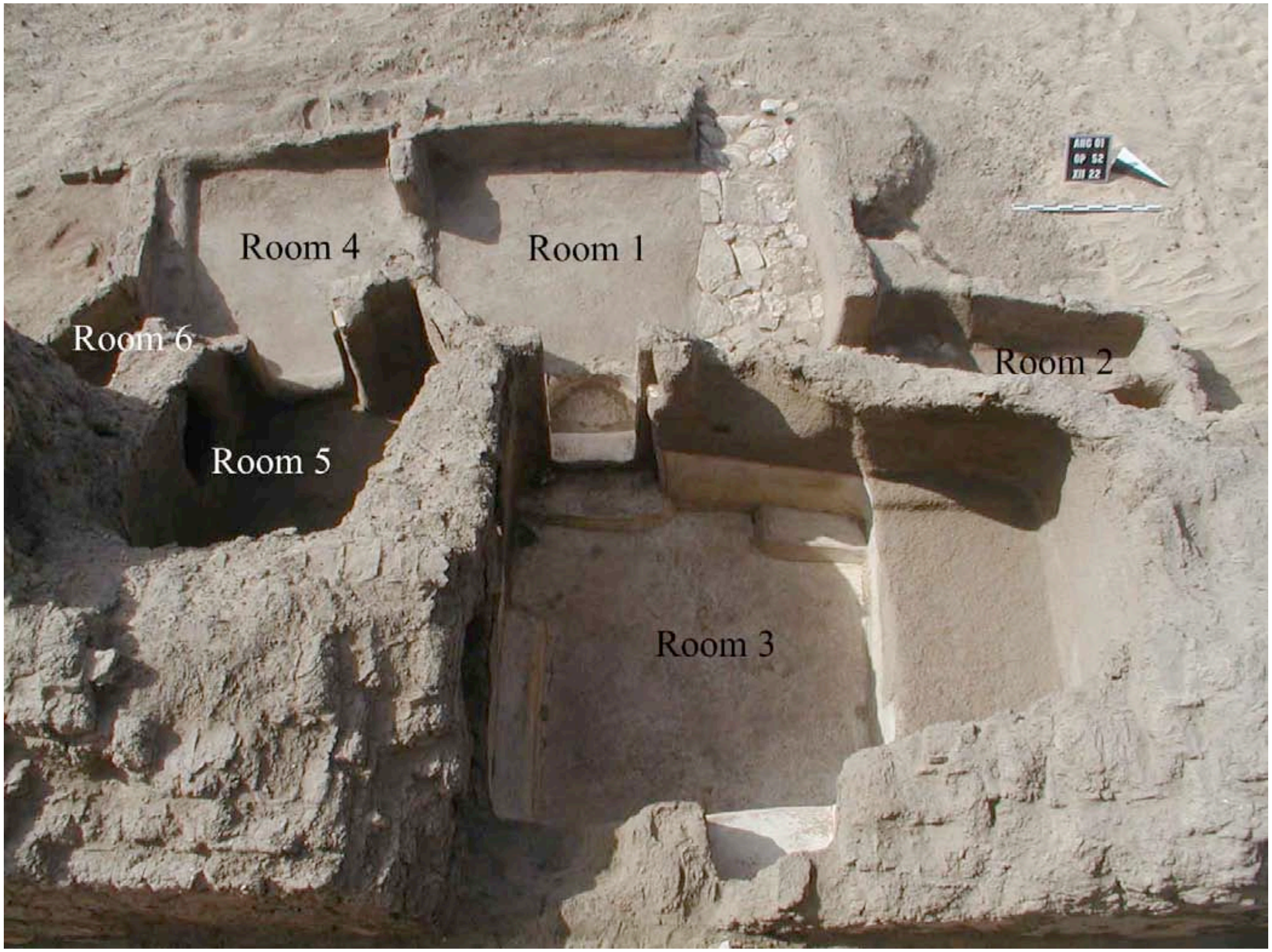


Figure 402. Detail of the monastic features (noted as Rooms 1-6) excavated in Operation 52 on the exterior side of the west perimeter wall. (Photo: Robert Fletcher 2001-2002)

Figure 403. Interior detail of the monastic complex excavated in Operation 52; note the well-preserved gypsum plaster on the walls and floor, and the remains of the high curb in front of the doorway to Room 3. (Photo: Robert Fletcher 2001-2002)

Figure 404. Interior detail of Room 3 in the monastic complex excavated as Operation 52, facing east; note the plastered niche in the northeast wall (at left) and the remains of a mud-plastered niche in the southeast wall (at right). (Photo: Robert Fletcher 2001-2002)

Figure 405. Interior detail of Room 3 in the monastic complex excavated as Operation 52, facing southeast; note the well-preserved plaster on the lower parts of the walls and floor, and the red painted band at the edge of the plaster, above which the room was finished in brown mud plaster. (Photo: Robert Fletcher 2001-2002)

Figure 406. Detail of the painted decoration and Coptic inscription below the niche on the northeast wall of Room 3, pictured in Figure 404, above; the inscription reads:

ⲡⲓ̄ⲱⲧ ⲡϣⲏⲣⲉ ⲡⲉⲡ̄ⲡ̄ⲛ̄ⲁ ⲉⲧ ⲟⲩⲁⲁⲃ ⲡⲥ̄ⲱⲧⲏⲣ ⲓ̄ⲥ̄ ⲡⲉⲭ̄ⲥ̄ ⲡⲉ̄ⲛ̄ϫ̄ⲥ̄
("The Father, the Son, the Holy Spirit, the Savior, Jesus Christ, our Lord.")

(Photo: Robert Fletcher 2001-2002)

Figure 407. Detail of the bed niche platform in Room 3 of the monastic complex excavated in Operation 52; note the remains of an earlier "seat" niche in the gypsum-plastered face of the bed platform (at center). (Photo: Robert Fletcher 2001-2002)

Figure 408. Detail of the partially excavated seat niche in Room 3, pictured in Figure 407, above; note the bricks that were used to fill the niche, covered by mud plaster. (Photo: Robert Fletcher 2001-2002)

Figure 409. Second detail of the partially excavated seat niche in Room 3, pictured in Figure 407, above. (Photo: Robert Fletcher 2001-2002)

Figure 410. Detail of the fully excavated seat niche in Room 3, pictured in Figure 407, above; note the painted red band decoration, and the imprints of what appear to have been some sort of cushions on the seat, sides and back. (Photo: Robert Fletcher 2001-2002)

Additional significant features belonging to the Late Roman/Byzantine occupation of the monument, namely two cooking installations, were revealed on the interior side of the west perimeter wall in Operation 58. The smaller of the two installations was built into a cavity that was dug out of the perimeter wall, and which was apparently accessed directly from the west corridor (Figure 411). The installation consisted of a bench-like construction containing a single firing chamber accessed via a small opening in the front of the bench. There were two openings on the top of the bench for the placement of cooking pots. This cooking installation had been blocked up and plastered over, later transforming the top of the bench into the floor of a small room. No artifacts were preserved on this secondary surface to indicate what the purpose of the room might have been.

Just southeast of this feature, a second cooking installation was found built into the west perimeter wall, which consisted of a small room dug into the mass of the perimeter wall and separated from the perimeter corridor by a thin wall, through which a narrow doorway provided access (Figures 412 and 413). A brick and mud-built bench was constructed at the northwest end of the room, with two firing chambers created by the installation of large ceramic vessels into bench. The firing chambers were accessed by means of two small openings in the front of the bench, with two larger openings in the top of the bench for the placement of cooking vessels. At the rear corners of the bench top were two smaller openings, apparently for the control of airflow through the firing chambers. Sherds from broken ceramic vessels were used as stoppers for these openings, some of which were *in situ*. In front of the vertical face of the bench was a shallow trough, defined by a low mud curb parallel to the front of the bench. This may have served to trap hot ash and burning fuel when fires were stoked, or when the firing chambers were being cleaned. At the western corner of the room, against the base of the bench and meeting the curb of the ash-trough, was a raised area of mud plaster into which two small ceramic vessels were set. The purpose of these vessels is uncertain, though they probably served to contain substances frequently used during cooking.

In the excavated area of Operation 50, again on the interior face of the west perimeter wall, the remains of another cooking feature with two firing chambers were found. Only the bases of the firing chambers were preserved, which had originally consisted of two large ceramic vessels. This feature also had a shallow ash-trough in front of the openings to the firing chambers.

Other more ambiguous features, most likely belonging to the period of Late Roman/Byzantine activity at the Shuneh, were also revealed along the west perimeter wall (see Figure 317, above). In the excavated areas of Operations 50, 57 and 58, mud-plastered floors were found in several locations on the eroded wall top. In most instances, these appear to have been the floors of rooms excavated into the mass of the wall. With the erosion and collapse of the upper parts of the perimeter wall, the surrounding brickwork, which would have formed the sidewalls of these rooms, has been lost (Figures 414 and 415). The only evidence remaining that relates to the function of these rooms were traces of small hearths. Additionally, the bottoms of several narrow transverse "cuts" through the perimeter wall were revealed in Operations 50, 51 and 56. These appear to have been doorways or walkway openings of some sort, as they are too narrow to have been rooms.

The rooms and features in the west perimeter wall are an important contribution to the understanding of the late antique history of activity at the site. The presence of the cells in the west main enclosure wall have long been known and interpreted as evidence for the occupation of the monument by an early Christian monastic community (Ayrton et al. 1904; Mariette 1880a). Little was known, however, about the nature of this community. The discoveries made during field season 4 provide important new information on the nature of monastic occupation at the Shuneh during late antiquity. The configuration of Room 3 in the suite of rooms built into the west perimeter wall, with its elevated seat, floor benches, plastering and other decoration, suggests that it may have been for the use of the abbot or leader of the community. The cooking facilities built into the west perimeter wall were large enough to prepare a significant quantity of food, and they appear to represent communal cooking. This new information gives some indication of the organization of monastic life at the Shuneh in late antiquity.

In addition, it should be noted that the discovery of such well-preserved remains from the late antique occupation adds a significant new dimension to the stabilization and conservation agenda for the enclosure of Khasekhemwy. In some cases, the recently discovered features do not appear to present major structural risks to the monument, however in other instances, such as with the suite of rooms excavated in Operations 51 and 52, where substantial segments of the perimeter wall were removed for the creation of Rooms 3 and 5, current conditions present a significant structural risk (see Figures 401 and 402, above). At present, the entire suite of rooms cannot be left exposed because of potential damage to the rooms and features themselves, and because of the risk the voids represented by the rooms' interiors pose to the surrounding fabric of the perimeter wall. Consequently, a wall of sandbags was erected around the area of the complex at the end of field season 4. The rooms and the entire area defined by the sandbag wall were filled with clean sieved sand and this sand was capped with additional sand bags, to prevent the fill from blowing away. The structural risks posed by these rooms, as well as the conservation challenges presented by these and other similarly well-preserved late antique features at the Shuneh, will be incorporated into the project's long-range conservation planning.

Figure 411. The excavated area of Operation 58 on the interior side of the west perimeter wall, which revealed significant features of late antique occupation at the monument, such as this cooking installation (see also Figures 412 and 413, below). (Photo: Robert Fletcher 2001-2002)

Figure 412. The larger of two late antique cooking installations revealed by excavation in Operation 58 on the interior side of the west perimeter wall. (Photo: Robert Fletcher 2001-2002)

Figure 413. Interior detail of the large cooking installation pictured in Figure 412, above; note access to the two firing chambers through the openings in the front of the bench (at center), one of which was found still stoppered, and the two additional openings at the rear corners, which may represent flues for airflow. (Photo: Robert Fletcher 2001-2002)

Figures 414, 415. The remains of two of the poorly preserved rooms excavated in Operations 50, 57 and 58 on the top of the west perimeter wall in field season 4. (Photos: Robert Fletcher 2001-2002)

The west gateway area of the perimeter wall was excavated in Operation 56, during field season 4 (Figure 416). This gateway opening is aligned with the west gateway opening through the main enclosure wall. The west perimeter gateway is quite well preserved, despite the fact that the adjacent walls are preserved to a height of only 40cm. The mud floor of the gateway opening is partly preserved, and the sidewalls retain their original facing plaster and some whitewash. The floor in this area extends some meters west-southwest from the gateway. In the southwestern area of Operation 56, erosion and wind scouring have reduced the ground surface below the level of the Dynasty 2 floor, of which no traces were preserved.

Excavation in Operations 56, 57, 58 and 59 revealed the exterior face of the west perimeter wall down to its foundation course, and a few traces of the original facing plaster and whitewash were found in this area (Figure 417). In the excavated area of Operation 59, the northwest corner of the perimeter wall was exposed, and traces of a shallow foundation trench cut into the underlying compact gebel substrate were identified, which had been filled with broken bricks in antiquity. The remains of brick stacks, presumably left during construction, were found on both the north and west sides of the corner.

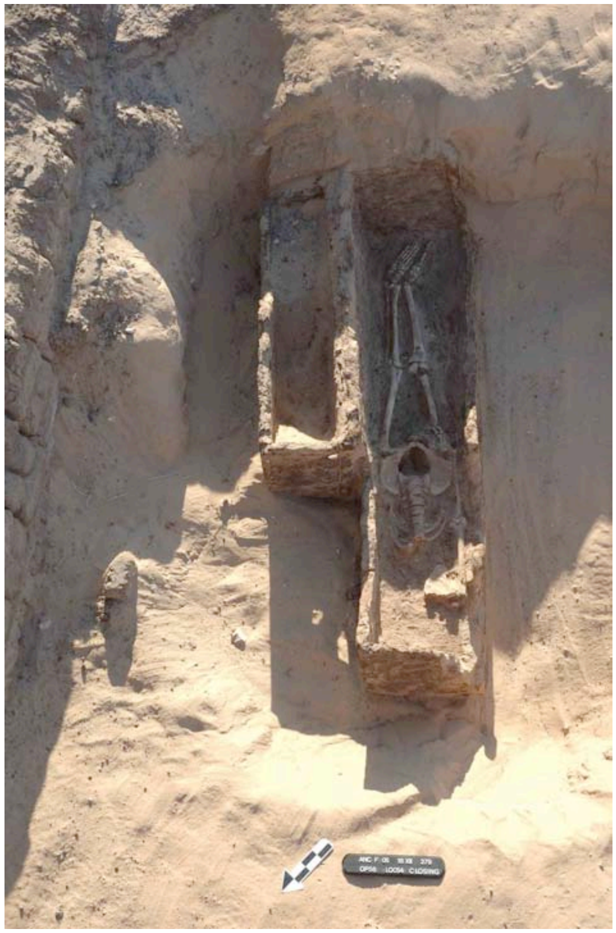
A number of mudbrick tomb shafts, probably dating to the Middle Kingdom, were also excavated along the exterior side of the west perimeter wall. The upper parts of the brick walls defining the shaft mouths were identified and documented, but the shafts themselves were not excavated.

The excavated areas of Operations 56-59 were carefully cleaned and documented and the condition of the west perimeter wall was evaluated. In some areas, brick debris from the collapse of major sections of the wall was identified. The preserved wall, which is at no location higher than 3m, has been affected by the same factors that have adversely affected other areas of the monument, including animal burrows, which have in some cases penetrated through the entire thickness of the wall, wind scour, insect damage, localized collapses and deliberate brick removal, all of which have contributed to significant undercutting in the wall. The most critically unstable areas were buttressed with temporary sandbag supports. For almost the entire length of the west perimeter wall, from the northwest corner to the gateway opening, the part of the wall subject to periodic exposure above grade has been significantly denuded, such that a “shelf” (roughly half a meter wide) exists a few courses up from the base of the wall (see Figure 417).

Along the exterior side of the west perimeter wall, a number of units excavated in Operations 56-59 during field season 4 (2001-2002) were re-opened and fully excavated in field season 7 (2005-2006), in preparation for architectural conservation (see Figures 190 and 317, above). A number of disturbed burials were found in shallow pits along the base of the west perimeter wall, which had not been fully excavated during the earlier work. Most of the burials were in plain rectangular box coffins and appear to date to the Middle Kingdom (Figures 418 and 419). All of the burials were disturbed (probably in antiquity) and the coffins were damaged. Most of the wood of the coffins had been reduced to frass by insect activity. In the case of one of the burials excavated in Operation 58, although the upper part of the body was disturbed, both of the legs were in place and most of the flesh on both legs was preserved. A matching pair of four strings of carnelian and faience beads, for the most part strung in their original order, was found around the ankles of this individual.

Figure 416. The west gateway area of the perimeter wall, excavated in Operation 56, during field season 4; note the mud plaster floor of the gateway opening, and the remains of original finish on the sidewalls. (Photo: Robert Fletcher 2001-2002)

Figure 417. The west main enclosure and perimeter walls, facing south from the northwest corner during excavation in field season 4; note the traces of original plaster and whitewash finish on the exterior face of the perimeter wall (at center), the remains of shaft tombs likely dating to the Middle Kingdom and small areas of Dynasty 2 mud surface (at right), and stacks of bricks left over from the original construction (at lower left). (Photo: Robert Fletcher 2001-2002)



Figures 418, 419. Details of three of the disturbed coffin burials, likely dating to the Middle Kingdom, excavated in Operations 56-59 along the exterior side of the west perimeter wall. (Photos: Robert Fletcher 2001-2002)

Excavation in Operation 136 on the eroded top of the south main enclosure wall, between the southwest corner and the south gateway area, revealed that a small room or cell had been cut into the wall from the exterior side (Figures 420-422). Unlike most other such rooms, the front, or southeast, wall of this cell appears to have been built up in brick after the cavity had been created, rather than by leaving original masonry in place. This construction method may relate to the relatively small size of the space. The degree of erosion of the front wall made the position of the entryway uncertain. Nothing of the actual floor surface was left in place, and judging by the level of the bottom of the preserved wall plaster, it appears that the floor and brick masonry underneath were robbed out to well below the original floor level, prior to the accumulation of the erosional deposit containing fragments of wall plaster. At the time the cell was in use, the ground level of the adjacent south corridor must have been substantially higher than in recent times, as access would have been quite difficult otherwise. Presumably, the excavations of a century ago resulted in the present ground level, as is the case elsewhere in the perimeter corridor.

Although the interior of the cell was very poorly preserved, the walls and possibly floor of the cell were originally covered with the same hard white lime plaster used in many other rooms associated with the monastic occupation of the enclosure (see Figure 422). Several concentrations fallen wall plaster fragments were found inside the cell, and some of these had traces of inscriptions and line drawings in red (Figure 423). A few small fragments of papyrus and parchment documents, with traces of Coptic inscriptions in black ink, were found loose in the brick debris inside the cell. The structural weakness created by this cell void eventually resulted in the collapse of a large section of the wall, which settled onto the sand deposit in the southwest, interior corner of the enclosure (see Figures 420 and 421).

The perimeter corridor between the south gateway and the southwest corner of the main enclosure was excavated in Operations 132 and 133, during field seasons 6 and 7 (Figure 424). Excavation reached the original Dynasty 2 floor level and found that the mud plaster floor had been cut by a series of parallel holes spanning the entire width of the corridor area (Figure 425). The pattern seen here is very similar to that in the north corridor (see above), and the parallel holes are probably the sondages of earlier excavations (most likely those of E. R. Ayrton in 1902-1903). A roughly circular hole cut through the Dynasty 2 mud floor, and bordered on the northwest side by a large stone set into the floor, appears to have served a particular purpose some years after Ayrton's excavations. The hole contained a foul-looking greenish deposit that had clearly once been liquid, as well as many broken eggshells, a wooden matchbox, a metal tube for "Kolynos Dental Cream," and a fragment of a paper envelope postmarked 26 January 1922, at which time W. M. F. Petrie and his small team were living inside the Shuneh. The hole appears either to have been a refuse pit for Petrie's team, or else its privy, an interpretation perhaps supported by the peculiar deposit found inside.

The lower part of the original finish on the façade of the south main enclosure wall is well preserved (Figures 426 and 427). Splashes of orange-red pigment were revealed at the bases of a number of the niches in this area, corroborating similar findings in the east corridor and indicating that the entire façade of the main enclosure was originally decorated in some fashion with red paint (see below).

A large cavity had been dug into and under the base of the main enclosure wall just west of the south gateway. Ayrton (1904) mentions finding burials under the walls, and this cavity may represent the location of such a burial, although no traces of a coffin or human remains were found to attest to that suggestion. It may be that whatever was originally present in the cavity was removed during the earlier excavations.

The exterior side of the south perimeter wall was excavated in Operations 38, 39, 40, 41 and 44, during field season 4 (see Figure 317, above). Denuded remains of the south perimeter wall that were visible prior to excavation demonstrated that only the lower part of the perimeter wall is preserved in this area. Excavation in Operations 38 and 39 revealed the full extent of damage to the wall resulting from erosion and hornet nesting (Figures 428 and 429). Only small sections of the wall's original facing plaster and whitewash were found preserved along its base. A prepared mud plaster floor contemporary with the monument's construction was found to extend some meters away from the south perimeter gateway. A basin feature that appears to have been used in the preparation of whitewash during construction was also revealed in Operations 38 and 39. The Dynasty 2 surfaces and the basin feature had been cut through by a number of large irregular pits. Several of these pits contained the disturbed, broken and highly decayed remains of wooden coffins, probably belonging to the Middle Kingdom. Virtually no wood remained of these coffins, which had been almost entirely reduced to frass by insects. The entire excavated area along the exterior side of the south perimeter wall was covered by layers of wind-deposited sand alternating with strata of mudbrick debris, which provides stratigraphic evidence of the gradual decay of the adjacent walls.

Excavation in Operations 40, 41 and 44 revealed the complete loss of the southwest corner of the perimeter wall (Figures 430 and 431). It appears that natural wind scour has reduced the ground surface at the southwest corner and along the exterior side of the west perimeter wall to a level below the wall base. Consequently, no trace of Dynasty 2 floor or other features remains in this area. A few highly eroded fragments of wooden coffins were found, which were probably originally placed in pits cut through the early floor (as with the coffins encountered in Operations 38 and 39), but wind scouring has removed the overlying deposits through which the pits may have been cut.

Figure 420. The top of the south main enclosure wall, facing west from the south gateway during excavation in field season 7; note the collapsed portion of original masonry (at lower right). (Photo: Jason Goodman 2005-2006)

Figure 421. Detail of the monastic cell (at left) excavated in Operation 136 at the top of the south main enclosure wall; the construction of this cell was responsible for structural instability leading to the collapse of the upper wall section in this area. (Photo: Jason Goodman 2005-2006)

Figure 422. Interior detail of the monastic cell excavated in Operation 136; note the large quantity of fallen wall plaster fragments on the floor of the cell. (Photo: Jason Goodman 2005-2006)

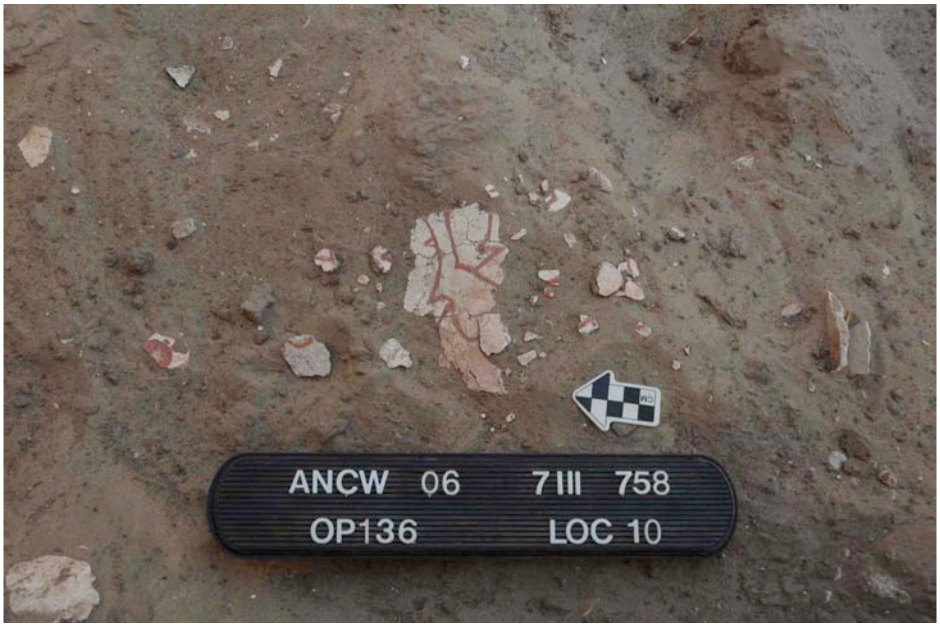


Figure 423. Detail of fallen plaster fragments excavated in the monastic cell pictured in Figure 422, above; some of the wall fragments in this cell bore traces of Coptic inscription, while others depicted abstract or geometric designs in bold red lines. (Photo: Jason Goodman 2005-2006)

Figure 424. The south corridor, facing west from the south gateway, prior to excavation in field season 7. (Photo: Robert Fletcher 2005-2006)

Figure 425. The excavated area of Operation 133 in the south corridor; note the preserved original finish on the lower part of the south main enclosure wall (through center), as well as the remains of the Dynasty 2 mud-plaster corridor floor and the pitting of floor resulting from early excavations in this area, including a hole presumably used as a refuse pit or privy by W. M. F. Petrie's team in the early 1920s (at lower right). (Photo: Jason Goodman 2005-2006)

Figure 426. Detail of the excavated area in Operation 132 at the western end of the south corridor; the level of the Dynasty 2 corridor floor is represented by the bottom edge of the finish plaster along the bases of the four niches and three pilasters (at center). (Photo: Robert Fletcher 2004-2005)

Figure 427. Detail of the drip-traces of red pigment revealed at the base of the middle pilaster pictured in Figure 426, above. (Photo: Robert Fletcher 2004-2005)

Figure 428. The excavated area of Operation 38 on the exterior side of the south perimeter wall; note the area of the south gateway (at upper left) and preserved Dynasty 2 mud surface (at center). (Photo: Robert Fletcher 2001-2002)

Figure 429. The excavated area of Operation 39 on the exterior side of the south perimeter wall; note the decayed remains of wooden coffins, likely dating to the Middle Kingdom, and the extent of intrusive pitting in this area. (Photo: Robert Fletcher 2001-2002)

Figure 430. The excavated area of Operation 132 at the southwest corner of the enclosure (see also Figure 426, above); note the complete loss of this corner of the perimeter wall due to wind erosion. (Photo: Robert Fletcher 2004-2005)

Figure 431. The excavated area of Operation 44 at the southwest corner of the enclosure; note the extent of preservation of the west perimeter wall approaching this corner, represented by the mass of mudbrick debris (at center). (Photo: Robert Fletcher 2001-2002)

The excavated area of Operation 102 was situated along the interior side of the east main enclosure wall, adjacent to a highly unstable vertical wall end (Figure 432). Excavation in field season 5 (spring 2004) exposed the collapsed roof of a cell belonging to the monastic occupation of the monument during late antiquity (Figure 433). At the rear (east side) of the cell, the lime plaster finish of the room's interior was visible. Removal of the collapsed brickwork and excavation of the cell's interior were undertaken in field season 6 (2004-2005), and detailed architectural documentation of the cell area was completed in field season 7 (2005-2006).

Excavation of the monastic cell in Operation 102 revealed that the entire mass of original masonry above the cell (to the east) had collapsed into it. The size of the cell void appears to have been the major cause of this collapse. The monastic cell excavated in Operation 102 penetrates more deeply into the wall than any other cell excavated at the Shuneh. There is less than 75cm of original masonry remaining on the east side of the cell, however the volume of masonry found inside the cell is not sufficient to suggest that the wall in this area stood to anything near its original height at the time of the collapse. Some major losses to the upper part of the wall in this area must have occurred prior to the construction of the cell, and the height of the wall at that time may have been similar to the adjacent area of wall on the south side of the cell. Like most other cells at the Shuneh, this one was finished in hard white lime plaster, but the force of the masonry collapse heavily damaged the plaster finish of the walls. The collapse apparently occurred some time after the cell had been abandoned, as the floor was covered by an accumulation of wind blown sand, which served to protect it from the collapsing masonry. Like a number of the cells in the exterior side of the west main enclosure wall, this cell had a set of three niches cut into the rear (east) wall, consisting of a larger central niche flanked by two smaller niches, all of which were finished in lime plaster. An additional unplastered niche or hole was revealed at floor level in the back wall of the cell. On the north side of the cell, a wide niche had been cut into the masonry of the enclosure wall, creating a sleeping platform with a raised line of bricks, or "pillow," at its eastern end. The foot (or west end) of the sleeping platform, as well as the wall that would have formed the western side of the large niche, were heavily damaged by the roof collapse. Along the edge of the floor below the bed was a low plastered bench, similar to those in Room 3 of the suite discovered in the west perimeter wall during field season 4 (see Figure 405, above). The west wall of the cell had two openings, one being a small window and the other being a doorway. Just inside the doorway, two pieces of limestone had been set into the floor, apparently to make a solid stepping place in a high traffic location. Also just inside the doorway was a small stone door pivot, which provides evidence that the opening was closed by a wooden door. The doorway also featured a raised, plastered threshold. Traces of black line drawings were preserved on both the east and south walls of the cell, most of which appear to depict boats, some with rigging and steering oars (Figures 434-436).

A small side chamber was dug into the masonry of the east main enclosure wall on the south side of the cell, but this was finished with mud plaster. The upper part of the side chamber was almost completely destroyed by the masonry collapse and the interior was heavily damaged. Between the side chamber and the doorway, remains were found of the base of another small niche in the wall, although the upper part and sides of the niche were completely destroyed.

At the time of excavation in field season 6, a large section of the upper part of the east wall of the cell was unstable and in danger of collapse. Consequently, a bracing system was installed to provide temporary support and to facilitate excavation (Figures 437-439). The bracing was removed in field season 7 to permit the obscured parts of the cell to be included in the detailed architectural documentation of the area.

The cell excavated in Operation 102 had a forecourt or anteroom on its west side, similar to the courtyard in the monastic complex located in the west perimeter wall. Considering the window in the west wall of the cell, the forecourt was probably an uncovered or partially covered space. A high white plastered curb formed a boundary between the mud-plastered floor of the court and the doorway into the cell. The semicircular space defined by the curb and the raised threshold of the doorway was coated in lime plaster. The west wall of the court has been almost completely destroyed, and the floor cut through, probably by one of the early excavators at the Shuneh (perhaps Mariette). This cut allows a section view of the stratigraphy of the court's floor, which appears to have been repaved a number of times, suggesting either that the court was in use for a considerable length of time or was subject to heavy traffic that necessitated regular renewal of the floor surface. At the western end of the court's north wall, the masonry turns a corner and appears to end in a jamb, suggesting that there was a doorway in the west wall adjacent to the corner.

In the southeast corner of the court was a small built feature, apparently a cooking facility, similar to those found in the west perimeter wall in field season 4. In this example, there was a single firing chamber at the rear, which was mostly destroyed, with a shallow ash trough in front. Beside the firing chamber on the north and separated from it by a thin brick wall was another small space, perhaps for storage. The floor in front of the firing chamber was paved in rough pieces of limestone set in mud. It seems likely that access to the cooking facility was through its west side, and stones set at floor level in line with this wall may represent a threshold.

On the north side of the court were the remains of a mud basin feature. Like the floor of the adjacent court, this basin had been cut through by the same trenching event, and only the east part survives. A number of *mahmara* (mud mixing basin) features relating to the construction of the enclosure have been found, but this feature differs from those in that its interior surface was quite smooth, whereas construction basins are frequently quite rough and show clear signs of the working of the wet mud. The edge of this basin feature consisted of a raised ridge of smoothed mud plaster. Damage to the area east of the basin obscured the exact relationship of the feature to the adjacent cell and court, but additional key evidence was found in field season 7. There was a void at the base of the enclosure wall adjacent to the basin, and this appears to have been a deliberately cut feature, probably contemporary with the cell, court and basin. A number of complete or reconstructable ceramic vessels were found in this area, as well as a leather object that may very well be a monk's cap (Figures 440-442).

The area of Operation 102 was further excavated in field season 7, following on the results of primary excavation in field season 6 and in preparation for architectural stabilization (Figures 443-447). The bracing installed in field season 6 was removed to permit full architectural documentation, with minimal loss of original fabric above the back wall of the cell. Removal of the bracing in the northwest corner of the room also allowed the removal of a significant amount of mudbrick debris in this area, and the preserved, original features of the cell were defined. The low bench along the base of the north wall, below the sleeping platform, appears to have been somewhat broader in the northwest corner, adjacent to the window. In front of this broader section of bench, a roughly circular area of the plaster floor was damaged. Two flat pieces of stone were set into the plaster to reinforce the floor here, and it appears that there may once have been additional stones that were removed at some point. Most of the wider part of the bench was missing, along with a significant volume of the fabric of the wall behind it. Excavation revealed a cavity that had been cut into the masonry of the enclosure wall. The remains of a wooden trough were revealed that was oriented in such a way as to suggest that its purpose was to channel liquids from some feature inside the wall cavity out toward the nearby mud basin. No direct evidence remained to indicate what the exact nature of this feature might have been.

In field season 7, a small test cut was made through the mud plaster floor of the court adjacent to the cell, to permit examination of earlier floor surfaces and the original configuration of some features of the court (Figures 448 and 449). In its earlier phase, the court had low, white-plastered benches built along its eastern and southern sides. The earlier floor was heavily worn, and thin, eroded lenses of lime plaster were preserved on its surface, suggesting that repeated replasterings gradually raised the floor level and obscured the benches.

To the east of the suite in the east main enclosure wall, but apparently not directly connected to it, another small room had been built into the east perimeter wall in late antiquity. This room was almost entirely destroyed by pitting of an undetermined date, which cut completely through the wall. The room had a white lime-plastered floor and walls. The location of the entrance to this room is uncertain, but it likely connected to a number of contemporary features on the exterior side of the east perimeter wall, which were excavated as part of Operation 114 (Figures 450 and 451). There appears to have been a single large room with a white plastered floor, which had a double bin-like feature (also with white plaster floors) cut into the wall at its southern end. This double-chambered feature was separated from the larger space by a low, white plastered curb. Another small space was separated from the larger room by a brick wall built perpendicular to the perimeter wall was. This space had a plastered floor in its outer (eastern) part, which was separated from an interior mud-plastered space by a low curb. These features were constructed on a deposit of mudbrick debris and sand that had accumulated against the perimeter wall in antiquity. The mudbrick deposit almost certainly relates to the gradual collapse and erosion of the perimeter wall. Under this deposit, the ends of two of the previously known boat graves (5 and 6) were found, dating to the Early Dynastic Period (Figure 452).

Close examination of the stratigraphic relationship between the ends of the boat graves and the adjacent east perimeter wall demonstrated conclusively that the boat graves pre-date the construction of the perimeter wall (Figures 453-455). A mud floor stratigraphically contemporary with the boat graves lies below a deposit of sand on which the perimeter wall was built. It appears that following the construction of the boat graves, a wind-blown sand accumulated around them, on which the perimeter wall was eventually built. Additionally, the pitting through the wall, along with a test cut through the floor of the east corridor, provided a continuous stratigraphic profile extending from the ends of the boat graves (under the perimeter wall) to the main wall of the enclosure. The stratigraphic relationships of this profile suggest that the boat graves pre-date the construction of the main wall, as well (see the Early Dynastic Boat Graves at Abydos, to follow).

An area in the central, exterior portion of the east perimeter wall, southeast of the known boat graves, was investigated in Operations 23, 24, 25 and 34 during field season 3 (spring 2001). The aim of these excavations was to investigate the conditions characterizing the exterior perimeter of the Shuneh, including the status of the perimeter wall and any adjacent Dynasty 2 surfaces or other features, as well as whether any additional boat graves are located southeast of Boat Grave 14.

Excavation in Operation 23 revealed the lower part of the east perimeter wall, with large patches of its original finish preserved (Figures 456 and 457). No original Dynasty 2 floor was preserved in this area, largely due to the presence of a large number of burials in wooden coffins that appear to date to the Third Intermediate Period. Virtually no wood was preserved from these coffins, almost all of them having been reduced to frass by insects. The surfaces of the coffins had been plastered and in some cases painted. A number of the coffins had been disturbed in ancient times, and there were scattered human skeletal remains found throughout the area of Operation 23. A deposit of dog skeletons and a ceramic vessel of a form typically used for ibis burials were also found among the coffin remains in this area.

Work in Operations 24 and 34 revealed the presence of a very substantial mudbrick structure with a distinctive plan (Figures 458 and 459). Although not entirely excavated, the exposed remains suggest that the structure was square, with a circular, vaulted central chamber. The diameter of this chamber was at least 5.5m. It appears to have been floored, at least in part, with mudbricks. Few artifacts were found in clear association with this structure, and its exact date remains uncertain. Comparisons of the plan with structures excavated by the Egypt Exploration Society in the Abydos North and Middle Cemeteries in the years prior to the First World War (Naville et al. 1914; Peet 1914; Peet and Loat 1913) suggest that this structure is, in fact, the remains of a large vaulted tomb. This type of tomb is known at Abydos from the late New Kingdom through the Late Period. A mud basin feature was found in the excavated area of Operation 25, which appears to have been related to the construction of the large building discovered in Operations 24 and 34. The coffin burials adjacent to the east perimeter wall and the large vaulted tomb have destroyed any evidence of earlier constructions in the area. Future excavation east of Operations 24 and 34 will be required to determine whether additional boat graves exist in this area.

Figure 432. The excavated area of Operation 102 on the interior side of the east main enclosure wall. (Photo: Matthew Adams 2004)

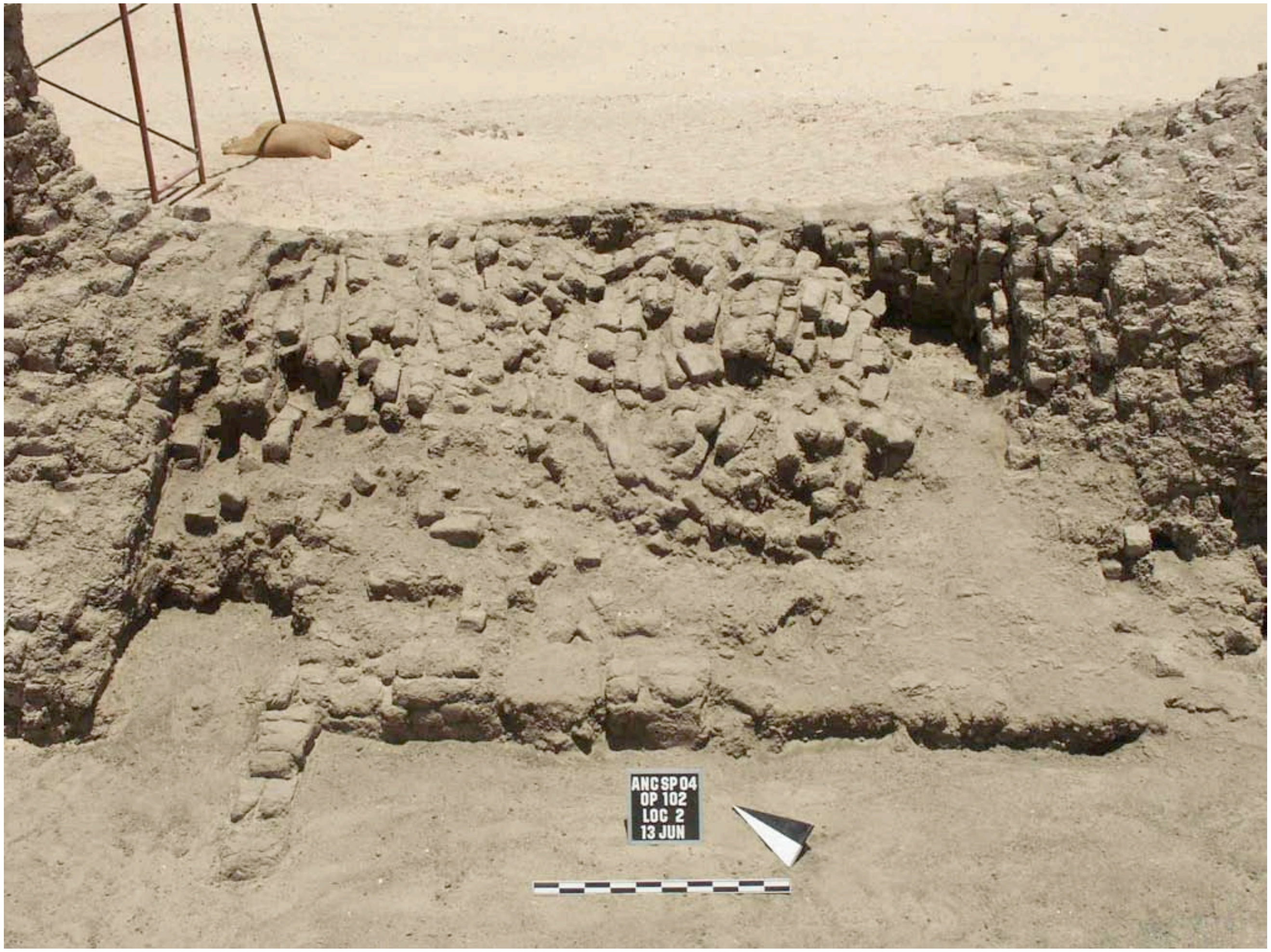


Figure 433. Detail of the monastic cell area excavated in Operation 102; the collapsed mudbrick represents a fallen section of original Dynasty 2 masonry from above the ceiling of the cell. (Photo: Matthew Adams 2004)

Figure 434. Interior detail of the monastic cell excavated in Operation 102, facing east; note the sleeping platform (at left), with a brick "pillow" at its eastern end. (Photo: Jason Goodman 2005-2006)

Figure 435. Detail of a boat with rigging drawn in black line on the rear (east) wall of the cell excavated in Operation 102; the discolored area (at center) is pictured just below the central niche in Figure 434, above. (Photo: Jason Goodman 2005-2006)

Figure 436. Traces of a second boat drawing in black line on the south wall of the cell excavated in Operation 102. (Photo: Jason Goodman 2005-2006)

Figure 437. Interior detail of the monastic cell excavated in Operation 102, which was temporarily braced with boards and sandbags in field season 6 to provide support during the excavation of the cell area. (Photo: Robert Fletcher 2004-2005)

Figure 438. Exterior detail of the temporary bracing in Operation 102. (Photo: Robert Fletcher 2004-2005)

Figure 439. Interior detail of the temporary bracing in the northeastern area of Operation 102; note also the small side chamber, perhaps for storage, at lower right, and the small niche near floor level, which is an unusual feature among the monastic cells excavated at the Shuneh (Photo: Robert Fletcher 2004-2005)

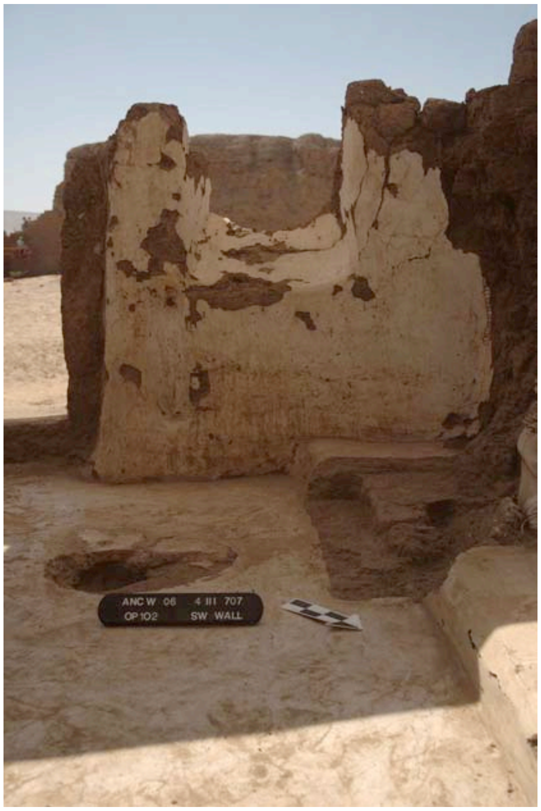
Figure 440. Detail of the void cut into the base of the east main enclosure wall, just north of the monastic cell and forecourt in Operation 102; note the northern wall of the court (at right) and the remains of a large ceramic bowl (at center). (Photo: Robert Fletcher 2004-2005)

Figure 441. Excavation of the area pictured in Figure 440, above, revealed a small ceramic bowl and leather cap. (Photo: Robert Fletcher 2004-2005)

Figure 442. The ceramic bowl pictured in Figure 440, above, after reconstruction. (Photo: Jason Goodman 2004-2005)

Figure 443. Monastic features excavated in Operation 102; note especially the kitchen feature (at lower right), the wooden trough and basin-like feature with a mud floor (at lower left), and the high plastered curb separating the forecourt from the interior chamber (at center). (Photo: Jason Goodman 2005-2006)

Figure 444. Interior detail of the monastic features excavated in Operation 102, facing west; note the sleeping platform (at lower right), the small side chamber (at lower left), and the large cavity in the masonry of the enclosure wall (right center). (Photo: Jason Goodman 2005-2006)



Figures 445, 446. The west corner and window of the interior chamber (left), and the wooden trough adjacent to the west corner (right). (Photos: Jason Goodman 2005-2006)

Figure 447. Detail of the wooden trough revealed in Operation 102, which appears to have drained some feature inside the wall cavity. (Photo: Jason Goodman 2005-2006)

Figure 448. The mud floor of the forecourt in Operation 102, facing east. (Photo: Jason Goodman 2005-2006)

Figure 449. Detail of the test cut made through the mud floor pictured in Figure 448, above, during field season 7; in its earlier phase, the court had low plastered benches along two walls. (Photo: Jason Goodman 2005-2006)

Figure 450. The excavated area of Operation 114 in the east perimeter wall, which revealed a suite of monastic features built into and against the wall. (Photo: Robert Fletcher 2004-2005)

Figure 451. Detail of monastic features excavated in Operation 114 on the exterior side of the east perimeter wall. (Photo: Robert Fletcher 2004-2005)

Figure 452. The fully excavated area of Operation 114 in the east perimeter wall; note the preserved original finish along the base of the perimeter wall and the contemporary mud floor adjacent, as well as the ends of two of the previously known boat graves in the foreground. (Photo: Robert Fletcher 2004-2005)

Figure 453. Excavation in Operation 114 revealed the remains of brick stacks possibly left over from the original construction, as well as a mud mixing basin, or *mahmara*, below the floor level contemporary with the perimeter wall. (Photo: Robert Fletcher 2004-2005)

Figure 454. The southwest ends of Boat Graves 5 (at right) and 6 (at left), adjacent to the east perimeter wall of Khasekhemwy's enclosure (through top). (Photo: Robert Fletcher 2004-2005)

Figure 455. Detail of the stratigraphic relationship between Boat Grave 6 (at left) and the east perimeter wall of Khasekhemwy's enclosure (at right); the sand deposit at rear center is later than the boat grave, but pre-dates the construction of the perimeter wall, which is built on this deposit. (Photo: Robert Fletcher 2004-2005)

Figure 456. The excavated area of Operation 23 on the exterior side of the east perimeter wall; the deposition of a large number of later burials in this area has destroyed any Early Dynastic features that may originally have been present. (Photo: Robert Fletcher 2001)

Figure 457. Detail of the coffin burials, likely dating to the Third Intermediate Period, excavated in Operation 23 on the exterior side of the east perimeter wall; at least 18 human burials, several dogs and one ibis jar were found in this area. (Photo: Robert Fletcher 2001)

Figure 458. The excavated area of Operations 24 and 34 on the exterior side of the east perimeter wall, which revealed the remains of a late vaulted tomb, just north of the east gateway area. (Photo: Robert Fletcher 2001)

Figure 459. Interior detail of the late vaulted tomb excavated in Operations 24 and 34. (Photo: Robert Fletcher 2001)

The Early Dynastic Boat Graves at Abydos

In 1988, David O'Connor, exploring the area just east of the Shuneh's east perimeter wall, discovered the rounded end of a low mud brick structure. Given the number of royal enclosures that almost certainly once stood in north Abydos that had not, at that time, been located, O'Connor suggested that this rounded feature could be the bastion-like corner of an early enclosure (O'Connor 1989). Subsequent larger scale excavations in 1991 revealed that, rather than being part of an enclosure, it was the end of a long, narrow, mudbrick boat-shaped structure (O'Connor 1991) and that it was one of a group of at least twelve parallel boat-shaped structures built in this area. Further investigation revealed that each boat-shaped structure contained the remains of an actual wooden boat and that these structures were, in fact, boat graves. The outlines of the wooden hulls could be identified in the eroded tops of the grave structures, and a small test cut into one, Boat Grave 10, provided a view of one hull in cross-section. The construction of the boat graves, as well as ceramics and eroded seal impressions found in association with them, allowed them to be dated to the Early Dynastic period.

Boat graves of this period were known from other Egyptian sites, including Saqqara (Emery 1961) and Helwan (Saad 1947, 1951), where they had been found in association with the large mudbrick mastaba tombs of the Memphite court elite. Unlike the situation at Abydos, however, the boat graves at other sites occurred only singly and were substantially smaller. Here were at least twelve boat graves, on average more than twenty meters long. In addition, the Abydos boat graves were situated among a series of royal monumental constructions, the enclosures, which were components of the royal funerary complexes of Dynasties 1 and 2, not private tombs as at Saqqara and Helwan.

The association of boats and the royal funerary complex at Abydos anticipates the dismantled and buried boats, and boat-shaped features, associated with royal funerary complexes of succeeding periods, as well as the boat symbolism of royal funerary religion.

From the outset of this project, one of the primary goals has been the further investigation of the boat graves at Abydos, and the work of field season 2 (spring 2000) was dedicated exclusively to the boat graves. The immediate aims of that season's work were to excavate inside one of the graves, to document the remains of the wooden boat it contained, to evaluate the condition of the wood, to undertake whatever conservation efforts might be needed to consolidate the wood, and to remove the wood for more detailed analysis in the more controlled environment of the field laboratory. More broadly, the work of field season 2 was intended to determine the basic form and construction of one of the boats, to determine whether or not it was a functional watercraft or a symbolic, or model, boat only, and to gain a better understanding of the nature of early Egyptian boatbuilding, as well as the way in which the Abydos boats expressed how nautical themes were already closely tied to the religious symbolism associated with Egyptian kingship near the beginning of Egyptian history.

In field season 2 (spring 2000), excavation re-exposed the best candidates known from the 1991 work in order to evaluate their potential for further more detailed investigation. Two areas from the 1991 excavations were re-examined. In the southern area, the 1991 units excavated in Operations 15, 17, 18, 19, 20 and 21 were re-opened, and a new unit, Operation 23, was excavated immediately south of Operation 21 (Figure 460). This work re-exposed parts of Boat Graves 9, 10, 11 and 12 (Figures 461 and 462). Additional documentation was undertaken on all structures. Boat Grave 10 was the location of the 1991 test cut that revealed with certainty the presence of a wooden hull inside the brick structure, as the test cut showed the complete profile of the buried craft. Additional observations in field season 2 determined that a well-preserved area between this test cut and ancient intrusive pits in Boat Grave 10 presented excellent potential for the interior excavations.

In Boat Grave 10, the 1991 test cut was re-exposed (Figure 463), and the area between it and a large ancient pit to the east was fully excavated. The first stage of the excavation entailed the careful removal of the mudbricks that had been used, anciently, to fill the hull. Under the bricks, a thick layer of frass, the organic residue left by wood-consuming insects, was encountered, which preserved the lines of the boat's hull (Figure 464). In some areas the original wood of the boat had been completely destroyed by insects. In many areas, however, there was substantial preservation of the wood. Significant lengths of the boat's wooden planks were revealed as the frass was removed (Figures 465 and 466). Substantial parts of five planks from the bottom of the hull were found, as well as the remains of three planks on the south side of the hull, and one on the north side. In some cases, important features relating to the boat's construction were well preserved or clearly indicated. The boat appears to have had parallel sets of closely spaced slots or mortises cut in its planks (Figures 467-469). The mortises ran from the top of each plank to the side. Rope lashing appears to have been woven through these mortises, binding the planks together laterally. There was no evidence for lateral wooden ribs or of any other internal supporting structure. In the spaces between the planks were found the remains of bundles of what may have been tightly packed reeds or plant fiber, and it appears that these may have been used as a kind of sealant between the planks, to prevent water from penetrating the hull. This type of boat construction is known as sewn boat technology, and it is otherwise unattested in an Egyptian context (Ward 2006, 2003). No artifacts other than the remains of the boat itself were found in the excavated portion of the interior of Boat Grave 10.

In a few areas on the south side of the boat in Boat Grave 10, where the wood of the hull had rested directly against bricks or mud, there were the remains of pigment (Figures 470 and 471). Based on careful examination of these remains, it appears that the boat was, at least in part, painted yellow. Traces of similar pigment were detected on the brickwork of one other boat grave, Boat 13, adjacent to the remains of the wooden hull (Figure 472).

In general, the condition of the preserved wood in Boat Grave 10 was found to be extremely poor. The wood was almost completely lacking in structural integrity, being heavily checked, with the wood fabric physically separated into small roughly cube-shaped sections, which retain their original relative positions in each plank, as long as the plank is not disturbed, but lacking any physical bond (see Figure 469). Given its condition, none of the wood could be removed without significant conservation. During the course of the excavation, the wood was cleaned, examined and consolidated by conservators Lawrence

Becker and Deborah Schorsch (of the Metropolitan Museum of Art), using a variety of methods as determined by the condition of each piece. The primary consolidant employed was cyclododecane, a wax with a low melting point and with the special property that it gradually sublimates at room temperature, leaving little residue. Through the liberal application of cyclododecane, sometimes in combination with other consolidants and supporting materials such as cellulose powder and conservation grade tissue paper, each plank was consolidated (Figure 473). The consolidant materials alone provided structural support and maintained the integrity of each plank. The basic conservation method involved first the application of melted cyclododecane to all exposed surfaces of each plank (Figure 474). Once the top and sides had been consolidated, the plank was carefully lifted by hand and rotated around its longitudinal axis until the underside (the exterior side of the hull) was exposed (Figure 475). This would then be similarly treated. Once the entire plank had been consolidated, it could be lifted and placed in a specially sized and padded box, which was completely lined with Marvel Seal, as was its lid, which, when closed, created a controlled micro-environment (Figure 476). Each plank could then be transported from the excavation site to the Abydos field house for further cleaning, conservation, documentation, analysis and storage. All the remains of the wooden hull exposed in Boat Grave 10 in field season 2 were successfully removed.

In addition to the work in Boat Grave 10 and the re-examination of Boat Graves 9, 11 and 12, a new excavation unit, Operation 23, was opened at the south edge of the 1991 area. The work here had the aim of defining the margins of the Early Dynastic Boat Grave area more clearly. The work in Operation 23 revealed that there are two additional Boat Graves immediately to the south of Boat Grave 12 (see Figure 460). These have been designated Boat Graves 13 and 14. The architecture of Boat Grave 13, though damaged by ancient pitting and erosion, is quite clear in its overall lines in its eastern half. Like the adjacent structures, it consisted of thick mudbrick containment walls, with the remains of a wooden hull inside. The interior of the hull appears to have been filled with brick, as in the other examples. One new aspect to Boat Grave 13 is that it was built contiguous to Boat Grave 12 (Figure 477). All the boat graves to the northwest appear to have had at least some space between the structures at their widest part, while with Boat Graves 12 and 13, no space was left at all, and the bricks of the two graves abut for some meters. Boat Grave 14 was much more heavily damaged by ancient pitting than the adjacent graves. Enough remains, however, to determine that it too contained a wooden hull inside a mudbrick structure of the same general dimensions as the other examples. It appears to have been built contiguous to Boat Grave 13.

In the northern of the two 1991 areas re-examined in field season 2, eight excavation units were re-opened: Operations 1, 2, 5, 7, 8, 10, 11, and 12 (see Figure 460). In addition, a new excavation unit, Operation 24, was opened immediately west of 1991 unit Operation 2. These units exposed all or part of Boat Graves 1, 2, 3, and 4 (Figure 478). The details and condition of the brick containing structures of these boat graves were re-studied and documented in detail, supplementing the data from the 1991 work, in order to consider the potential of each boat grave for interior excavation in future. Boat Grave 1 appeared, based on the 1991 work, to be the least damaged by pitting of the northern group, although its eastern end was apparently destroyed by the construction of a later tomb shaft. Operation

24, a new excavation unit, was located so as to expose the area of Boat Grave 1 not seen in 1991, as well as to study the nature of the area north of the known boat graves, between them and the southern line of subsidiary graves of the enclosure of king Djer. The work in this unit revealed that long after the construction of the boat graves, several tomb shafts were dug in the area adjacent to Boat Grave 1, damaging its northwestern side (see Figure 478). These shafts appear to have been heavily looted in ancient times, judging by a number of small broken and highly decomposed fragments of plastered wooden coffins and broken human bones disarticulated and scattered in the sand near the mouths of the shafts. In spite of the damage from the tomb shafts and other pitting damage, Boat Grave 1, with large areas of intact brick "fill," still appears to be the best preserved of the northern group.

Boat Grave 1 provided particularly important evidence about the condition of the wooden boats at the time of the construction of the boat graves. On the southern side of Boat Grave 1, small intrusive pits exposed the remains of the wooden hull inside the grave structure. This side of the hull, which would be expected to be, in section, on a diagonal, appears to be flat, not in the expected profile. Unlike in Boat Grave 10, where the sides of the wooden hull rested against the brick masonry of the grave structure, here, the masonry appears to have been built over the flattened side of the hull. It appears that when the hull of Boat 1 was put in position, the middle part of its southern side warped, coming to rest flat on the ground. In one location near the eastern end a large stone appears to have been used to prop up part of the hull, but the remainder was left in its warped state and the brick grave structure simply built over it. This evidence suggests a wooden hull that did not easily retain its shape out of the water. In the absence of internal supports, it is possible that the boat would have used the pressure of water on the outside of the hull to maintain its shape. The warping of the hull also suggests that the boat encapsulated inside Boat Grave 1, and, by implication, the others as well, was a fully functional boat, not a model only.

The combination of evidence from all the boat graves and particularly Graves 1 and 10 suggests the basic construction sequence of the graves. In each instance a shallow trench was dug in the compact sand of the natural desert surface to receive the boat. Each wooden boat was probably dragged across the ground from the nearest canal or harbor (possibly adjacent to the nearby town) and positioned in this trench. Stones were sometimes used to prop the hull into position, although this was sometimes ineffective. It seems likely that each brick grave structure was built after the hull was in place, since each has different dimensions reflecting those of the hull it contains. The interior of the hull was filled with masonry up to the level of the top of the sidewalls of the grave. The grave structure was then finished in mud plaster and whitewashed.

A number of the boat graves have large desert boulders encased in the brickwork at each end (see Figure 478), and it seems likely that these may have acted as symbolic anchors, permanently fixing each boat in position. Alternatively, the large stones at the ends could have been simple props, used to hold up the prow and stern of each hull, which in longitudinal profile were higher at the ends than in the middle. One grave (10) exhibited evidence in the masonry of its east end that a wooden pole approximately 10cm in diameter had been set into the brickwork (Figure 479), which is reminiscent of the wooden flagpoles sometimes found in front of Egyptian temple pylons of later periods.

In Operation 10, a large deposit of coarse ceramic vessels ("beer jars") was found adjacent to the east end of Boat Grave 2. These jars may have originally come from inside this structure, since its northeast end was pitted out in ancient times, although it is also possible that they may have come from Boat Grave 3, having been dislodged when its northeast end was destroyed, also in antiquity. Among these jars were two Early Dynastic seal impressions. Unfortunately, they are too weathered to be read easily, although it seems clear that they do not have a royal name.

Determining the date of the boat graves is somewhat problematic. A small test cut made by David O'Connor in 1988 between the western end of Boat Grave 2 and the east perimeter wall of the Shuneh established stratigraphic relationships in which the boat grave pre-dates the construction of the perimeter wall, suggesting that the boat graves as a group may pre-date the Shuneh. Re-examination of this area by Matthew Adams in field season 2 confirmed O'Connor's original interpretation. Additional evidence may be considered. Adjacent to the exterior side of the east perimeter wall is a significant deposit of mudbrick debris that appears to be the result of the construction of the Shuneh (see Figure 478). In this debris is a plaster-mixing basin, a construction feature, like those found in a number of other locations at the Shuneh. In the area of Boats 1-3, a thin mud plaster that represents the exterior floor surface of the Shuneh runs over this construction debris deposit, which itself was deposited against and around the west ends of the boat graves, which obviously already existed. A similar set of stratigraphic relationships was encountered in Operation 114 (see Archaeological Investigation of the Monument, preceding), where the west ends of Boat Graves 6 and 7 were exposed, and where the stratigraphy could be followed to the main enclosure wall. The combined stratigraphic evidence seems clear, that the boat graves are earlier than the construction of the enclosure of king Khasekhemwy. If that is the case, to which king do they belong, and with which enclosure are they associated?

The arrangement on the ground is suggestive. The fourteen known boat graves are distributed across an area that corresponds almost exactly with the length north-south of a First Dynasty enclosure found by Petrie known as the "Western Mastaba." Excavations conducted by the Institute of Fine Arts' North Abydos Project on the east side of the boat graves in 2002-2003 found evidence for stratigraphic contemporaneity between the boat graves and the west wall of the "Western Mastaba," which probably belongs to a king in the middle or later part of the First Dynasty. Despite this evidence, assigning a First Dynasty date to the boat graves remains problematic, since the pottery found in association with some of them is similar to forms known from nearby Second Dynasty contexts. At present, a date for the boat graves in the Early Dynastic Period is certain, but specificity must await further work.

The nature of the relationship between the boat graves and the enclosure to which they belong (if any) may have some parallels in the graves found around nearby enclosures of the First Dynasty. Human courtiers appear to have been sacrificed and entombed around the enclosures of Aha, Djer, Djet and Meret-Neith, in order to follow and, presumably, to be available to them in the next world. In the case of another enclosure belonging to the early First Dynasty but not yet assigned to a specific reign, donkeys were entombed beside the enclosure, animals that may very well have served the king in this world and the services of which might be valued in the next. The boat graves also represent the entombment of objects of value and utility to the king, here, too, to make them available to the king in the next world. Thus, there may be a kind of basic functional equivalency between the occupants of all the graves associated with the enclosures – humans, donkeys, and boats. All were of use to the king and at his disposal. The variation exhibited by the Abydos enclosures suggests that a level of individual preference or circumstance may have been involved in determining what would accompany the king at his cult enclosure.

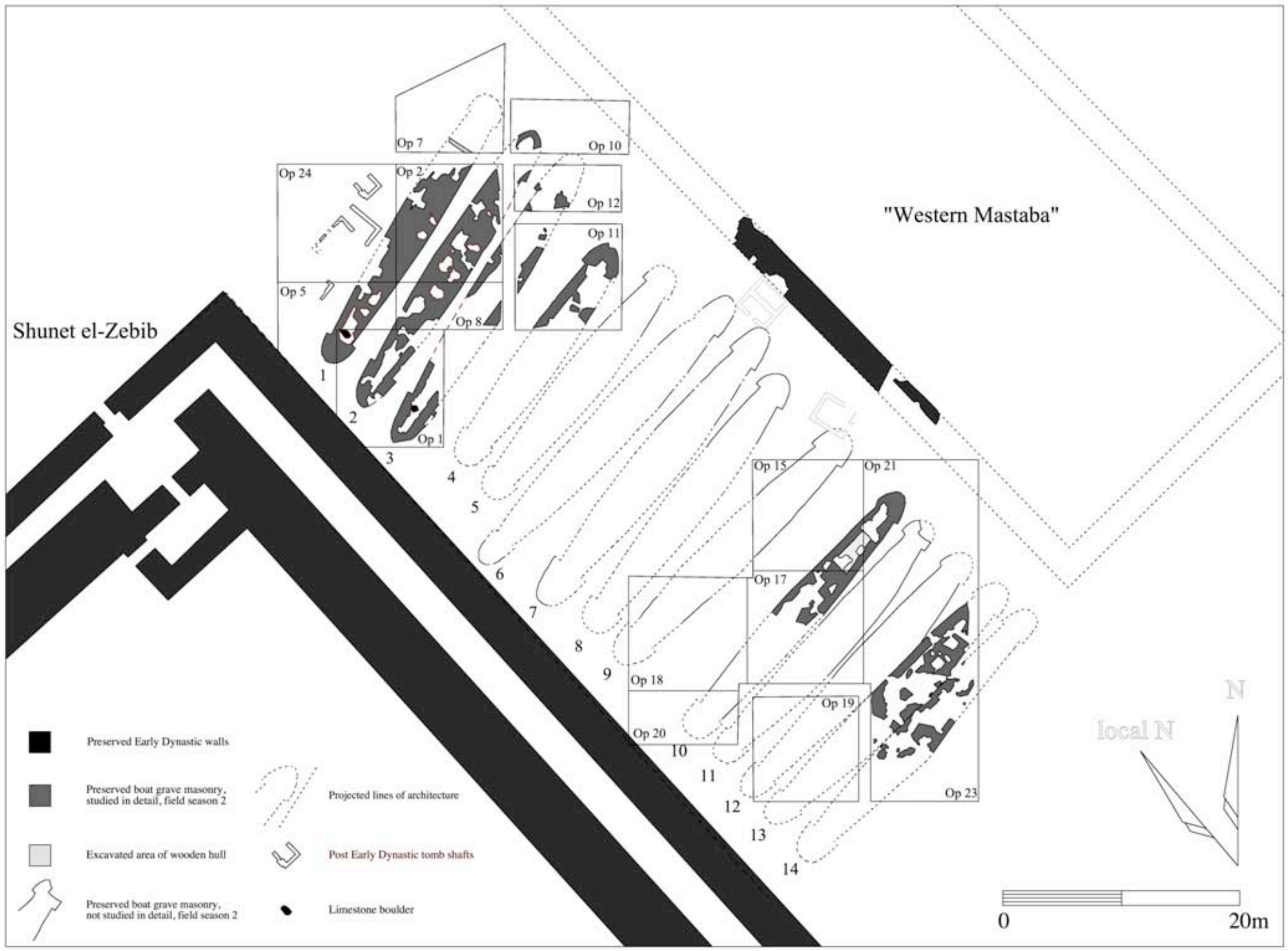


Figure 460. Plan of the boat grave area excavated in field season 2 (spring 2000). (Institute of Fine Arts, New York University 2007)

Figure 461. The excavated area of Boat Graves 10-14 (left to right, respectively); the middle parts of the graves were originally lower and are more heavily eroded than the ends. (Photo: Matthew Adams 2000)

Figure 462. Boat Graves 10, 11, 12 and 13 (from right to left, respectively); the remains of Boat Grave 14 are behind Boat Grave 13. (Photo: Matthew Adams 2000).

Figure 463. The 1991 section cut in Boat Grave 10, after it was re-exposed in field season 2; the trough-like profile of the wooden boat hull is visible in the dark wood and frass under the mudbrick masonry that filled the interior of the boat, and at left and right are the brick sidewalls of the grave structure. (Photo: Matthew Adams 2000)

Figure 464. The interior portion excavated in Boat Grave 10, after removal of the mudbrick masonry that filled the hull; cleaning has revealed two relatively well-preserved planks from the bottom of the hull, while the remainder is still obscured by frass, the waste product of wood consumption by insects. (Photo: Matthew Adams 2000)

Figure 465. Cleaning frass from the remains of the side of the wooden boat hull. (Photo: Matthew Adams 2000)

Figure 466. The eastern end of the excavated interior portion of Boat Grave 10, showing the profile of the hull as it was preserved in the frass; note the remains of wooden hull planks under the frass. (Photo: Matthew Adams 2000)

Figure 467. The excavated interior portion of Boat Grave 10 fully cleaned of frass, showing the remains of the wooden hull planks. (Photo: Matthew Adams 2000)

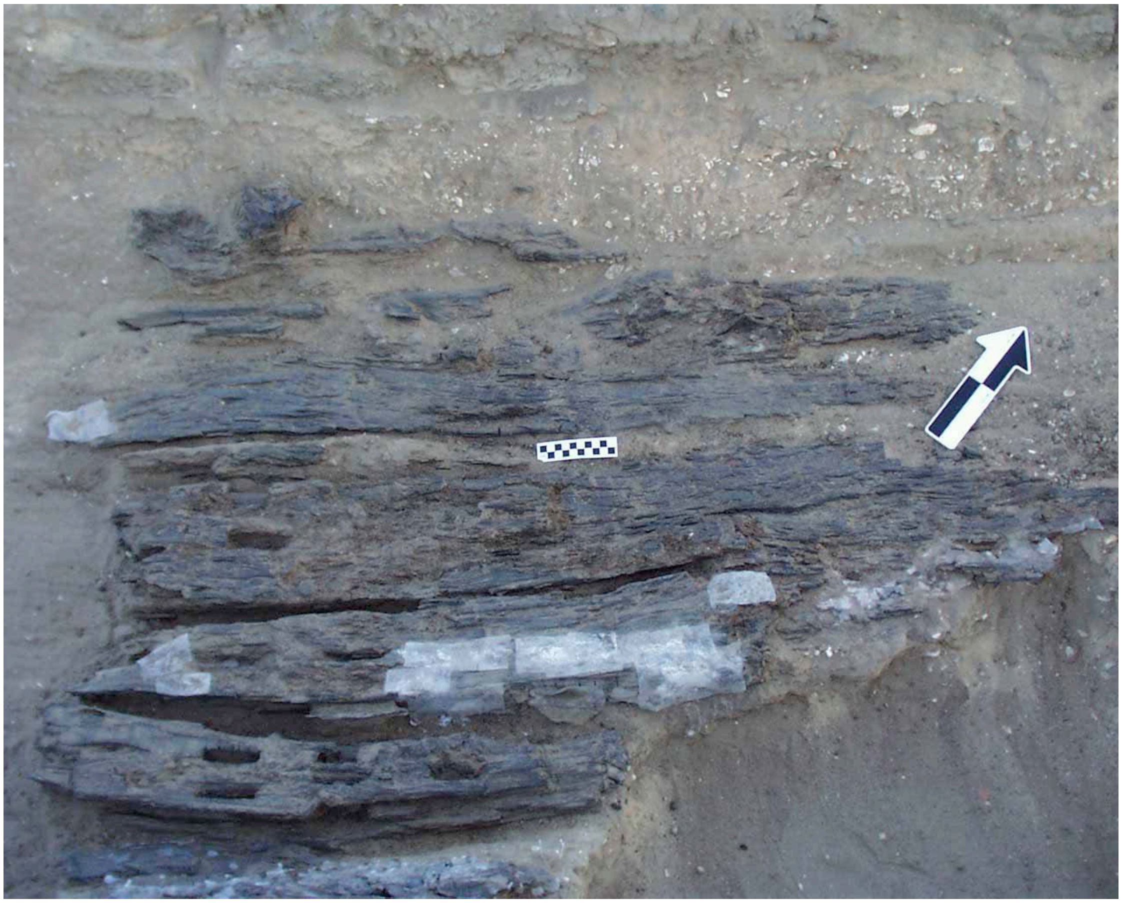


Figure 468. The bottom planks of the hull of Boat Grave 10; mortise holes are clearly visible in several of the planks, which in some cases have been filled with cellulose powder as part of the conservation process, indicated by the white areas covered with tissue on the plank second from the bottom in this photograph. Pitting has destroyed the remains of the hull at left and right. (Photo: Matthew Adams 2000)

Figure 469. Detail of three mortises in one of the planks; note that the mortises are cut through both the top and side of the plank. (Photo: Matthew Adams 2000)

Figure 470. South side of the excavated interior portion of Boat Grave 10; note that where the side of the hull touched the bricks of the grave's sidewalls, yellow pigment has adhered to the bricks. (Photo: Matthew Adams 2000)

Figure 471. Detail of the traces of yellow pigment on the bricks of the south sidewall of Boat Grave 10, as they are consolidated. (Photo: Matthew Adams 2000)

Figure 472. Traces of yellow pigment on a brick of the sidewall adjacent to the remains of the wooden hull in Boat Grave 13. (Photo: Matthew Adams 2000)

Figure 473. Filling mortises in one of the planks with cellulose powder. (Photo: Matthew Adams 2000)

Figure 474. Applying cyclododecane to the remains of the planks on the south side of the wooden hull in Boat Grave 10. Cyclododecane is a waxy consolidant with a low melting point that could be applied safely directly to the wood, establishing structural integrity where none existed. It slowly sublimates at room temperature, leaving little residue. It was instrumental in the consolidation and successful removal of the wood from Boat Grave 10. (Photo: Matthew Adams 2000)

Figure 475. Once the upper side of each plank had been consolidated, the plank was turned over to expose the underside for consolidation. (Photo: Matthew Adams 2000)

Figure 476. With both upper and lower sides consolidated, the plank could be carefully lifted; each plank was placed in a specially sized and padded box lined with Marvel Seal for transportation from the excavation site to the field lab and in which the plank is stored. (Photo: Unidentified 2000)

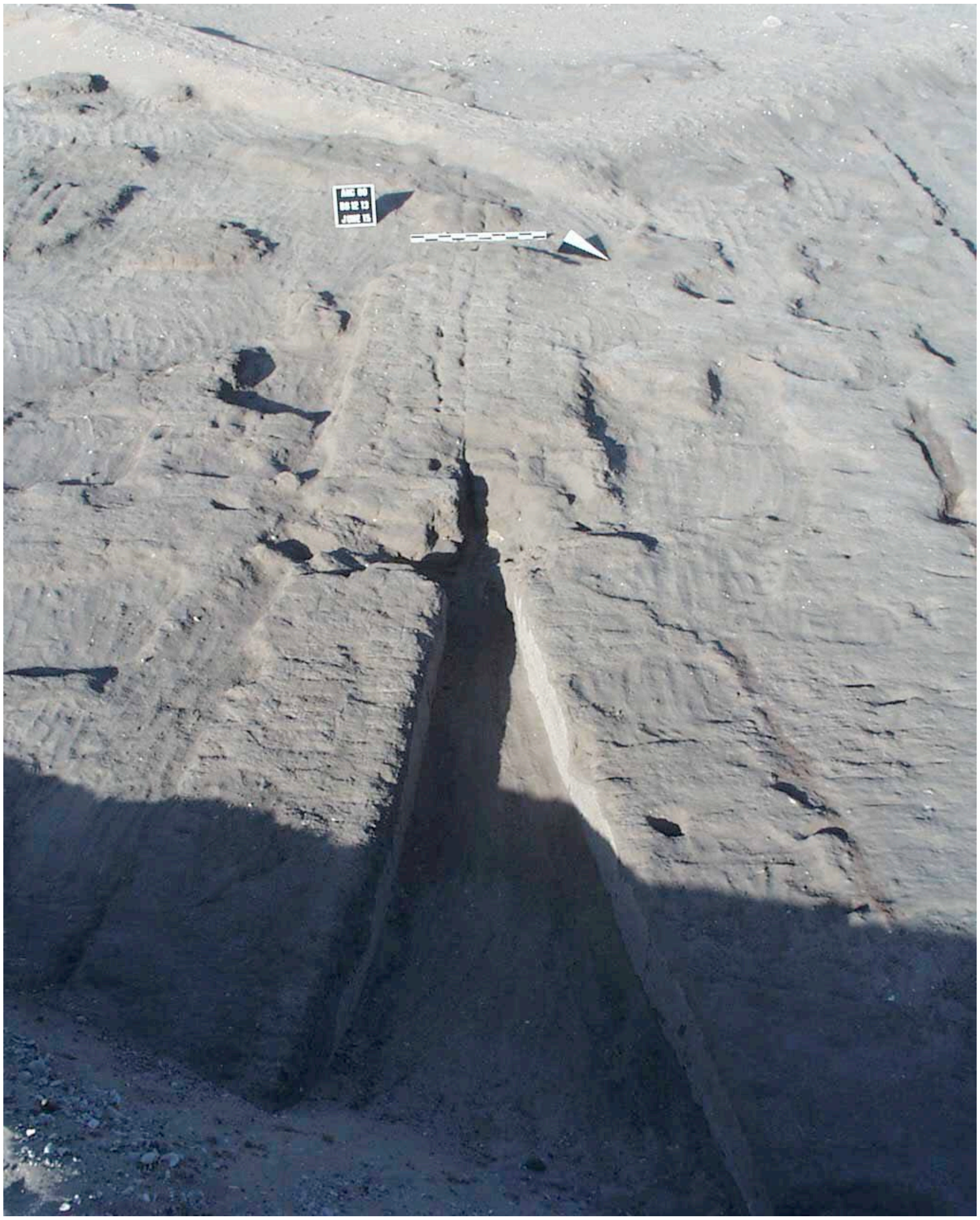


Figure 477. Boat Grave 12 (at right) and Boat Grave 13 (at left); the area where they join is clearly visible at center. (Photo: Matthew Adams 2000)

Figure 478. Boat Graves 1, 2 and 3 (from left to right, respectively). The ancient pitting damage to the mudbrick grave structures is clearly visible. At the far left are the remains of tomb shafts, the construction of which damaged the north side of Boat Grave 1. In the foreground at lower left is the denuded east perimeter wall of Khasekhemwy's enclosure. Between it and the west ends of the boat graves is a deposit of mudbrick debris probably associated with the construction of the Shuneh, as is the small plaster mixing basin between the ends of Boat Graves 2 and 3. The fact that this construction debris is deposited against the boat graves suggests that the boat graves pre-date the construction of the Shuneh. A small test cut located between the west end of Boat Grave 2 and the perimeter wall confirmed that the boat grave pre-dates the construction of the perimeter wall. Note the boulders at the ends of Boat Graves 1 and 3. (Photo: Matthew Adams 2000)

Figure 479. Remains of a wooden pole set into the brick masonry of the east end of Boat Grave 10. (Photo: Matthew Adams 2000)

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