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Silos 2022: End Game at Heit el-Ghurab?

Discoveries in the Silo Court of the Royal Administration Building hint at the final days of the Heit el-Ghurab site … 2

Silos in the silo court of the Royal Administrative Building at the Heit el-Ghurab site during the 2022 excavations.

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Silos 2022: End Game at Heit el-Ghurab?

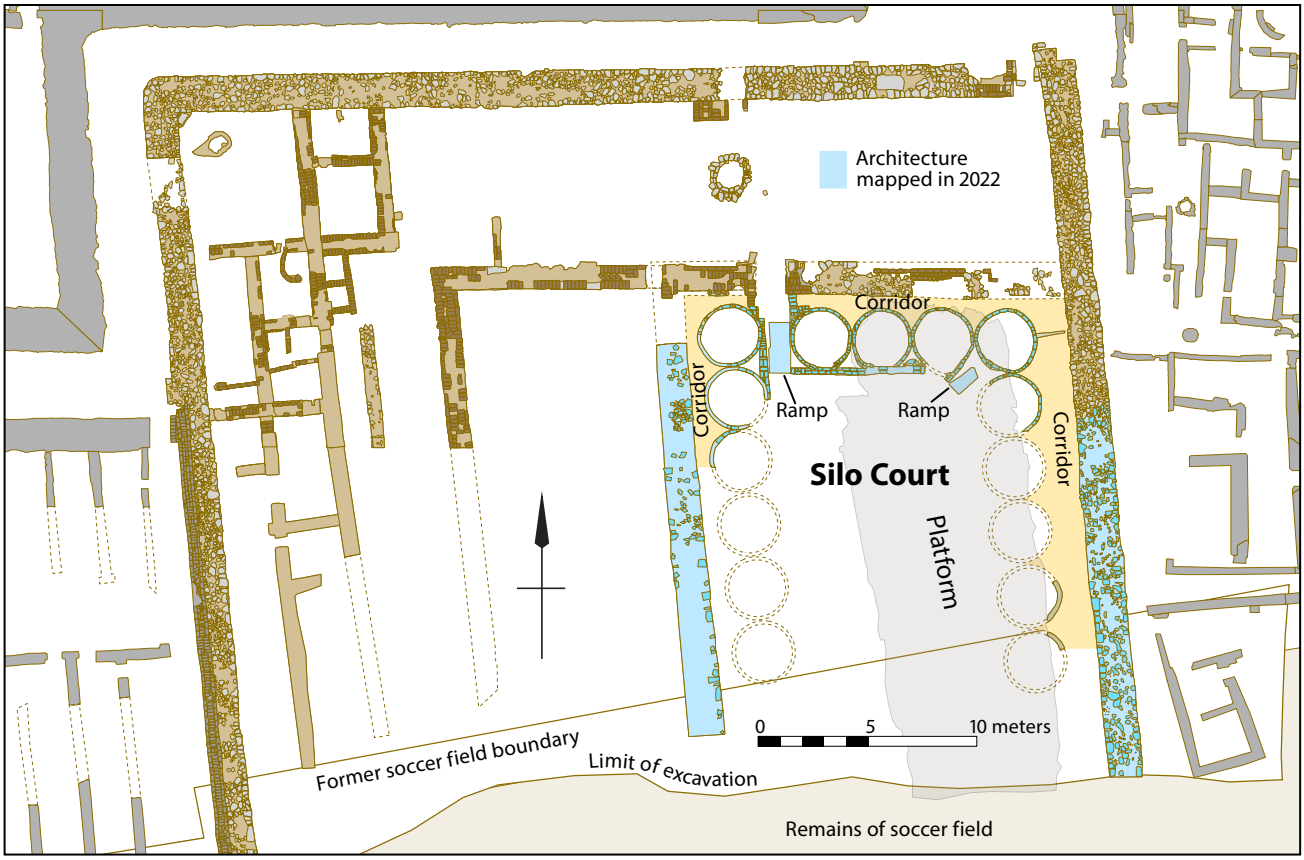
Ever since the fall of 2021, when we began excavating in the former Abu Hol soccer field,[1] we have been filling in blank areas on our Heit el-Ghurab (HeG) site map and gaining new insights into the settlement. Our hypotheses about what lie under the southwest corner of the soccer field and beyond had to be seriously revamped after our Spring 2022 excavations (see the stories about Standing Wall Island starting on page 6). At the north end of the soccer field we produced a fuller, albeit still incomplete, picture of the silo court in the Royal Administrative Building (RAB) and we found ourselves in new territory with evidence of a more complicated end game for this area of HeG than we previously expected. What happened in those final days of occupation at HeG?

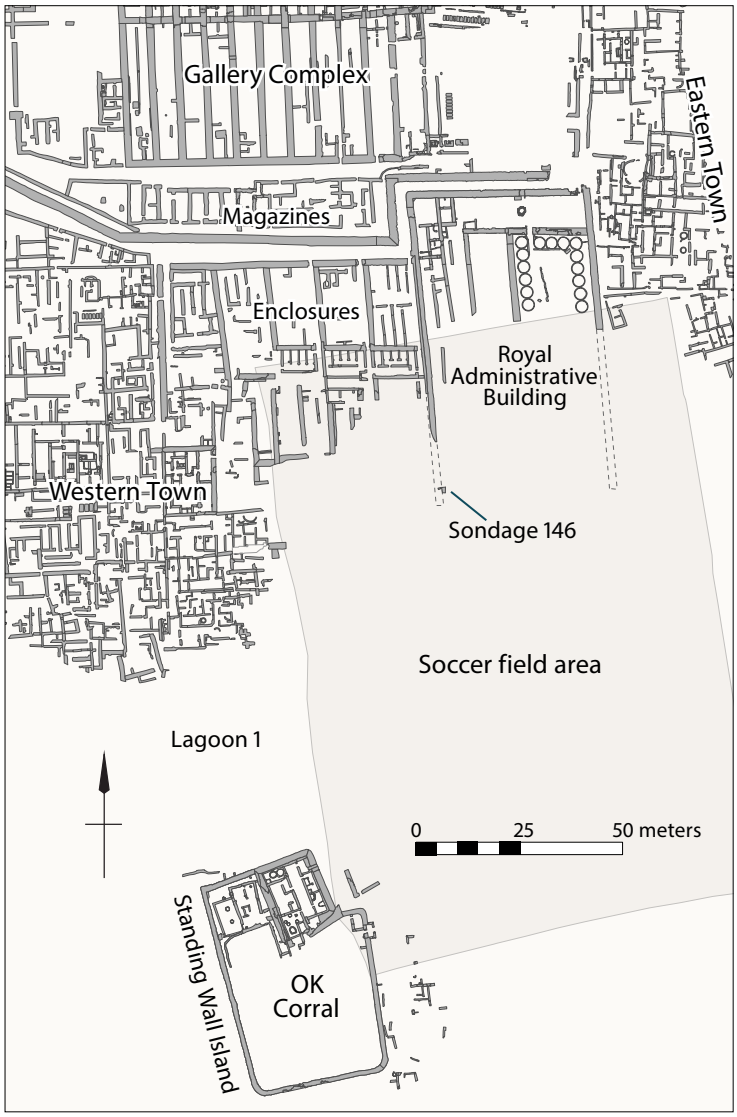
BEFORE 2021

In 2001 we discovered a large compound at the southeast of the HeG site. Between 2002 and 2007 we excavated the entire 42-meter width of the compound and 20 to 30 meters of its north–south length. During these five excavation seasons we learned more about the compound: it once included craft workshops, a courtyard, a bakery, several occupation phases, and a sunken court of large silos. We recovered many clay sealings used to secure pots, boxes, bins, and papyrus documents, suggesting administrative activity—hence the name Royal Administrative Building (map on the right). But we could only dig the northern end. The walls disappeared south under the Abu Hol soccer field. In 2003, Tremaine and Associates carried out an electromagnetic (EM) conductivity survey, which suggested the west wall of the RAB ran more than 30 meters under the soccer field, hinting at a truly monumental Old Kingdom building.[2] But we could not excavate to see if this was true.

Finally, in the fall of 2021, after the soccer club had been moved, and with authorization to put our hands on the ground, we dug in. First, to trace the extent of RAB, we excavated two test pits (sondages) on the projected line of the RAB west wall. In Sondage 146 we discovered what appeared to be the wall. During Fall 2022, we confirmed this by clearing sand overburden south to Sondage 146. RAB's total north–south length was at least 90 meters![3]

The silo court during the Fall 2022 excavations. View to the southwest. Photo by Mark Lehner.





SILOS GALORE

During the Fall 2022 season we focused our six-week excavation on the silo court in the RAB. We cleared about 15 meters to the south of our previous work, an area that had become inaccessible after our 2002 field season due to rising groundwater. During the Fall 2022 season, taking advantage of the fact that groundwater is at its lowest in the fall, we returned to the silo court to resume excavations.

After removing the backfill sand we had laid over the site to protect it, we picked up where the 2002 excavation left off and partially removed the top layer, a large mass of stone that we had left in place at the time (labeled "platform" in the image on left page). Then we went down into the silos and removed more stone as well as mudbrick collapse debris.

We uncovered eight silos and discovered traces of more lined up along the east and west sides of the court, adding up to a total of 15 silos. But we believe there are still more to be discovered. We also learned more about the layout of the silo court. We excavated the only entrance into the silo court we have found so far. It opens between the silos and the outer north wall in the form of a corridor that slopes down from a high floor level on the north.

Left: Map showing the southern portion of the Heit el-Ghurab site and the location of the Royal Administrative Building.

Above: Map of the Royal Administrative Building showing features excavated in the silo court during Fall 2022. Map by Rebekah Miracle, AERA GIS.

From the north side of the RAB, ancient Egyptian workers could step down into the silo court entrance and immediately turn right or left. Both routes took them through a narrow corridor, less than a meter wide, behind the rows of silos (map, page 3). Workers probably accessed the silos here in order to pour grain, or other foodstuffs, into openings at the top.

The RAB silos are huge, averaging 2.62 meters by 2.53 meters across, and much larger than the household silos we have found at HeG and the Khentkawes Town, the largest of which is about 1.5 meters in diameter. The RAB silos, with walls a single mudbrick thick, may have been domed at the top, like silos depicted in ancient Egyptian tomb reliefs and paintings. An open question is whether, below the domes, they took form as cylinders or cones.

Going straight into the silo court from the entrance, a worker could walk down the sloping corridor into the large, open center of the court. A low mudbrick wall runs along the front of the silos, close to the level of openings where people must have been able to access grain or other stored material. We found two floor surfaces in the center of the sunken court. The uppermost floor decreased in elevation from east to west 0.32 meters. The underlying earlier floor also sloped from east to west, but by only 0.13 meters. To access the silo in the northeast corner of the court, with its higher-level floor, workers could use a small ramp leading up to it.

THE STONE PLATFORM: LATER ACTIVITY

When we began excavating in the silo court this past fall, we first tackled that large, thick, level stone mass, partially excavated in 2002, which was built over the collapsed silos. We now believe that it was dumped intentionally over a large area of the silo court after the silos were decommissioned and collapsed. The west face of this stony platform features a steeply angled face, built at a batter to retain the stone debris (photo on facing page). People created the platform in a single operation. They took material from at least three different places: areas where stone walls had already collapsed and mixed with windblown sand; an area where standing architecture was dismantled, possibly the RAB itself;

Archaeologist Daphne Myrhvold emphasizes that the silos are very large. View to the north. Photos on this page by Mark Lehner.

Looking south into the silo court.

The northeast corner of the silo court. View to the northeast.

and a domestic or industrial context, as suggested by much ash and pottery mixed with stone. Alongside the platform was a depression we dubbed the "ditch" that served as an access route to the platform from the south.

We removed over 7 metric tons of stone—granite, diorite, and limestone—from just a portion of the platform. Many of the granite pieces had beveled surfaces, suggesting they were fragments or trimmings from architectural elements. The diorite pieces may have broken off pounders and hammers. A few of the limestone pieces might have been cornerstones of walls or thresholds and another, a door socket. There was also a small circular limestone table with a short stand. If these all came from HeG, they reflect some of the craftwork carried on here for the pyramid complexes.

Why did the Egyptians build the platform on top of the ruined silo court? And when? At this point, we do not know. The platform may have been infrastructure for mining stones from HeG buildings for other construction projects, such as the Workers' Cemetery on the slope above of the HeG. But if it is just a cache of stone for use elsewhere, why retain it so carefully with a battered wall?

In our original RAB excavations, we had a hint of post-Khafre and Menkaure HeG activity when we discovered in the silo court area five clay sealings bearing the name of the 5th Dynasty king Userkaf (photos at the right). At the time, we were uncertain as to their relationship to the RAB because we found them in pits that were not connected to any intact architecture. Further excavation may show they are connected to the end game at RAB, like the stony platform.

It is worth noting that the back impressions of these Userkaf sealings—which show what item the clay was placed on to seal it shut—indicate that they sealed a wooden peg, wound tightly with twine. At HeG, this is what we expect for the doors of small architectural constructions like silos and bins. Finding them here might suggest this Userkaf official, who was a *smsw pr* or "Elder of the House," was working in this area when the silos were still in use, predating the platform's construction entirely. Additionally, finding several sealings that were impressed by the same seal, as we believe these were, also suggests a stronger connection between this official and the adjacent architecture. The plot thickens!

The Fall 2022 field season, like many in the past, answered some of our questions about HeG, but left us with new questions. We now know that something was happening here after the silos were abandoned. Who built the angled stony platform and for what purpose? Will we find mention of any additional kings that might help us date these final days of HeG? Our next field season may provide some answers.

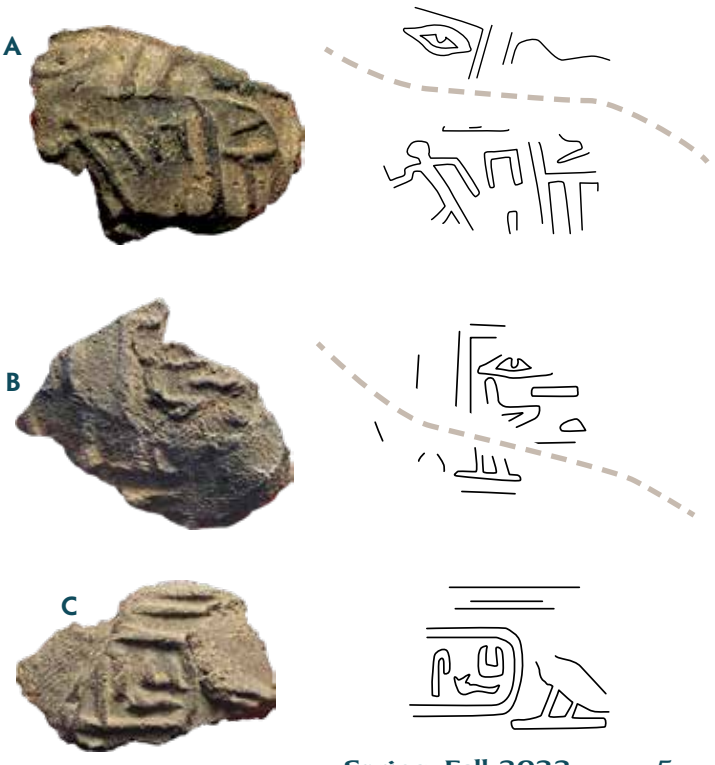
Profile of the angled outer face of the stone platform. Photo by Dan Jones.

1. Lehner, Mark, 2021. "Soccer Field Sondages, Palace Promises," *AERAGRAM* 22-1&2 (Spring–Fall), pp. 2–10.

2. Dash, Glen, 2004."Seeing Beneath the Surface," *AERAGRAM* 7-1 (Spring), pp. 1, 6–10.

3. Lehner, "Soccer Field Sondages, Palace Promises."

Three of the five clay sealings (a, b, c) found in RAB that were impressed by a cylinder seal belonging to an official who served during the reign of Userkaf. He was a *smsw pr* or "Elder of the House." The backs of these sealings show they were pressed onto a wooden peg and wound tightly with twine, such as might have closed a wooden door on a silo. Gray lines indicate the break line between overlapping rolls of the seal. Our reconstruction of this seal currently has two sections based on five sealings. Although we are unable to join those two sections at the moment, the similarity in carving between the two suggests they are indeed the same seal. Photos and drawings by Ali Witsell.



A Tale of Two City Districts

In 2022, with the Abu Hol Sports Club moved to the south, we were pleased to finally be able to excavate the club's soccer field. It covered part of the Heit el-Ghurab (HeG) site and for years kept us from answering some compelling questions about the settlement.[1]

During our spring 2022 field season, when we excavated the southwest corner of the field, we uncovered more of Area Standing Wall Island (SWI). We wanted to prove a hypothesis we first proposed in 2011. Just to the east of SWI we were surprised to find evidence of settlement, which has altered our understanding of HeG's history and size.

SWI: A BEAUTIFUL HYPOTHESIS

Under the soccer field we expected to find the entrance to a large enclosure attached to SWI that we discovered in 2011 and dubbed the "OK (Old Kingdom) Corral,"[2] (see map on right and on page 3). Based on this discovery, we had concluded that SWI was a facility for holding and slaughtering livestock to supply meat to the town. We envisioned a chute where livestock were driven into the corral. But in 2022 we discovered something quite different.

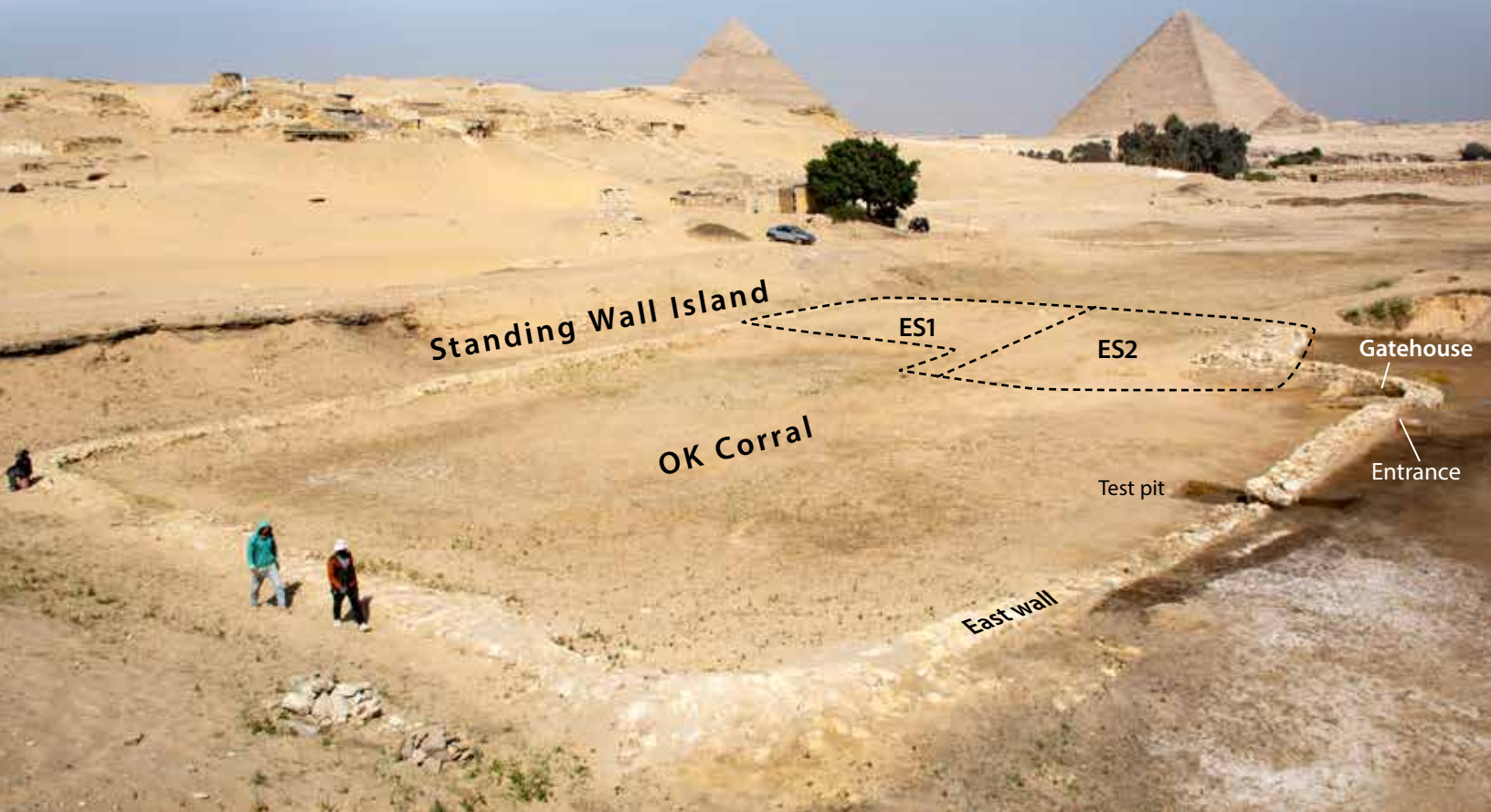
We first encountered Standing Wall Island in 2004, when we cleared south of a large depression we called Lagoon 1 and found a fieldstone wall standing one meter high (hence the name). It formed the northern wall of two large enclosures (ES1 and ES2, see map on right) that fronted onto another depression to the south (Lagoon 2).[3]

When we excavated ES1 and ES2 in 2011, we were surprised to find that the fieldstone western wall of the compound continued south beyond ES2 under the overburden for 30 meters. The wall then turned east, then north, and finally disappeared under the soccer field, beyond our reach. On our map we followed the east wall's trajectory and extended it north up to ES2 (see map on right). Richard Redding, AERA's faunal specialist, recognized that what we had envisioned as a paper clip-shaped enclosure was a corral, which he explains on pages 10 to 11 of this issue.

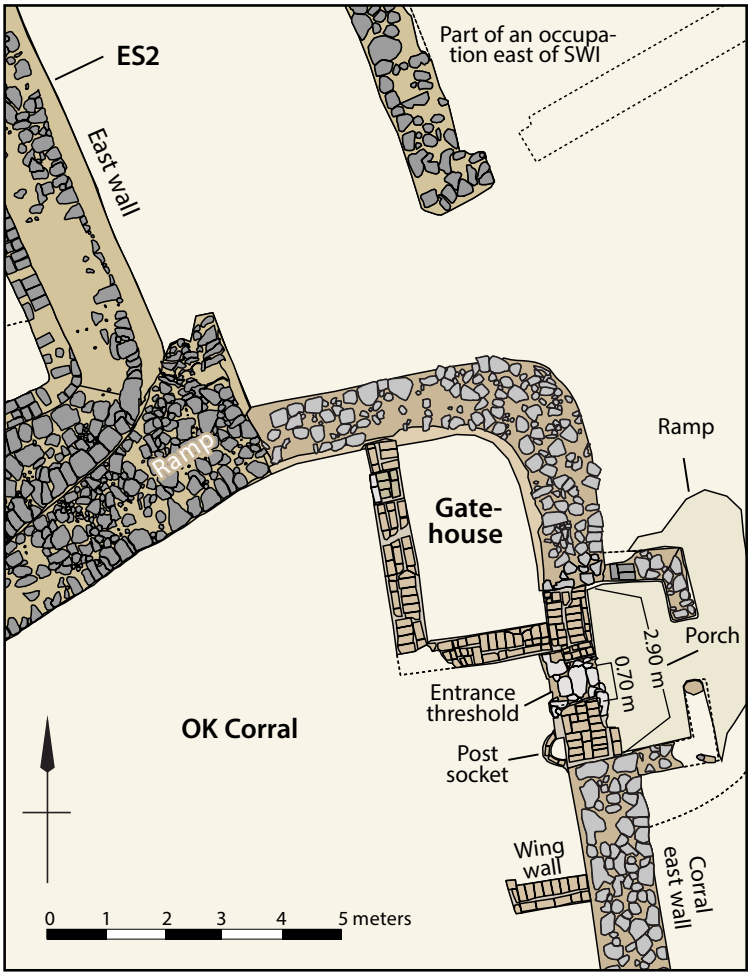
THE MOMENT OF TRUTH

After we had removed all the soccer club fixtures and the field pitch, we expected to find the buried north end of the corral wall and the chute. Workers cleared the eastern OK Corral wall from the south, proceeding in a straight line northward. But at the north end, amidst wall collapse debris, we discovered that it turned to the west and

A view of SWI looking northwest after the Spring 2022 excavations. Note that the north end of SWI (Enclosures 1 and 2) is not visible except the outer east wall. We backfilled ES1 and ES2 to protect the remains after excavations in 2015. Photo by Dan Jones.



Above: Map of SWI prepared in 2011 showing the "chute" between ES2 and the continuation of the OK Corral east wall. All maps of HeG in this issue created by Rebekah Miracle, AERA GIS, and modified by Wilma Wetterstrom.



Above: The walls discovered during the Spring 2022 field season along with those of ES2 to the west, which was excavated in 2011 and 2015.

abutted the ramp at the southeast corner of ES2. There was no chute, only a dead end. In the "elbow" formed by the wall's turn, we found a small room we dubbed the "Gatehouse," and next to it an entrance into the corral.

THE GATEHOUSE

Sometime after they finished the entrance, builders formed the small room with two thin mudbrick walls and the curved corner of the corral wall (photo page 8). They provided a doorway on the west side with a threshold higher than the floor. The curved fieldstone wall was coated with thick plaster inside the chamber. The plaster and raised threshold suggest this could have been a bin for storing fodder, such as clover. We found a similar bin with a curved side in ES2 (map, above left).

THE REAL ENTRANCE

Once the wall tumble was cleared, we found an entrance fitted into a 2.90-meter gap that separated the north end from the rest of the corral wall. Builders added mudbrick door jambs to both sides of the gap—reducing it to 0.85 meters—and a stone threshold with a mud ramp on the east side. They probably finished the entrance with the jambs and threshold as soon as they had built the walls.

If people brought livestock into the corral, they had to get the animals through this entrance. It was not nearly as wide as the chute we had envisioned. Eventually, someone added to the north jamb, further narrowing the entrance to 0.70 meters. A stone projecting from the south jamb just above the threshold might have made the entrance even narrower—0.56 meters—but we don't know if there were more stones stacked above it. Late in the occupation on the east side of the entrance, builders enclosed the ramp with two L-shaped mudbrick walls, apparently creating a porch (see map, above). Could cattle have fit though these various configurations? See Richard Redding's article on pages 10 to 11 to find out. And if you are wondering why the entrance was narrowed, Richard has some ideas about that too.

MORE SURPRISES, ANCIENT WALLS

The shape of the corral wasn't the only surprise of 2022. When the soccer field overburden to the east of SWI was

Top: Dan Jones and Moustafa Mahmoud Ahmed finish excavating the limestone threshold of the entrance to the OK Corral. On the right, a semicircular socket. View to the east. Photos by Mark Lehner.

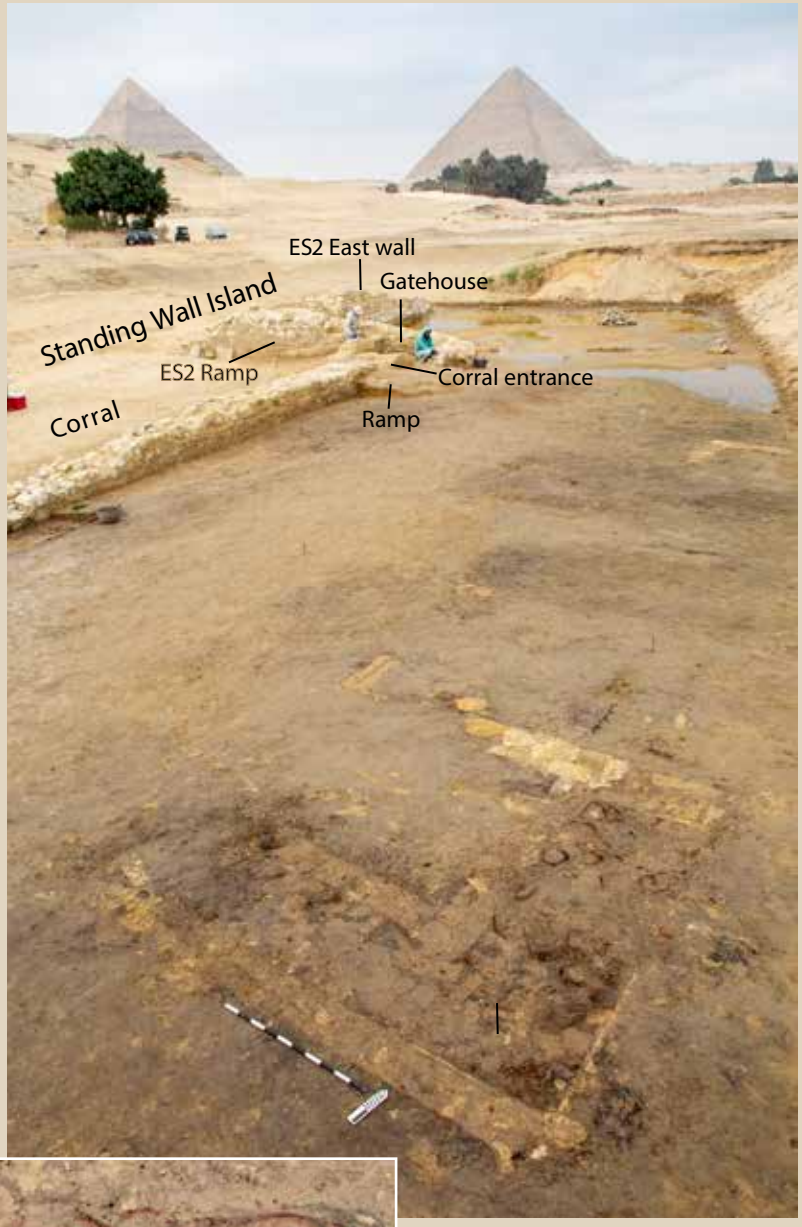
Above: The northeast corner of the OK Corral with the Gatehouse in the foreground. The north end of the corral wall turns west and abuts the ramp on ES2. In the Gatehouse, dark occupation deposits have been exposed below the floor and date to a time before the corral wall was built. View to the north.

cleared away we were surprised to find evidence of settlement—a dark mound with hints of walls and features—where we had expected to find none, based on test trenches and drill cores in previous seasons. We nicknamed this area "the occupation mound" due its to mounded shape, stepping up 1.3 meters in height over a 45-meter distance, as if formed over time by accumulating debris and refuse deposits. After removing the sand overburden we uncovered a number of walls and installations built of marlbrick[4] and limestone that stood out in stark contrast to the color of the mound's makeup.

This made it easy to map the ancient walls of broken stone and mudbrick in the dark surface of the mound by scraping with trowels and cleaning with brushes, in the same way we have found many of the walls across HeG.

One of the buried buildings appears to have been a bakery, full of large, conical bread molds like we have found elsewhere at HeG. There was also a small, saddle-shaped quern for grinding grain into flour. Other remains included two pig jawbones, a triangular scraper that would have been used to scrape leather hides, more Old Kingdom pottery, a cow tooth, and other animal bone. All of these were embedded in dark ashy waste from many fires, possibly from cow dung used as fuel.

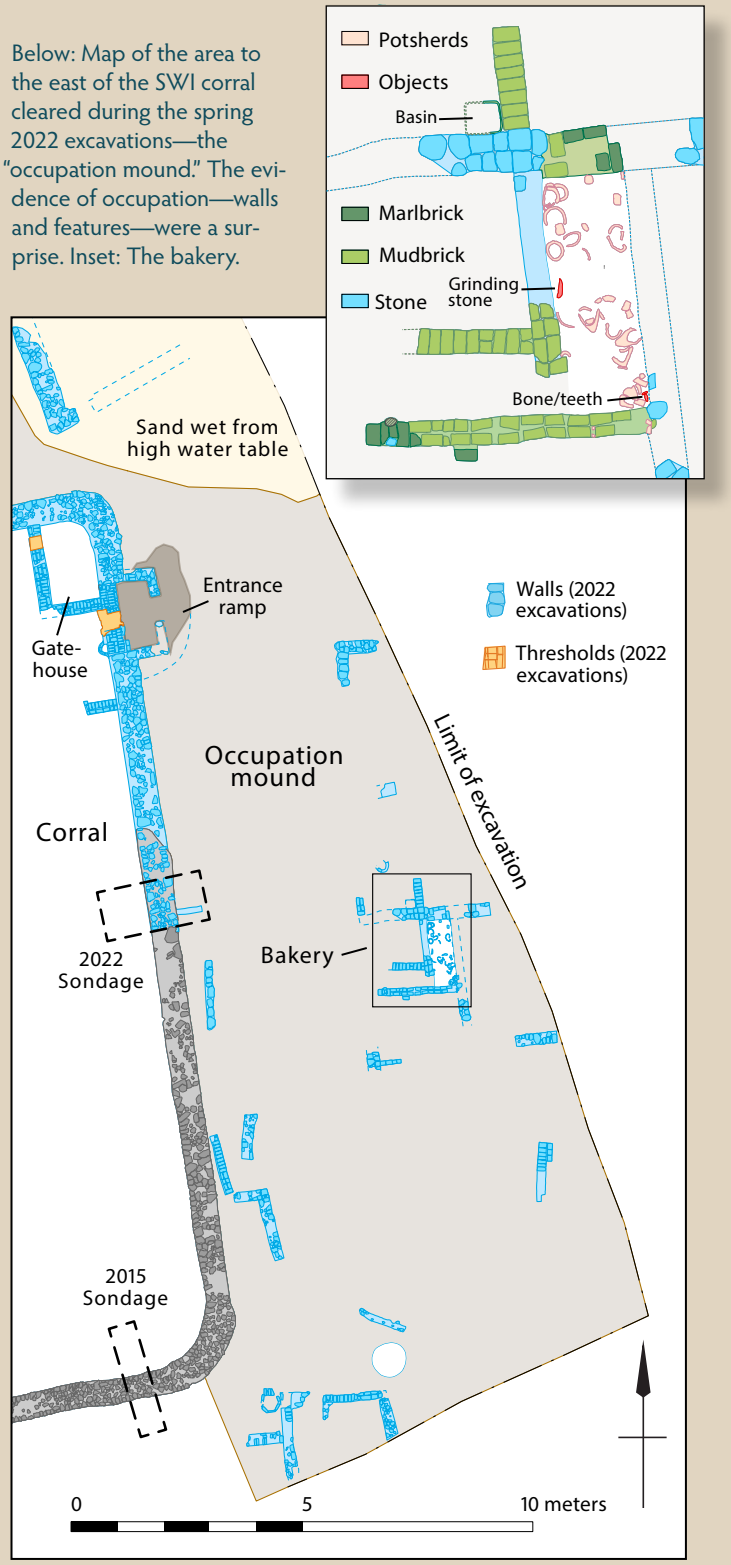
Our excavations in the southwest end of the soccer field have prompted us to rethink our ideas about HeG. Additional small 2022 sondages were aimed at teasing apart the relationship between the corral, the occupation mound, and the lagoons. As usual, these raised more questions than provided answers. But we now know that the OK Corral was a late addition and was entered from a narrow opening on the east side, and perhaps in the final years used only to hold sheep and goats (see pages 10–11). We also now recognize that SWI was not a lone compound at the southern end of HeG—as our site map had shown for years—but part of a wider inhabited landscape south of Lagoon 1. In addition, the newly discovered occupation



Above: The bakery in the newly discovered settlement area east of the SWI Corral, seen on the left. In the background, the eastern wall of ES2 and ramp at the southeast corner of ES2 appear. View to the north.

Left: Detail of the bread molds stacked in the bakery, just barely exposed. Photos by Dan Jones.

Below: Map of the area to the east of the SWI corral cleared during the spring 2022 excavations—the "occupation mound." The evidence of occupation—walls and features—were a surprise. Inset: The bakery.



on the east side of the corral wall alters our ideas about the history of this area. We determined that it was occupied before the stone-walled corral was built (see page 11 for evidence from the sondage cut through the east wall of the corral) and continued in use afterward. The area was occupied for a longer period and was more complex than we had believed. We hope that future excavation in this area will help answer our new 2022 questions.

1. Lehner, Mark, 2021. "Searching for a Royal Building Under the Soccer Field," *AERAGRAM* 22–1&2 (Spring–Fall), pp. 2–4, 6–10. Download back issues of *AERAGRAM* for free at aeraweb.org.

2. Redding, Richard, 2011. "The OK Corral: Standing Wall Island Mystery, Solved," *AERAGRAM* 12-1 (Spring), pp. 2–5.

3. Lehner, Mark, Mohsen Kamel, and Ana Tavares, 2009. *Giza Plateau Mapping Project Season 2004, Preliminary Report.* Giza Occasional Papers 1. Boston: Ancient Egypt Research Associates, pp. 39–44.

3. Marlbricks are similar to mudbricks but made with marl, a desert clay.

Showdown at the OK Corral! Testing the Hypothesis

by Richard Redding

No plan of operations extends with certainty beyond the first encounter with the enemy's main strength. – Helmuth von Moltke

Today, this military truism has been simplified to "no plan survives contact with the enemy." This can also be applied to science, but the quote should read, "no hypothesis survives contact with the data." An example is our work at Standing Wall Island (SWI) at the Heit el-Ghurab (HeG) site (see article starting on page 6 for more about the 2022 work). In 2011, I confidently laid out an explanation for the enigmatic complex of walls.[1] But that old theory and the new ground truth had a showdown at the OK Corral! It was not a pretty sight.

THE OK CORRAL

In 2011, I suggested that SWI was a stockyard complex that included a large pen, the OK (Old Kingdom) Corral, where cattle, sheep, and goats were held before being butchered to feed the residents of the HeG. The abattoir was one of two enclosures at the north end of the complex, ES1 or ES2. Subsequent excavations revealed that ES2 was a house, probably of the official overseeing the complex (map, page 7).

In 2016 AERA published an article on the excavations in ES2.[2] We were so convinced that the SWI was a stockyard complex that we included an image of a scribe sitting on a ramp recording cattle as they entered the corral through a "chute" between the outer wall of ES2 and the hypothetical extension of the corral's east wall (drawing shown above). But as a result of our excavations in March 2022, the stockyard hypothesis has been slightly wounded.

I suggested that SWI was a corral in 2011 based on the rounded corners at its south end.[1] I cited Temple Grandin, the preeminent cattle behaviorist and expert in the management of cattle and other domesticates. Cattle in right-angled corners become trapped and cannot move because their very wide field of vision reveals walls all around except in their blind spot behind them.

I described the corral as paper clip-shaped with an opening in the northeast corner (map, page 7), the area under the soccer field. We have ancient Egyptian examples: two representations of paper clip-shaped corrals on the Narmer macehead and the footprint of one at Old Kingdom Kom el-Hisn. And all three had rounded corners. So, our expectation of an opening in the northeast corner seemed reasonable.

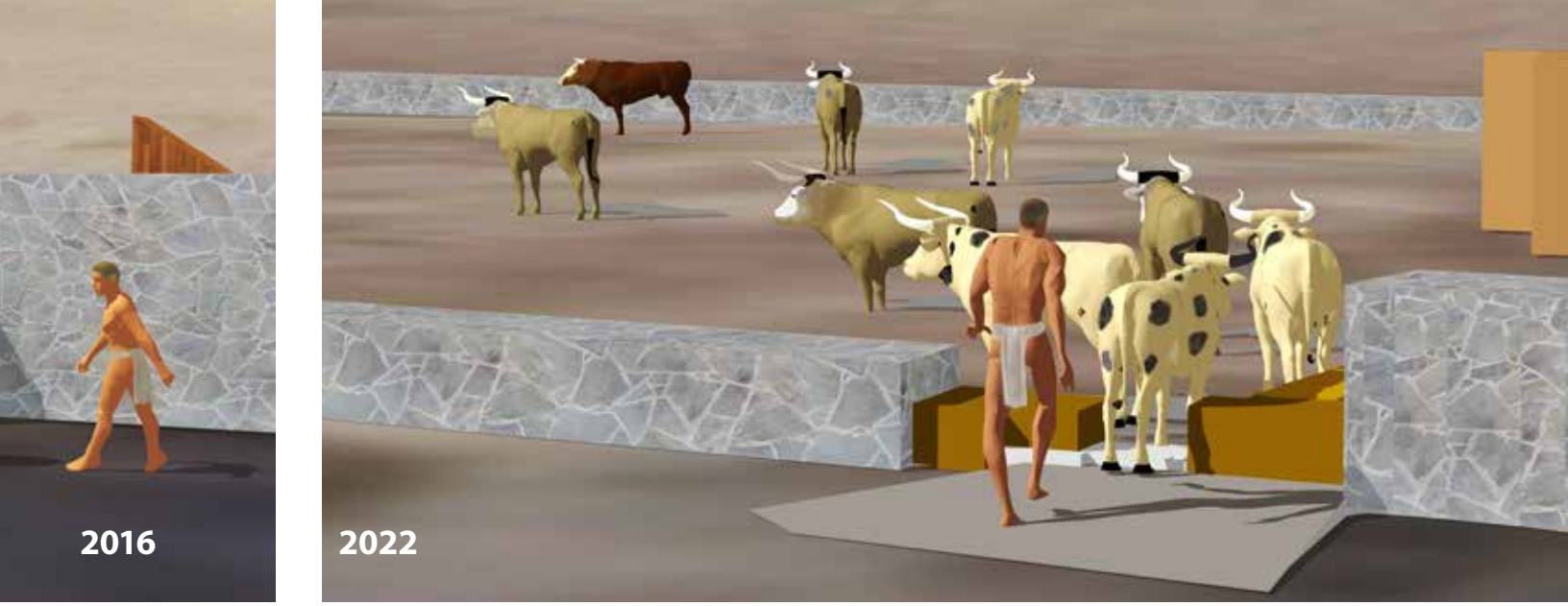
After finally receiving permission to excavate the soccer field, one of the areas we tackled first was the hypothetical corral entrance. The results are shown in the map on page 7..

SURPRISE!

Alas, the corral wall does not run straight, but makes a sharp turn to abut what we described as a ramp on the southeast end of ES2. There is no opening that allowed animals to be driven into the corral. But we found an opening in the east wall at the north end of the corral (map, page 7), allowing animals to enter from the east. These results are not a fatal blow to the hypothesis, but certainly call for rethinking and follow-up testing.

The width of the newly discovered entrance was somewhat narrower than we had expected. The initial opening was 2.90 meters but was reduced to 0.85 and later 0.70 meters (map, page 7). It might have been even narrower, 0.56 meters, because of a stone projecting from the southern side. But we don't know if there were other stones above it. The single stone would not have made a difference, but if all of the opening was narrowed such that it was too small for the widest part of some livestock bodies to go through, it would have limited the species passing through. Could cattle go through? Temple Grandin's website[3] says that a cattle chute needs to be 0.61 to 0.71 meters wide. That's for animals in the modern livestock business. Small cattle typical of Old Kingdom Egypt might have fit through a 0.56-meter opening into the corral.

But why did the Egyptians narrow the entrance so drastically? To answer this question we have to look at the construction history of the complex (see map, page 7).



The oldest part was at the north end, ES1 and ES2. The ramp was constructed in the next phase. The third phase enclosed the corral with a stone wall that included the 2.90-meter entrance on the east side.

AN ANIMAL PEN WITH NO WALLS?

Is it possible that the corral complex existed without a wall originally? This is highly unlikely. In its early incarnation the corral may have had an ephemeral wall, possibly made of plants. A scene on a block recovered from Karnak depicts a corral with four cattle, a herder, and a wall that appears to be made of palm fronds.[4] I have seen pens in Egypt made from palm fronds and woven reeds. The first corral wall may have been replaced later by the one of stone. Why the replacement and changes?

Cattle do not need a solid wall to keep them penned, but sheep and goats require a wall they cannot eat. Sheep would easily chomp their way through a palm frond fence and goats would chew almost any plant material, even prickly camelthorn.

Perhaps the earliest corral was only for cattle? If so, there must also be an undiscovered small one for sheep and goats, probably with a mudbrick wall.

When the Egyptians replaced the early wall with the one of stone, they were probably mixing cattle, sheep, and goats in the same pen. All three can be herded together if there is enough space. This might have occurred because the demand for meat was declining as the work on Menkaure's pyramid was winding down. The slaughter of a bull/steer/ox yields a great many servings: 1,075 portions of 179 grams—179 grams is half the daily protein requirement of an adult male engaged in heavy labor. A sheep yields only 145 179-gram portions and a goat, 93.[5] So as the number of workers being fed declined, there may have been a shift toward sheep and goats. The size of the entrance to the corral could be reduced from a cattle-sized to a sheep-goat-sized gateway. Going further, I would expect that as the number of workers continued to decline, the livestock may have even shifted from sheep to goats.

We now have a whole new series of predictions to test. Is there a second corral? If we remove a section of the wall, will we uncover indications of a trench for the fence made of plant material or other evidence of its existence?

So far, after having excavated two sondages that cut across the corral wall we have found none (map, page 9). In our 2022 sondage we discovered that the occupation mound to the east of the corral had originally extended west into what became the corral. The mound was cut back to make way for the stone wall. A sondage dug in 2015 through the south wall of the corral showed that it had been built upon sand. Still, we should not dismiss the possibility of an earlier wall of plant material since the sondages sampled such a small area of the corral.

Another prediction to test is that there was a shift toward sheep and goats in the latest levels of the HeG—those associated with the decommissioning of the site. A research design for a future season of work is emerging.

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1. Redding, Richard, 2011. "The OK Corral: Standing Wall Island Mystery, Solved, " *AERAGRAM* 12-1 (Spring), pp. 2–5. Download back issues of *AERAGRAM* for free at aeraweb.org.

2. Wetterstrom, Wilma, 2016. "How Was ES2 Roofed? Modeling in 3D," *AERAGRAM* 17–1&2 (Spring–Fall), p. 9.

3. Temple Grandin's website, www.grandin.com, is filled with short articles summarizing animal behavior and management.

4. Redding, 2011, "The OK Corral," p. 3.

5. These data come from a book I am preparing on cattle, sheep, and goats in Pharaonic Egypt. The other protein half would come from fish, beer, bread, and other foodstuffs.

COPPER at Giza: Analyses Tell Stories

by Martin Odler and Jiří Kmošek

If we could pick just one topic that is very poorly understood about the "Pyramid Age" by both the general public and many Egyptologists, it would be the production and use of copper. The tools at our disposal for exploration of this topic have changed in recent decades, but they are only gradually being applied to the material from ancient Egypt and Nubia. Previously, it was necessary to cut out large chunks from objects, and the remains of the production of such objects did not attract much interest. Now we understand more clearly that non- or only mildly invasive techniques can provide information on how ancient Egyptian copper objects were produced, beyond just their chemical composition and practical properties.

Luckily, the finds excavated at Giza by AERA, in the Heit el-Ghurab (HeG) settlement (also called the Lost City of the Pyramids) and the Menkaure Valley Temple (MVT), give sufficient information to better understand the ancient technologies of metallurgical production during the Pyramid Age. Moreover, as far as we know, this is the largest corpus of Old Kingdom metallurgical remains in the whole of Egypt and Nubia. The meticulous stratigraphic excavations by AERA teams make analyses even more valuable … and exciting.

Since 4th-Dynasty Giza—as an exceedingly royal site—was the endpoint of the Egyptian state's supply chains, it is much more likely that we can learn about those supply chains at HeG than at mining sites in the Eastern Desert or on Sinai. Further, the Old Kingdom mining and copper processing installations on Sinai were destroyed by modern mining activity, except for the Old Kingdom site Seh Nasb, which might be of a similar date. Several such installations of likely contemporary, early 4th Dynasty date were uncovered in the Eastern Desert, but they have been published only in brief preliminary reports.

PROJECT PHASES

Research is not simply "done." It is a multistage process of asking pointed questions and seeking answers within the relevant material. The initial stage of our project took place in 2019, and we published a report on this work in *AERAGRAM* at that time.[1]

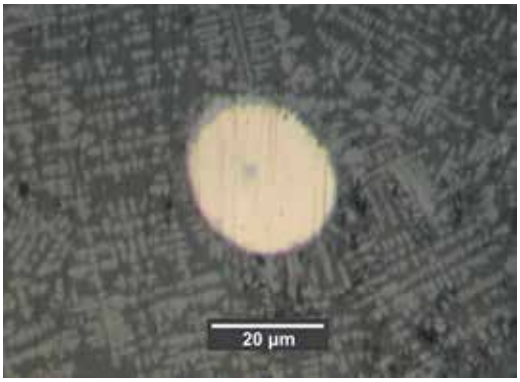
Martin Odler prepares metalworking fragments for photographic documentation. Photo by Claire Malleson.

The first batch of 23 samples was selected in Spring 2019 from all AERA metalworking remains. It was transported to the archaeometric laboratory of the Institut français d'archéologie orientale du Caire (IFAO). There we prepared thin sections and analyzed them under the metallographic microscope. IFAO has facilities to prepare the cross-sections and for subsequent microstructural study of samples; it is the only archaeological institution in Egypt currently possessing such equipment.

For a thin section, the selected sample is fastened in a block of resin, cut, and polished, so that the internal microstructure of the metal and surrounding material can be observed under the microscope. Since we can see the inside of the sample, below the outer corrosion layer, the analysis of chemical composition is more precise. These first analyses demonstrated that the presence of arsenical copper was ubiquitous. We listed and explained the results in our first article.

And then the COVID-19 pandemic halted any further work until Spring 2022. In two weeks of early March, we were able to bring the portable X-ray fluorescence machine into the AERA magazine at Giza to analyze the chemical composition of the copper materials. In addition, we were able to photograph them.

Now, after producing several thousand photographs and several hundred X-ray fluorescence spectra (described below), we know much more than we did only a few years



Above: A thin section of a metalworking sample viewed under a metallographic microscope. In the slide one can see the microstructure of an iron-rich compact slag fragment with a bright arsenical copper prill in the center. The prill is a little more than 20 microns (0.00079 inches) wide, less than the diameter of a human hair. Photo by Jiří Kmošek.

Left: Jiří Kmošek describes parts of a crucible fragment. Photo by Mark Lehner.

ago about the nature of the Old Kingdom metallurgical material uncovered at HeG. The results are already enough for a book, or at least a series of academic articles in scientific journals, and will eventually be published as such.

In this article, we would like to share some of the results of the second session, using a few examples of metalworking remains and artifacts. With these specimens, we show how the analyses enable us to understand the metallurgy of the Old Kingdom Egyptians.

METALWORKING REMAINS AND COPPER ARTIFACTS FROM GIZA

The HeG material we analyzed contains the minerals from which copper was produced. It was processed in ceramic crucibles, and the metalworking waste of these processes are slag and small copper droplets (also called prills). The metalworking was not perfect; thus the waste products of the processes contain some of the intended finished material, which can now be studied.

Bread molds were used as crucibles for melting the copper, and probably also producing small items, such as needles and fishhooks. But the volume of Old Kingdom bread molds provides space to fit in enough material to produce big objects as well.[2]

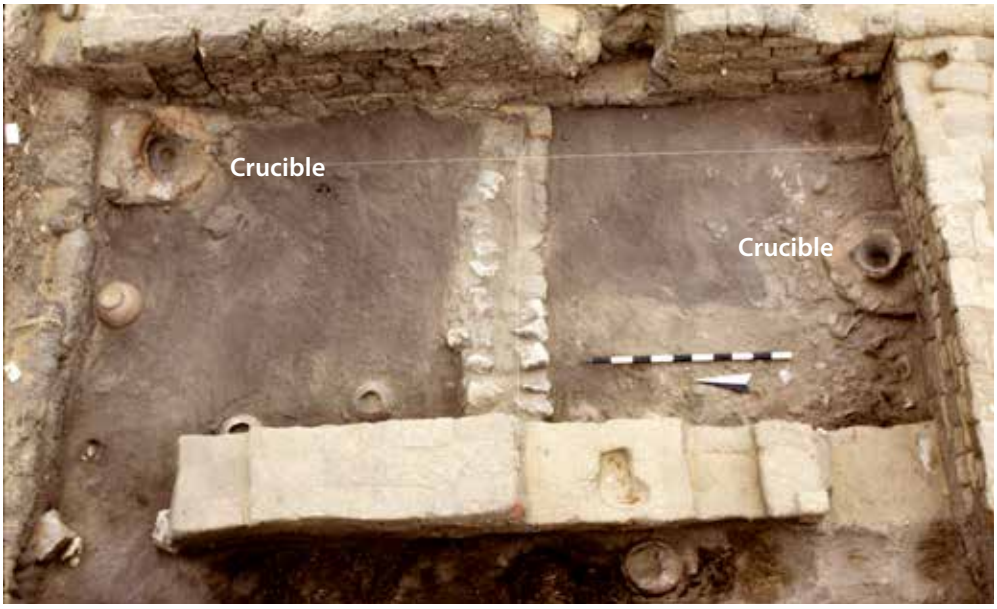
However, since HeG was abandoned in an orderly fashion (i.e., the very opposite of a site like Pompeii), we believe all recyclable bits of metal and large objects were carried away. AERA teams found a number of artifacts, but mostly of a rather small nature, such as fishhooks, needles, and rarely also bits of chisels. Such artifacts might have been easily lost or overlooked and not recovered for further recycling of the metal.

Our main focus was on the material from the copper workshop in Square 4.D17x, situated in the back chamber of Gallery III.8 and excavated in 1998 (see map, page 14), but we also studied comparative assemblages from other areas of Giza.

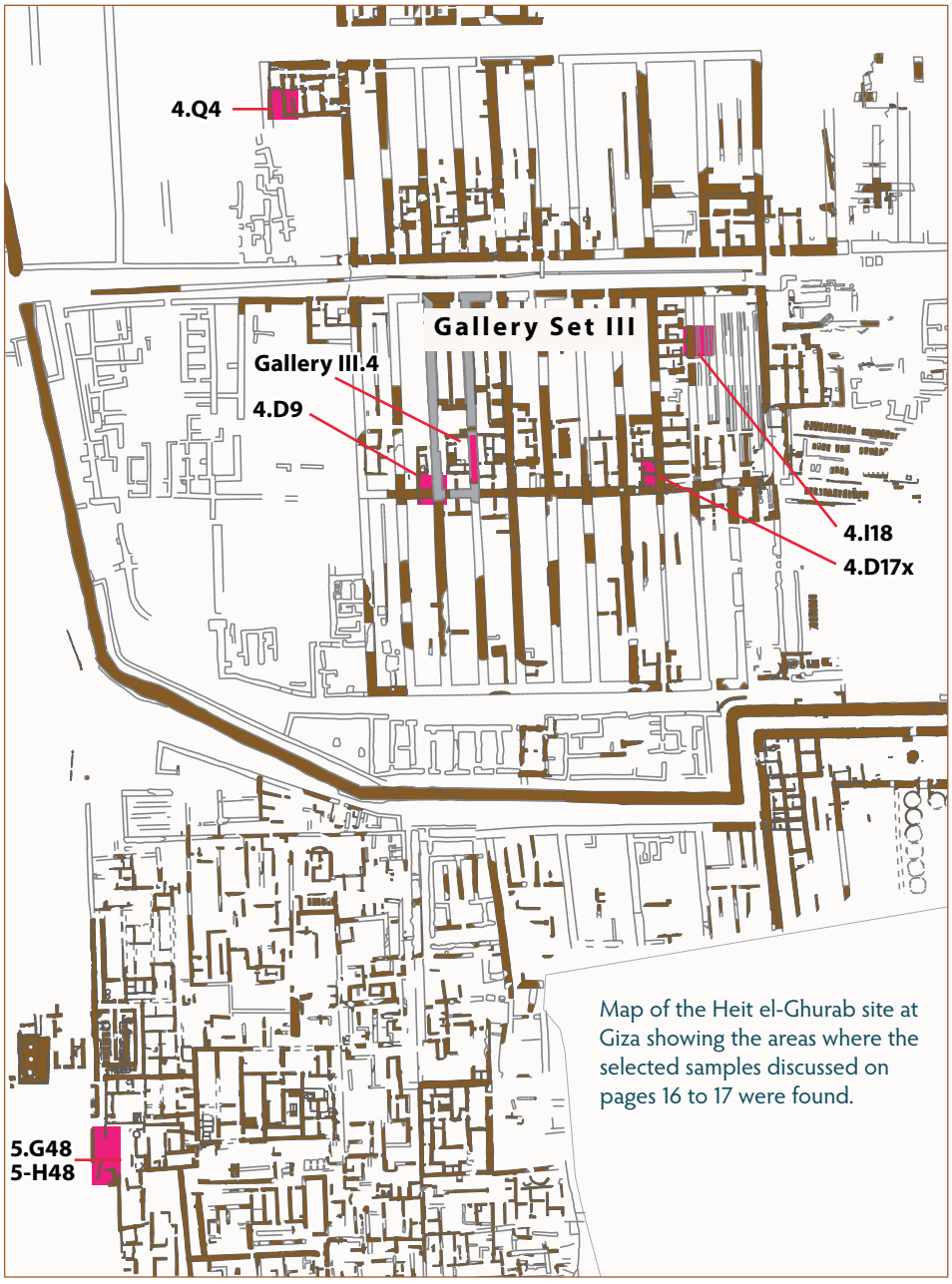
Having only two weeks, March 5 to 17, 2022, we needed to use our time in the Giza magazine wisely and collect as much data as possible for further processing. The most important part of the corpus was found in the workshop in 4.D17x. Already in the first batch we selected samples from each layer of this workshop, and each layer turned out to contain bits and pieces of arsenical copper. This was confirmed in 2022, and on pages 16 and 17, we describe the selected pieces.

WORK IN THE LAB IN 2022: RESULTS IN BRIEF

We took more than 4,800 photographs of the metallurgical remains, which will be typologically described in detail elsewhere later, during further processing. Such a vast photographic archive assured that the precious time in the magazine was used effectively. A special macro lens was used to ensure that minute details on the fragments were clearly recorded.



Copper workshop in Square 4.D17x of the Heit el-Ghurab site. Photo by Mark Lehner.



Map of the Heit el-Ghurab site at Giza showing the areas where the selected samples discussed on pages 16 to 17 were found.

For a week, we also gathered information about the samples using a portable X-ray fluorescence machine, the Bruker S1 Titan. This device, a type of spectrometer, produces information about the chemical composition of the analyzed material in the form of spectra, a graph-like print-out from the machine that shows the quantities of each element present in the sample, such as iron, arsenic, and tin, as well as copper.

Instead of analyzing just a few bits and pieces, it was possible to produce several hundred spectra for metalworking remains and artifacts. Altogether 530 spectra were recorded for selected fragments: 21 minerals, 150 slags, 259 crucibles, and 101 artifacts. We analyzed the spectra using Bruker Artax software to determine the concentrations of major and minor elements in each of the objects. Our information on the samples is currently the largest dataset of Old Kingdom copper metallurgy anywhere in Egypt and Nubia.

The main alloy produced was confirmed to be arsenical copper (and artifacts made of it), further corroborating the analytics done on the first batch in 2019. This is a material that was produced in the Early Bronze Age throughout the entirety of the Eastern Mediterranean.

Arsenic is a toxic element but small doses are not lethal. An addition of just a few percentage points of arsenic to copper along with subsequent hammering causes the material to become harder, very similar to properties in the later-used tin bronze, the material that named the whole Bronze Age.

Since the last arsenical coppers in ancient Egypt were produced at the latest in the New Kingdom, several millennia ago, there is no one to ask about it in contemporary Egypt or Nubia—no ethnoarchaeology is possible. Thus, in order to understand the intentions of ancient craftspersons, we need to engage the analytical results and other archaeological information.

The main research question to be posed is whether the ores smelted already contained both copper and arsenic, or if the arsenic was intentionally added from other ores. In the second case, the material in question ought to be properly called arsenical bronze, because it was made by alloying several ores. To prove which is the correct answer, we would need to present the data in more scientific detail first.

Martin Odler photographs metallurgical fragments with a macro lens in a foldable photo-tent. An app on his phone serves as a remote control for the shutter. Photo by Claire Malleson.

But in this article, we can present a selection of analyzed objects and fragments—considering the analytical results with the contextual and archaeological information. In this way, we can show how a case is made for the use of arsenical copper in the Old Kingdom and how the analyses enable us to understand the metallurgy of the Old Kingdom.

We plan to carry out further evaluation and measurements in 2023, with the goal of preparing a second batch of samples for transfer to the archaeometric laboratory of the IFAO, for preparation of cross-sections and microstructural study under the metallographic microscope.

PIECES OF COPPER METALLURGY FROM GIZA

From the selected pieces of evidence we can see the almost ubiquitous presence of arsenic as an element, both in the metalworking waste and in the finished products. Despite our best efforts, separate and stand-alone arsenic minerals were not identified in the samples we studied. But it is possible to imagine that arsenic could have been more precious than the copper alone, even of "strategic" technological importance to Old Kingdom Egyptians, and therefore used down to the last bits. Since there are copper ores without arsenic, artifacts made of copper with very little arsenic, and arsenical coppers as well, it all seems like an intentional production of specific materials. More robust data within peer-reviewed publications is necessary before confirming such a conclusion.

Iron is also ubiquitous, which we interpret as being an indication of better reducing conditions during the metalworking process. That is, oxygen and outside air were kept out of the crucibles where the ores were melting. If oxygen were present, it would combine readily with iron, as well as arsenic, and the product would not be arsenical copper containing some iron.

This is particularly exciting, as there has been recent and ongoing debate on the nature of iron present in arsenical copper, and the material studied by us from Giza can add another and completely new chapter. But the selected samples first need to be investigated under the microscope.

As it is often the case with scientific research, you can answer some questions, and receive a lot of food for thought, but also prompt a round of new, better-informed questions and problems to solve.

1. Odler, Martin, and Jiří Kmošek, 2019. "Copper at Giza: the Latest News," *AERAGRAM* 20-2 (Fall), pp. 11–17.

2. The bread molds used were the largest of the three conical Old Kingdom molds (Anna Wodzińska, personal communication, February 2023). They were 27 to 36 centimeters high and had a capacity of about 6.5 liters (Anna Wodzińska, 2006. "Preliminary Ceramics Report." *Giza Reports I*, edited by Mark Lehner and Wilma Wetterstrom. Boston: Ancient Egypt Research Associates, p. 306).

ELEMENTAL COMPOSITION OF SELECTED SAMPLES*

Sherd AW-60395_b. A small bread mold sherd from 4.D17x with a black vitrified layer of slag, this is metallurgical waste from smelting copper. Green nubbins in the slaggy layer are the corroded bits and bobs of copper that were trapped in slag. Since they are quite small, they were not processed further, just thrown away. The analysis demonstrates that these prills are in fact made of arsenical copper with about 20% copper, 1% arsenic, an admixture of lead, and a high portion of iron. With the naked eye, plain and arsenical copper cannot be distinguished.

Sherd AW-60353_c. Partly corroded metallic prills in the sherd contain an extremely high proportion of arsenic (8.5%) and lead (7.8%) in proportion to copper (14.8%), along with admixtures of tin, antimony, and zinc. The iron content of such metal is very high (60.6% of Fe_2O_3) but even higher concentrations of iron were also recorded in the slag, if we compare its composition with the composition of the ceramic sherd. This further gives the same result over and over: the workshop in 4.D17x was processing arsenical copper from ores or ingots that also contained iron in high proportions.

Object No. 5072, fishhook. Two complete objects were found in the workshop in 4.D17x, a fishhook and a needle (see Object 5075, below). The fishhook is a typical Old Kingdom copper fishhook hammered into the angular shape from a rod. It was made of arsenical copper with almost 3% arsenic and almost 10% iron. Since the surface is corroded, and we cannot drill or cut into the object, the results are not as accurate as we would wish. But we can safely rule out that it was made of a different material.

Object No. 5075, needle. This is a plain, ordinary needle for mending textile in the Old Kingdom. With more than 1% arsenic and 3% iron, it is made of material similar to the fishhook. Both complete artifacts from the workshop corroborate the use of arsenical copper by the 4th Dynasty Egyptians.

Sherd fragment, Bag 531. One of the sherds from Gallery Set III, it has black slag and small copper droplets. It has more than 1% of arsenic and more than 3% of iron, i.e., the same elemental pattern described for the needle 5075.

Copper with chlorine, Bag 777. This was an absolutely unexpected find: rock with copper mineral compounded with chlorine. It is very probable that with 19% copper, it would be a viable source of either green pigment or copper for smelting. Unfortunately, the techniques currently available in Egypt do not enable us to decide what the final destination of such pieces were. But their mere presence at Giza demonstrates that raw copper ore could reach the pyramid fields, either from the Eastern Desert or from Sinai. But since, as we mentioned, the supply chains of the Old Kingdom state ended in Giza, it is likely that if we want to find examples of all necessary elements, Giza is the most promising candidate.

Black slag fragment, Bag 306. This is slag with a metal droplet from the floor in the Area AA-South. Here the concentration of metalworking remains was not as high as in 4.D17x. But since the remains are conspicuous, there must have been some copper metallurgy going on in AA-South in the 4th Dynasty. This particular fragment has about 4% arsenic, 30% copper, and almost 70% iron oxide—a metalworking waste product of the same processes happening elsewhere.

Object No. 5076, needle. Large metal artifacts were usually picked up and recycled; if a metal object is heavy, it can hardly be lost. Thus, even after several decades of AERA's excavations, all of the metal artifacts recovered are small, like this needle from Square 4.Q4. It is broken into three pieces. What remains is the corroded metal core, which is thus accessible and can be readily analyzed. The needle was almost 10% iron with low admixtures, including arsenic, antimony, lead, and silver, but also a small bit of tin (0.21%) that does not seem to be a coincidence. But this material appears to be slightly different than the objects mentioned above.

Composition of Artifacts

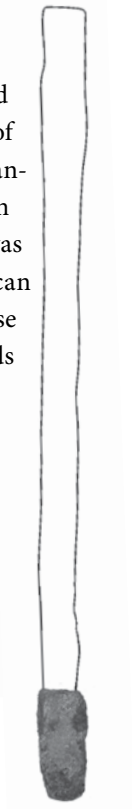
Sample Number	Material	Weight in grams	Percent by weight							
			Copper	Iron	Arsenic	Silver	Tin	Antimony	Lead	Total
1892 Obj. 5076	artifact - pin	1.4	87.12	9.91	0.32	0.10	0.21	0.24	0.21	99.66
2270 Obj. 5072 or 134	artifact - fish hook	2.1	85.01	9.95	2.75	0.21	—	0.40	0.16	99.74
1961 Obj. 5075 or 117	artifact - needle	0.6	94.59	3.36	1.16	—	0.09	0.17	—	99.80
43 Obj. 5078	artifact - chisel	53	94.63	1.93	3.21	—	—	—	—	99.88
3983 Obj. 5089	artifact - needle	1.1	92.38	3.80	3.01	—	0.12	0.12	0.09	99.90

Composition of Crucibles, Slags, and Minerals

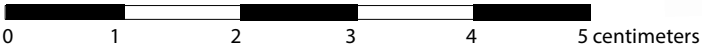
Sample Number	Material	Weight in grams	Percent by weight							
			Iron	Copper	Arsenic	Tin	Antimony	Zinc	Lead	Chlorine
AW-60395_b	C-slag	4.9	12.75	19.81	1.14	—	0.02	—	0.35	—
AW-60395_b	C-pottery fracture	4.9	11.22	0.32	0.05	—	—	—	—	—
531	C-metal	16.4	5.21	93.55	1.38	0.11	—	—	0.80	—
531	C-pottery fracture	16.4	9.17	0.25	—	0.53	0.38	—	—	—
AW-60353_c	C-metal	40.5	60.63	14.77	8.47	—	0.05	0.25	7.79	—
AW-60353_c	C-slag	40.5	13.26	5.10	1.01	—	0.05	0.18	1.45	—
AW-60353_c	C-pottery fracture	40.5	10.69	0.08	0.05	—	0.07	—	0.06	—
306	slag with prills	1.4	25.81	10.07	1.44	—	—	—	0.26	—
306	prill	1.4	69.57	29.98	4.09	0.05	—	—	—	—
777	mineral w/ copper	6.8	6.08	19.07	—	—	—	—	—	3.76

Object No. 5089, needle. This was uncovered in Gallery III.4 not far from workshop 4.D17x. It is corroded on the surface, broken, and what projects is again the metal core. There is more than 3% of both iron and arsenic in this particular needle, thus confirming the pattern of the artifacts from Gallery Set III.

Object No. 5078, chisel tip. The most massive and intriguing object from the settlement material is a tip that broke off a full-size chisel like the one in the sketch. Weighing 53 grams, it is the heaviest metal object that the ancient residents did not recover and recycle from the galleries. It was found in a dense concentration of pottery across the south end of Square 4.I18. Despite the corroded outer surface, the weight means that the metal core of this particular object is well preserved and could even be sampled in the future. The chisel from which it broke off was likely used to shape stone blocks at Giza. It contained more than 3% arsenic and almost 2% iron. The rest of the chisel would be a longer bar of metal with a rectangular section adjoining the preserved bit, as shown in the drawing on the right. Since the tip broke off, it was likely deemed not worthy of recycling, although we can presume that fragments of similar size were otherwise recovered. If it were not so, there would be more finds like this from the settlement remains.



* All samples shown at approximately the same scale (except for the sketch of the chisel). Scale on the right. All photos and the sketch by Martin Odler.



Art and Accounting of the Heb Sed

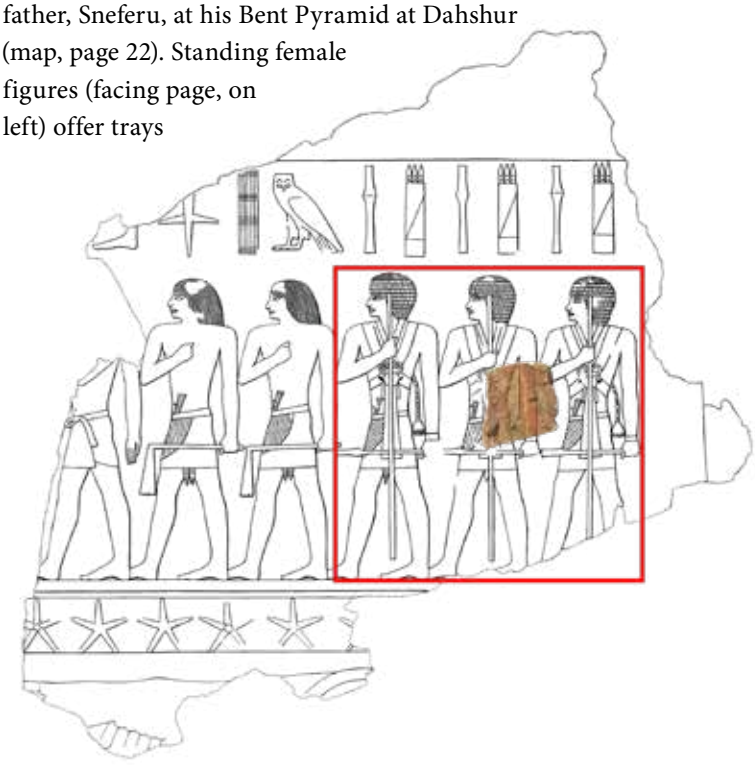
by Florence Dunn Friedman

The Heb Sed was a major ancient Egyptian royal festival, typically celebrated in the 30th year of a king's reign. Its purpose was to ritually rejuvenate and crown the king for eternity. Reliefs and statues made to commemorate the Heb Sed, suggests Egyptologist Florence Friedman, may bear an unexpected feature: the incorporation of mundane bookkeeping data that recorded in abbreviated form the goods that supplied the Heb Sed and where those goods came from. Art in the royal-religious sphere, she suggests, included a visual shorthand for the prosaic sorts of information recently found in an accounts ledger on papyrus from Wadi el-Jarf that records the provisioning of the king's crew in the secular sphere. Bureaucratic bookkeeping "on paper" was so fundamental to the ancient Egyptian mindset that its basics were taken into art. Still, the reliefs and statuary associated with the Heb Sed transcend papyrus ledgers. They were also propaganda, visually presenting the king—with divine support—as controller of the Egyptian sites from which his Heb Sed food and related resources came.

Two recent finds from the 4th Dynasty reign of king Khufu offer insights into Heb Sed-related reliefs and sculpture. The first find comes from the ongoing Great Pyramid Temple Project (GPTP), co-directed by Zahi Hawass and Mark Lehner, which aims to record and conserve the poorly preserved remains of Khufu's once grand temple that stood in front of his pyramid at Giza.[1]

While removing debris, the GPTP team discovered fragments of four limestone relief blocks that came from a temple wall. The most notable block shows portions of two standing men (below left), who are part of a procession of officials in a multi-figure scene from the Heb Sed, more fully captured in a block found elsewhere (below right). The newly found block adds to previously found examples—like one of Khufu enthroned in a Heb Sed cloak—that over the years have been assigned to different parts of the complex, including its causeway and, most importantly, its upper (pyramid) and lower (valley) temples. Taken together, the evidence suggests that the Heb Sed may have been the focus of more than Khufu's upper pyramid temple at Giza,[2] as it seems also to have been the focus of other 4th Dynasty upper and lower pyramid temples, discussed below.

Right: A scene from the Heb Sed. This relief probably dates to the reign of Sneferu. The GPTP block (below) belongs to a group of officials like those boxed in red. The GPTP block is shown superimposed over one of the figures and flipped to face left, like the figures in the relief. After Hans Goedicke, 1971, *Re-Used Blocks from the Pyramid of Amenemhet I at Lisht*, New York: Metropolitan Museum of Art, page 39.



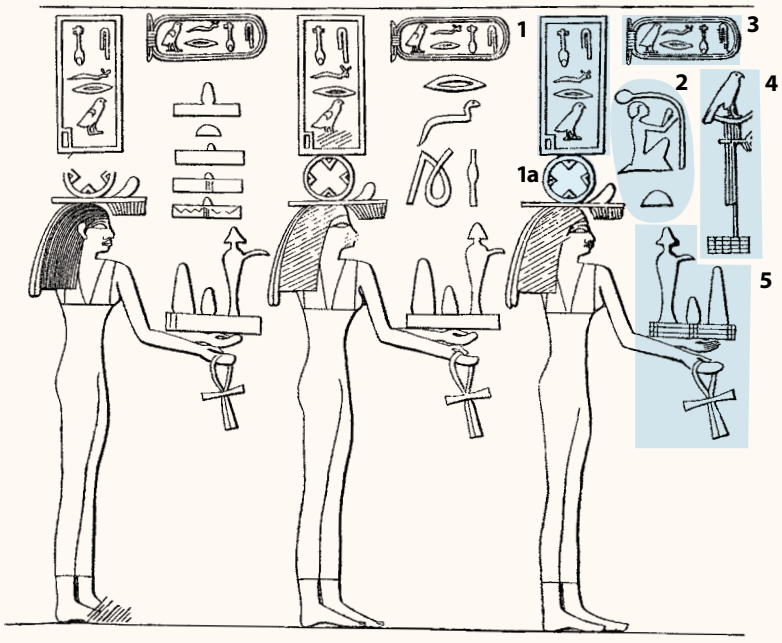
A wall block from Khufu's Great Pyramid Temple showing part of the torso and arm of one man and a fragment of another man's arm (on the left). Both face right. Photo by Mark Lehner.

The second find is one of the accounting ledgers from a spectacular cache of papyri discovered by Pierre Tallet and his team, in a storage gallery cave at Wadi el-Jarf, a harbor installation on the Red Sea coast during the reign of Khufu (see map, page 22).[3]

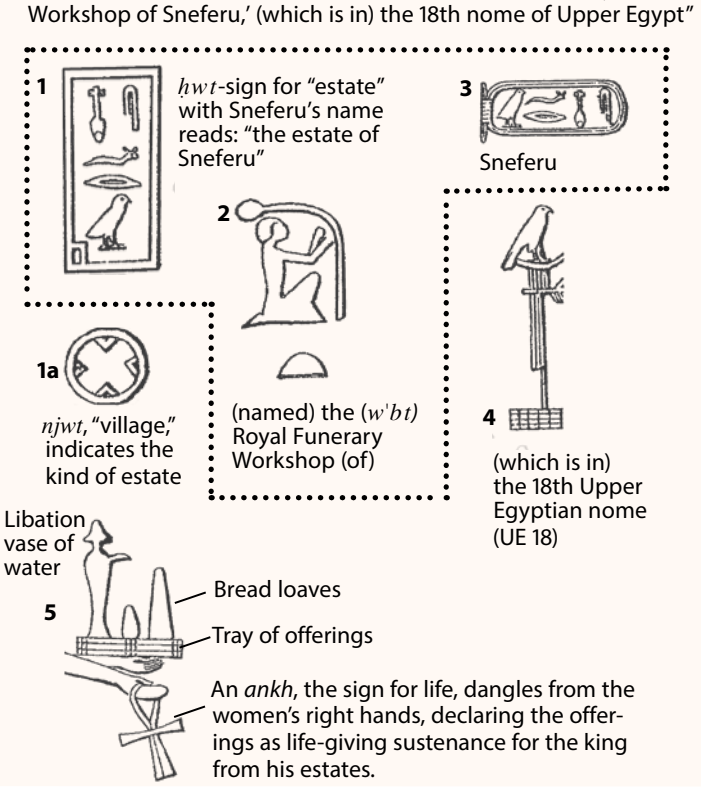
What follows are preliminary thoughts prompted by these findings that tie together Heb Sed-related works of art with the bureaucratic need to keep accounts of incoming goods. In addition, works like the statues of Menkaure and two female figures (called triads) that were found in his lower temple (valley temple), may, in part, also be abbreviated ledger accounts of food deliveries that derived from strategically important nomes (the equivalent of provinces) for *his* Heb Sed.

FOOD FOR THE FESTIVAL

Food was a requirement of the Heb Sed festival. This is illustrated in the scene from the valley temple of Khufu's father, Sneferu, at his Bent Pyramid at Dahshur (map, page 22). Standing female figures (facing page, on left) offer trays



Part of a procession of personified estates from King Sneferu's entrance corridor at the lower temple of his Bent Pyramid at Dahshur. The personifications of the estates, shown as women, hold offering trays in their left hands. The trays themselves are the hieroglyph for "offering." The offering consists of tall pots of water and bread loaves. These constitute life as shown by the *ankh*/life signs that dangle from the women's right hands under the offering trays. The meaning of the whole image is that the king's estates will provide him sustenance, i.e., life, for eternity. Modified drawing after Ahmed Fakhry, *The Monuments of Sneferu at Dahshur II, The Valley Temple, pt. I, The Temple Reliefs*, Cairo, 1961, fig. 18.



of provisions, plus pendant *ankh*-signs for "life," to the king (not shown here).

Each female figure personifies an estate, a "*ḥwt*" (also called a domain), a grammatically feminine word for parcels of land made up of one or more towns, founded by the ruler. The feminine gender of the ⊗ *njwt*-determinatives (a closely related term meaning an inhabited place like a town, village, or general locality) defines the type of estate and explains why the personifications are female.

Estates were part of an economic countrywide network that, through local officials working in concert with the crown, supplied the king's material needs. Each estate's name is read via the tall rectangle inscribed with Sneferu's name, to the right of which is the particular name of that estate, which in the first instance (above, left image, far right), is "*w'bt*," meaning Royal Funerary Workshop, with the name of Sneferu added in the cartouche at top. The whole reads: "the Estate of Sneferu (named) 'the Royal Funerary Workshop of Sneferu,' (which is in) the 18th nome of Upper Egypt" (UE 18), shown at right by the falcon on a standard (4), the insignia for that nome (map, page 24).

A nome, which was an administrative district akin to a province, could hold multiple estates. Three personified estates line up behind the UE 18 nome standard. In perhaps a blend of the real and wished-for, the Sneferu reliefs document the nomes and their estates that provisioned Sneferu in the ritual depicted in the temple. That ritual, as in Khufu's pyramid temple, was the Heb Sed.

SNEFERU'S HEB SED

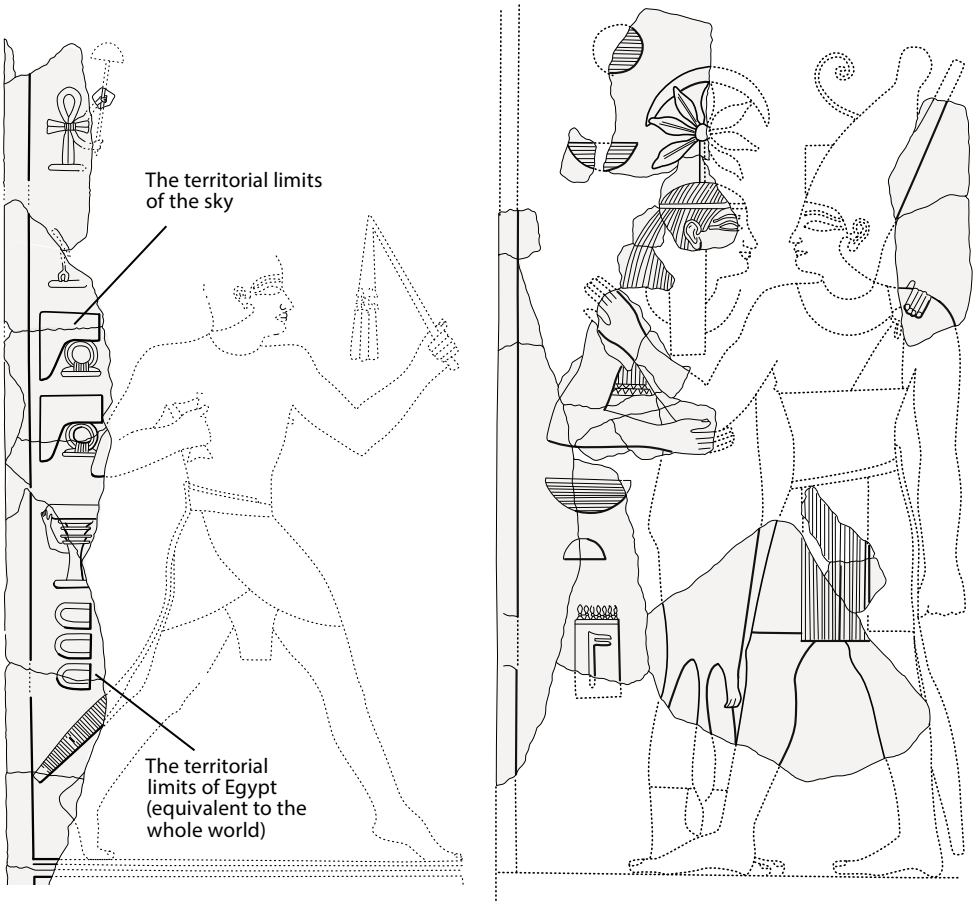
Although this ritual is not specifically named in what has survived from Sneferu's temple, images of activities associated with the Heb Sed appear on walls and pillars in the temple (page 20, top right). One (left) shows Sneferu with Heb Sed symbols behind him. Based on other reliefs in the temple, he can be reconstructed (shown by the dotted lines) as running the Heb Sed race, to demonstrate his fitness to rule. He once held in his right hand a document case, possibly made of leather, called the *mekes*. The document that was understood to be inside was probably an *jmyt-pr*, a will or testament, which was used in the secular sphere to transfer private property from person to person. But at the Heb Sed, which occurs in the sacred, royal sphere, the document seems to transfer property on a cosmic scale, granting the king a right to all of Egypt, which included heaven and earth.

A relief on another pillar (right) shows Sneferu embraced by the goddess Seshat. Her name means "female scribe," and she is most notably connected with writing, record-keeping, and time. Thus she would be concerned with recording the length of a king's reign—and the Heb Sed is about ensuring a king's eternal reign. Seshat's

embrace shows her divine legitimation of the king. The gods alone are above the king. When the king is embraced or has his hand held by a god, it's a sign that he has that god's divine approval/authorization. Though an aspect of the king is divine, he still (apparently) needs deities to fully legitimize him in the eyes of his court and people. And he wants this legitimation at the Heb Sed, his festival of rejuvenation that ensured him eternal rule.

Identification of the Heb Sed theme of the temple is verified by an ink inscription found a few years ago in the building. It refers to the year of the 15th counting. Being a biennial tax census, that would be the 30th regnal year of Sneferu, the year of the Heb Sed,[4] or slightly before, in year 28.

The Sneferu reliefs depicting delivery of provisions from the nomes and their estates to the king are thus for his Heb Sed, forever celebrated symbolically within the open court of his lower (valley) temple.



Two Sneferu Heb Sed-related images on pillars in the valley temple of Sneferu's Bent Pyramid at Dahshur. Left: On Pillar A, Side 2, Sneferu running the Heb Sed race to demonstrate that he is fit to rule. Based on parallel scenes, he holds in his right hand a document case called a *mekes*. Inside is the Heb Sed document, a will or testament that grants the king the right to the skies and lands that make up the Egyptians' bounded view of all that exists. Right: On Pillar E, Side 2, Sneferu is embraced and thus legitimized by the goddess Seshat, a deity of writing, record-keeping, and time. She wears a headdress described as a seven-pointed star. Above it is a crescent shape, described as horns pointing down. After Ahmed Fakhry, 1961, *The Monuments of Sneferu at Dahshur, II, Pt. 1,* Cairo: General Organization for Government Printing Offices.

KHUFU'S HEB SED THEME

Khufu also deemed visual documentation of goods and their geographical origins (real or desired) for his Heb Sed important enough to memorialize in reliefs in his pyramid temples. Relief fragments from his pyramid temples (and possibly causeway) reveal a Khufu-personified estate (right), similar to what we saw with Sneferu, as well as a cattle procession with what may be the names of the estates from which the cattle came,[5] and another of goats, where the estate names might have been lost to damage.

This relief fragment from one of Khufu's temples shows a female figure from a procession of personified estates, similar to Sneferu's relief (page 19). The lower part of Khufu's cartouche sits on a standard on the figure's head. After Hans Goedicke, 1971, *Re-Used Blocks from the Pyramid of Amenemhet I at Lisht*, New York: Metropolitan Museum of Art, pages 16–17.

The animals, I suggest, are examples of foodstuffs that were not just offerings for Khufu's afterlife—which is a well-known use of offerings proffered by estate processions—but, as with Sneferu, part of the visual record of offerings and (at least with the cattle) their geographical origins that provisioned Khufu's afterlife Heb Sed—the very Heb Sed theme now confirmed for his upper temple by Zahi Hawass and Mark Lehner's GPTP discoveries.

ANCIENT BOOKKEEPING IN THE SECULAR SPHERE

The Sneferu and Khufu reliefs have their conceptual origins, I suggest, in ancient Egyptian accounting records that documented what goods came from what localities in what nomes for feeding the king's crew. Such accounting records are demonstrated by papyri found at Wadi el-Jarf, a port installation on the Gulf of Suez along the Red Sea coast of Egypt, studied by Pierre Tallet and his team beginning in 2011 and ongoing.[6]

The Wadi el-Jarf site, in use during Sneferu and Khufu's reigns, sprawled across more than 5 kilometers and included encampments, barracks, large storage galleries cut

into limestone in the sides of hills, and a jetty forming a port. This was an "intermittent port," used only when expeditions were sent for raw materials from Sinai, the most important being copper, which was essential for pyramid-building. Sinai was also a source for turquoise.

From April to the end of the summer, crews ferried laborers and supplies from Wadi el-Jarf across the Red Sea to Sinai and carried back copper from royal mining operations. At the end of the summer, crews disassembled the boats and stored the parts along with other equipment in the Wadi el-Jarf galleries. They then shut down the facility and returned to the Nile Valley.

Perhaps the most astounding find at Wadi el-Jarf—"beyond our wildest dreams," Tallet said—is a group of papyrus fragments consisting of accounting documents and logbooks dating to the end of Khufu's reign. They were left in the Wadi el-Jarf caves, but were probably meant to be archived at an administrative center (at Giza?) for the pyramid project.

The documents show what kind of commodities were needed by and delivered to the king's crews, including raw cereal grains for making bread as well as the "cooked" bread itself. The Egyptians, being avid bureaucrats, kept records of the origin of these commodity deliveries.

PAPYRUS H

One of the documents, Papyrus H, was an accounts ledger, laid out in table form akin to a modern spreadsheet, detailing how one of Khufu's naval work-gangs was provisioned over a period of four months. A scribe recorded the month and day when stated amounts of bread, flour, grain, and dates were delivered, on a rotational basis.[7]

The food for this royal crew came from two towns in two different nomes, the Harpoon nome in the northwest Delta and the Dolphin in the northeast Delta. Each nome supplied food for two months, alternating with the other nome, a practice which distributed the burden between opposite sides of the Delta.

Papyrus H—detailing food types, quantities, sites of origin by nome and town, delivery dates, and more—gives us a glimpse into ancient Egyptian accounting methods at the height of the pyramid age. Such accounts, concerning the real-world feeding of a royal workforce in the secular sphere, I suggest, were so basic to ancient Egyptian bureaucratic thinking that they were translated into art forms that in visual shorthand recorded the feeding of the king in the religious sphere.

Section IV — [2nd month of] Akhet — The Residence

Arrears	Delivered	Full amount	Detailed account
		101.25	flour
		17	barley
		15	[grain]
		8.5	[dates]

Section III — 1st month of Akhet — Town of Ibet-Hesire, Dolphin Nome — 1/10e Hesi, 1/6e Qeni — Deliveries in heqat of cooked bread: 6

Arrears	Delivered	Full amount	Detailed account
[63.25]	78.5	141.75	Overall total
41.25	60	101.25	flour
9	[8]	17	barley
8	[7]	15	grain
5	[3.5]	8.5	dates

Section II — Epagomenal Days; 4th month of Shemu — Town of Ibet-Hesire, Dolphin Nome, Harpoon Nome — 1/10e Ny-hedjet[.our] 1/6e Khen[...] — 1/10e Khemientnu 1/6e (Sen) Merer(?) — Deliveries in heqat of cooked bread: 6 — Account of this(?) by Irtysen

Arrears	Delivered	Full amount	Detailed account
7.37	16.31	23.69	[51.75]
4.87	12	16.87	flour
1	1.87	2.56	barley
1	1.5	2.5	grain
0.5	1	1.5	dates

Arrears	Delivered	Full amount	Detailed account
90	141.75		Overall total
41.25	60	101.25	flour
5	12	17	barley
3.5	11.5	15	grain
2.5	6	8.5	dates

Section I — 3rd month of Akhet — Town of Ro-Huu(d), Harpoon Nome — 1/10e Ny-hedjet-ur 1/6e Sen-Merer — Deliveries in heqat of cooked bread: 6

Arrears	Delivered	Full amount	Detailed account
52.25	89.5	141.75	Overall total
41.25	60	101.25	flour
5	12	17	barley
3.5	11.5	15	grain
2.5	6	8.5	dates

Reconstruction of Papyrus H, an accounts document, and hieroglyphic transcription. Portions of the left side of the document are missing. Red hieroglyphs are used for the quantities that fell short (arrears) of the full delivery. Below: Translation of Papyrus H. After Tallet and Lehner, *The Red Sea Scrolls*, Thames and Hudson, 2022, page 254. Courtesy of Pierre Tallet.

Epagomenal days: five supplementary days added to make 365 days

Individual who calculated the account and probably person responsible for dispatching the food.

Heqat: ancient Egyptian volume = 4.8 liters

Food deliveries in sacks-*Khar*. *Khar* = 48.05 liters

ANCIENT BOOKKEEPING IN THE RELIGIOUS SPHERE

The named and personified estates from Sneferu's lower temple (many examples) and Khufu's upper or lower temples (a few fragments) are examples of such visual shorthand for Papyrus H's detailed accounts. Were the most fundamental features of the record-keeping system found on Papyrus H from Khufu's reign already in use under Sneferu? Indeed, accounts ledgers in the papyri from Gebelein, a site in Upper Egypt, may date to as early as Sneferu.[8]

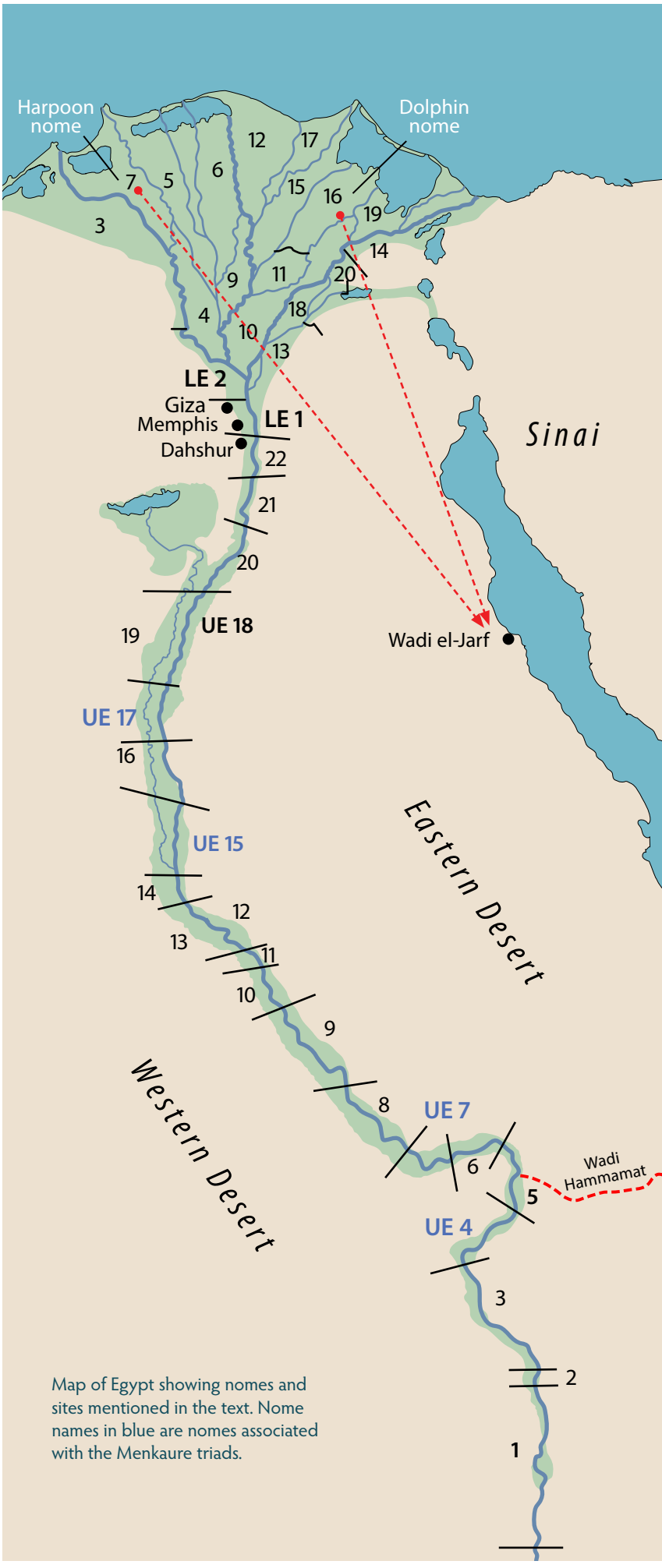
While Papyrus H mentions towns in two Delta nomes as sources of foodstuffs, we know more localities in nomes from both Upper and Lower Egypt were exploited for agricultural goods and other materials that were funneled into Giza for royal pyramid projects. Recalling the new block discovered at Khufu's upper temple with part of a procession of officials at Khufu's Heb Sed, one of those needs was feeding the festival's participants, most specifically the king.

MENKAURE'S ACCOUNTS IN SCULPTURE

The need to record the origins of incoming food for the king at his Heb Sed, as seen with Sneferu and Khufu's reliefs, becomes a precedent, I think, for what Menkaure—the last of the three Giza pyramid-builders—would later do through sculpture in a series of triads. These statues show Menkaure with two other figures. George Reisner recovered them when he excavated Menkaure's lower (valley) temple between 1908 and 1910. They may have been used in the open court of his temple, which, I have argued, was focused, in part, on the Heb Sed.[9]

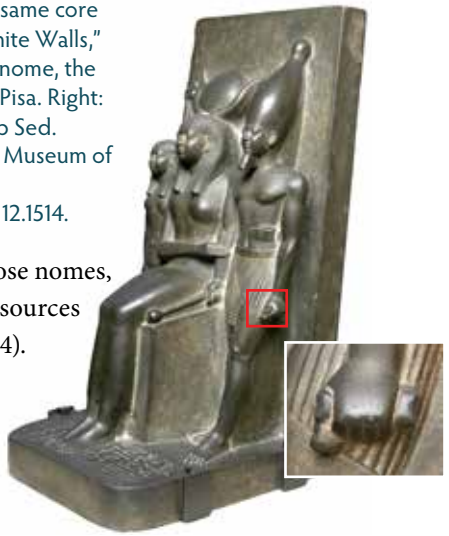
There are six known Menkaure triads (facing page), four intact, all under life-size, and all made of greywacke, a dark greenish stone. The ancient Egyptians may have linked this color to Egypt's dark, fertile soil, and thus to Hathor, goddess of fertility, who appears on each triad.

The triads comprise a distinct sculptural group, though each is unique, with varied dimensions, details, nome signs, and inscriptions. And there may be more than the six known sculptures. The Museum of Fine Arts, Boston, has a collection of triad fragments that Reisner recovered during his excavations at Menkaure's lower temple, which suggest to me that there may have been eight to ten triads originally. And Mark Lehner's re-excavation of Reisner's work is now turning up even more fragments that may go to triads.



Map of Egypt showing nomes and sites mentioned in the text. Nome names in blue are nomes associated with the Menkaure triads.

Four intact (a, b, c, e) and two fragmentary (d, f) triads from Menkaure's lower temple. Triad f has the same core arrangement as its mate to the left and is hypothetically restored with the nome standard of "The White Walls," for Egypt's Memphite capital in the first nome of Lower Egypt (LE 1). Because this is a Lower Egyptian nome, the king is given the Lower Egyptian crown. Gray areas are reconstructions by author, drawn by Michelle Pisa. Right: Another view of e, with inset showing Menkaure's hand gripping the mekes document case of the Heb Sed. Photos by Michael Fredericks. Triads a, b, c, courtesy Egyptian Museum, Cairo. Triads d, e, f, courtesy Museum of Fine Arts, Boston.
Museum accession numbers: a. JE 40678; b. JE46499; c. JE 40679; d. MFA 11.317; e. MFA 09.200; f. MFA 12.1514.



Each of the known triads shows (or originally showed) three forward-facing figures attached to a wall-like back slab. One arrangement of figures (a–d) shows the king striding between a nome personification and Hathor. She was his mythological mother/wife, and goddess of rebirth (appropriate to a Heb Sed festival of rejuvenation), whose very name, *Ḥwt Ḥr*, means "Estate of Horus"—with Horus being the king.

The second arrangement of figures (e–f) shows Hathor seated (a high-status pose) in the center of the composition (the place of primacy), doubly embracing the king who stands to her left gripping the *mekes* document of the Heb Sed (right)—the unnamed theme (as with Sneferu) that I argue obtains for all the triads. Four nome standards survive from the six surviving triads: the 4th nome of Upper Egypt (UE 4), the 7th of Upper Egypt (UE 7), the 15th of Upper Egypt (UE 15), and the 17th of Upper Egypt (UE 17).

ALL GOOD THINGS

Inscriptions on the base of the triads state, with variations, that "all things" or "all good things" plus "all offerings" and "all food" come to the king from the South, meaning, from UE 4, 7, 15, and 17.

Why were UE 4, 7, 15, and 17 (and more nomes whose signs have been lost) chosen as sources of benefit for Menkaure at his Heb Sed? I think it was because unnamed towns within them had agricultural produce, raw materials, or other benefits attractive to the crown, meaning that the geographic origins of Menkaure's provisions (like those in the Sneferu and Khufu reliefs) were not just embedded pieces of accounting information but visible assertions of the king's control over those nomes, their localities, and the resources within them (map, page 24).

These resources could include things as disparate as textiles from the estate at Gebelein in UE 4, alabaster from the estate at Sheikh Said in UE 15 (map, page 24) or, more generally, the resource of power yielded by virtue of a nome's geographic position. The map shows that the triads for UE 4 and UE 7 (a and b above), for example, bracketed the Qena Bend, a critical power base stretching from around Armant to Nag Hammadi and where a road from Coptos led to the Wadi Hammamat quarries with the very greywacke stone from which the triads were made.[10]

The Qena Bend was also an area that held one of the two most densely populated areas in Old Kingdom Egypt (the other around the capitol region including Giza[11]), rich with people, trade, and one might venture, ideas and talent. The Theban nome (UE 4) was also well positioned for control over the roads into the eastern and western deserts, replete with minerals and other resources.

LABOR

But the triad with the 17th Upper Egyptian nome may relate, in part, to quite a different and important resource: labor, without which the king's monuments could not be built. Nine huge blocks with 13 examples of red-inked graffiti from the northern half of Menkaure's upper temple name one of the king's crews,[12] (probably

translated) "Known Ones of Menkaure."[13] These are the men who put those blocks in place, one graffito giving not only the crew's name and phyle affiliation (the name of its part-time rotation group) but also the name of the nome from which the men hailed: the 17th nome in Upper Egypt, shown as a jackal on a standard. This is the very nome standard on one Menkaure triad (facing page).

Lehner suggests that these UE 17 crewmen may have been part of a "home-based fellowship,"[14] making one wonder if the UE 17 nome, or specific localities in it, were understood as tried and true sources for young recruits who could haul, deliver, and place the pyramid stones.

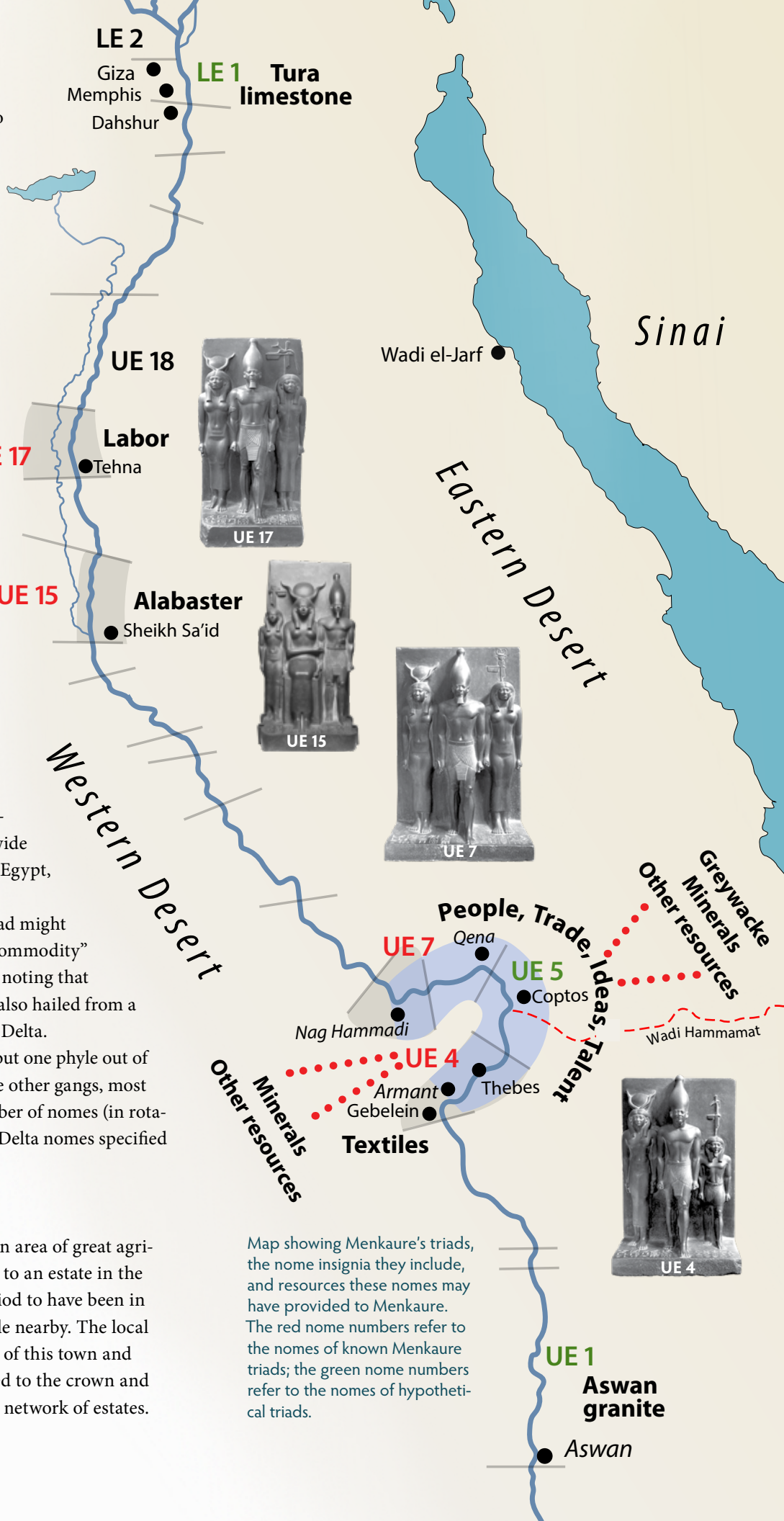
The crewmen might have also performed royal and cultic duties, such as those mentioned in the logbooks on papyrus from Wadi el-Jarf. These papyri are a record of the daily activities of an elite workgang under a foreman named Inspector Merer, whose gang performed a wide range of tasks at various locations in Egypt, including Giza.

That one particular nome on a triad might have been largely responsible for a "commodity" like labor recruits is strengthened by noting that Merer and his crew in Khufu's reign also hailed from a single nome, in this case, LE 2 in the Delta.

But given that Merer's phyle was but one phyle out of four for that gang and that there were other gangs, most probably the labor came from a number of nomes (in rotation?) like the produce from the two Delta nomes specified in Papyrus H.

TIES TO HATHOR

And the value of UE 17—a nome in an area of great agricultural wealth—may have been tied to an estate in the town of Tehna that seems at this period to have been in UE 17 and which had a Hathor temple nearby. The local Hathor temple, an important feature of this town and nome, was served by elite persons tied to the crown and acted within a broad royal economic network of estates.



Map showing Menkaure's triads, the nome insignia they include, and resources these nomes may have provided to Menkaure. The red nome numbers refer to the nomes of known Menkaure triads; the green nome numbers refer to the nomes of hypothetical triads.

The inset highlights the jackal on the nome standard.

Left: Menkaure triad. The nome personification, on the right, bears a jackal insignia, indicating this is the 17th nome in Upper Egypt. Photo by Michael Fredericks. Courtesy Museum of Fine Arts, Boston.

An inscription shows that Menkaure allotted a small amount of land to this temple to maintain its provincial Hathor cult service that may have preceded him—for it behooved any king to link approval from the divine Hathor to a project of economic importance, religion and economics going hand in hand. Did the UE 17 triad signal both Menkaure's economic and cultic relationship with this nome as well as to its being a source of labor?

We can hypothesize about nome insignia for at least three other triads inferred from scattered fragments. These might include one insignia for UE 5 with a route from Coptos out to the greywacke quarries, another for UE 1 with Aswan granite, and another for LE 1 with Tura limestone, all materials well used by Menkaure.

Nome insignia of other now-lost triads might also have referenced sources for sculptors, artists, and craftsmen who made the pyramid temple statues, the cream of Egypt's talent probably having been recruited from every part of the country or even from outside Egypt. A number of Menkaure's granite casing blocks attest to craftsmen of the "hill country," foreign craftsmen, most likely Asiatics. And as human resources, foreign or domestic, passed into Menkaure's Giza pyramid project, they were probably, like other resources, documented on now-lost papyri archived at a palace administrative center.

TRIADS' LINK TO NOMES

Menkaure's triads, I suggest, link to nomes and unnamed localities within them (like the estates and towns) that were his (real or desired) provincial bases of power and from which his Heb Sed offerings and related resources originated. Like the Sneferu and Khufu reliefs, the triads turn account registers into art that in abbreviated form shows in real and maybe fictive terms, the geographic reach of the king's power into his income-producing provinces.

And just as the nomes and their towns in Papyrus H provided goods on a rotational basis, thereby "spreading the effort involved in the maintenance of the work-gangs equitably across the whole territory controlled by the king,"[15] so the triads' nomes and their estates might also have been understood, for the same reason, to supply the king with goods on a rotating basis. But the triads add something not found as a column heading in Papyrus H: divine intervention.

DIVINE INTERVENTION

As I argue that the king was understood as the ultimate provisioner for his workforce through the nomes in Papyrus H, Hathor should be understood as the ultimate provisioner for the king through the nomes on his triads. Inscriptions on the base of each triad (see page 26), state (with variations) that "I" have given to you (the king) all things/all good things, and all offerings and food. The offering texts are carved below the nome personifications—anthropomorphized land units—who appear to be the speakers.

But I would argue that the ultimate donor is the highest-status member of the triad, the one who trumps even the king: the goddess Hathor. As the king in Papyrus H is the ultimate provisioner since he (theoretically) controls the given nomes and their localities, Hathor, in the triads, is the ultimate provisioner since she (symbolically) controls the fertility/productivity of the king's nomes and their localities. The anthropomorphized nomes are the conduits through which she acts. By showcasing Hathor as the "I"-provisioner of goods, a new dimension is given to administrative record-keeping.

Finally, the intact triads with the king at center (a–c, page 23) state that the food goods come "when [or since] you [the king] appear as Dual King forever," a not uncommon statement but one charged with meaning. Provisions come to Menkaure when, or since, he "appears," the hieroglyph showing the sun's rays rising over a hill. The verb means to appear in glory like the sun (or stars), the very word Khafre builds into his own name, meaning something like "He who appears in glory (like) Re." When Menkaure "appears," it is an epiphany—the king rising anew as the young sun. Hathor, daughter of the sun god, and divine mother and provider, funnels all good things and offerings to the king via the nomes when he rises as king like the young sun, crowned for eternity in the Heb Sed referenced by the document he holds in one triad(e). At this moment of ritual renewal, all provisions come to him from real or symbolic estates in the nomes under his control. Hathor is the key here: the embodiment of the fertility of the land, including all the king's nomes and estates from which she provisions her son—the king and ruling god Horus, whom

Left: Triad a (page 23) representing UE 4. Below, its inscription: "Recitation: I have given you all things which are in the south, all food, all offerings, when/since you appeared as King of Upper and Lower Egypt forever." Photography by Michael Fredericks, inscription drawn by Michelle Pisa. Courtesy Egyptian Museum, Cairo.

she holds within her body, as stated in her name, *Ḥwt Ḥr,* "Estate of Horus."

The Menkaure triads, in sculpture, like the Sneferu and Khufu reliefs, are, I suggest, abbreviated forms of accounting texts intended to document in a shorthand version the origins of the food goods coming in perpetuity to the king, the visual language of the statues and reliefs acting as conceptual cousins to the detailed written language of the accounting ledger in Papyrus H. The works of art spring, in part, from the same economic need that created the accounting ledgers: the mundane, bureaucratic requirement to record goods and where they came from.

We might look forward to more revelations from the Wadi el-Jarf papyri and more findings from the GPTP—and to AERA's continuing excavations at Menkaure's lower (valley) temple that may yield more greywacke fragments (one hopes for more nome signs) that could increase our understanding of both Menkaure's triads and Heb Sed-related art.

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Visit the New AERA Website at aeraweb.org!

Our last major website update was in 2013, and our old website was really starting to show its age. It was becoming difficult to update, hard to view on mobile devices, and needed a complete overhaul. So last year AERA board member Matthew McCauley spearheaded a push to completely redesign, rewrite, and modernize our website and helped provide the funds to make it a reality.

The new AERA website is mobile- and tablet-friendly, easier to navigate, and contains the most up-to-date information on all of our work. We've added some new features, like a Teams page for readers who want to "meet" the team and a slideshow on the home page that gives a brief overview of our 30+ years work on the Giza Plateau.

The Publications section has been redesigned and now has an easy-to-navigate list of our books, online data, and all AERA publications with links to download the free PDFs.

As AERA depends on the support of donors and members like you, we have also made the membership page easier to use and more secure.

We'd especially like to call your attention to the new Fieldwork project pages. Starting with Mark Lehner's work at the Sphinx in 1979, each one of our field sites now has its own web page with a short history of our fieldwork along with maps, videos, and photo galleries of the site. Each page also includes a linked bibliography of our publications to allow you to delve deeper into our research. There will be more material added in the future, as we continue to expand these pages with updated information, photos, and maps.

There's a lot to explore and new information is always being added. We hope you'll visit it soon!

~ Rebekah Miracle

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Water from Below, Water from Above

by Mark Lehner

Last Fall we resumed our excavation of the silos, as we moved southward in the Royal Administration Building (RAB), where the Soccer Field had covered it, toward the hypothetical harbor basin. The season gave us more evidence of how the ancient structures of the Lost, now found, City of the Pyramids had been used in their final stages before being abandoned—along with some significant challenges (see article starting on page 2).

WATER FROM BELOW: THE BATTLE OF THE PLANTS . . . AND *OUR* BATTLE WITH THE PLANTS

Seeing the OK (Old Kingdom) Corral for the first time since April, Dan Jones exclaimed, "This is insane." He was referring to the pernicious and aggressive overgrowth of weeds that greeted us when we resumed work last September. As I have written before, each season we chop down those reeds. Each time, they rise again, to full height. We are used to clearing this seasonal weed growth before we can resume excavation at the Heit el-Ghurab (HeG) site. But in just the four months since we had last worked here, the plants staged a massive takeover the likes of which we'd never seen.

This happened because of water from below: the groundwater. In earlier years of the excavation, between 1999 and 2004, we mapped most of the HeG in a window of opportunity provided by a low water table. For more than a decade, though, the water table has been much higher, causing the weeds to flourish with staggering ferocity.

The trouble started around 2006, when the water began a dramatic rise. By 2007, small lakes and ponds had formed in the lower parts of the settlement ruins. By 2008, weeds were sprouting. As it so happens, a well-pumping field was shut down in 2006 at the site of the new Grand Egyptian Museum, not far northwest of the Giza Plateau, and at about the same time, authorities began to fill in the Mansouriyah Canal, which runs south to north just 300 meters east of the HeG. We think these two events may have been major contributing factors to the rising water table. And while dewatering efforts have been made—by a team from Cairo University and by Arab contractors funded by USAID—whether through groundwater pressure or lack of maintenance of the dewatering system, or both, these efforts have sadly not prevented the high-water challenge we are facing.

Right inset: Sayed Gamal Fawzi steps up through the gate into the OK Corral in late March 2022. Below: Richard Redding stands in the same spot, just inside the gate, five months later, in September 2022. Views to the west. All photos in this article by Mark Lehner, except goat shot on facing page, top, by Wilma Wetterstrom.

Top: left: A goat about to graze on camelthorn.

Above right: Honeyvine wrapped around a *Phragmites* stem. Dry seed pods hang off the vine.

Left: Honeyvine sprawls across the ground.

FRIGHTFUL PHRAGMITES

Flourishing in all this moisture, three species of weeds have invaded our site. The common reed, *Phragmites australis*, found today on every continent except Antarctica, produces rhizomes and roots that cluster in tangled nets in the interface between our protective backfill and the surface of the ancient settlement ruins. In addition to its subsurface root-and-shoot system, *Phragmites* employs a devious surface strategy: within ten days of cutting its rhizome-root network, it shoots up a reed stalk that will soon grow over 3 meters (10 to 13 feet!) high, essentially creating a jungle in the desert. When the reed stalks grow so tall they can no longer support their own weight, they bow down to the ground and become runners that snake across the surface, sprouting new roots as they go. Once *Phragmites* has taken hold, hand-removal is nearly impossible. It's creepy—literally. We watch in horror.

PRICKLY CAMELTHORN: "STRIKE ME DOWN, AND I SPLIT INTO A HUNDRED"

Camelthorn (*Alhagi maurorum*) is another component of our triad of weed-invaders. It thrives in the slightly higher, drier areas of the site, leaving *Phragmites* to the wetter, lower parts, but it is just as resistant and relentless. And like *Phragmites*, it produces rhizomes that send out exponentially more underground shoots when chopped—that is, when we cut camelthorn, we abet its growth. According to the Southwest Biological Science Center of the U.S. Geological Survey, "Mechanical removal of this species may be a futile effort."

OUR TREACHEROUS BUT LOVELY NEWCOMER: THE HONEYVINE

This season saw a newcomer to the battle of the plants. Between April and September, a lovely vine with heart-shaped leaves and small white flowers had literally carpeted Area SWI (Standing Wall Island) and the OK Corral (see map, page 7). We identified this third species of invasive weed as *Cynanchum acutum,* commonly known as honeyvine, which has been documented across northeast Africa, southwest Asia, eastward to southwest Russia. It could prove to be as pernicious as *Phragmites* and camelthorn. It spreads aggressively from long 2-meter tap roots, while sending out lateral roots near the ground surface. The roots are brittle and break easily when the vine is pulled. In what has become for us an all-too-familiar nightmare, pulling these weeds leaves behind pieces of broken roots that promptly sprout vines anew.

In places on site where *Cynanchum* and *Phragmites* meet, the vine will wind its way up the *Phragmites* stalks. Will it choke the reed and kill it, or is this some kind of perverse love affair? We can't afford to find out.

WHAT'S TO BE DONE?

It takes no small part of our budgets each season to clear away the massive weed-overgrowth from those areas of the site where we intend to excavate. Remarkably, the walls, floors, and other features of the ancient settlement survive these repeated cycles of growth and shearing. The solution would seem obvious: get rid of the weeds with pesticides. We could, for example, use glyphosate, known commercially as RoundUp, which effectively kills weeds. But it has also been shown to increase the risk of non-Hodgkin lymphoma in humans. So, no—we will not be using any chemical weed killer at HeG.

Our seasonal weed-clearing creates a huge biomass. Might we find some constructive use for this green waste? Camels eat camelthorn (hence its name), despite its needle-like barbs. But it would be a bad idea to allow the pyramid-police's camel corps, or goats, to graze on it during our off-season, as they might also feed on the *Cynanchum*, which is toxic to livestock. So much for our battle with the plants. What we know for sure is that this war is fueled by ground

Above: The Royal Administrative Building (RAB) and the excavation through the northwest corner of the soccer field after clearing reeds and camelthorn. In this view, plants remain on the western (foreground) part of the Heit el-Ghurab (HeG) site. View to the east around October 20, 2022.

water. Little did we know last October, however, that we would also be struck by water from above.

WATER FROM ABOVE: THE DAY THE RAIN CAME DOWN

On the afternoon of October 25, 2022, after work on site, a downpour drenched the Giza Plateau. Back at the AERA Center, I watched the rain out the window. In my 47 years at Giza, I've seen some powerful storms, one of which I wrote about two years ago: the disastrous two-day rainstorm of March 12, 2020, which shut the Cairo Airport and truncated our field season at the Menkaure Valley Temple (MVT). The rain on this October day lasted only an afternoon, so I wasn't too concerned. Little did I know that I had reason to be very concerned, since this brief hard rain proved to be a bigger disaster for our Royal Administration Building (RAB) than the previous prolonged rain had been for the MVT.

Driving to the site the next morning, we saw miniature canyons cutting the southern sandy slope of the plateau. Rain always cuts crevices and fissures through sand or soil—this is normal—but I had never seen so many canyons cut so deeply as I did on that early morning drive. We nervously wondered what shape the site would be in when we got there.

THE SAGA OF THE STORM

At the site, rainwater had apparently filled to the brim Sondage 146 (one of three test-trenches we dug through the Soccer Field in 2021) before bursting through the trench's northwest side. It cut a Grand Canyon through the clean underlying sand as it flowed into the depression (the possible extension of an ancient harbor) we excavated last February–March, before splaying out as a fan of dark silt in a miniature replica of the Nile Delta. Six hours of hard rain had essentially produced a model of what resulted from six millennia of geologic time.

Our foreman, Sayed Salah, quickly got going, directing repairs of the sondage breach, cleanup of the spontaneous delta, and removal of the water, via pump, back into Sondage 146.

In the northwest corner of the RAB, the hard rain partially dissolved the mudbrick walls, washing off chocolate-colored silt that now coated the room surfaces, aptly demonstrating that rain melts mudbrick.

To the northeast, in the sunken silo court, the rain had cut fissures and small canyons through the rims of silos we had excavated in 2002. Thank goodness we had not excavated more of them before the downpour!

The storm's saga also revealed itself at the neighboring Old Kingdom Workers' Cemetery perched on the eastern slope of the Gebel el-Qibli, west of our site. Here the rainwater flowed down the steep slope, cutting canyons between the mudbrick superstructures of tombs. Where the mudbrick came into contact with water, it basically melted like butter. The water then continued its journey right into the westernmost reaches of the HeG, washing away some of our backfill that had protected the ancient settlement ruins. And the natural geography itself was not spared: I was saddened to see that a large chunk of the craggy rock formation on the Gebel's northwest edge had fallen away in the storm. These rocks have a personal significance for me as a place where, through the years, I have gone for peace and reflection. Of all the effects of that downpour, this surprised me the most.

THE OCTOBER 25 DOWNPOUR: A LESSON IN HISTORY AND CLIMATE

While I'd hesitate to say that October's storm clouds had a silver lining, I do want to convey that the downpour helped affirm our understanding of how the HeG site was formed, and of regional climate change.

The climate was relatively stable during the early Old Kingdom, when HeG was in full swing. When people abandoned the pyramid-builders' city, they deconstructed walls, leaving behind the lower parts, which is what we find at the site.

A "phase transition" toward less rain appears to have started a bit later, in the 5th Dynasty. It was likely during this transition that forces of erosion cut horizontally through the settlement ruins. When the climate stabilized again, Egypt—at the latitude of HeG—was hotter and drier. Wind blanketed the settlement remains with 2 to 6 meters of clean sand. Rainfalls like that of October 25 and its aftermath demonstrate the erosion process—how intermittent rain and the effects of hot, dry wind effectively shaved the abandoned HeG settlement ruins down to waist- and ankle-level.

A comparison of the downpour's impact on the Workers' Cemetery is likewise affirming. A gradual deterioration of abandoned structures left exposed (we saw the potential of a single rainstorm to dissolve exposed mudbrick tombs) creates a sediment fill—one of windblown sand interlayered with silt and mudbrick chunks—distinctly different from the intact, plastered lower parts of walls we find at HeG. And we've long known that superstructures of some of the tombs on the lower slope of the Gebel el-Qibli were built upon the intact shaved surface of our abandoned settlement ruins. In the days that followed, we watched as fine silt that collected in low catchments crackled on drying. As the crackles disintegrated, wind blew them away. We were witnessing the processes that left us the site as we find it.

A season of understandings, hard won.

Left top: Ben Bazeley examines the waterlogged silo court after the October 25th downpour. View to the northwest.

Left middle: Rainwater filled our September 2021 Sondage 146, then burst through the northern side and cut a canyon through to where we had removed the soccer field and underlying sand in February–March 2022. View to the north.

Left: In the foreground a canyon that rainwater cut through the slope to the west of the Heit el-Ghurab site. Beyond is the silt that collected in low catchment area and crackled upon drying.

ARTIFACT OF THE ISSUE: SEALING 2760

At AERA, we are often able to tell a big story from a small find. To celebrate these finds, we begin in this issue a new series, an "artifact of the issue"—an informal glance at a single, special piece of material culture excavated by our team, with a discussion of why it's unique and what it can tell us about Old Kingdom life at Giza.

Our inaugural artifact is Sealing 2760, excavated from the Heit el-Ghurab site, just north of the Royal Administrative Building. According to traces in the clay on the back of this sealing, it was placed on a ceramic container. The mouth of the jar was covered in textile and long blades of grass or reed were wrapped under the jar rim to pull the textile taut and secure the jar's contents from spilling. The clay was placed where the two ends of straps crossed each other around the jar's neck.

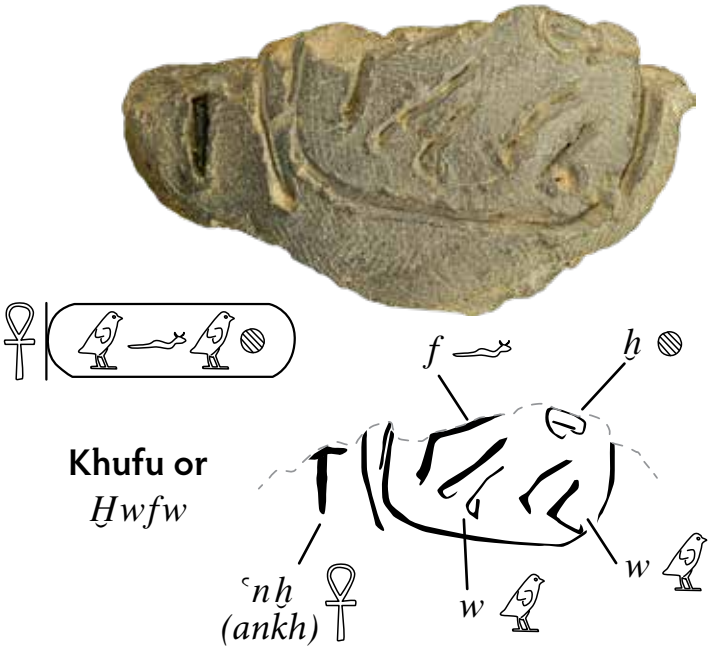
Sealing 2760 is an incised sealing, meaning its outer surface was scratched with a stylus to mark or label it. This sealing bears hieratic Egyptian—a sort of cursive shorthand. Incised sealings are thought to have been quick labels for an item coming or going, when a seal was not on hand or needed. Because only a small portion of ancient Egyptian society could read and write, they imply literacy on the part of the sender. At Giza, incised sealings are not as common as those impressed by cylinder or stamp seals. Rarer still are incised sealings that are complete enough to actually be readable. There are only a few dozen that we can make something of, and there are no others that are marked in this manner. This sealing is unique at HeG because it bears a name written in a cartouche, and a special name at that: Khufu, builder of the Great Pyramid.

Although Khufu's name inside the cartouche is certain—*Ḫwfw*—unfortunately a section of the cartouche is broken away, as well as any traces of additional signs that may have been above the cartouche.

One vertical stroke is preserved at the far left, which was truncated by a short horizontal one. The traces are appropriate for an *ankhu* sign,[1] such that a possible reading might be *Ankhu-Khufu* ("Khufu lives!"), here likely meant to be read either as part of a personal name or a place name. Several ancient Egyptians with this name are known to us,[2] but most of them lived after the known occupation of HeG. Perhaps the closest in time might be Ankhu-khufu—wife of prince Mindjedef, a grandson of Khufu himself—or another possibility might be the high official and friend of the king, Ankhu-khufu, owner of sarcophagus CG 1790 in the Cairo Museum—both of whom lived during the time of Khafre and Menkaure. However, in this instance we believe a more realistic interpretation is for Ankhu-Khufu to be interpreted as a place name. It is a well-attested place name in the Wadi al-Jarf Khufu-era papyri,[3] where it is thought to refer to a large portion of the lower Giza Plateau, including the HeG. Additional classificators[4] we might expect, such as a city determinative, would likely have been omitted in such a short cursive note.

Although it bears Khufu's name, this is not an indication that 2760 necessarily dates to his time. We do not know how long the *Ankhu-Khufu* name was used. But the fact that the sealing was broken—this being a label on a jar presumably shipped *into* the site, with its contents consumed near HeG's administrative center—supports the identification of HeG with the name.

~ Ali Witsell and David Jeřábek



Left: Sealing 2760 from HeG, photo by Yuki Kawae, shown at 2:1. Below: line drawing of incisions of 2760, gray dotted line shows sealing surface break. Drawing by Ali Witsell based on sketch by David Jeřábek. We take the slightly curved vertical line to the left of the cartouche oval to be the stand at its base.

1. 2760 fits well with Pierre Tallet's so-called "Form 2" in the Wadi el-Jarf papyri. See Tallet, 2021, *Les Papyrus de la Mer Rouge II: Le Journal de Dedi et Autres Fragments de Journaux de Bord (Papyrus Jarf C, D, E, F, Aa)*, IFAO, p. 194, table VII. For other Old Kingdom comparatives, see Vassil Dobrev, Miroslav Verner, and Hana Vymazalová, 2011, *Old Hieratic Palaeography I, Builders' Inscriptions and Masons' Marks from Saqqara and Abusir*, Czech Institute of Egyptology, pp. 22, 23, and 64.

2. Scheele-Schweitzer, Katrin, 2014, *Die Personennamen des Alten Reiches: Altägyptsche Onomastik unter lexikographischen und sozio-kulturellen Aspekten*. Philippika, Marburger altertumskundliche Abhandlungen 28, Harrassowitz, p. 305, [747].

3. For more on the location of Ankhu-Khufu, see Tallet and Mark Lehner, 2022, *The Red Sea Scrolls*, Thames & Hudson.

4. For a discussion of the use of classificators in the Ankhu-Khufu name based on the Wadi al Jarf papyri, see Tallet, *Les Papyrus de la Mer Rouge II,* pp. 192–93.

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