



AERA GRAM

ANCIENT EGYPT RESEARCH ASSOCIATES

Groundbreaking Archaeology

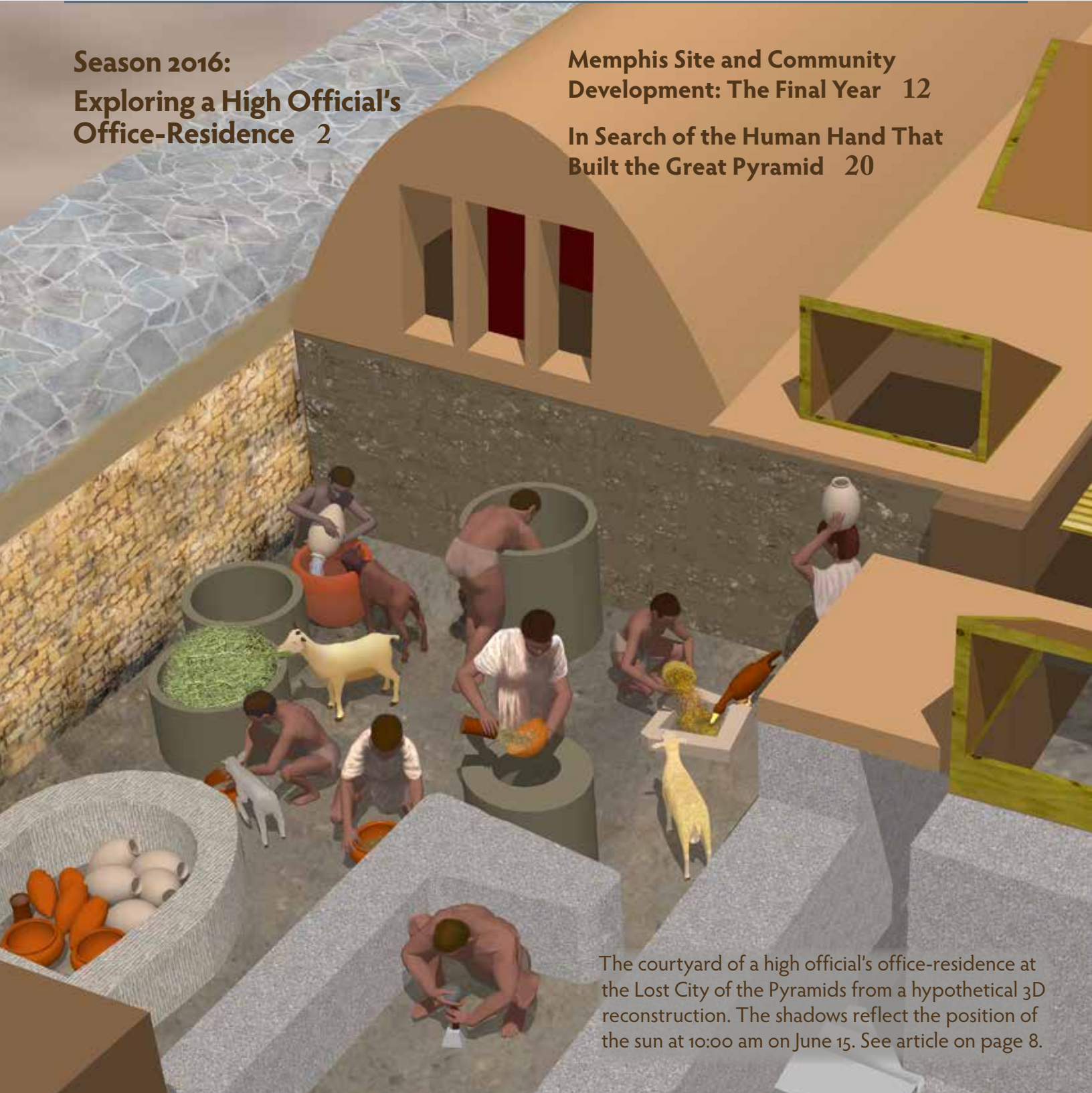
VOL. 17 NO. 1 & 2
Spring & Fall 2016

ISSN 1944-0014

Season 2016:
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The courtyard of a high official's office-residence at the Lost City of the Pyramids from a hypothetical 3D reconstruction. The shadows reflect the position of the sun at 10:00 am on June 15. See article on page 8.

Season 2016: Exploring a High Official's Office-Residence

Season 2015 at Giza ended on a high note with the discovery of an official's residence in Area SW1 (see sidebar on facing page and *AERAGRAM* 16-2)¹ at the Heit el-Ghurab (HeG) settlement site (also called the Lost City of the Pyramids). But we ran out of time to explore in depth. So in February 2016 we resumed excavations and reached the most recent floor level, uncovering walls, built features, artifacts, and collapse debris.

On the latest floor of this house, people were much occupied by storing and producing food. But this was an evolving structure. The compound changed over time, like so much of the architecture at HeG. As the pyramid projects progressed, the city saw many changes during the roughly 50 years that people lived and worked here.

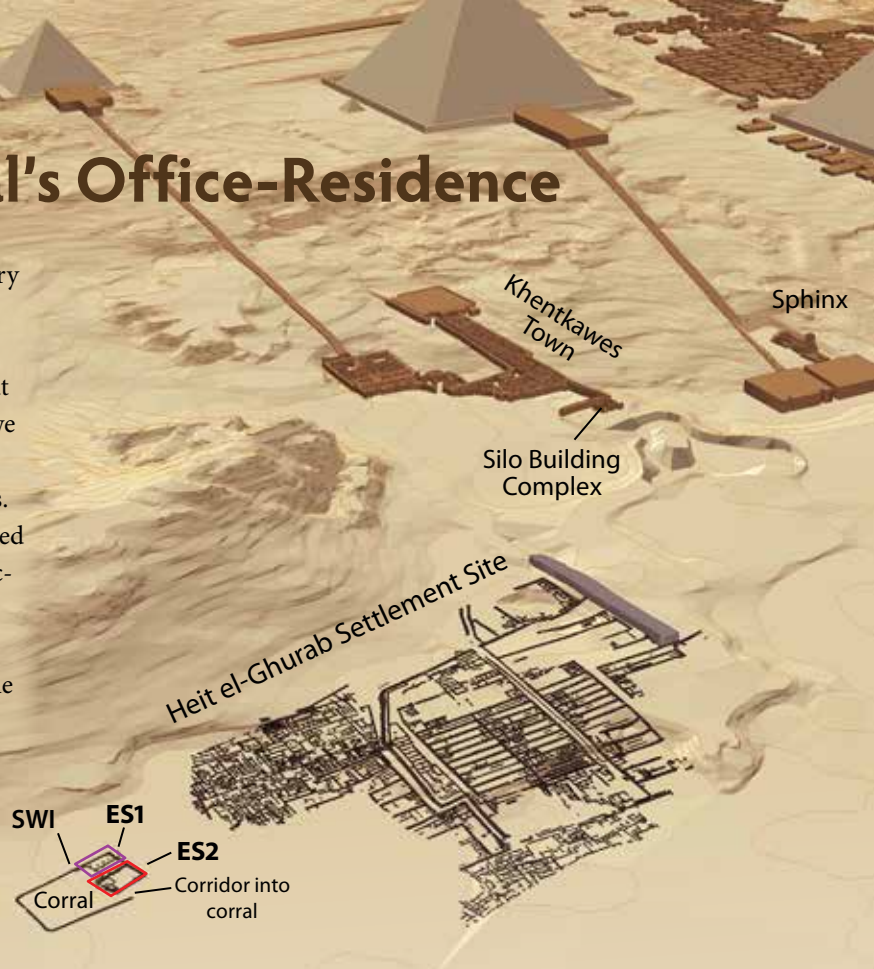
An Unusual House

The layout of ES2 (map on facing page) is unlike any we have seen thus far at HeG or the priests' houses in the Khentkawes Town (κκτ).² Other houses at HeG, all different, comprise a series of interconnected rooms, often with a central courtyard. The κκτ priests' houses, all very similar, also have an interconnected-room layout. ES2 uniquely features a wide aisle down the center, flanked by six main chambers, five of which open directly onto the aisle and are not interconnected.

In addition, this official's suite appears to have been the only living quarter. Work and storage areas, hallways, and a vestibule take up the rest of the structure. The lack of other sleeping quarters suggests that there were no other residents, except possibly staff who may have had informal sleeping arrangements, such as on the roof or in the courtyard in the southwest corner of ES2. The high official apparently did not bring his extended family with him when he stayed at HeG.

Storage – Grain Silos

The small room in the northwest corner of ES2 housed two large silos where people probably stored grain (top left photo, page 4). Made of a single wall of mudbricks, the large silos, about 4.7 feet (1.44 meters) across, were cut down in recent times to only two or three courses of bricks. Thus we do not know their original height or shape. However, the better-preserved silos that we excavated in 2014 in the Silo Building Complex (SBC) next to the Khentkawes Town² (map above) offered some clues as to what the ES2 granaries originally looked like. Since the diameters are roughly the same, about 4.9 feet (1.5 meters), the ES2 silos may have been nearly 7 feet (2.10 meters) high and elliptical-conical in shape, like the SBC silos. Mark Lehner estimates that at this size, the ES2 silos



could have held enough grain for 12 people for a year, assuming grain allowances like those listed in a household account for a Middle Kingdom land-owning official.³

The only access into the silo room appears to have been a narrow doorway from the official's suite, suggesting this person may have controlled grain distribution. The silos were probably filled from the top via an outside staircase.

Storage and Work in the Pantry Courtyard

The courtyard in the southwest corner of ES2, crowded with assorted containers, appeared to be both a work and storage facility, set on a floor about 1.5 feet (0.47 meters) above the level of the rest of the house (except for the back hallway). We found four small silos made of clay directly on the floor. Two of them stand in a row with three other containers: a large bin, a pot, and a vat. This lineup of vessels could be happenstance—as additional vessels were needed, workers may have put them in where the containers could be accessed without impeding traffic flow.

But the row of vessels also suggests a production line. Each container might have held a different ingredient, perhaps for various stages of processing (bottom photo, page 4). At the south end of the line, a D-shaped bin made of mudbricks looks like an open container that could have held pots or other objects. Next to this bin, a pot sunk upside down in the courtyard floor stands adjacent to one of the two silos. The pot, with the bottom removed, may have served as an ad hoc storage

(continued on page 4)

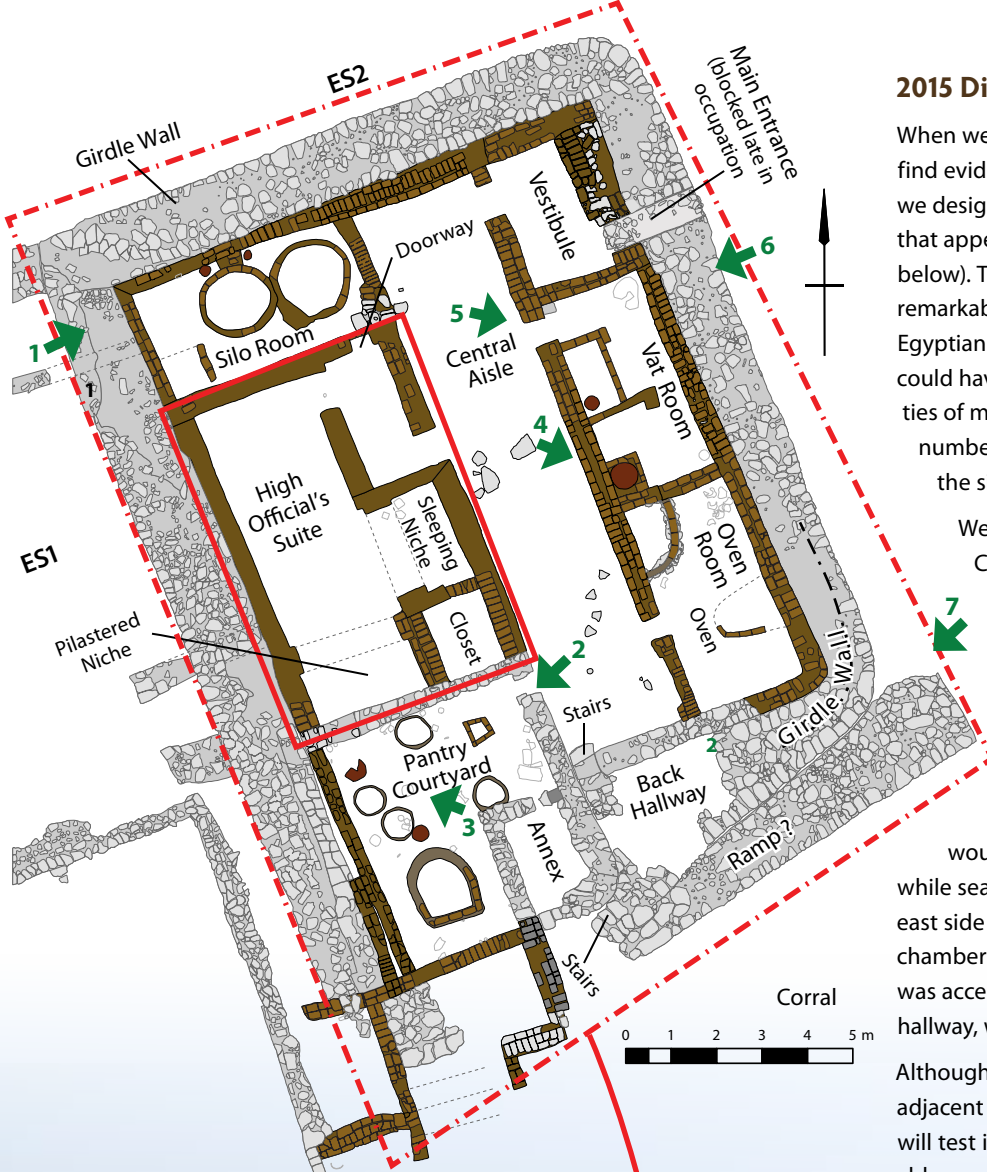
2015 Discovery: High Official's Office-Residence

When we started work in SWI in 2015, we had expected to find evidence of a slaughterhouse in the compound that we designated ES2, which is attached to a large enclosure that appeared to be a corral (map on facing page, photo below). The rounded corners and chute-like opening bear a remarkable resemblance to animal pens depicted in ancient Egyptian art and to modern livestock corrals. Here, occupants could have penned cattle that produced the great quantities of meat people consumed at HeG, evidenced by large numbers of cattle bone we find in our excavations across the site.

We dubbed the large enclosure the OK (Old Kingdom) Corral. But in ES2, we discovered a house instead of a slaughterhouse and concluded that it was the office and residence of the administrator of the larger establishment.

In the center of the compound we found a long hall oriented north-south with a pilastered niche at the south end, along with remains of the niche's red frame. The master would have received visitors in the long hall, probably while seated in the pilastered niche. A second niche, on the east side of the hall, may have been for sleeping, and a small chamber attached to it probably served as a closet. The suite was accessed by a zigzag entrance off the central aisle or hallway, which would have assured privacy.

Although ES2 did not turn out to be the slaughterhouse, the adjacent compound ES1 most likely was—an hypothesis we will test in a future season. The principal resident of ES2 probably oversaw the operation of the stockyard-slaughterhouse.



Above: Map of ES2. The green arrows indicate where photos on the next four pages were taken. Below: Photo of SWI during 2016 excavations. A low fieldstone wall around the corral was probably topped with brush or perhaps mudbrick. View to the north-northeast. Map prepared by Rebekah Miracle, AERA GIS, and photo by Mark Lehner.





Hanan Mahmoud and Rabee Eissa map the silos in the silo room. View to the east. See Arrow 1 on map, page 3, for location. Photo by Sayed Talbah.

container. At the north end of the line stood a large, deep vat, which we found partially crushed (inset photo, below). The same type of vessel has turned up in bakeries at HeG and in Old Kingdom tomb scenes of bread baking, although here the vat was probably not used to mix bread dough. The courtyard has none of the features we see in bakeries elsewhere at HeG, which include baking pits and hearths, and it shows no signs of any fire. Perhaps the vat served as a container for liquids in this row of vessels.

We did find evidence suggesting that people measured out goods from these containers: two pots that served for standard

measures (bottom inset photo below) turned up in one of the silos. The tall one is depicted in tomb reliefs as an oil measure. The globular pot held half its volume. A low rectangular installation in the northeast corner of the courtyard could have supported jars while being filled.

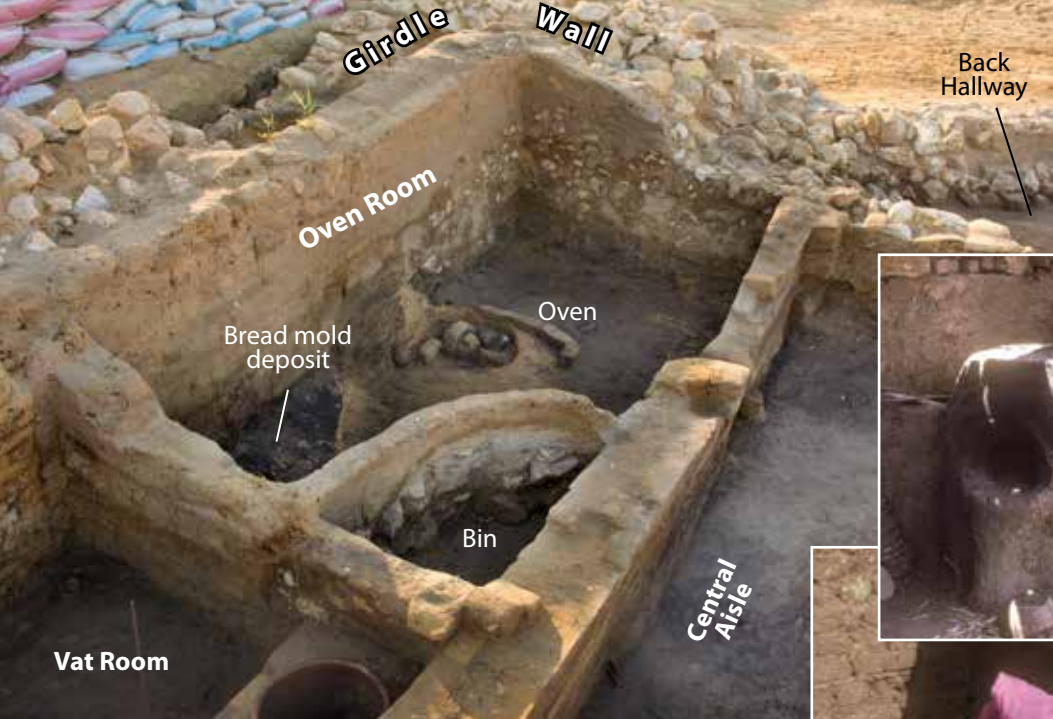
Below on right: A modern courtyard silo in Luxor protected by a simple awning of straw. It consists of a bin for grain, topped with a smaller, but wider, bin used to store baked bread, cheeses, etc. Photo by Mohsen Kamel.

Below: The pantry courtyard. View to the southwest. See arrow 2 on map, page 3. Photo by Dan Jones.

Top inset: A worker clears around the large vat found in the courtyard at the location marked by the white dotted line. Arrow 3 on map. Photo by Hanan Mahmoud.

Lower inset: The two measuring pots found abandoned in one of the silos and a shallow bowl was used as a lamp, as indicated by soot residue. Photo by Dan Jones.





Left: The oven room. View to the southeast. Arrow 4 on map, page 3. Photo by Dan Jones. Inset: An oven in a courtyard in an Upper Egyptian village photographed in 1978 by Wilma Wetterstrom.



Below: A woman in Gurna, Upper Egypt, prepares dough for *aish shemsi*, a round loaf made of modern bread wheat. After allowing the loaves to rise, she bakes them in the oven shown in the inset photo on the left. Photo by Wilma Wetterstrom.



The two silos on the west side (in the lineup) are probably preserved to their original height,⁴ but we do not know how high the other two originally stood. They may have been tall storage containers for food or fodder (see photo of a modern courtyard silo on facing page).

Another possibility is that some of the silos served as feeding troughs for small livestock, like examples ethnographically documented in Upper Egypt.⁵ These modern, round troughs fashioned of mud are about the same size and height as the two silos on the west side of the courtyard. We can imagine inhabitants keeping sheep, goats, and ducks in the courtyard before they dispatched them for meat.

Also, in this courtyard, people could have crafted items of daily use. In the deposits that covered much of the courtyard and annex (the small chamber in the southeast corner of the courtyard)—and that might possibly have come from elsewhere—we found capstones for rotary drill rods, a stone axe, dolerite pounding stones, beads and abraders, querns for milling cereal, and handstones for grinding. We also discovered three pyramid-shaped limestone furniture supports, possibly unfinished (see page 10).

These three possible functions—craft-working, animal holding, and food storage/processing—would not necessarily have been mutually exclusive. In modern Middle Eastern villages most spaces serve a variety of functions, and an activity may be carried out in different locations, depending on availability as well as the season. A rooftop might be the best place to work on a cold winter morning, but the shady side of a courtyard would be more desirable during summer days.

The Oven Room

While the courtyard showed no signs of baking, across the central aisle we found the remains of what appears to be an

oven. Robbers had gouged out most of the installation, leaving a curving line of mudbricks, suggesting an oval structure (photo above), possibly like the ethnographic example in the inset photo above. Next to the installation, a 6.5-foot stretch on the east wall shows scorching, confirming that a fire burned here. Fuel for the oven might have been stored in the tall bin in the northwest corner of the room.

In the northeast corner we uncovered a deposit of bell-shaped bread molds. But they do not inform us about *this* chamber, as they would not have been used here. The bell shape only works as a bread pan when the molds are placed in eggcrate-like depressions—which hold them upright—in baking pits, of which there is no evidence here, at least not so far. The oven, on the other hand, could have been used to bake a flat bread, as well as to provide heat for cooking pots. A baker might have worked near the oven, mixing and shaping flat loaves. The photo on the right above shows a woman in Upper Egypt preparing dough for round loaves to be baked in the oven in the inset photo. Working on the floor, she requires little space and few utensils. We can imagine workers in the oven room preparing flat bread dough and perhaps cooking on small portable stoves made of mud, like those still used in Egyptian villages.

The Vat Room

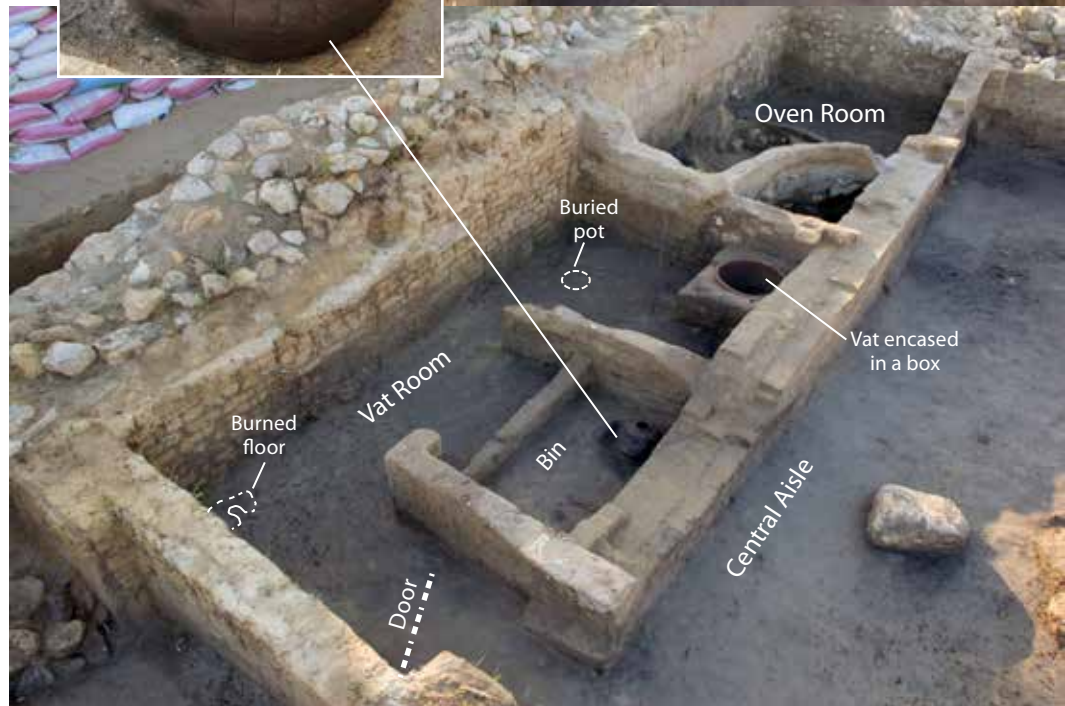
The chamber next to the oven room, the vat room, was probably another type of food processing or storage facility (photo below). Whatever it was, the chamber appears to have been private and secure. Unlike the oven room and courtyard, the room could be sealed with a door, as documented by a limestone pivot socket, which allowed the door to swing inward (photo on the far right). When the door was open, the view from the central aisle was limited by the wall between the hall and the room, which was more than 1.5 feet thick, and further impeded by a thin partition that created a narrow entrance hallway. The floor at the end of this little corridor showed evidence of a fire; we can imagine a doorman warming himself, while keeping out intruders.

The partition forming the entrance hallway bounded the north side of a shallow bin, fronted with a rim about 6 inches (0.15 meters) high. In the southwest corner of the bin, a storage jar was partially buried in the floor. A potmark etched on the jar's shoulder may have been a label for the contents (inset photo at right). But the mark would have been most useful before the pot was embedded, since it faced into the bin's corner where it could not have been readily seen. Ashes packed around the outside of the pot may have served to deter pests.

The wall on the south side of the bin defined a second work area. A large vat in this "backroom" was sunk about 3 inches (0.08 meters) into the floor and then encased up to its rim in a box formed of clay with limestone chips and pottery sherds. In the bakeries at HeG we have found this type of vat buried in the floor, although in the ES2 courtyard it stood on the floor. In this vat people may have held liquids, mixed ingredients, or allowed food to ferment. In the southeast corner of the room a storage jar, like the one embedded in the bin floor, was partially sunk into the floor.

What went on in the vat room? If it had been roofed (see page 8), it would have been a dark space and most likely used for storage—rather than workspace—possibly for food best kept under cool, dark conditions, such as wine, oil, and dried fish and meat. We can imagine jars, crates, and baskets standing on the floor, and some containers hanging from the ceiling or walls.

Right: Hanan Mahmoud points to the socket on which a door pivot once swung in the vat room. Arrow 6 on map, page 3. View to the southwest. Photo by Dan Jones.



Above: The vat room. Arrow 5 on map. View to the southeast. Photo by Dan Jones. Inset above: The pot found in the bin of the vat room. Note the mark inscribed on the pot. It may have been a label for the contents. Photo by Sayed Talbah.

If the room had windows set high up in the sidewalls, some light would have filtered in, but probably not enough for detail-oriented work. However, a square limestone table, which might have been a cutting board (see page 11), turned up in the fill. If anyone used the table in this room, perhaps windows or a lamp gave them light enough to work.

The Vestibule and Central Aisle

The main entrance to ES2 was through the small zigzag hallway in the northeast corner. A guard may have perched on a narrow bench just inside the door.

The vestibule opened into the wide central aisle, from which the other chambers could be accessed. While it served as a thoroughway, the aisle was probably also a workspace.

Back Hallway and Ramp

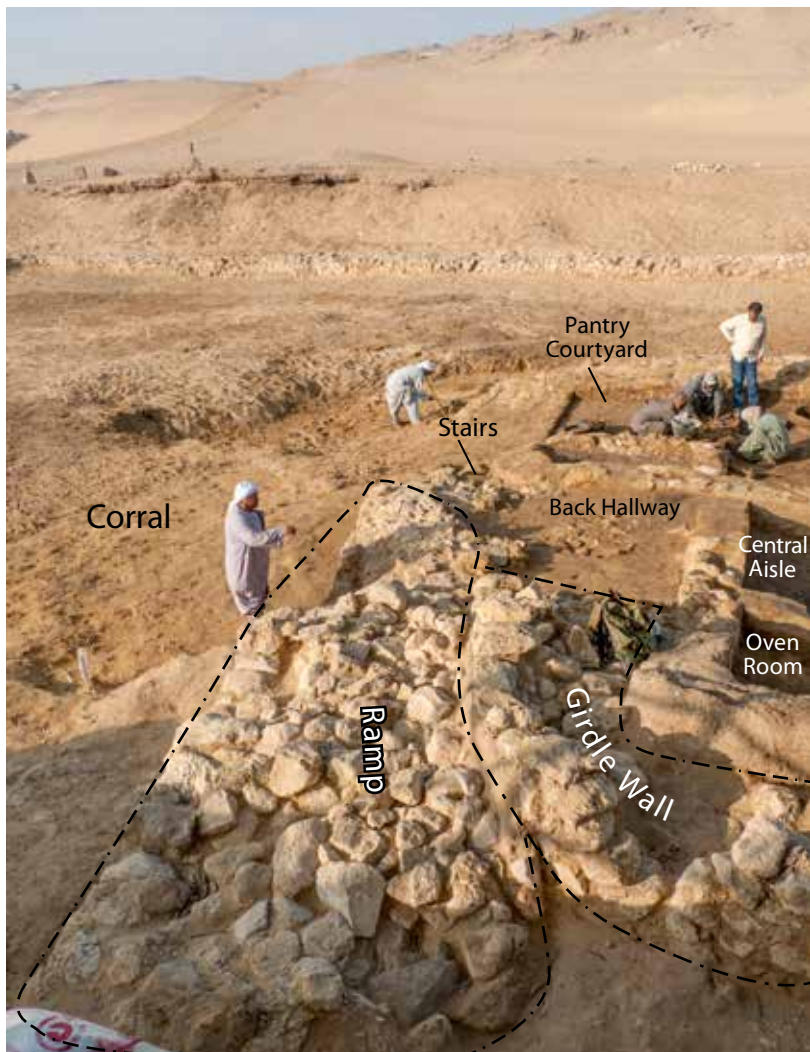
At the south end of the aisle, four crude steps lead up to a back hallway, with a high floor at the same level as the pantry courtyard. Off the west side of the hallway another set of stairs descended down into the corral. The east side of the back hallway is formed by a thickening of the girdle wall that encircles ES2. We think this thickening might be the remains of a stairway to a roof over rooms on the east side of the compound.

Against the southern segment of the girdle wall, builders added an even thicker trapezoidal accretion of stones, perhaps as a ramp to access the roof. Its squared-off eastern end, projecting just beyond the girdle wall, may have served as a viewing station for monitoring activity around ES2 or a perch for a scribe recording cattle marching into the OK Corral. The space between the east wall of ES2 and the northern extension of the corral wall formed a chute, we hypothesize, for herding livestock into the enclosure (see map page 2).

The Evolving ES2 Compound

Although we have not yet excavated lower levels of ES2, we see evidence of earlier configurations, primarily as blocked openings in the walls. The sequestered high official's suite, with the

The Ramp and the southern end of ES2. Arrow 7 on map, page 3. View to the southwest. The girdle wall turns the corner of ES2, but much of its stone was robbed. Photo by Mark Lehner.



pilastered niche, did not exist as such in an earlier phase. An opening in its west wall once offered access to the adjacent compound. A door in its south wall opened into the pantry courtyard, which also once had a door at its south end that was later blocked.

We also found alterations in access in the vat room. Originally a door—located where the box was built around that vat—opened into the oven room.

In the silo room we uncovered traces of an earlier wall that was taken down to make way for the western silo. The fieldstone girdle wall was a late addition. Builders wrapped it around the compound shortly before the last occupation phase, perhaps to make the interior more secure.

The Last Hurrah for the ES2 Compound

During its final days ES2 was blanketed with a thick, undulating layer of ash and charcoal, with bits of mudbrick. The ash may have been dumped, a basket-load at a time, from elsewhere. Also, as sections of ES2 were abandoned, people would have pulled out roof beams, setting off a rain of dried mud and bricks and possibly ash from hearths or ovens on the roof. Curiously, the official's suite and the silo room were not covered by the ash layer and were perhaps still used.

Some time later, a second layer of ash and charcoal descended on ES2, blanketing all but the long hall in the official's suite. Then the walls along the central aisle collapsed into the hallway, some as whole sections. By this point ES2 must have been abandoned.

But ES2 did not suffer the destruction we see elsewhere at Heit el-Ghurab, where many walls were cut down to ankle-level. By comparison, ES2 is remarkably well-preserved with some walls still standing a meter high and features such as the small silos, bins, and the vat box, still intact under the ash and charcoal layers.

Farther down in ES2, below the final floor level, older phases lie waiting to be studied. We look forward to exploring them in future seasons.

1. Lehner, M., "Discovery 2015: House of a High Official," *AERAGRAM* 16-1, pages 2-7. Spring 2015. All back issues of *AERAGRAM* can be downloaded for free from our website: aeraweb.org.

2. "Bread and Beer for Dead Kings: Piety and Politics," *AERA Annual Report 2013-2014, Revealing the Past, Building Our Future*, pages 4-13, 2014. Available for free download from our website.

3. Allen, J. P., *The Heqanakht Papyri*. New York: The Metropolitan Museum. pages 146, 258, Appendix E (Table A), 2002.

4. Mahmoud, H., R. Eissa, and D. Jones, "Data Structure Report (DSR) for the 2016 excavations at Standing Wall Island (sw1)," on file at Ancient Egypt Research Associates, Boston. April 2016.

5. Ikram, S., "Mud Matters: Domestic Silt Technology in Upper Egypt," page 167, In *Moving Matters: Ethnoarchaeology in The Near East*, ed. by W. Wendrich and G. van der Koojo. Leiden: Research School CNWS, Leiden University, 2002.

How Was ES2 Roofed? Modeling in 3D *by Wilma Wetterstrom*

Creating a 3D model of an ancient structure is a great way to gain insight into how it was constructed, functioned, and, in this case, how it was roofed. To create a 3D model, generalities that suffice in a narrative text, such as “probably roofed with a vault,” have to be replaced with data—the vault’s dimensions, shape, and so on. Applying “hard data”—drawn from archaeological remains, ethnographic sources, etc.—reveals how various arrangements might have worked or failed and sheds light on their implications for occupants and activities.

Building the Model

To come up with the “hard data” for the ES2 model, I first considered all the evidence from ES2. But we do not know how high the walls originally stood, nor which spaces were roofed, as well as many other variables. To supplement the limited ES2 data and arrive at reasonable scenarios to test with the model, I looked to better-preserved archaeological sites and to studies of mudbrick architecture, both ancient and modern.

I considered how the climate in the Middle East poses challenges that builders have addressed for thousands of years with roofs and canopies: bright, direct sunlight and intense heat during the summer; cold in the winter; and rain, wind, and dust storms. Since roofs also obstruct natural light and airflow, builders have incorporated central courtyards, clerestory windows, windcatchers, and other devices in their designs.

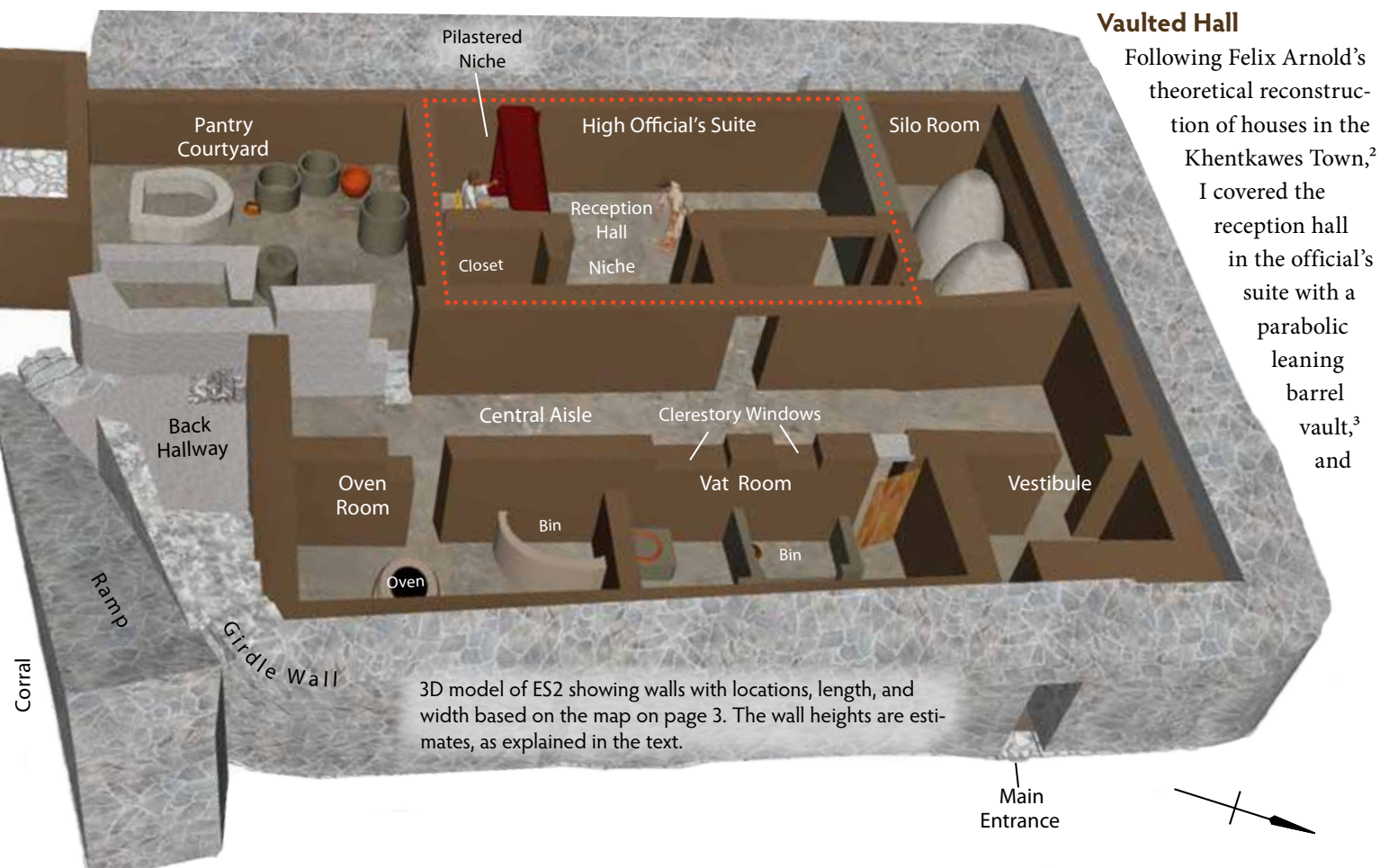
Walls and Courtyards

As a starting point, I created full-height walls for most of ES2.¹ I based the locations and widths on our excavation data. Bounded by full-height walls, ES2’s large central aisle would have functioned like a central courtyard. If open to the sky, it would have been a well-lit, ventilated space, while also providing privacy, security, and shelter from wind and dust storms. An open-air aisle also offered light and air for the surrounding rooms, especially if they were outfitted with clerestory windows.

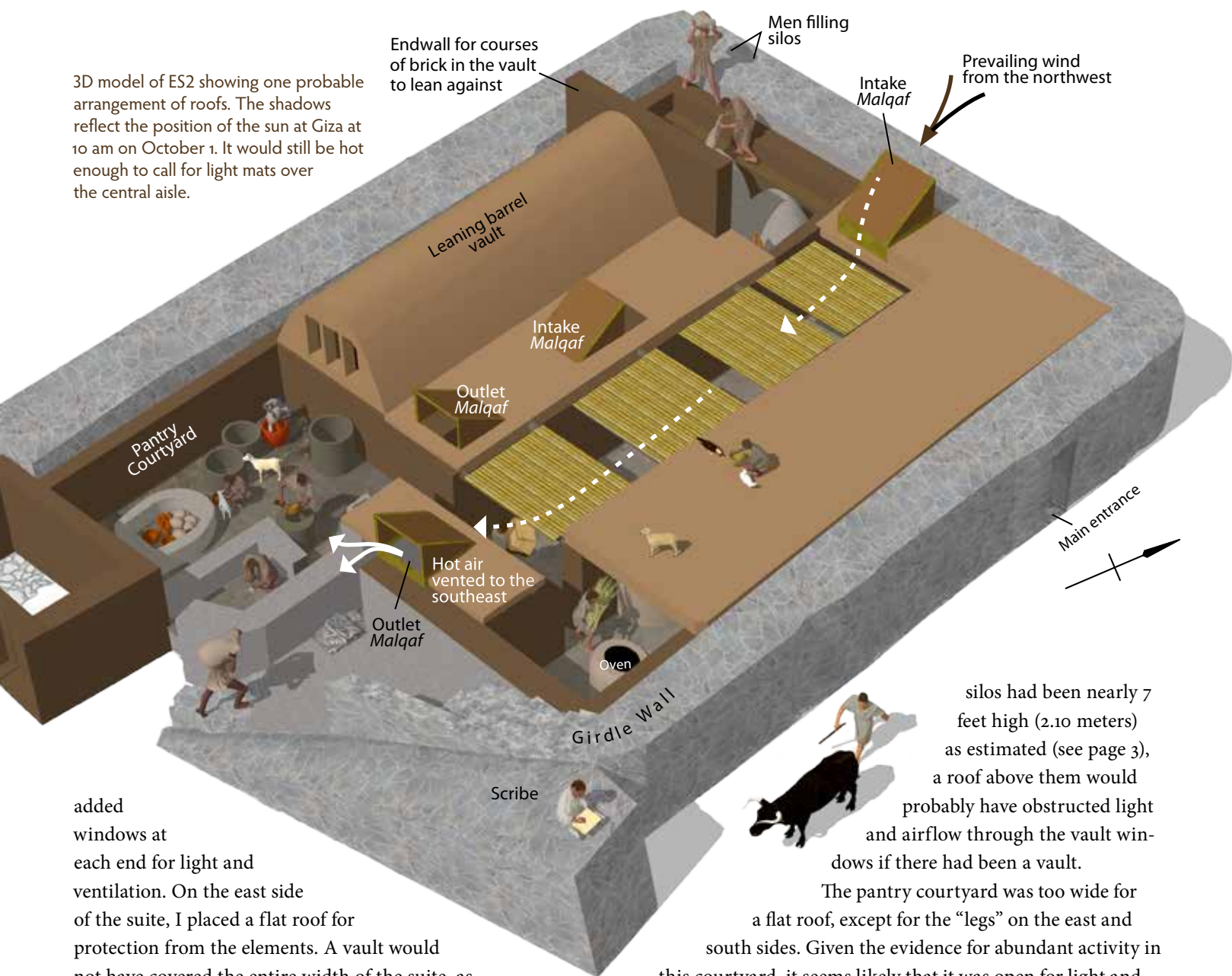
During the summer the aisle, if it had been open, might have been covered with temporary canopies of light matting to provide shade. The gaps between and on either side of the mats would allow light to penetrate and rising hot air to escape.

Flat Roofs

I placed a flat roof over spaces on the east side of the central aisle, leaving half of the oven room open to vent smoke. We do not know that the east side rooms were roofed, but it seems likely given the benefits of a roof: security and shelter from the sun and the elements. In addition, a flat roof, accessed via ladders or a ramp/stairs, would have been additional space for work and storage, as well as the coolest place to sleep during the summer. Clerestory windows in the vat room would improve airflow and lighting in what would otherwise be a dark, stuffy space if roofed.



3D model of ES2 showing one probable arrangement of roofs. The shadows reflect the position of the sun at Giza at 10 am on October 1. It would still be hot enough to call for light mats over the central aisle.



added windows at each end for light and ventilation. On the east side of the suite, I placed a flat roof for protection from the elements. A vault would not have covered the entire width of the suite, as the narrow walls could not have supported such a massive structure, over 16 feet (5 meters) wide.

Malqafs

The *malqaf*—also called a windcatcher or ventilator—was the ancient Near East’s air conditioner and is still used today. Set high up on the windward side of a building, this hood-like device catches and funnels cool air into the structure. I mounted *malqafs* on opposite ends of the central aisle.⁴ The one on the north faces into the prevailing wind, funneling cool air into the aisle, while the one on the south vents the hot air. In the official’s suite, I placed a set of *malqafs* over the sleeping niche. Without ventilation the sleeping niche would probably have been hot and uncomfortable in the summer. At Amarna, we see parallels in windcatchers over sleeping niches.⁵

Open Spaces

I left the silo room open to the sky, based on silo courts found at Amarna,⁵ Elephantine, Tell el-Dab’a, and Edfu.⁶ Also, if the

silos had been nearly 7 feet high (2.10 meters) as estimated (see page 3), a roof above them would probably have obstructed light and airflow through the vault windows if there had been a vault.

The pantry courtyard was too wide for a flat roof, except for the “legs” on the east and south sides. Given the evidence for abundant activity in this courtyard, it seems likely that it was open for light and ventilation. However, a light awning might have protected one or several of the silos (see photo on page 4).

What about other arrangements of roofing, wall height, etc. for the entire compound? I plan to experiment with other options and report on them in a future issue of *AERAGRAM*.

1. I used 2 meters, about 6.5 feet, as full height, based on the elevation view of Hassan Fathy’s peasant houses at New Gournā. H. Fathy, *Architecture for the Poor*, Chicago: University of Chicago Press, fig. 106, 1973.

2. Arnold, F., “Die Priesterhäuser der Chentkaues in Giza,” *Mitteilungen des Deutschen Archäologischen Instituts*, Abteilung Kairo 54, pages 1–18, 1998.

3. Nolan, J. S., and G. Heindl. “Double-Decker Dorm? Reconstructing the Galleries.” *AERAGRAM* 11-2, pages 7–9. Winter 2011.

4. This arrangement of malqafs at opposite ends of an enclosed space is based on experiments that have shown this arrangement achieves the best airflow. S. G. M. Attia, and A. De Herde, “Designing the Malqaf for summer cooling in low-rise housing, an experimental study,” *Passive and Low Energy Architecture*, Vol. 1, no. 1, 2009.

5. Kemp, B., *The City of Akhenaten and Nefertiti*, London: Thames & Hudson, figs. 5-23, 5-26, 2012.

6. Moeller, N., *The Archaeology of Urbanism in Ancient Egypt*, Cambridge: Cambridge University Press, pages 257, 314, 319.



From the Giza Field Lab: Unique Finds in a High Official's Office-Residence

During Season 2016 Emmy Malak, AERA Objects Analyst, studied the finds discovered in ES2, the house-office compound in Area SW1 at the Heit el-Ghurab site (see pages 2–9). Here she offers preliminary observations about two of the interesting and unique objects from this past season.

Standing Wall Island (sw1) not only has distinctive features and architecture, but it also produced two types of objects that differ from those found elsewhere at Heit el Ghurab: limestone furniture supports, which are unique to ES2, and limestone tables that are our most complete examples of the object type.

Furniture Supports

During Season 2015, excavators found three limestone furniture supports in the ES2 space that served as the high official's suite (see map page 3). In ancient Egypt these truncated pyramidal blocks stood on the floor under the legs of chairs and beds, probably to keep away pests and the damp. High officials are often depicted in tomb scenes seated, with their chair legs resting on such supports, as in the image on the left. We thought that the ES2 furniture supports were used by the high official who resided there.

Three more limestone furniture supports turned up during 2016, but in a different area: the pantry courtyard located in the southwestern corner of the building. These 2016 examples seem to be not as complete or finely finished as the ones recovered during the previous season (photo below). It could be that the former were left in the house before they were completely

Top: Emmy Malak, AERA objects analyst, shows the back of the rectangular limestone table (Object 4075) in the Giza Field Lab. Photo by Mark Lehner.

Left: The wife of Pepi'onkh sits before an offering table in a 6th Dynasty rock tomb at Meir. The chair stands on furniture supports that are shorter in front than in back. Pepi'onkh was a high official with many titles, including "Overseer of Upper Egypt in Reality." From A. M. Blackman, *The Rock Tombs of Meir, Vol. IV: The Tomb-Chapel of Pepi'onkh the Middle Son of Sebkhotpe and Pekhernefert*. London: Egypt Exploration Society, pl. XIV, 1924.

Below: Furniture supports found in SW1 in 2015 and 2016. Photos by Claire Malleson. Note that the 2016 specimens are different sizes.



2016 Furniture Supports

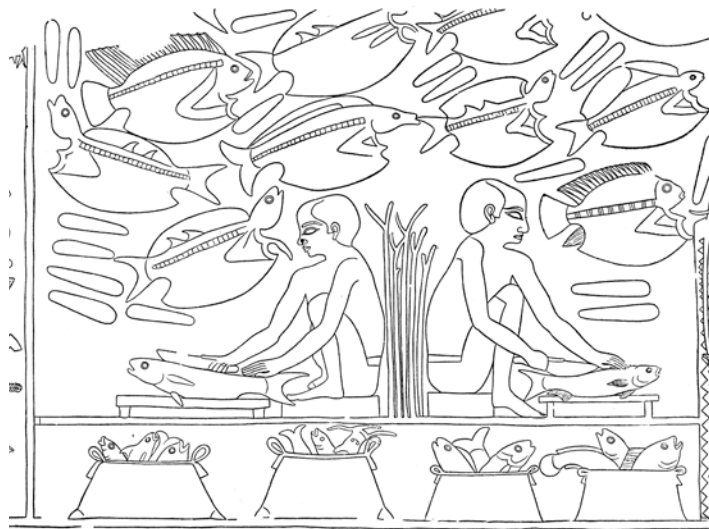


2015 Furniture Supports



01 5 10 centimeters

Fishermen filleting fish from a scene in the 5th Dynasty tomb of Ti at Saqqara. From H. Wild, *Le Tombeau de Ti*, Fas. II, Cairo: Institute Française d'Archéologie Orientale, 1953. Note that the fishermen are cutting the fish on low tables. Although these tables are different from the swi examples—they appear to have four legs—they nonetheless show that low tables set on the ground or floor were essential tools in ancient Egypt.

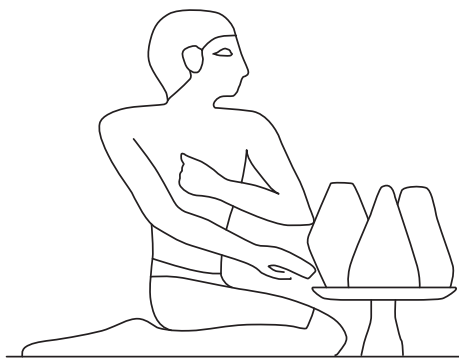


finished. They also are different sizes. Perhaps they were intended for a set that was higher in the back than the front, as shown in the tomb painting on the facing page.

Tables

While limestone tables occur in other areas of Heit el-Ghurab, such as the Royal Administrative Building and House 1, the tables found at swi are the only complete examples recovered from Heit el-Ghurab. One table has an oval/circular top and a single leg, located in the center of its underside (Object 4042; see photo, upper right). It was found in the silo room in mudbrick debris from wall collapse and so probably came from elsewhere in the house. The other table, found in the vat room, has a rectangular top and a rectangular, knob-shaped base, also in the center (photo on facing page).

Tall, round top tables are common in offering scenes in tombs of high officials, but examples like Object 4042 are more utilitarian in nature; a short table, close to the floor at ankle-height and used for keeping foodstuffs off the ground, as seen in Kahjef's tomb example (see above) and the poultry feeding scene from Ti's 5th Dynasty tomb at Saqqara shown below.



Above: Emmy Malak, AERA objects analyst, displays the round limestone table (Object 4042) discovered in swi. Photo by Mark Lehner.

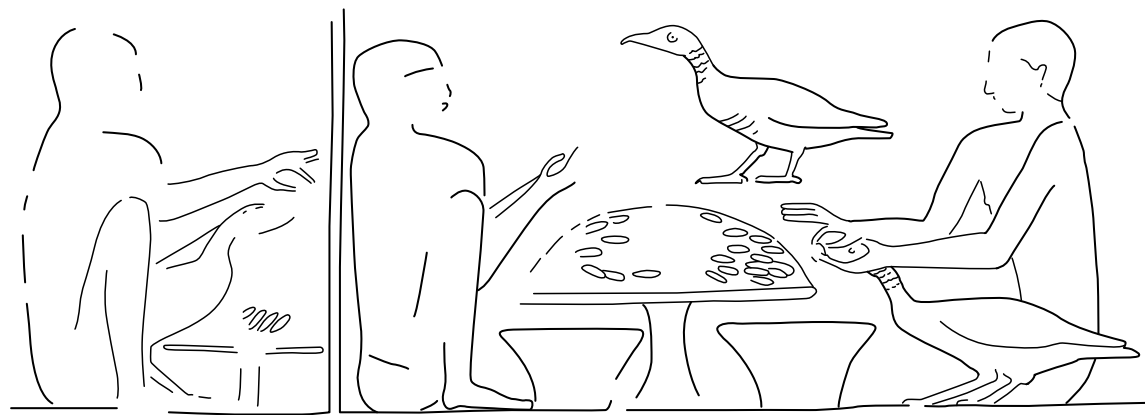
Left: Detail from the Mastaba of Kahjef. After H. Junker, *Giza VI. Die Mastaba des Nfr (Nefer), Qdfjj (Kedfi), Khjf (Kahjef) und die Westlich Anschließenden Grabanlagen*, Abb. 38b. Vienna, Leipzig: Hölder-Pichler-Tempsky, 1943.

However, our square table, Object 4075, is of a different type. It was likely meant to be a working floor-platform, used to create hard surfaces on dirt floors, like those shown in the fisherman scene in Ti's tomb (top image above). The short legs were probably pushed into the dirt floor to stabilize the table. The rectangular table may have been used as a cutting board, as suggested by marks on the top that look like they were made by a blade. In the scene from Ti's tomb, two fisherman fillet fish using chert knife blades on low tables.

The tables and furniture supports are but two of many objects from εs2. I look forward to studying the others awaiting analysis in the Giza Field Lab and reporting on the insights they offer into life in this ancient compound.

~ Emmy Malak

At left: A scene from Ti's 5th Dynasty tomb at Saqqara showing workers force-feeding poultry before slaughter. Note the two short, single-legged tables piled high with food for the ducks. After H. Wild, *Le Tombeau de Ti*, Fas. II, Cairo: Institute Française d'Archéologie Orientale, 1953.





A panoramic view of the Ramesses II Temple (center middle) and the Tombs of the High Priests (far left), two of the eight sites being prepared for the new Memphis walking circuit. Photos and panoramic by Freya Sadarangani.

Memphis Site and Community Development: The Final Year

Since our last report in *AERAGRAM* 16-2,¹ much has happened on the ground at Mit Rahina, ancient Memphis, site of our Memphis Site and Community Development Project (MSCD). A two-year program generously sponsored by USAID, the MSCD project allowed us to run four field school sessions in 2015–2016, with the overall goal of exposing students to the concept of cultural heritage practice and development, as well as community archaeology and outreach. These areas of archaeology challenged our students to think outside the excavation square to issues of conservation, interpretation, audience assessment, the distribution and publicizing of archaeological work, and the engagement of local communities in their cultural heritage.

Goals and Intent

The MSCD project sought to achieve this cultural heritage exposure through the implementation of three basic goals: 1) the preparation of a tourist walking circuit across eight sites at Mit Rahina, 2) the development of a heritage and outreach program for the central Memphis area, and 3) a conservation assessment of the monuments within the circuit area.

We achieved these goals through the production of a series of deliverables like the walking circuit and its signage, the development of plans for long-term cultural outreach, site guard engagement, tourist and business plans (including site tours and information packages to engage tourist companies), and media and publicity plans. We employed local residents of Mit Rahina in the preparation of the circuit and trained more than 77 students (29 men and 48 women) over four six-week sessions in basic skills of site management, cultural heritage development, and outreach. As with most AERA Field Schools, our students were current Inspectors in the Egyptian Ministry of Antiquities (MoA).

Besides the physical walking circuit and signage, one of the goals of the MSCD project was the production of a Memphis website for public use—prepared by the students and staff—as well as a brochure and guidebook for distribution at the site.

Students helped prepare all MSCD products, which are meant to promote tourism and enhance knowledge of the site. The website and printed outputs will be presented in both English and Arabic.

Teaching Community Archaeology

Dr. Sara Perry, assisted by AERA staff and supervisors, ran four heritage and outreach training sessions during the two-year project. Most recently, Sessions 3 and 4, from September to mid-December 2016, focused on teaching the students how to re-imagine cultural heritage at the broadest level—how the public takes in and processes information at a museum or site. Field trips to sites such as the Children’s Civilization and Creativity Center in Heliopolis, the Greco-Roman site of Karanis, and the paleontological site of Wadi el-Hitan encouraged students to critique what they encountered. At each stop, they assessed narrative and presentation, including signage, and infrastructure for visitor flow and movement. What was engaging or inviting? What was informative? Students then gave presentations to the group on what they learned.

Students also prepared summary presentations on assigned articles about community archaeology, sharing basic information with fellow students. They asked questions: What is this project? Where did it take place? Who were the stakeholders affected by the project? What were the outcomes, both positive and negative? Each lecture, article, and field trip gave students another chance to broaden their knowledge and approach their work at Memphis from a new perspective.

Social Media and Archaeology

In addition to learning to think critically about how archaeologists explain results to the public on site, our students also received training in the responsible usage of social media as it relates to cultural heritage. Digital forms of communication provide exposure and worldwide attention for lesser known, but still important, cultural heritage sites like Mit Rahina. Students benefited from lectures and hands-on training in the creation of Facebook, Twitter, and blog posts, including how to target and reach particular audiences and how to encourage

1. “Memphis Site and Community Development: Ambitious Plans, Big Challenges,” *AERAGRAM* 16-2, 2–7. Fall 2015.

response and interaction between visitors and cultural heritage. The students' work will be posted online at the Memphis website.

York staff also introduced the concept of using film for heritage archaeology. Students learned basics of filmmaking, including how to decide on a topic and target audience through the exploration of fictional personas, or characters representative of larger target audiences (such as children, elderly visitors, teenagers, local community, academics, and international visitors). From this, the students produced five short videos on Memphis, which will be posted on YouTube.

The Walking Circuit

The crowning achievement, undoubtedly, of the MSCD project will be the opening of the eight-site walking circuit with new signage and pathways (see next page for map). While the students received their heritage training, AERA staff and former field school students conducted a rigorous campaign² of cleaning and recording the eight sites chosen for the circuit. These include seven ancient sites and the modern Memphis Museum and Open-Air Sculpture Garden.

Students and supervisors of Field School Sessions 1 and 2 (September–December 2015) designed paths for the Ptah Temple West Gate, Apis House, Sculpture Garden, and Hathor Temple sites, while students and supervisors of Sessions 3 and 4 (September–December 2016) designed paths around the Ramesses II Temple, the Seti I Chapel, the Tombs of the High Priests, and the Ramesses II Chapel. Students worked with our conservation team to understand where to lay paths so as to avoid damage to the archaeological remains.

Throughout the duration of the project, we laid trial paths to test materials and installation techniques. We laid palm tree logs, sourced from a local provider and cut lengthways to create borders for paths. As much as possible, we based the locations of the paths on existing trackways used by members of the local community in order to not inconvenience the town and to keep down plant growth. In new areas with no established footfall, we placed tafla gravel, which hardens after it has been wetted and provides a more durable walking surface that is less susceptible to weeds (see photos, next page).

Graphic designer Ian Kirkpatrick created images to complement text and content from students and staff, and then worked to convey an overall interpretative narrative according to professional design standards.

(continued on page 16)

2. The continued clearance and maintenance of the circuit has been an ongoing challenge. The rampant growth of weeds and reeds requires constant pruning, and windblown debris and dust need regular removal. Along with a conservation report documenting the current state of the sites, we are preparing a long-term maintenance plan to help the Ministry address these problems after the conclusion of the MSCD project.



Field School students and supervisors listen while a colleague gives a presentation covering the highlights of an assigned reading. Photo by Amel Eweida.



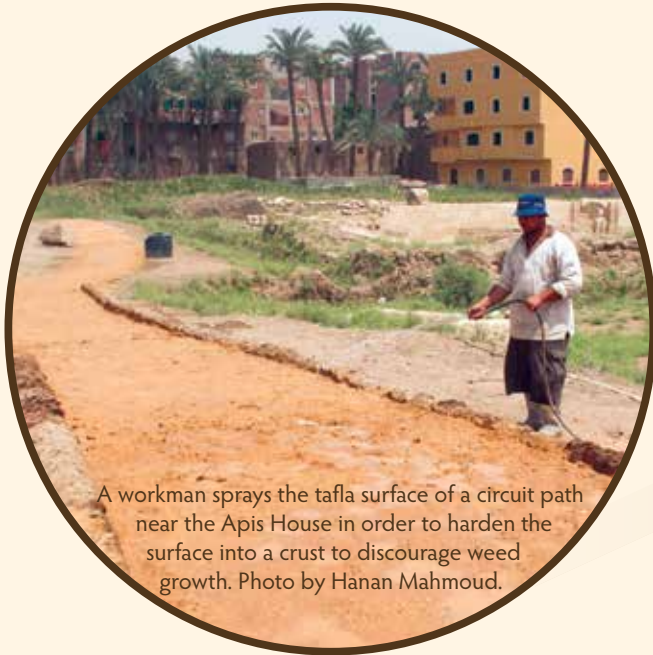
Field School student Mohga Ramadan Abdel-Kader Abdel-Kawy delivers a presentation on her critique of Wadi-el Hitan in the AERA-Egypt Center library. Photo by Amel Eweida.



Heritage Assistant Katrina Gargett working with students on the practical aspects of filmmaking in the AERA-Egypt Center garden. Photo by Amel Eweida.



AERA-MSCD Senior Archaeologist Dan Jones and Reis Sayed Talbah examine a batch of newly delivered signage for the walking circuit. Photo by Mohsen Kamel.



A workman sprays the tafla surface of a circuit path near the Apis House in order to harden the surface into a crust to discourage weed growth. Photo by Hanan Mahmoud.



MSCD Co-Director Freya Sadarangani (front right) leads a tour on a section of the newly installed Memphis walking circuit. Photo by Amel Eweida.

Ptah Temple West Gate

Built in the reign of Ramesses II, the Ptah Temple was the central temple of the most important god at Memphis. The temple was so important that it most likely gave rise to one of the names used for the city of Memphis, *hwt-k3-Pth*, meaning "Temple for Ka of Ptah."

Tombs of the High Priests

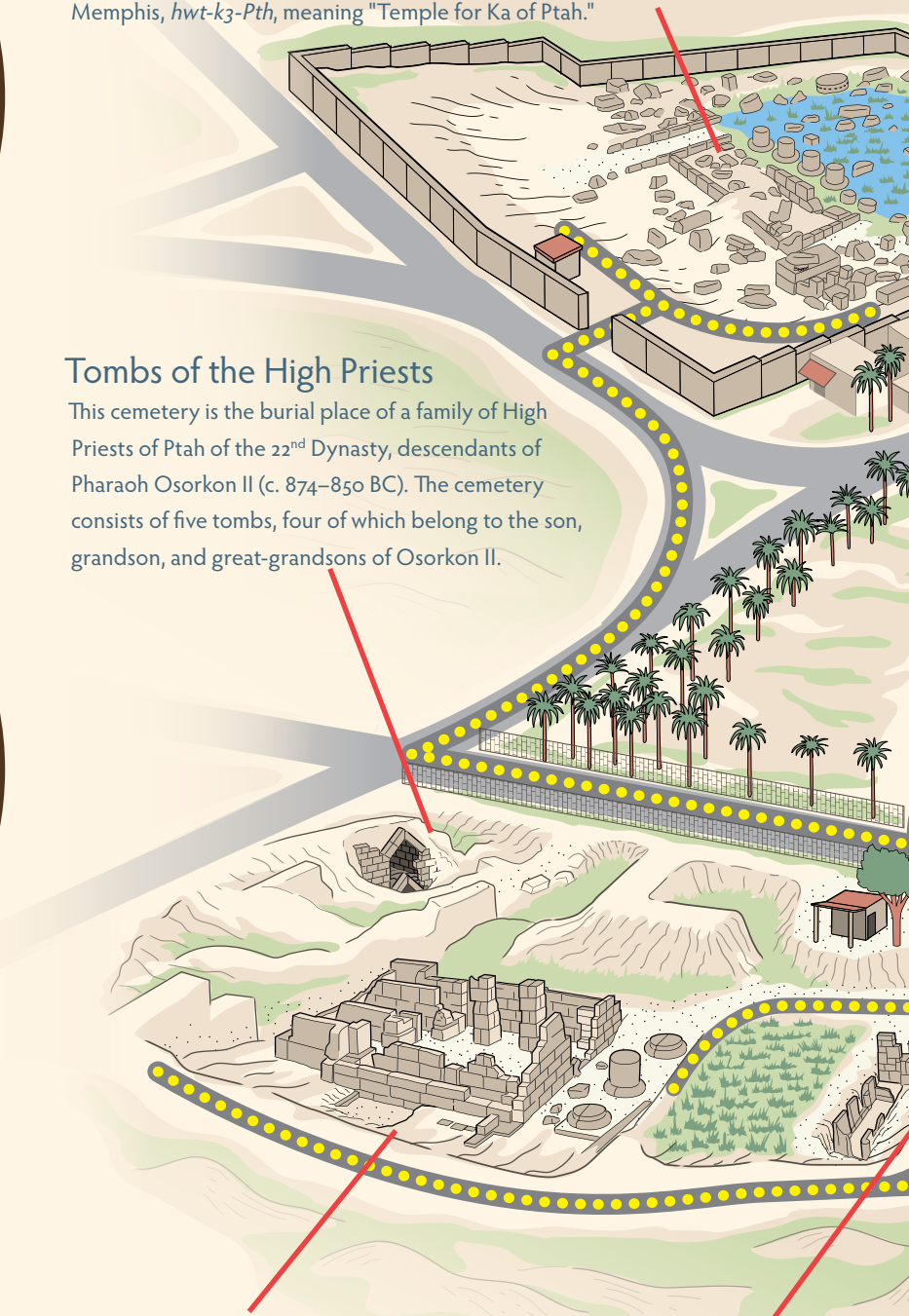
This cemetery is the burial place of a family of High Priests of Ptah of the 22nd Dynasty, descendants of Pharaoh Osorkon II (c. 874–850 BC). The cemetery consists of five tombs, four of which belong to the son, grandson, and great-grandsons of Osorkon II.

Ramesses II Temple

Ramesses II built this temple and dedicated it to Ptah. It is sometimes referred to as "the Small Ptah Temple." It has not been reconstructed, and looks exactly as it did when it was first discovered in the 1940s and 1950s.

Seti I Chapel

Situated within the southwest corner of the Great Ptah Temple, it is the only standing chapel that remains inside the temple complex. It was commissioned by Seti I to show his power and connection to the god Ptah.



Apis House

This building was part of the religious complex within the Ptah Temple devoted to the sacred Apis bulls. Here a succession of bulls were cared for, worshipped, and upon death, embalmed and prepared for burial in the Serapeum at Saqqara.

THE MEMPHIS WALKING CIRCUIT

This illustration of the new Memphis walking circuit was produced by graphic designer Ian Kirkpatrick for use on the circuit signage and brochure. The gray and yellow-dotted line indicates the placement of the new pathways. Visitors will begin their 1.3 kilometer journey at a version of this sign on the main wall outside of the museum.

Open-Air Museum

Situated in the heart of the Memphis ruin-field, the museum showcases 80 artifacts from Memphis that detail its transition from a Pharaonic city to a Christian and Islamic community. Several pieces on display here are considered Egyptian masterpieces.

Hathor Temple

Famous for its Hathor-headed columns shaped like musical sistra, this temple is thought to have been reserved only for the Pharaoh and priests. It was built during the reign of Ramesses II.

Rameses II Chapel

This chapel was likely dedicated to the worship of Ramesses II and the patron gods of Memphis (the god Ptah, his consort Sekhmet, and the child-god Nefertum). It was one of a network of chapels and small shrines set along the approach to the southern gate of the Ptah Temple.

On to the Finish Line

At the time of this writing, the signage for the circuit and museum are being printed, the rubbish bins and benches have been delivered, and the brochure and guidebook are receiving final approval. Soon we will begin a final clearing of the circuit and install the signage. We are currently working with the Ministry of Antiquities (MoA) on a date for the opening of the circuit, with a concomitant launch of the website.

We are happy to report the MSCD is a great success. We are proud of the work our team and students have accomplished and grateful for the lessons we have learned from the MSCD experience. And it is with great pride that we mention the formation within the MoA of a new committee initiated by former field school students and staff to share the lessons learned from the MSCD project with a larger audience. Building on the concepts they were exposed to during the MSCD field schools, this committee—led by Dr. Sherif Abd el-Monaem and Dr. Mennat-Allah el-Dorry, former AERA trainees—will soon begin to assess visitor experience and site presentation at museums and sites throughout Egypt.

Acknowledgments

It is with great thanks that we acknowledge the sponsorship of the United States Agency for International Development (USAID) throughout the two years of the MSCD project. We also wish to thank the Egyptian Ministry of Antiquities for their stalwart support, with special thanks to Minister of Antiquities Dr. Khaled el-Enany, Dr. Mahmoud Afifi (Director of the Egyptian Pharaonic Sector), Alaa Shehat (Director of the Central Department for Cairo and Giza's Antiquities), and Ibrahim Rifaat (General Director of Mit Rahina).

We also wish to thank the York University team, led by Heritage Specialist Dr. Sara Perry, including Heritage Assistants Katrina Gargett, Zoe Critchley, Zack Goodall, Katie Hausch, and Olivia Sharrad. The MSCD project would not have been a success without the heritage backbone provided by the York team.

We thank our students for their inspiring hard work, and most notably we wish to thank our 2016 Field School Supervisors for Sessions 3 and 4: Samar Mahmoud Mohamed, Mahmoud el-Shafey, Mohamed Eied el-Seaidy, Azmy Taha Mohamed Seif Salama, Shaimaa Magdi Eid, and Reham Mahmoud Zaky el-Sayed, as well as our workmen and their irreplaceable leader, Sayed Talbahah.

Lastly, we wish to acknowledge the passion, dedication, flexibility, and tenacity of the AERA MSCD staff, most especially that of Co-Director Freya Sadarangani. The AERA 2016 team, led by Dr. Mark Lehner, included Dr. David Jeffreys (Senior Egyptologist and Archaeologist), Dr. Mohsen Kamel (Director, AERA Egypt-Center), Dan Jones (Senior Archaeologist), Dr. Aude Gräzer Ohara (Egyptologist and Archaeologist), Rebekah Miracle (AERA GIS Director and Website Team Member), Manami Yahata (Archivist), Amel Eweida (Photographer), Ian Kirkpatrick (Graphic Designer), Mohammed Said (IT Director), and Andrew Henderson-Schwartz (Research Coordinator). A special word of thanks for their key roles also goes to Safinaz Ouri (AERA Grants Financial Manager), Mohammed Farouk (Accountant), Dr. Richard Redding (Conservation Coordinator of MSCD), and Lamia el-Hadidy (Conservator).



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The Memphis Site and Community Development project was made possible by the generous support of the American people through the United States Agency for International Development (USAID), Program No. APS-263-14-000008. The contents of this article are the responsibility of AERA and do not necessarily reflect the views of USAID or the United States Government.

Egyptian Minister of Antiquities Dr. Khaled el-Enany (front row, fifth from left) poses with our Session 3 Field school students and MSCD staff at their graduation. Photo by Amel Eweida.



Mit Rahina Museum Catalog in the Works

As an offshoot project to the MSCD, AERA archaeologist and MSCD staff member Aude Gräzer Ohara took on the expansion of the Mit Rahina Museum catalog draft prepared during Year 1 of the MSCD into a full-blown book, *Treasures from the Lost City of Memphis*. Although the catalog was only meant to be a document produced as an initial assessment of the museum collection, thanks to Aude's keen interest in the material and our extensive collection of outstanding photographs produced by photographers Amel Eweida and Bassem Ezzat, the project quickly morphed into something much larger. In tandem with AERA Publications Department, Aude has produced a lushly-illustrated catalog, almost 300 pages in length, providing art historical background and archaeological findspot data for many of the artifacts on display in the museum.

The catalog will feature an introduction on the creation of the museum and the development of the collection. Aude's research led her to the Ministry's Centre de Documentation et d'Etudes sur l'Ancienne Égypte in Zamalek, Cairo, where she was able to study early Memphis excavation records and procure copies of early photographs of the discovery of several pieces in the catalog to supplement her own personal collection of early Memphis photographs. These will provide a new and unique perspective to the background story of these pieces. The catalog also contains a brief history of fieldwork at Memphis, and is being prepared in close collaboration with Dr. David Jeffreys, Director of the Egypt Exploration Society's Survey of Memphis project.

The text is in both Arabic and English. In addition to making it available via our website, aeraweb.org, and the new Memphis website, we hope to work with Ministry officials to make a print version available for purchase at the museum.

From upper right: Draft cover of the new catalog, sample spread featuring the Memphis sphinx colossus, and an 1880s photograph of the discovery of the of Ramesses II colossus known as Abu el-Hol ("Father of Awe"), lying face down in its excavation trench before it was raised by A. Bagnold of the British Royal Engineers. Photo courtesy of the Centre de Documentation et d'Etudes sur l'Ancienne Égypte, Collection scientifique et documentaire, Ministry of Antiquities, Cairo, SCA-archive 00009.



Windfall Films on AERA's 2017 Work

Secrets of the Pyramids and *Unearthed: Sphinx*

We are pleased to report the production of two forthcoming films involving AERA's work, one (*Unearthed: Sphinx*) focused on the Sphinx, the other (*Secrets of the Pyramid*) on our work in the Lost City of the Pyramids and on the connections between our site, the Pyramids, Khufu's port on the Red Sea at Wadi el-Jarf, and the recently discovered Wadi el-Jarf Papyri. The films will feature myself, AERA board member Dr. Richard Redding, AERA Director of Archaeological Science Dr. Claire Malleson, and AERA Manager Sayed Talbayah.

A London-based film company, Windfall Productions produced a film about AERA's work at the Great Pyramid in 2016 as part of their *Unearthed* series (<http://www.windfallfilms.com/show/6863/episode-5-secrets-of-the-pyramids.aspx>). A signature sequence of their *Unearthed* series is to “blow up” or deconstruct a monument, and then recompose it, in order to show the structure and to advance understanding of how ancient people built incredible monuments. I suggested a film on the Sphinx and its associated temples—the Sphinx Temple and the Khafre Valley Temple—based on work I did with Thomas Aigner in the 1980s demonstrating that the 4th Dynasty Egyptians created the Sphinx and these temples as part of the same quarry-construction sequence. Windfall was onboard

with this idea and sent a team to Giza to film in mid-February.

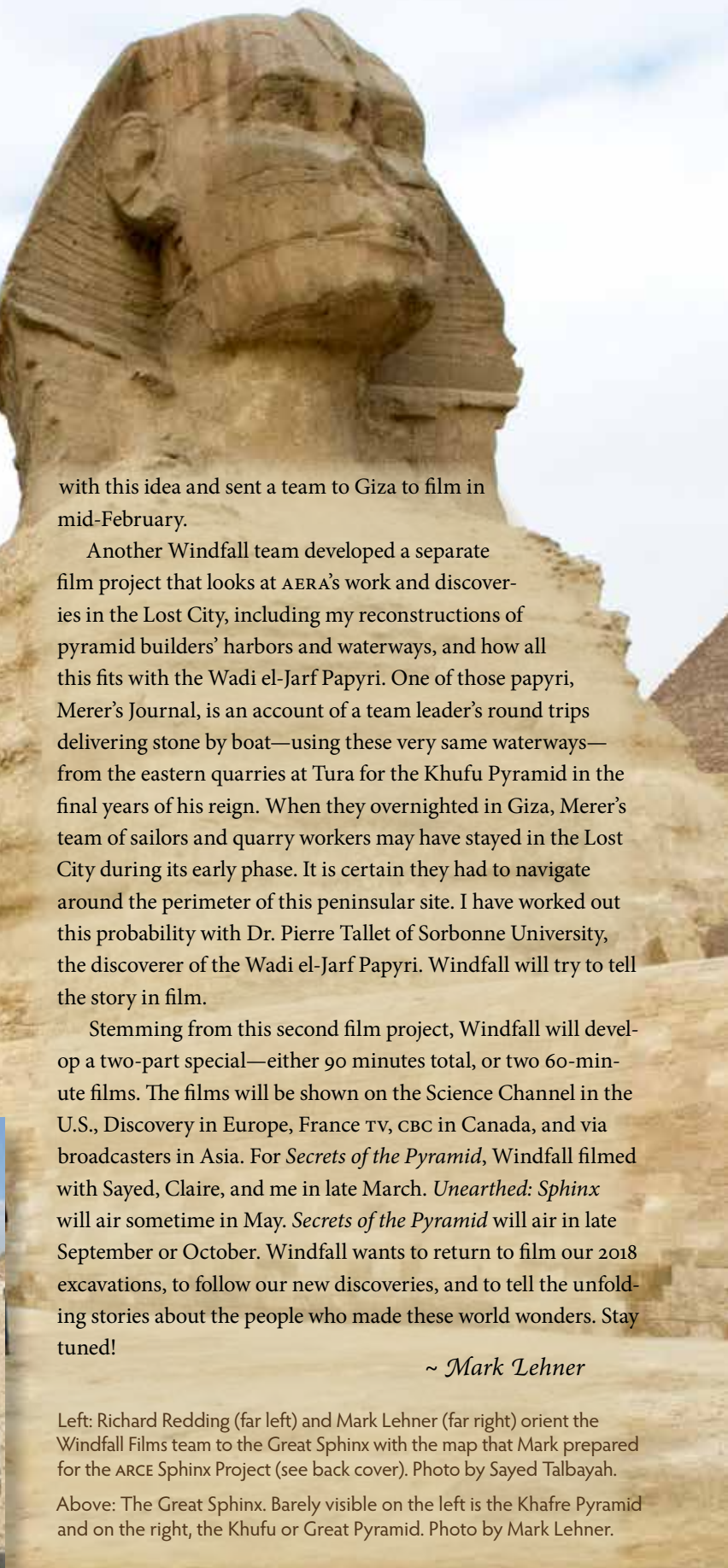
Another Windfall team developed a separate film project that looks at AERA's work and discoveries in the Lost City, including my reconstructions of pyramid builders' harbors and waterways, and how all this fits with the Wadi el-Jarf Papyri. One of those papyri, Merer's Journal, is an account of a team leader's round trips delivering stone by boat—using these very same waterways—from the eastern quarries at Tura for the Khufu Pyramid in the final years of his reign. When they overnighted in Giza, Merer's team of sailors and quarry workers may have stayed in the Lost City during its early phase. It is certain they had to navigate around the perimeter of this peninsular site. I have worked out this probability with Dr. Pierre Tallet of Sorbonne University, the discoverer of the Wadi el-Jarf Papyri. Windfall will try to tell the story in film.

Stemming from this second film project, Windfall will develop a two-part special—either 90 minutes total, or two 60-minute films. The films will be shown on the Science Channel in the U.S., Discovery in Europe, France TV, CBC in Canada, and via broadcasters in Asia. For *Secrets of the Pyramid*, Windfall filmed with Sayed, Claire, and me in late March. *Unearthed: Sphinx* will air sometime in May. *Secrets of the Pyramid* will air in late September or October. Windfall wants to return to film our 2018 excavations, to follow our new discoveries, and to tell the unfolding stories about the people who made these world wonders. Stay tuned!

~ Mark Lehner

Left: Richard Redding (far left) and Mark Lehner (far right) orient the Windfall Films team to the Great Sphinx with the map that Mark prepared for the ARCE Sphinx Project (see back cover). Photo by Sayed Talbayah.

Above: The Great Sphinx. Barely visible on the left is the Khafre Pyramid and on the right, the Khufu or Great Pyramid. Photo by Mark Lehner.



Archaeology Magazine Features "Children of Giza"

Some 3,000 years after the Heit el-Ghurab site was abandoned, it became a cemetery for poor local residents. Through the Saite period (664–525 BC), and again during the early Roman period (1st–2nd centuries AD), thousands of adults and children were laid to rest in simple graves. Mark Lehner suggests that this site might have been chosen because of the interest in Egypt's past, and especially the monuments on the Giza Plateau, during both of these periods.

Although these periods are not AERA's focus, we have excavated many of these burials during our 25+ years here, led for ten years by bioarchaeologist Jessica Kaiser. Her analyses and observations were featured in the July/August 2016 issue of *Archaeology* magazine in "Children of Giza," by Daniel Weiss.

The Heit el-Ghurab cemetery offers important insights into views about children and the afterlife. We know from other cemeteries that people believed children had an afterlife—it is reflected in the grave goods accompanying them. The Heit el-Ghurab child burials showed

how very important this

belief was.

Although

these

communi-

ties were

poor, they

buried their

children with

great care and

with a dispro-

portionate share

of grave goods.

While they placed

a single bead or

amulet in adult buri-

als, they bestowed upon the corpses of their deceased children multiple items, such as earrings, cowrie shells, and amulets of various gods or the Eye of Horus. According to Jessica, the relative abundance of grave goods suggests that children needed more protection after death than adults and that these communities "concentrated their meager resources" on them.

The importance of grave goods persisted through both periods at the cemetery, but some practices changed. The Saite child burials were concentrated at the east end of the Wall of the Crow, the massive stone edifice at the north end of the Heit el-Ghurab site, while the Roman period children were mixed with adults away from the wall. The latter children were laid to rest in anthropoid coffins, as were older Saite children, while the youngest Saites were interred in plain boxes.



Volume 17 Number 1 & 2 Spring & Fall 2016

Executive Editor: Dr. Mark Lehner

Science & Arts Editor: Dr. Wilma Wetterstrom

Managing Editor: Alexandra Witsell

AERAGRAM is published by AERA, Ancient Egypt Research Associates, Inc., a 501(c)(3), tax-exempt, non-profit organization.

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Ancient Egypt Research Associates
26 Lincoln St. Ste. 5, Boston, MA 02135 USA
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Scanning by Eye and Experience: In Search of the Human Hand That Built the Great Pyramid

by Mark Lehner

The Great Pyramid of Giza, more than 4,500 years old, remains a never ending source of fascination. For years people have scrutinized it, theorized about construction methods, and speculated about hidden chambers. Recently ScanPyramids¹ announced that they found “anomalies,” possible interior spaces when they used muon tomography and infrared thermography to scan the pyramid.

We at AERA are also trying to understand how the Great Pyramid was built, but not with high-tech methods to probe its interior. We map the builders’ marks in the surface around the base of the pyramid.

The builders constructed the massive tomb on the limestone bedrock of the Moqattam Formation. So they started with a very solid, but sloping surface. They quarried away the rough bedrock to level it for a courtyard around the pyramid perimeter.

To help them maneuver and lay massive stone blocks they cut and chiseled post holes, lever sockets, lines, and other traces in addition to their levelling cuts. These marks are not attention-grabbers. When people visit the Great Pyramid they look up, not down at the plethora of holes, cuts, and lines on the floor around the monument. Even Egyptologists for the most part have shown little interest in these markings on the bedrock. But, the overall set of “tracks” reveal much about the builders’ movements and *modus operandi*. They offer insights into the building process.

The marks were never meant to be seen. The builders laid a thick limestone pavement over the bedrock floor of the

Mark Lehner draws the socket at the northwest corner of the pyramid during the 2016 Glen Dash Foundation Survey. Though the sockets have been much discussed, no one has ever drawn and published their form in detail. The survey team mapped the feature, but Mark’s drawings will include a lot of detail the photos and the total station will not pick up. It’s the human hand and eye at work. Photo by Ashraf Abd el-Aziz.

court that surrounded the pyramid, enclosed by a 10-foot tall enclosure wall set 33.5 feet (10.2 meters) out from the pyramid platform. When robbers stripped the pyramid of its outer casing, they removed most of the enclosure wall and the pavement, except for big patches on the north and west. The exposed bedrock foundation shows the bedrock cuttings of Khufu’s builders—their backstage operations.

What Can the Holes Tell Us?

I have been photographing and thinking about all these features since the early 1980s. In 1983, I published an article about a series of large holes that runs parallel to the pyramid platform. But I could only provide a schematic map of the holes.

Now, 33 years later, Glen Dash has helped make it possible to thoroughly map all the holes and other features for the first time.

During the past two seasons, as part of the Glen Dash Foundation Survey (GDFS), an AERA team tracked these “footprints” of the pyramid builders. Amr Zakaria, who learned to survey in the AERA-ARCE Field Schools, took coordinates on features with the total station, while Ashraf Abd el-Aziz labeled and photographed every one of them. All of the data went

into a database. At the end of the 2016 survey, Amr plotted all the features in AutoCAD. AERA GIS Director Rebekah Miracle imported the data into our GIS and generated maps, such as the one below, which shows the 2,898 features we recorded: 1,000 holes in the bedrock floor and 1,898 quarry features.

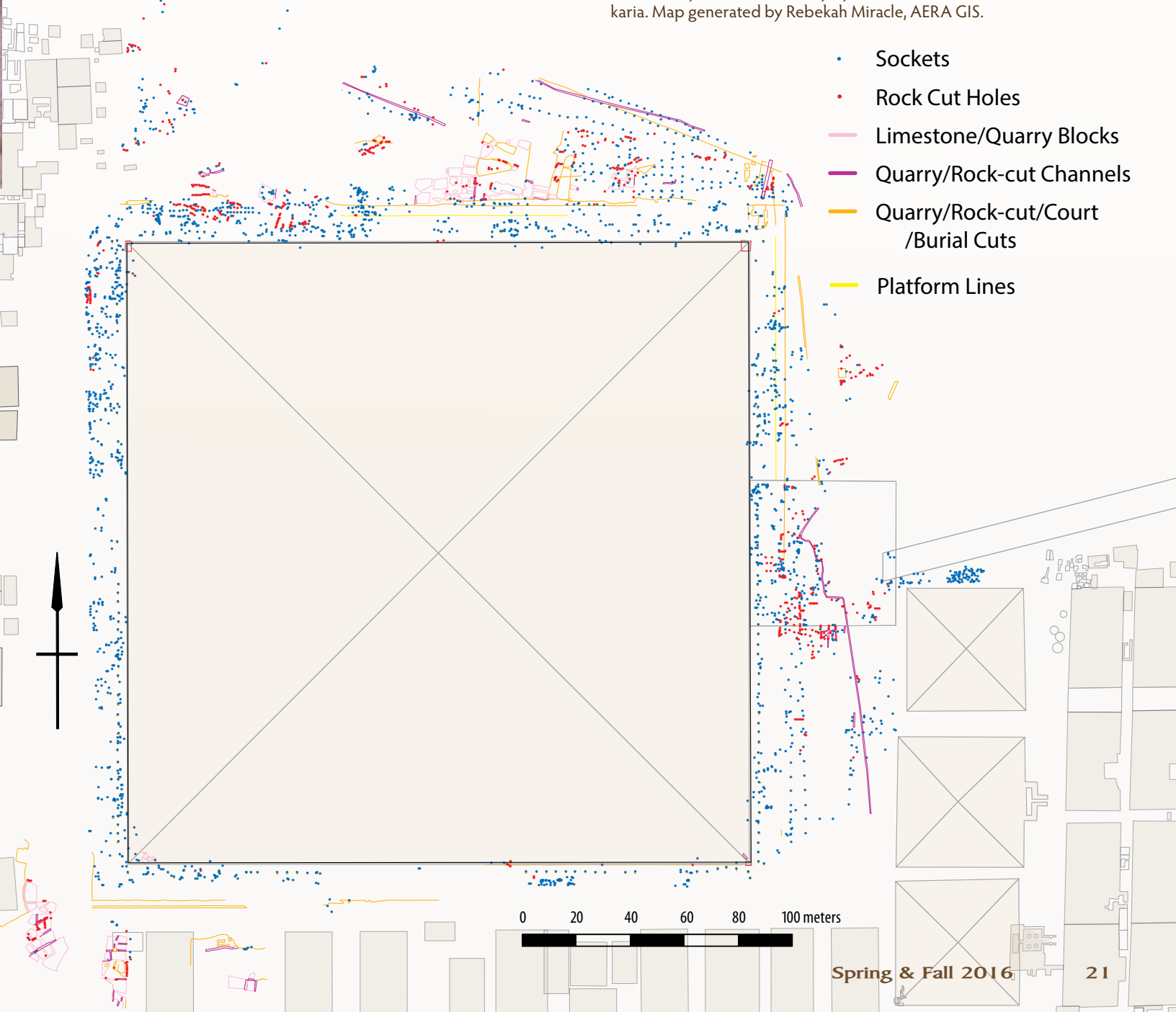
Now, we can work with this data to try to understand what these marks might tell us about how the builders and engineers went about creating the Great Pyramid. We can zoom in on any feature, or group of features, to gain insight into the techniques and operations of the ancient surveyors. For example, some of the holes track their use of offsets and reference lines for setting and trimming the pyramid platform (described below).

Lever Sockets

All around the pyramid court we see wedge-shaped cuttings, deeper at one end, and slightly wider than a wooden railroad

tie, in sets of three or four in a row (photo at left). Workers cut these as sockets to wedge the ends of their wooden levers under large, heavy stones that had ended up flat on the bedrock floor. Having worked at Giza with masons and quarrymen as they moved heavy stones, I know you generally do not want to let a block rest flat on one side until it reaches its final destination. It is hard to get a lever under a large block lying on one flat side—to “get purchase” as they say—in order to lift and shimmy it about. When workers move big, heavy stones by tumbling (which they often do), they tip them onto a smaller rock, such as a hard round chert cobble stone or small pile of limestone chips. Positioned on these ball bearing-like objects, the stone can easily be tipped and tumbled again, or turned on its hard pivot by only one or two workers. When the 4th

Plot of the holes and other features cut into the bedrock floor around the Great Pyramid, from survey by Ashraf Abd el-Aziz and Amr Zakaria. Map generated by Rebekah Miracle, AERA GIS.



- Sockets
- Rock Cut Holes
- Limestone/Quarry Blocks
- Quarry/Rock-cut Channels
- Quarry/Rock-cut/Court/Burial Cuts
- Platform Lines

0 20 40 60 80 100 meters



Ashraf Abd el-Aziz points to the line between the pyramid court pavement and the platform on the east side of the pyramid. Amr Zakaria stands "on line" to the south. Mohammed el-Saidy, then Inspector of the pyramid, and an assistant stand in the background. Photo by Mark Lehner.



GDFS 2016 team members, from left to right, Joan Dash, Rebecca Dash, Glen Dash, Amr Zakaria Mohamed, and Eric Sperber. Team members not included in the photo: Mohamed Abd el-Basset, Mark Lehner, and Ashraf Abd el-Aziz. Photo courtesy of Windfall Films.

Dynasty builders happen to "flat-bed" a stone, they would cut the bedrock floor underneath, allowing them to pry the stone with thick wooden levers. These lever sockets track movements of heavy stone by the pyramid builders.

Pavement Props

We found curious pairs of small holes in the bedrock floor of the court (photo below right). The builders may have used

them, somehow, for setting the thick limestone slabs for the court pavement. They seem to relate to the rectilinear cuts that masons made in the bedrock floor to lay in the court pavement slabs. The slabs were odd shapes and sizes, and large, nearly half a meter thick. Khufu's masons custom-trimmed one

A pair of small holes (bottom of view) within the emplacement cutting for a slab of the pyramid court pavement. *In situ* pavement exists in the background, abutting the pyramid platform on which the builders founded the casing. View to the north. Photo by Mark Lehner.



Lever sockets cut into the bedrock floor of the court along the northern side of the Great Pyramid. They allowed wooden boards to be placed under a slab to keep it elevated and to move it around until the slab was finally bedded. View to the north. Photo by Mark Lehner.





Joinery of court pavement at the northern side of the Great Pyramid. View to the north. Photo by Mark Lehner.

pavement slab to its neighbor, creating complex jigsaw patterns (photo above). Perhaps the masons inserted short wooden props into the pairs of small holes to keep the slab tilted up, close to its final position, as they cut its matching emplacement into the bedrock floor, so that when they lowered the slab, it would be close to flush with the slabs next to it.

Platform Alignment Holes

These large holes run in series parallel to the pyramid platform, 9.8 to 13.1 feet (3 to 4 meters) from the platform and 3 to 4 meters from hole to hole. Shorter series near the corners run in a line a little more than 16.4 feet (5 meters, around 5 Egyptian cubits) from the line of the pyramid platform. These holes vary

Amr Zakaria (right) holds a reflector over a quarry channel on the east side of the Great Pyramid. Mahdi Amin holds the board with information about the feature. View to the south. Photo by Ashraf Abd el-Aziz.



in shape, from rectangular to round, with sides ranging from 14 to 24 inches (35 to 60 centimeters) and depths varying from 16 to 24 inches (40 to 60 centimeters). The going hypothesis is that these holes held wooden posts, wide enough to carry a reference line, perhaps marked with string tied to nails in the tops of the posts, and that from this reference line the pyramid builders set and trimmed stones to form the platform and the casing. Now that we have surveyed and mapped these holes, we can test this hypothesis. We will be able to see if altogether they span a margin of a single, straight line that is as well oriented to the cardinal directions as the line of the platform (photo facing page top left).

Builders' Successive Approximation

Setting and trimming the pyramid platform and the baseline in the casing was probably the final operation of Khufu's pyramid builders, after they had leveled the overall pyramid court by cutting down the original rough, sloping bedrock surface of the Giza Plateau. We mapped and recorded—for the first time ever—evidence of first levelling stages of Khufu's builders, that is, their crudest quarrying to dress down the surface. We also mapped the quarrymen's channels that define the bedrock blocks near the southwest corner of the pyramid, where they left the blocks un-extracted.

Across the modern road from the pyramid, Khufu's quarrymen left an example of their earlier and higher stage of quarrying to cut the surface down to the level of the pyramid court. Here, their quarry blocks and channels are neither rectilinear nor oriented to the cardinal directions (red lines on map). They simply wanted to waste away the bedrock, to work it down several meters, without regard for orienting their quarry cuts. Next, on the east side of the modern road, closer to the pyramid, they left a later, more advanced stage of working down the surface (photo on the left). Here, they aligned their bedrock blocks and channels to the cardinal directions, as they got closer to the level of the pyramid court, which they wanted to be square and oriented exactly north-south and east-west.

The main (reference) line holes, parallel to the pyramid platform, reflect Khufu's builders' final operations in a procedure of successive approximation.

Since they left a colossal chunk of bedrock projecting in the base of the pyramid core, they really only achieved their finest levelling over the width of a city sidewalk, around the perimeter of the core. With successive approximation they created the near-perfect base of the pyramid, a bit more like sculptors than brick and mortar masons. As different as this is from how modern engineers and builders might make the Great Pyramid, they did a damn good job, a job that is the marvel of modern engineers and builders.

1. http://www.hip.institute/press/HIP_INSTITUTE_CP9_EN.pdf

AERA to Publish Unique Archive of the Great Sphinx

We are pleased to announce that AERA has been awarded an American Research Center in Egypt (ARCE) Antiquities Endowment Fund (AEF) grant for the conservation and online publication of the archive of the ARCE Sphinx Project. Led by James Allen and Mark Lehner from 1979–1983, the fieldwork component of the project formed the basis of Mark's 1991 PhD dissertation, *The Archaeology of an Image: the Great Sphinx of Giza*.

AEF grants are one-year grants given to projects that support preservation, conservation, and documentation of Egyptian antiquities more than 100 years old. To this end, the Sphinx Archive Project will culminate in the online publication of some 266 maps and drawings, 5,000 slides, 2,716 black and white photographs, and reams of reports, journals, and survey data. The archive also includes 1:100 drawings of the Khafre Valley Temple, the Sphinx Temple, and the Amenhotep II Temple, as well as topographical and geological maps of the wider Sphinx "amphitheater."

The project produced 1:50 elevations of the front and sides of the Sphinx, as well as cross-sections through masonry layers added in ancient times as casing against the Sphinx bedrock core. Photographs and scale drawings show the history of ancient repairs and the degree of erosion

present when stonemasons first added protective casings to the monument. Restoration during the 1980s–1990s and subsequent efforts at consolidation have hidden this unique record of work. Unless there are new efforts to remove these additions, the Sphinx Project Archive will remain the only dataset to document the full history of masonry work on the Sphinx.

Mark and AERA team members Megan Flowers and Stephen Dilks are now working over 12 months to survey, organize, and scan this material. Once scanning is complete, the originals will be housed in archival folders and boxes for their continued physical preservation.

After we compile the digitized version of the archive, we will partner with Open Context—a web-based, open access publishing service that archives archaeological research data for public access and long-term preservation—to provide a permanent online home for the archive. Additionally, AERA GIS Director Rebekah Miracle will create GIS files that help provide a location and spatial context for the project's data. This will provide an enhanced level of interactive analysis and presentation for colleagues and the public.

For more than 35 years, these records have remained largely unpublished and inaccessible to the public. We are thrilled to share this unique and priceless dataset related to a true global treasure.

Detail from one of the Sphinx Project's 1:50 drawings of the Great Sphinx of Giza. Several of the original plots measure nearly five feet in length. Once the material is online, viewers will be able to zoom in on the remarkable detail captured in this important archive.





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