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AERA Archaeologist Aude Gräzer Ohara packages animal bone and fragments of wood from this spring's new excavations in the Kromer dump on the Giza Plateau.

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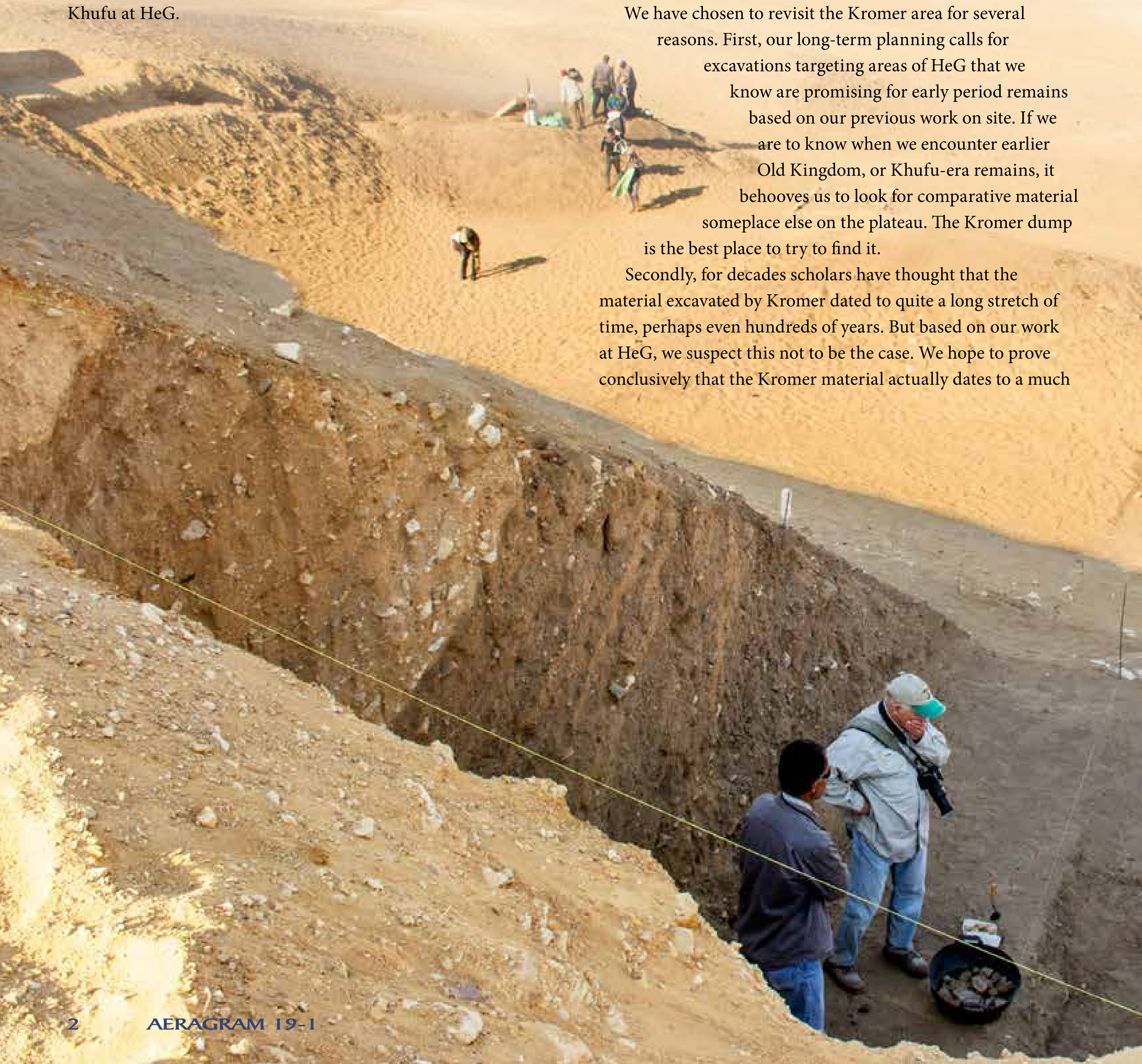
Kromer 2018: Basket by Basket by Ali Witsell

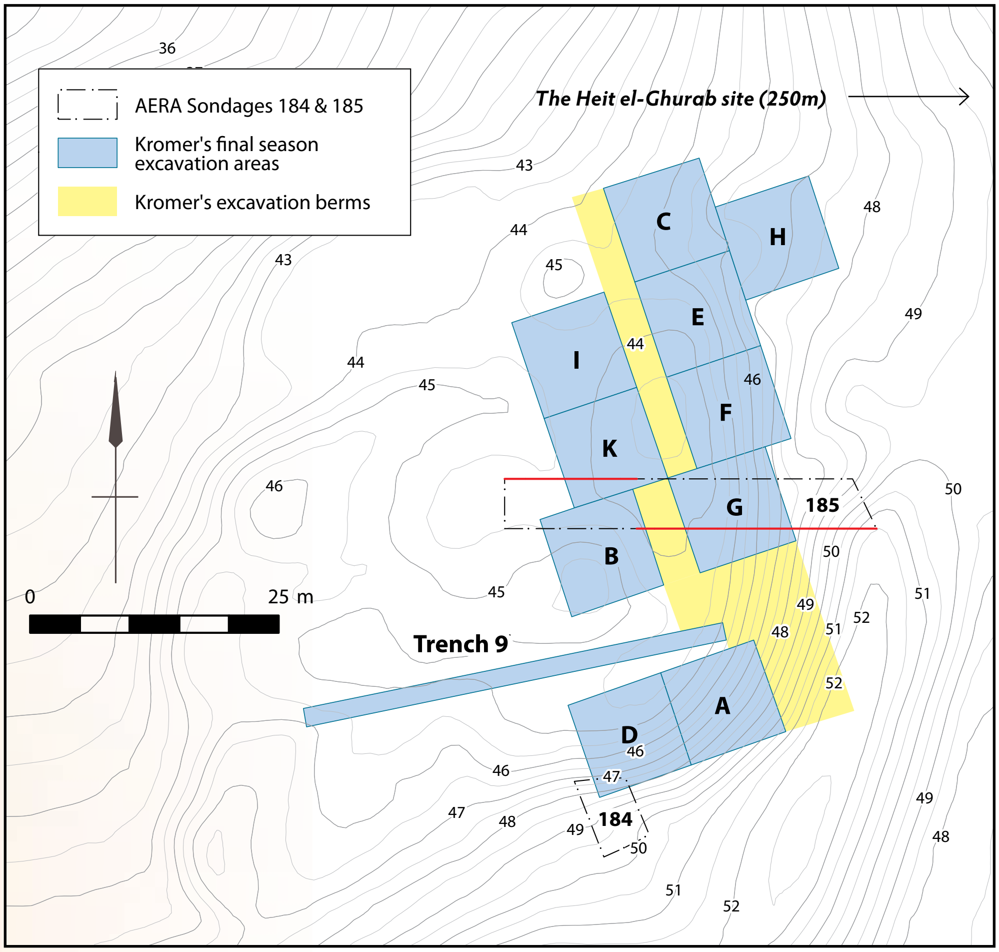
In the last issue of this newsletter, we laid out our new research agenda targeting the earlier part of the Old Kingdom and our search for evidence of the first pyramid-builder at Giza, Khufu, and his pyramid town.[1] We seek to test the hypothesis that a lurking, lower level of the Heit el-Ghurab (HeG) site—one that we have dipped into on occasion, but never conclusively understood—might be that town. The footprint of HeG as we know it largely dates to the time of Khafre and Menkaure, builders of the second and third pyramids at Giza. As of yet, we have no clear evidence of Khufu at HeG.

Our first step is to revisit the 1970s excavation area of Karl Kromer, an Austrian prehistorian who identified and excavated a massive, crescent-shaped mound of settlement debris on the other side of the Gebel el-Qibli, the escarpment running along the western edge of HeG. Over six seasons he cut ten 10 × 10-meter excavation squares and other trenches into the mound to determine its nature and date (see map, facing page). Based on his findings, Kromer believed that the mound was the debris of a demolished royal resthouse or settlement dating from the 1st to 4th Dynasties, up until the time of Khufu and Khafre.

We have chosen to revisit the Kromer area for several reasons. First, our long-term planning calls for excavations targeting areas of HeG that we know are promising for early period remains based on our previous work on site. If we are to know when we encounter earlier Old Kingdom, or Khufu-era remains, it behooves us to look for comparative material someplace else on the plateau. The Kromer dump is the best place to try to find it.

Secondly, for decades scholars have thought that the material excavated by Kromer dated to quite a long stretch of time, perhaps even hundreds of years. But based on our work at HeG, we suspect this not to be the case. We hope to prove conclusively that the Kromer material actually dates to a much





The Kromer area, with new contours surveyed by the AERA team. The red lines on Sondage 185 represent the location of the profile shown on the next page. Map by Rebekah Miracle, AERA GIS.

smaller window of time, perhaps just the few decades covering the reigns of Khufu and Khafre.

Thirdly, we suspect that some of the same officials working at the HeG site in its final phases were also active in the building or buildings from which the Kromer debris originated. Finding concrete ties at the level of the individual would not only help us to date the Kromer material more conclusively, but also potentially help us understand where on the plateau these buildings may have stood.

Kromer 2018

But before we could begin the work to determine what exactly we were standing on, we had to determine where exactly we were standing. Although the general area of the mound was clear on the surface (see photo on page 30 of the last *AERAGRAM*[1]), decades of drifting sand covered the area, and, unfortunately, the map Kromer produced had errors.

Our first task was to resurvey the area, stake out grid squares, and try to find Kromer's original survey points and trenches.

Under the supervision of Field Director Mohsen Kamel and archaeologists Aude Gräzer Ohara and Virág Pabeschitz, we completed this work and opened two trenches over seven weeks from February through April this past spring.

Sondage 184 was located along the southern, inner edge of the crescent-shaped mound, intersecting Kromer's Square D. This trench exposed a deep deposit of limestone quarry debris. We abandoned it due to lack of material culture.

Sondage 185 proved to be more fruitful, overlapping Kromer's Squares B, G, and K. By locating where he worked, we were able to extend beyond his excavations to both the east and west, allowing us to sample portions of the mound that remained untouched, for a total length of almost 40 meters (about 130 feet). We were also able to dig 75 centimeters (about 2.5 feet) deeper in Kromer's Square B before having to stop excavating due to time.

Into the Mound

We started in the east, at the crest of the mound, and it quickly became clear that "Kromer 2018" would prove to be both a different sort of site and a different sort of excavation for our team—a giant trash heap, created by basket after basket of dumped settlement debris, toted by hand up into the desert. The result of this sort of activity is difficult to peel back in contained units, or features (our unit of excavation), but easy to see in profile as tiplines, where soil differences in color, texture, and compaction are plainly visible. The tiplines in Sondage 185 are diagonal deposits of orange windblown sand, white limestone quarry debris, and

Standing in front of the southern section of a deep cut through the Kromer debris mound, Mark Lehner (second from left) and Mohsen Kamel discuss the day's progress as workmen clear away sediment during this spring's excavations in Sondage 185. In the section wall behind them, one can easily see the distinctive orange and brown striping of the tiplines created as basket after basket of dumped debris gradually built up the trash mound. To their right, experienced workmen are tasked with soil removal, while younger men carry *muktafs* (buckets) of material to the sieving area in the background. Sondage 184 is partially visible to the left, stepped for safety due to collapse of the soft deposits. Photo by Sayed Salah Abd el-Hakim.

dark brown decomposed Nile mudbrick and ashy settlement waste (see image on facing page, upper left).

The great height of the mound meant that the trench became increasingly difficult to excavate safely, as the soft sand and sediment in the section walls continually collapsed. While we initially tried to remove the tiplines as individual deposits, this quickly proved impossible given their steep pitch and soft composition. In the upper eastern portion of the trench, we resorted to excavating major sequences together. It is clear, however, that the section shows bands and distinctions that must relate to different dumping events and/or a change in material.

At the top of Sondage 185, we found quarry debris ([35,514] in the profile below and photo at right) identical to the ancient debris we abandoned in 184, but mixed with more modern trash dating to the 1940s–1970s. Purely ancient debris started in the section with deposit [35,516] and carried on down the mound. Deposits [35,518] and [35,512] proved rich in Old Kingdom finds. We did not reach the bottom of the dump in this upper portion of the sondage. The diagonal striations of the tiplines of [35,512] continue deeper beyond our excavations.

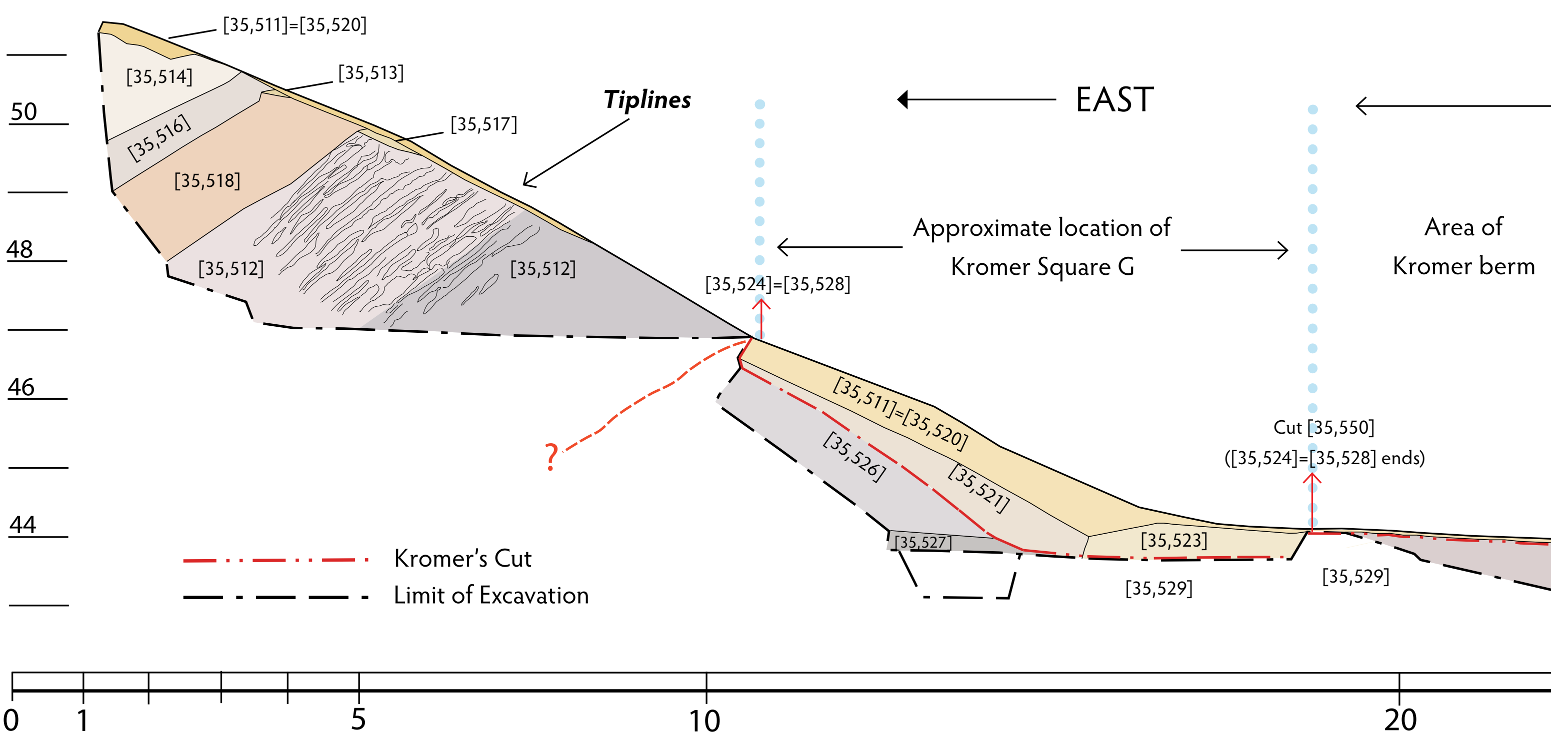
After excavating this untouched part of the mound for 3 meters' depth, we moved down the slope to the west and encountered evidence of Kromer's digging. We found the ten-meter hole where he dug his Square G, followed by fill equivalent to his berm (or unexcavated area that he left between squares, but later removed), and then finally the hole of his Square B. In the area where the berm once stood, we removed remnants of a sandy limestone deposit [35,520] and a dark, ashy deposit rich in finds (discussed below) and mudbrick debris untouched by Kromer.

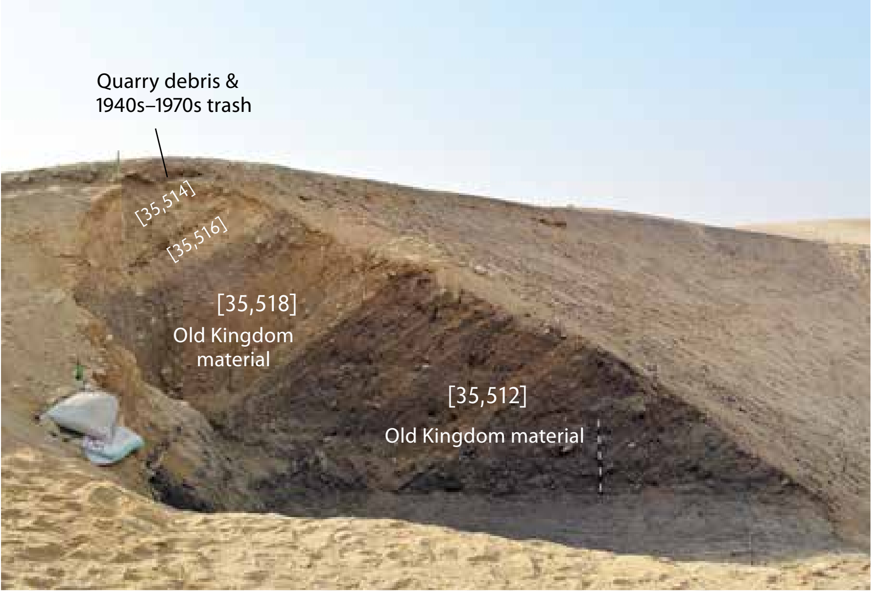
Beyond his Square B, we were again in an untouched part of the mound. This western sequence of the trench is much lower in elevation and the deposits not nearly as steeply pitched. We could once again peel back and assign feature numbers to clear units (see features [35,533] through [35,547] in the section drawing below. These western layers slope down to the west. They are more distinct than those on the east, ranging from coarse, clean sand to dark, sandy Nile silt and black ash, possibly representing individual basket dumps.

Clay Sealings and Dating

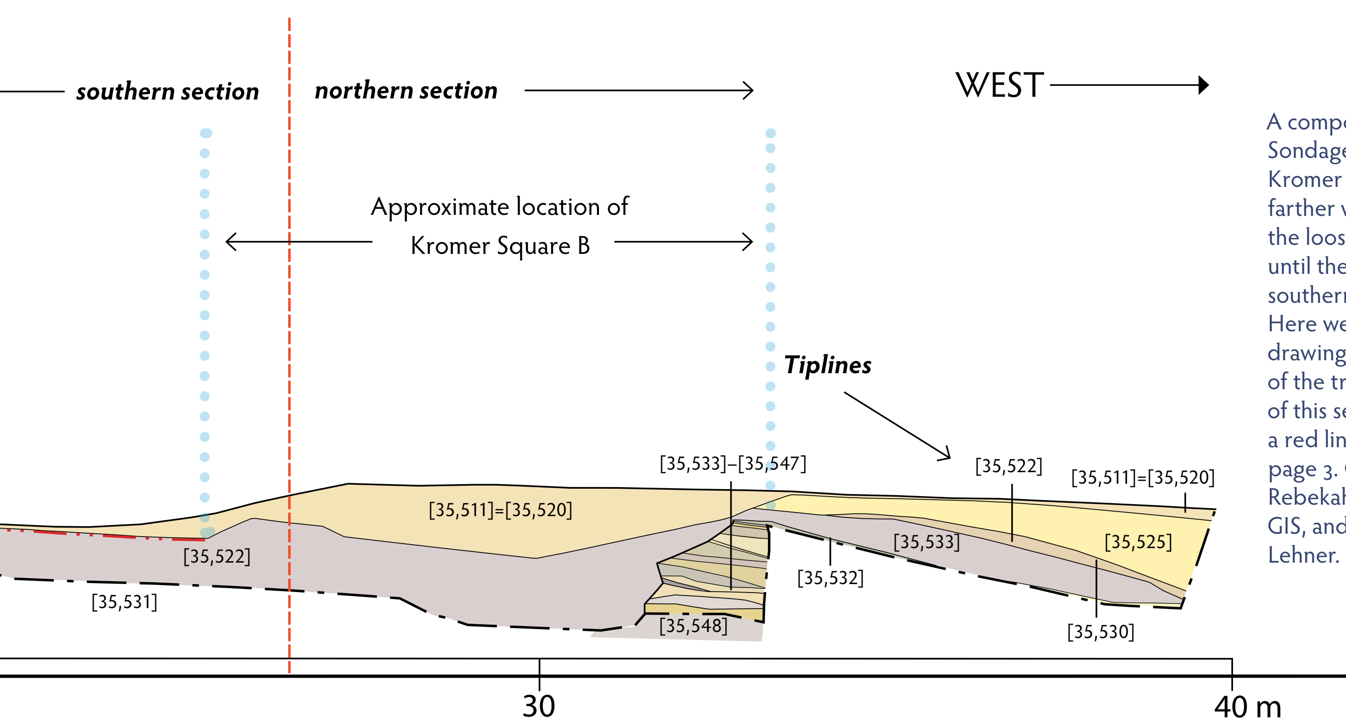
Kromer believed the mound dated up until the time of Khufu and Khafre based on the presence of sealings—small pieces of clay impressed with hieroglyphic designs carved onto small cylinders and rolled over the clay before it dried, securing string locks on doors and packages. Administrators used them to seal goods and rooms for which they were responsible. In Old Kingdom Egypt, seals often bore the job titles of these officials, as well as the name of the reigning pharaoh—a business card of sorts. Because of this, these types of seals and sealings can often be used as relatively secure chronological markers, especially in large quantities. They can help to date other classes of objects—such as ceramics, lithics, and other small finds—with which they are found.

At HeG, sealings enable us to date the main occupation to Khafre and Menkaure. Also, sealings found at both HeG and in Kromer's 1970s excavations that were impressed with the same seal allow us to draw connections between the two sites (see Seal 1 from the Pottery Mound deposit at HeG, page 6).[2] The early level of HeG could have been a source for the Kromer material. Kromer found only Khufu and Khafre sealings. With





Above, left: The upper portion of Sondage 185, showing the clear differences in the sediment color and composition of the mound's tiplines. Photo by Aude Gräzer Ohara. Above: Aude Gräzer Ohara crouches on the tafla limestone "floor" of [35,531], after [35,529] and [35,522] were removed. Note the rapidly collapsing sides of the trench. Photo by Mark Lehner. At left: General view of the entirety of Sondage 185, looking back to the east. At the western end, in foreground, the tipline deposits ramped up toward the east before they were cut by Kromer in the 1970s. He excavated away the center of the mound here, leaving the low area in the middle of 185. Photo by Mark Lehner.



A composite section of Sondage 185 from the 2018 Kromer excavations. The farther west we pushed, the looser the soil became, until the eastern end of the southern section collapsed. Here we switched the drawing to the other side of the trench. The location of this section is shown as a red line in the map on page 3. Original profile by Rebekah Miracle, AERA GIS, and amended by Mark Lehner.



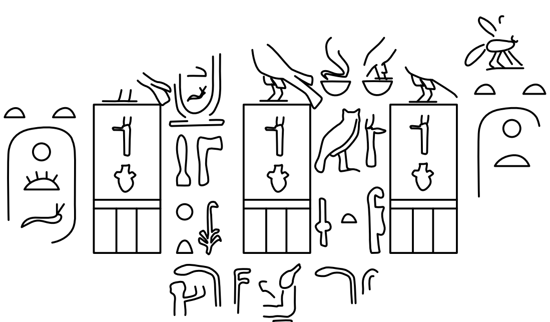


no Khufu sealings from HeG as of yet, the common link is Khafre. Although we recovered more fragments of Khafre sealings than Kromer did in all his six seasons, we found no Khufu sealings in Sondage 185. We did, however, find another impression made by our HeG Seal 1, confirming that the owner of this seal—a "Scribe of Royal Documents" and "Keeper of Royal Instructions"—was active in the buildings that produced the debris in both Pottery Mound and the Kromer dump.

Information from the Mound

Although we have not yet identified the location(s) of the building(s) that produced the Kromer mound, we now know

Below: On top is "Seal 1" from the Pottery Mound deposit at HeG. Hieroglyphs give the titles "Scribe of Royal Documents" and "Keeper of Royal Instructions" (drawing by J. Nolan). Someone used this seal in both the HeG and the site that produced the material in the Kromer dump, and examples were found in both the 1970s (Squares G and I) and this year's excavations (from feature [35,517]). On bottom: A new reconstruction for a high priest of Khafre, serving as both a *wꜥb* priest and *ḥm nṯr* priest (field drawing by A. Witsell). The three sealings impressed by this seal are all from [35,522] in Sondage 185, including Sealing 5844 in the photo at lower right. Photo by Mark Lehner.



more than we did a few months ago about what they looked like, what went on inside them, and where they may have stood.

The striking differences in the color, composition, and compaction of the tipline deposits may indicate that the contents of the baskets came from different locations. This was most notable between deposits [35,518] and [35,512] (see upper left photo, page 5). The lines are interspersed, dark from settlement debris and light from sandy lenses, with limestone debris as well. Are these sediments from separate parts of one massive building, where dark ashy fill came from active bakeries, while lighter sediments were from cleaner formal rooms that saw less activity?

Our excavators noticed that individual bucket dumps could sometimes be distinguished by their upper surfaces, which were occasionally hardened by moisture, presumably rain. Would this, plus the intermittent lenses of windblown sand, indicate the mound was a general dump for the plateau, open to the elements for years between dumping events? Or, conversely, does the presence of mudbricks (picture at right) suggest a one-time episode of dumping, after the demolition of a single building?

Help from the Lab

We found architectural components consistent with an important building that remained in use for a long time, including plastered doorjambs, mudbricks, and patches of striated flooring, built up over time. And we found plaster painted in blue, white, black, and red, with evidence of carefully painted dados—a band painted at the base of walls

in pilastered reception halls and other rooms of Old Kingdom officials.

Small finds run the gamut: everyday items like beads; fragments of tools made of wood, bone, and stone; pottery; and fragments of metal. Finer objects, like fragments of alabaster/travertine vessels, a stone table, a piece of carnelian, and a possible piece of decorative inlay, also hint at elite origins. We found a wide range of chipped stone tools, including sickle blades, knife fragments, and a projectile point—only the third one we've found in 30 years of Giza excavation.

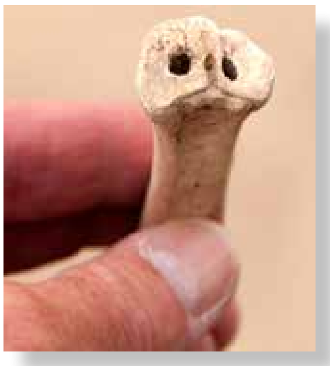
The dry sediments and high elevation of the Kromer site—between 44–52 meters above sea level (asl), compared to the average 15–16 meters asl of the HeG site—allowed organic material to survive: fragments of wood, reed, twine and rope, straw and palm fronds, textiles (see article starting on page 12), leather, and possibly even wool. We do not find these materials at HeG; they would have decayed in the damp and waterlogged deposits. In addition, the Kromer dump has a richer record of edible and weedy plants because the dry conditions allowed for the preservation of not just burnt plant material, such as we find at HeG, but also desiccated remains not present at HeG, including the delicate seeds of figs. All of these finds contribute to our understanding about the activities in the Kromer source building(s).

Mixed Markers: Privilege and Obligation

Our sealings and ceramics teams found themselves in somewhat uncharted territory. Among the many bags that came to the lab, we noticed an unprecedented amount of clay—what appeared to be just raw material, some with traces of working by hand, but twisted and misshapen. On closer inspection, we began to see steps in the manufacturing process of the finished items with which we are very familiar.

The ceramics team found chunks of clay prepared as if for throwing on the wheel, fragments of aborted pots, and pieces of unfired vessels. Although the sealings team found sealings of elite officials in the service of Khafre, they also found many fragments of clay jar closures—what we playfully refer to as "stoppers, toppers, poppers, and lids"—many more than we have ever encountered on the HeG site. And like the unfired vessels, many of these were quickly and crudely made, twisted and

Samples of material culture recovered during this year's Kromer excavations. From left: a plastered and painted doorjamb; fragments of colored plaster; plaster with a section of precisely painted dado; a large section of flooring, built up in layers; a chipped stone projectile point; fragments of flint knives; and pieces of wood. Below: Mudbrick fragments recovered this year, and a clay jar stopper. Photos by Mark Lehner and Samar Mahmoud.



Above: Our team found large quantities of long bones with the ends broken off, as well as some bones with holes drilled in the ends (left), possibly for sucking out the marrow. Photos by Mark Lehner.

Below: A detail of Sealing 5848, showing the three hieroglyphs in *stp za*, or "palace." To their left is a depiction of the pharaoh wearing the White Crown of Upper Egypt and carrying a flail over his shoulder. The impression fades out below the king's torso. Photo by David Jerabek.

misshapen, as if they were applied but removed while the clay was still wet—implying that the jars were being sealed nearby.

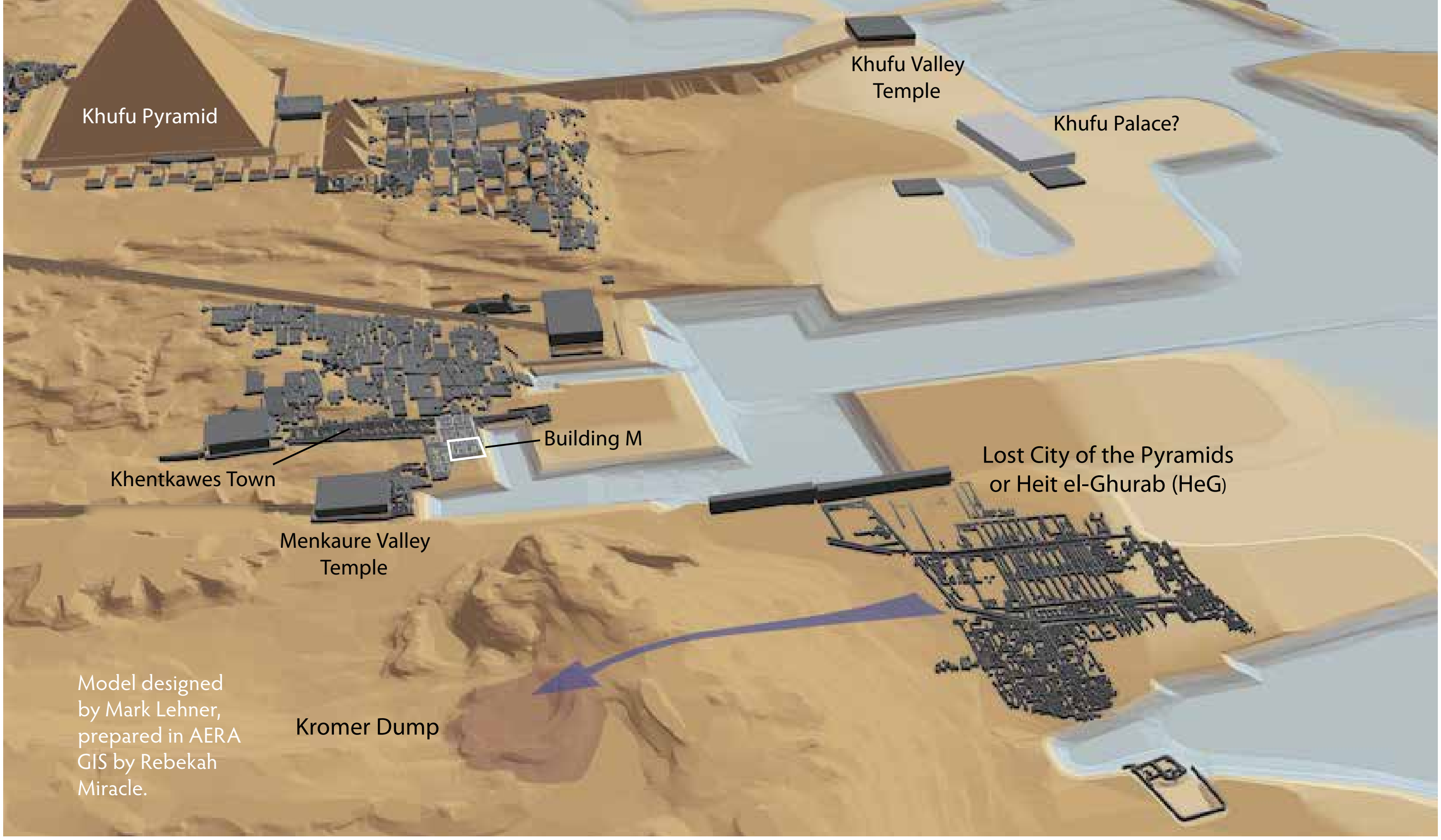
These unassuming items belonged to day-to-day activities in buildings where people dealt with food (like the glass jar tops, plastic cling wrap, or Tupperware lids of our modern kitchens). All of these items would seem to suggest that the buildings in question contained a potter's workshop and received a steady supply of clay both for making pots and quickly sealing them, presumably for foodstuffs on the go.

Our archaeozoologists also found a mixed story of high and low status reflected in the faunal remains. Sheep and goat long bone shafts (except for the femur and humerus) were unusually abundant compared with what would be expected if the whole carcasses were represented. Bearing both meat and marrow, the shafts found in the dump may have been cooked in stews. The ends of these long bones had been hacked off, probably for rendering bone grease which, embedded in the bone, can only be removed by boiling broken pieces of the bone in water.[3] The ends could also have been cooked in soups for workers. The humerus and femur, while present in the dump, are underrepresented so far in the archaeozoologists' analysis of the sample; being the meatiest cuts, they might have been reserved for high status people elsewhere at HeG. But the long bones with missing ends, while not the highest quality, are good meat-bearing bones, reflecting higher status. We also found evidence of still higher status in the dump, a leopard bone. Elites wore leopard skins as a mark of status. At HeG we found four leopard teeth in a high official's dump.[4] The Kromer dump animal bone came from a place of high status, where meat was prepared and shared with people of lower status, possibly pyramid workers.

At face value, this mix of markers of both high and low status, of privilege and obligation, might seem contradictory. But one sealing from this season may shed further light on this conundrum. Sealing 5848 (at left), from feature [35,522], includes an attestation of the word *stp za*, a term used for the palace, its guard force, and royal entourage. This is the first occurrence of the word from AERA's excavations. High officials attested in this season's sealings included both *wꜥb* and *ḥm nṯr* priests (purification priests and high priests), as well as a "Scribe of the King's Writing Case" and another "Scribe of Royal Documents." We also found an attestation of "Great is Khafre," the name of Khafre's pyramid complex, several new "sealer of the storehouse" seals, and a few examples of what are thought to be seals belonging to private individuals. All in all, this represents a wide spectrum of actors in the Old Kingdom economy. Sealing distribution patterns at HeG indicate that priests and scribes, at least at that site, did not really intermingle architecturally, but rather kept largely to themselves. If the KRO mound represents one large building where elite and non-elites may have mingled—a place that saw goods and letters coming in from different offices and individuals, but may have had an obligation to feed multitudes at its table—a palace may fit the bill.

The Source?

So it would seem that in broad strokes Kromer was right when he concluded that the dumped material derives from an elite, probably royal, building or complex dating, at least, to the time of Khafre. If the debris in the Kromer dump did indeed come from a palace, was it located at HeG, the site where we



Model designed by Mark Lehner, prepared in AERA GIS by Rebekah Miracle.

hypothesized the debris originated? Perhaps, but there are two other possibilities. Selim Hassan found remnants of a large, multi-colored plastered building under Building M in the Khentkawes Town, and 1980s sewage excavation work encountered a possible palace of Khufu out under the modern town at the base of the plateau. Although the latter would be an unrealistic excavation goal, revisiting Building M might prove informative in a future season.

Season 2018 put us well on our way to untangling the mystery of the lost Khufu settlement at the foot of the plateau. But, as usual, our excavations left us with more questions than answers, and we have much work to do in the lab (see next page). We are hopeful that a return to the Kromer dump site in future seasons will provide evidence of Khufu and more sealings to help us identify specific officials, to tie together findspots, and to suggest an origin for this colossal dump, created by hand, basket by basket.

1. Witsell, A., "From Khufu to Kromer: A Jubilee Agenda Thirty Years in the Making," AERAGRAM 18-2, pages 30–31, Fall 2018. Available for free download at aeraweb.org.
2. Nolan, J. *Mud Sealings and Fourth Dynasty Administration at Giza*. PhD Dissertation, University of Chicago, pages 141, 145, 155, 313–317, 2010.
3. A deposit of highly fragmented bone found at HeG in 2007 was apparently the discards of bulk processing for bone grease, Yeomans, L., "Stews, Meat, and Marrow: Extracting Protein and Fat for the Lost City; Frugal Cooks, Careful Fish Handlers," AERAGRAM 12-2, pages 13–15, Fall 2011.
4. Redding, R., "'Treasures' from a High-Class Dump," AERAGRAM 8-2, pages 6–7, Fall 2007; "The Telltale Tooth," AERAGRAM 12-1, page 14, Spring 2011.

In a scene perhaps not too far removed from how the Kromer deposit may have been created, a procession of workmen carry *muktafs* (buckets) of clean sand to backfill this year's excavations in the Kromer area at the close of the season. Photo by Sayed Salah Abd el-Hakim.

FROM THE LAB: MECHANICS OF AN INFLUX

Before beginning excavations in the Kromer dump, we braced ourselves for what we suspected would be an avalanche of material culture. The six seasons of Kromer's original excavations produced over 1,500 finds, representing many aspects of ancient daily life. Our first six-week foray into the Kromer trenches proved to be equally fruitful.

In hopes of quickly gathering as complete a picture of the Kromer material as possible, our lab team cleaned, reorganized, and made as much space as possible before the first delivery of finds arrived from the trenches. Led by Dr. Claire Malleson, AERA Director of Archaeological Science, our specialists began their preliminary study of the ceramics, animal bone, plant remains, clay sealings, lithics, textiles and leather, roofing and architectural fragments, mudbrick, and small finds from not only this season's Kromer work, but also that of this year's excavations in the Khentkawes Town and Standing Wall Island at the HeG site.

Above: AERA archaeologist Virág Pabeschitz works on labeling and bagging a seemingly endless array of small finds prior to their trip from the Kromer site to the lab. Photo by Aude Gräzer Ohara.

A Veritable Flood…of Small Pieces

The analysis of archaeological material starts in the field, where we retrieve it in several ways. We pick it by hand and also collect it from the large sieves used to dry-sieve dirt on site. Samples from all excavated deposits and fills are also processed via machine flotation on the site using a 0.25 mm mesh. The samples are placed in a tank of water where the light

Below: Abd el-Latif, long-time AERA wet-sieve technician, stands amongst the fruits of his labor. Each bag of soil removed from an excavated deposit is sifted, and large items not caught during excavation are bagged for study. Remnants left in the sieve are then passed through a stream of water and a series of smaller and smaller sieves, and left to dry in the sun. Once dry, the contents are sent for heavy fraction sorting, where they are separated by hand and distributed to the material culture specialists in the lab. Photo by Sayed Salah Abd el-Hakim. Inset: Assistant Lab Manager S. A. Hitchens and Senior Lab Technician Mohamed Hassan work with others to separate heavy fraction. Photo by Claire Malleson.

Assistant Lab Manager Reham Mahmoud (far left), and Lab Assistant Mohamed Hassan (far right), work with Ministry of Antiquities Inspectors Rasha Safaan and Ahmed Ezz to accept and catalog a delivery of finds from the field. Photo by Claire Malleson.

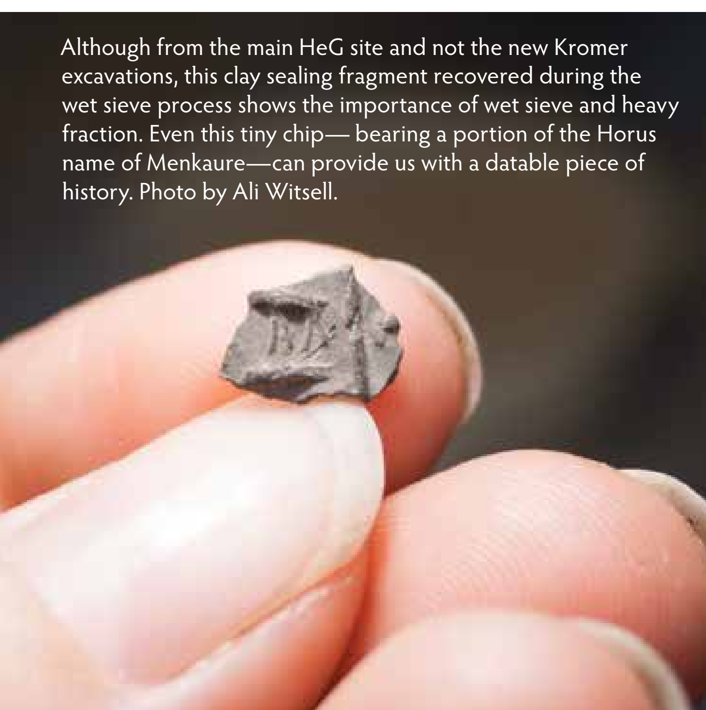
AERA lithics specialist Samar Mahmoud sorts chipped stone debitage from the 2018 Kromer excavations. Photo by Claire Malleson.

plant remains float. The material that sinks, called the "heavy fraction," is saved, dried, and then sorted by hand into type. The material that floats—the "flot"—is then allowed to dry and sent for analysis by the archaeobotanist. All these recovery methods produce valuable finds and ensure that we catch even the smallest bones, seeds, sealing, and other materials.

Given the richenss of the Kromer dump, wet-sieving added even more to a mountain of heavy fraction to sort through. We carried on until the last moment, but we were unable to finish sorting, meaning that no specialist had a chance to look through all their material. Claire reports that we still have approximately 110 unsorted sacks of wet-sieved material to sort and distribute, and an additional 83 waiting to be sieved. This season our ceramics team bore the brunt (and weight!) of the flood. While they were able to complete the Herculean task of sorting all of the 175 pottery bags brought to the lab, they were able to select only a few of the most important pieces of pottery to draw for their preliminary analysis.

When faced with a large dataset, some material culture analysts employ sampling strategies to get a preliminary feeling for an area, as they see repetition of the same sorts of material. But for other specialists, like those that look at sealings and small finds, it can be difficult to look at only a portion of a sample. With these items, a single piece could be the missing portion of a seal reconstruction, a pharaoh's name (see photo below), a fragment of a rare projectile point, or a bead made of imported stone. These fragments have stories to tell, and we ignore them at our peril.

What we desperately need now is time in the lab. The amount of time it takes to remove a *muktaf*, or bucket, of soil from a site never correlates 1:1 with the time it takes for a specialist to complete their analysis of that same *muktaf's* contents. The washed remains left behind in a single screen of microflora can take days or weeks to identify under the microscope, one seed at a time. Our excavation team worked for six weeks in Kromer. At HeG, the working estimate we use for budget-planning is three weeks in the lab to complete basic recording and documentation for every single week of excavation. But given the tremendous richness of the Kromer material culture, we estimate this will be more like four to five weeks. We still have a great deal of basic counting and sorting to do, and our analysis and research has just begun!



Although from the main HeG site and not the new Kromer excavations, this clay sealing fragment recovered during the wet sieve process shows the importance of wet sieve and heavy fraction. Even this tiny chip— bearing a portion of the Horus name of Menkaure—can provide us with a datable piece of history. Photo by Ali Witsell.

AERA Assistant Ceramicist Aisha Montaser, with but one (!) delivery of Kromer ceramic bags piling up behind her (in *schwals*, large sacks used for dry goods supply), begins the long process of sorting the pottery recovered this year. Photo by Claire Malleson.

Dressing the Pyramids in Cloth and Cordage: Spinning and Weaving at the Pyramids by S. A. Hitchens

Much has been discovered about the pyramid builders' tools, living areas, food, drink, and administration. However, little has been discovered or said regarding an equally important product: textiles. "Textile" refers not only to things made out of woven cloth, such as clothes, furnishings, and nets, but also includes items made of grasses, reed, and palm fronds, such as basketry and ropes. During the Pharaonic Period, many of these items would have been made out of linen. Egypt was known for its linen manufacturing, which played an important role in Egypt's economy.

Linen was made from *Linum usitatissimum*, commonly known as flax. Flax grows best in well-irrigated soil and was sown in mid-November following the inundation of the Nile; it took about three months to mature. Younger flax plants yielded fibers that were good for making fine yarn, while older flax fibers were used for making coarser cloth and cordage.

Flax was not cut when harvested, but pulled from the soil because the fibers extended through the entire length of the plant stems. Before the fibers could be spun into yarn for weaving or made into cordage, they had to be freed from the other layers of cells in the stalks.[1] First the flax stalks were soaked in water to rot away the outer bark, a process called retting. The water sped up bacterial action that broke down the pectin and other substances holding the plant cells together.[2] The stems were then laid out to dry, after which they were beaten with mallets. And finally a blunt tool, often of wood, was used to scutch (scrape off) the remaining bits of bark to extract the fibers.

Heit el-Ghurab Textile Manufacturing

Direct and indirect evidence for textile manufacturing has been found at the Heit el-Ghurab site (HeG) in the form of a small number of surviving textile-working tools, such as spindle whorls and bone points, as well as cloth impressions on the back of clay sealings. Another indication for textile processing at Giza is Sealing 5209. Discovered in the spring of 2012 during excavations at the Menkaure Valley Temple, Sealing 5209 was a label for a special kind of linen called *jtjw*.[3] John Nolan found that this same type of *jtjw* linen was documented in a contemporaneous account register found at the Pyramid Temple of Raneferef at Abusir. The account register documented a shipment of *jtjw* linen as having come from the Menkaure Valley Temple at Giza. It is quite amazing how such a little object from Giza can show the importance that linen and the pyramids at Giza played in the wider Egyptian economy.

However, it is surprising that there is not more evidence for textile manufacturing at Giza, as the nature of the building works would have required a constant supply of cordage, bedding, bandages, clothes, cloth for sealing jars, and furnishings. The site's low-lying areas are frequently covered by groundwater, which could account for the lack of textiles and textile-working implements, as organic materials, such as wood, cloth, cordage, and plant fibers, do not preserve well in damp environments.

Spindle whorls and other weaving tools have been recovered from excavations at HeG, but they have not been studied in detail. Last season I was privileged to analyze the spinning and weaving tools in the AERA Giza Field Lab. I weighed and measured all the specimens, noted any decoration, and documented any surface features, such as tool and wear marks, in order to gain a better understanding of how the tools were made, as well as to find out more about Heit el-Ghurab's textile industry.

Spindle Whorls

Spindle whorls are simple tools, ubiquitous on archaeological sites throughout the world. They have been used for thousands of years to spin yarn for cloth and cordage, and despite their diversity in shape, material, and design, they have kept the same general form through all these millennia: round with a central hole. Serving as weights, whorls are wedged on a stick, i.e., a spindle.

Examples of spindle whorls found at Heit el-Ghurab. Clockwise from top: object 3566, ceramic; object 1998-55, limestone; object 3688, ceramic; object 02-454, tentatively identified as a type of quartzite; object 3567, ceramic. Photos by S. A. Hitchens.

In Egypt, archaeological evidence in the form of tools as well as tomb reliefs show the whorl at the top of the spindle, as in the example shown on the right. The whorl helps give the spindle momentum while twisting the fibers into yarn or string. Although spindle whorls are often circular in shape, they do not have to be perfectly round; nor does the perforation have to be precisely centered in order to function (see the examples on the facing page).

I analyzed all the known spindle whorls stored in the Giza Field Lab. The majority of the 17 examples are either reused potsherds or pieces of limestone, and all are undecorated. Most of the spindle whorls are discoid in shape.

As the table and graph below illustrate, the majority of the whorls have diameters between 2 to 2.25 centimeters (0.8 to 0.9 inches) or 3.5 to 5 centimeters (1.4 to 2.0 inches). Many are almost complete. For the broken ones, I calculated the diameters using a rim chart (or radius chart) borrowed from ceramic analysis. The rim charts also allow ceramicists to calculate the proportion (percentage) of the rim represented by a sherd. I applied the same procedure to the whorl fragments. The weights were calculated with a simple equation (cross-multiply and divide using the proportion or percentage of the remaining fragment and known weight). But these values should not be taken as exact.

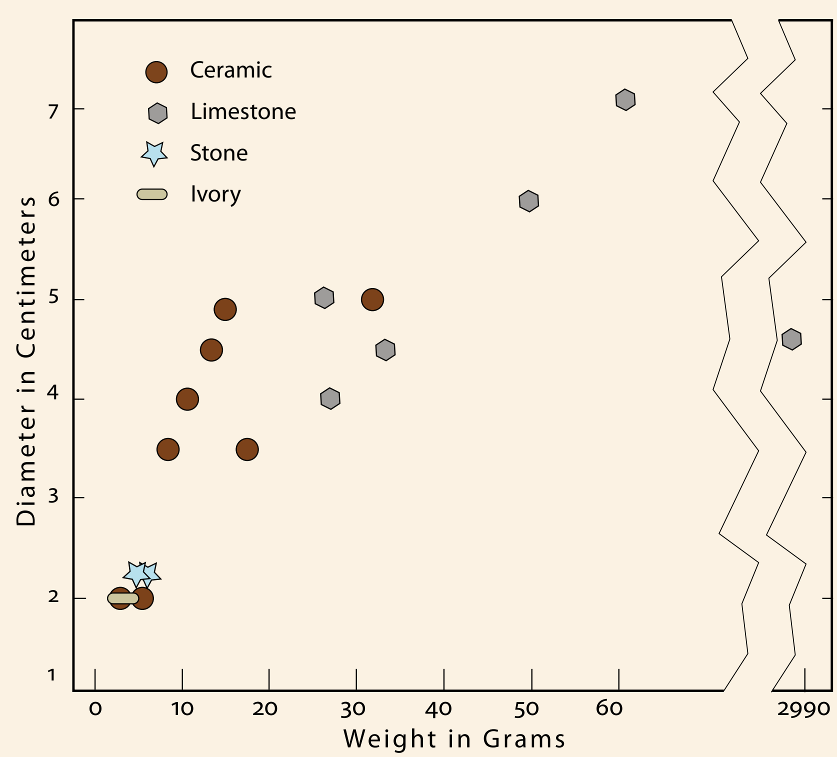
The weights for the whorls vary, suggesting that a variety of yarns were spun. Whorls can be used to spin a range of

A woman spinning thread with a drop spindle. Scene on the west wall of the tomb of Chnemhetep, Middle Kingdom. From *Beni Hasan Part IV. Zoological and Other Details,* ed. by F. Ll. Griffith, London: Egypt Exploration Fund, Plate XV, 1900. As in this scene, spinning was commonly associated with women, but there is evidence of men spinning as well.

Weights and Diameters of HeG Spindle Whorls

Object no.	Weight (grams)	Diameter (centimeters)
Actual values		
2558	17.4	3.5
2935	5.1	2.25
3025	13.5	4.5
3567	14.9	4.9
2994	5.9	2.25
1571	5.4	2.0
2715	3.3	2.0
Calculated values		
3564	26.83	4.0
3566	8.57	3.5
3569	3.5	2.0
3271	61.0	7.0
4041	31.2	5.0
2998	2998.0	4.5
2852	49.63	6.0
3926	33.08	4.5
1998-15	26.13	5.0
3688	10.8	4.0

Diameter of HeG Spindle Whorls Plotted against Weight



Above: Examples of bone points found at Heit el-Ghurab. From left: object 01a-71, bone; object 1833, bone. Photos by Yukinori Kawae.

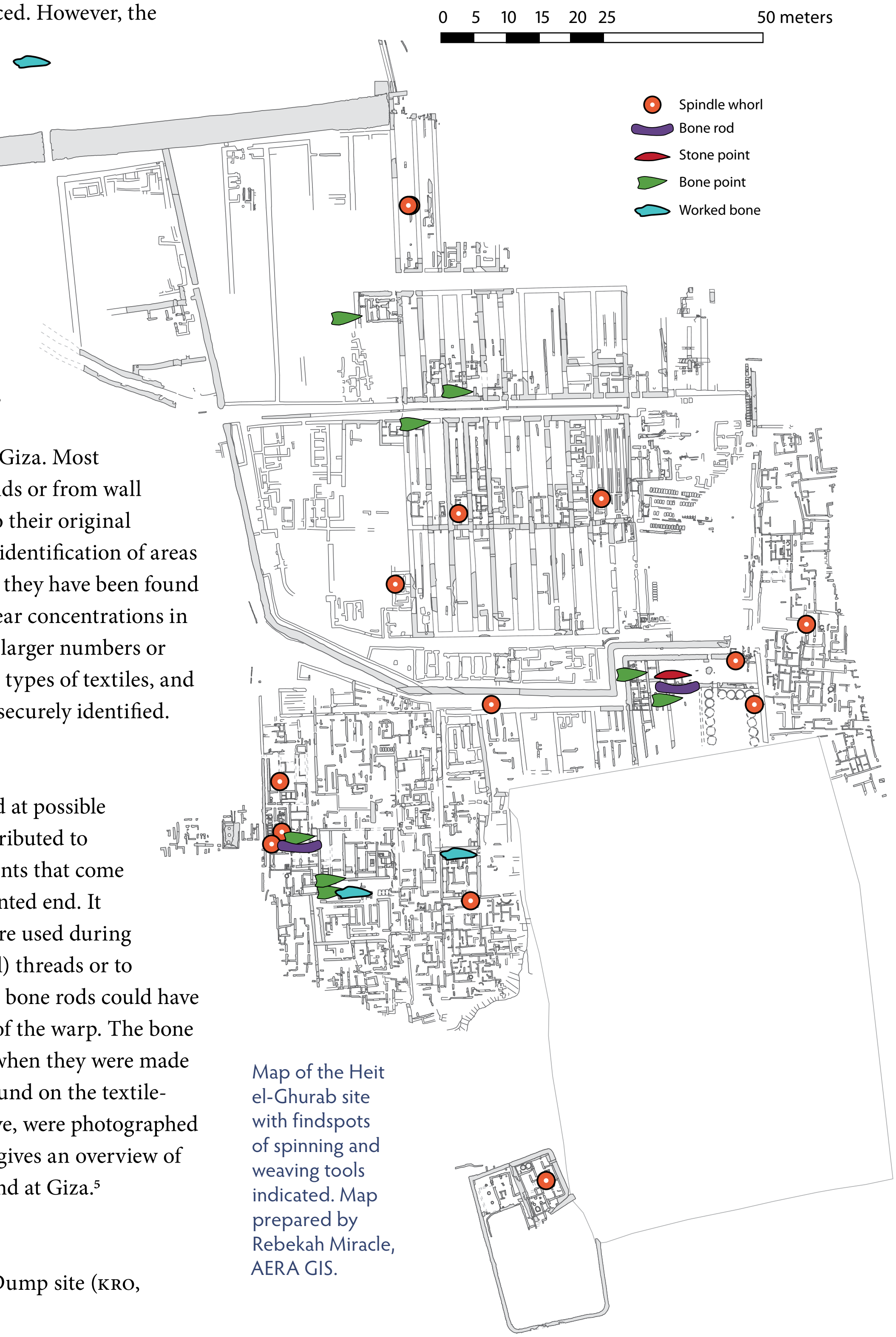
Left: Photomicrograph of a bone point weaving tool showing striations. These lines were probably created by grinding stones used to shape the bone to a point.[4] Photo by Yukinori Kawae.

threads of differing thicknesses, and the mark of a skilled spinner is the evenness of the yarn produced. However, the general rule is larger, heavier spindle whorls are for thicker yarn and smaller, lighter spindle whorls are for finer yarn. Most of the excavated whorls with diameters less than 5.4 centimeters (2.13 inches) weigh between 3 to 5.5 grams (0.1 to 0.2 ounces); others weigh between 15 to 26 grams (0.53 to 0.92 ounces); and most of the larger whorls weigh 30 grams (1.1 ounce) or more (see diagram, page 13).

With only 17 excavated spindle whorls, there are not enough to allow for general observations about the textile industry at Giza. Most of the spindle whorls are either surface finds or from wall cleaning or general cleaning of a trench so their original location is unknown, preventing possible identification of areas dedicated to textile processing. Moreover, they have been found scattered widely across the site with no clear concentrations in any areas (see map on the right). Without larger numbers or secure context correlations between tools, types of textiles, and production areas cannot be accurately or securely identified.

Weaving Implements

In addition to spinning tools, I also looked at possible weaving implements. Most of the tools attributed to weaving are broken bone rods or bone points that come to either a round pointed end or a flat pointed end. It is believed that these bone implements were used during weaving to beat down the weft (horizontal) threads or to rearrange the warp (vertical) threads. The bone rods could have acted as spacers to separate certain areas of the warp. The bone points have small surface scratches from when they were made and shaped. Some of the surface marks found on the textile-working implements, such as the one above, were photographed by Yukinori Kawae in 2004. Ana Tavares gives an overview of other textile implements and remains found at Giza.[5]



Map of the Heit el-Ghurab site with findspots of spinning and weaving tools indicated. Map prepared by Rebekah Miracle, AERA GIS.

Kromer Finds

This season's excavations at the Kromer Dump site (KRO, see article starting on page 2) produced a number of surprises. KRO is farther into the desert and at a higher elevation than HeG. The soil is dry and not affected by groundwater in the way that it is at HeG. This has allowed for greater preservation of organic material, including textiles! Fragments of cloth as well as cordage were recovered from Kromer this season.

The cloth fragments are small. The warp and weft yarns are S-spun (twisted to the left) and tabby (plain) woven. The cordage is S-spun and Z-plied (two or more threads spun together, twisted to the right). The textiles were found within the deposits as well as in mudbricks. Further analysis will be needed in order to identify the type of material used to create the textiles. This was only the first season at Kromer, but future seasons may produce even more textiles.

Given the nature of the building works on the Giza Plateau and the surviving spinning and weaving tools, and now the Kromer textiles, we can assume that textile processing of some sort was happening on the plateau. To what extent is uncertain as any spinning and weaving implements made of wood have not survived. A study of the textile impressions on the back of clay sealings would also further our knowledge and understanding of the textiles used during the Old Kingdom.

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1. The information on flax in the second and third paragraphs (except for the sentence with footnote 2) come from Vogelsang-Eastwood, G., *The Production of Linen in Pharaonic Egypt,* Leiden: Textile Research Centre, pages 5–7, 10–12, 1992.

2. Andersen, S. T., and S. Karg. "Retting pits for textile fibre plants at Danish prehistoric sites dated between 800 B.C. and A.D. 1050," *Vegetation History and Archaeobotany,* vol. 20, page 518, 2011.

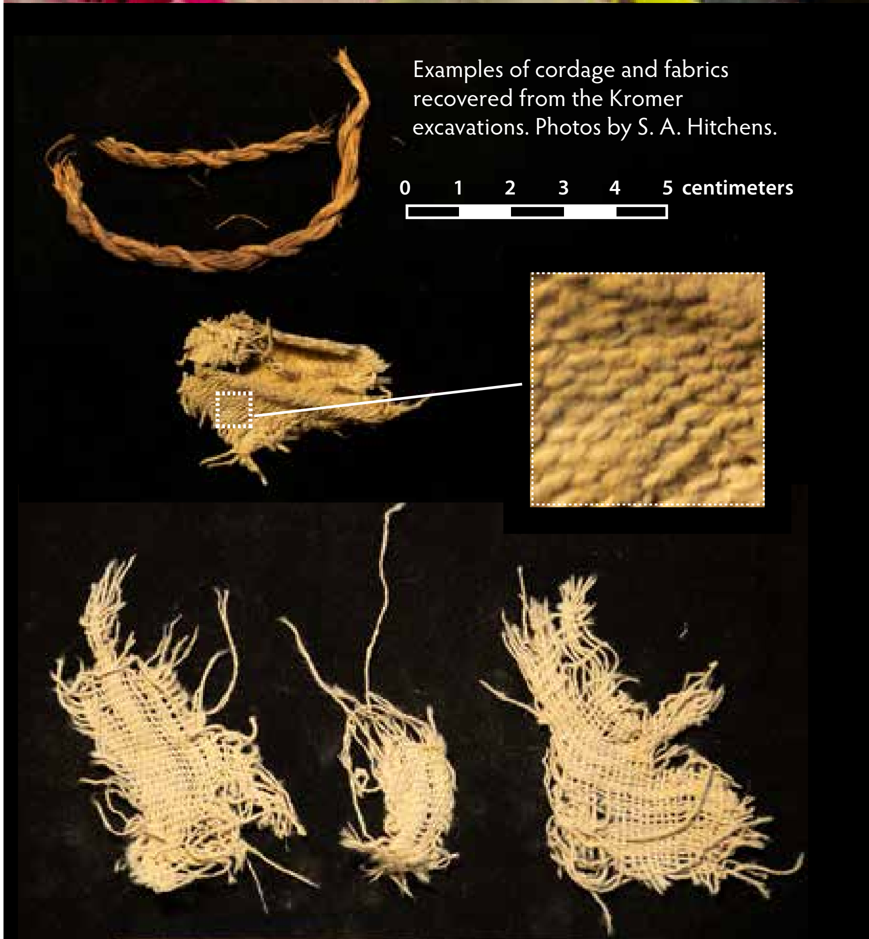
3. Nolan, J., "A Small Clay Label, a Bundle of Linen, and an Ancient Economic Network," *AERAGRAM* 14-2, page 20, 2013.

4. Kemp, B. J., and G. Vogelsang-Eastwood, *The Ancient Textile Industry at Amarna,* London: Egypt Exploration Society, page 369, 2001.

5. Tavares, A., "The Hidden Industry: Weaving at the Workers' Settlement," *AERAGRAM* 7-2, pages 10–11, 2004.

The back of an HeG sealing showing an impression of cloth. Cloth was placed over the top of a container and either held in place with string or tied with straps of cloth and then sealed with clay. Photo by Hilary McDonald.

S. A. Hitchens examines two of the spindle whorls as she works on her analysis in the Giza Field Lab. Photo by Claire Malleson.



Examples of cordage and fabrics recovered from the Kromer excavations. Photos by S. A. Hitchens.

Where in the World Is the Great Pyramid?

by Glen Dash*

Despite all the research carried out at the Great Pyramid over the centuries, we did not have useful coordinates for its position. Not until Glen Dash and his team took on the project. This was not a simple matter of surveying on the ground. The Dash team had to scale the huge monument, carrying survey equipment, and take measurements from its summit.

The Great Pyramid is one of the most studied monuments of the ancient world. Herodotus, who contributed both fact and legend to our knowledge, said that it took 100,000 men 20 years to build, was "square at the base, its height …. equal to the length of each side."[1] John Greaves (1602–1652) of Oxford was one the first modern scholars to measure the Great Pyramid in a methodical way.[2] He calculated its height to be 499 feet and the sides to average 693 feet, reasonable estimates considering the mounds of debris which then encased the Pyramid. (Our best estimates today make its height 481 feet 4 inches[3] and the average length of its sides, 755 feet 9 inches.[4]) Since Greaves's day the Great Pyramid has been systematically surveyed by Napoleon's savants (1798), Colonel Howard Vyse and John Perring (1837), Piazzi Smyth (1865), and the great Flinders Petrie (1880–1881). Today AERA, in cooperation with the Egyptian Ministry of Antiquities, continues the work, applying 21st century technologies to the problem of measuring the Great Pyramid. We seek to understand how it was built, what the builders who built it knew of technology, and how well they executed their plans.

Where Is the Great Pyramid?

It is surprising then to find out that until our recent mission, researchers did not have useful coordinates for the Great Pyramid. To illustrate the problem, we need only put the published coordinates for the Great Pyramid into Google Earth. Its published coordinates are Latitude 29 degrees 58 minutes 44.44 seconds North and Longitude 31 degrees 7 minutes 57.08 seconds East (or in decimal form 29.979001° N, 31.132522° E).[5] Those coordinates place the top of the Great Pyramid more than 180 meters west of where it truly is. How could the earlier surveyors have been so wrong?

The surveyors who proceeded us were not wrong, nor has continental drift or some other force moved the Pyramid. The reason for the discrepancy is that our model of the Earth has changed. Our planet is not a perfect spheroid. Rather, it is more of an ellipsoid, flattened at the poles. The exact shape of the ellipsoid has been the subject of much study. In 1906, the "Helmert reference ellipsoid" was proposed as the shape of the Earth. The published location for the Great Pyramid is its place on the Helmert ellipsoid.

However, in 1984 geologists proposed a new reference ellipsoid, the World Geodetic System WGS 1984, which was widely adopted. Unfortunately, there is no practical way to convert from the Helmert reference ellipsoid to the WGS 1984 ellipsoid with high accuracy. Therefore, in February 2018 we set out to climb to the top of the Great Pyramid with our survey equipment to re-establish its exact coordinates, this time on the WGS 1984 reference ellipsoid.

Climbing the Great Pyramid

Climbing the 37-story Great Pyramid requires more than just getting in shape. It requires the permission of the Egyptian Ministry of Antiquities, and the Ministry does not grant such permissions lightly. The monument, though imposing, is fragile. Furthermore, climbing the Great Pyramid is dangerous. People have died doing what we were proposing to do. Nonetheless, owing to the patient and persistent work of AERA's personnel, principally AERA-Egypt Executive Director Dr. Mohsen Kamel and AERA's Director, Dr. Mark Lehner, and the importance of the project, we did receive permission to climb.

The day of the climb was February 26, 2018. Ascending would be Joel Paulson of the survey firm NV5; Sayed Salah Abd el-Hakim, AERA-Egypt Manager and *Reis*; and Rebecca Dash Sperber, Eric Sperber, and myself representing the Glen Dash

* Glen Dash Foundation for Archaeological Research

The published coordinates for the center of the top of the Great Pyramid plotted on Google Earth place it more than 180 meters west of its true location. These coordinates are based on the now obsolete "Helmert reference ellipsoid," proposed as the shape of the Earth in 1906. The current, widely adopted reference ellipsoid, WGS 1984, was proposed in 1984. Since there is no practical way to convert from the old to the current reference ellipsoid with high accuracy, the Glen Dash Fundation Survey team climbed to the top of the Great Pyramid to re-establish its exact coordinates on the WGS reference ellipsoid.

Foundation for Archaeological Research. Joel Paulson, the group's principal surveyor is both a surveyor and archaeologist. His task this day would be to take his Global Positioning System (GPS) to the top of the Great Pyramid and make the critical measurements. A GPS uses satellites, computers, and receivers to determine the latitude and longitude of a given point. The rest of our survey team would assist and document the current state of the top of the Great Pyramid.

The slope of a pyramid being least at its corners, Sayed Sayed Salah Abd el-Hakim, our guide, chose the southwest corner for our ascent. When we approached the Pyramid, I was immediately struck with the size of the stones at its base. I was familiar with them, having surveyed at the Great Pyramid over several seasons, but climbing over them was another matter.

The first stone I would have to climb over was almost five feet high. You don't climb the Great Pyramid with your legs, I discovered; you lift yourself with your arms. I hoisted myself up on the first stone, then lay flat on my stomach on its top. I pulled my legs around and tucked them in under me. I lay on the stone momentarily and then sat upright. Then I noticed the feathers. The surface of the Giza limestone is tough as coral, and its rough surface had torn away part of my down jacket. I stood up. There were about 200 courses to go.

I repeated the process for each successive course. Lift the body, lie on the stone, tuck in the legs, turn, sit up, then stand. Mercifully, the stones got smaller as we climbed. Then, unexpectedly, at course 35 the stones got significantly larger again. There, at course 35, we had encountered one of the mysteries of the Great Pyramid. See the sidebar about the height of the courses on page 20.

As I climbed the Pyramid, I kept my gaze fixed always on the next stone up. I heeded the warnings I had been given: just don't look down. But one third of the way up (about 150 feet or 11 stories!), fatigue started to set in. So we stopped to rest. I turned to see the expanse of the Giza Plateau around me. It took my mind off the perilous heights. We rested for a few minutes; then Dr. Mohsen Kamel, who was watching from the base, waved us on. Our permission was for a limited time, he reminded us, and we had to keep on moving.

We would rest one more time. Then, soon after the second break, I looked up to see the tip of the mast that rests on the top of the Pyramid just visible over the courses I still had to climb. I stopped for a moment and stared. This was the mast that I had written so much about. It had been placed at the top of the Great Pyramid in 1875 by astronomer and surveyor David Gill.[6]

Facing page: The Glen Dash Foundation Survey team makes the perilous and exhausting climb up the Great Pyramid to its summit in order to take its measurements at the top and determine its location in terms of coordinates that are consistent with the current model of the Earth.

First to arrive at the top, Rebekah Dash Sperber waves her arms up high in celebration. Still climbing are, left to right: Joel Paulson, surveyor; our guide Sayed Salah Abd el-Hakim, AERA *Reis* and AERA-Egypt Manager; Glen Dash; and Eric Sperber, carrying much of the equipment.

Sayed chose the southwest corner of the Pyramid for our ascent as the slope of a pyramid is least steep at its corners. Photo by Claire Malleson.

Glen Dash (left) and Joel Paulson, our surveyor, rest as a GPS device mounted over Station E1 remeasures the location of the station. Khafre's pyramid stands in the background. View to the southwest. Photo by Sayed Salah Abd el-Hakim.

At the mast. Eric Sperber and Rebecca Dash Sperber stand at the mast placed at the top of the Great Pyramid by David Gill in 1875. The base of the mast is shown in the inset above. Photo by Glen Dash.

Rebecca reached the top first, throwing her arms up in the air in celebration. I was fourth, behind Joel Paulson and Sayed Salah Abd el-Hakim. Eric Sperber, carrying much of the equipment, was behind me. Downwind of me during the entire climb, he reached the top brushing away the feathers from my down jacket.

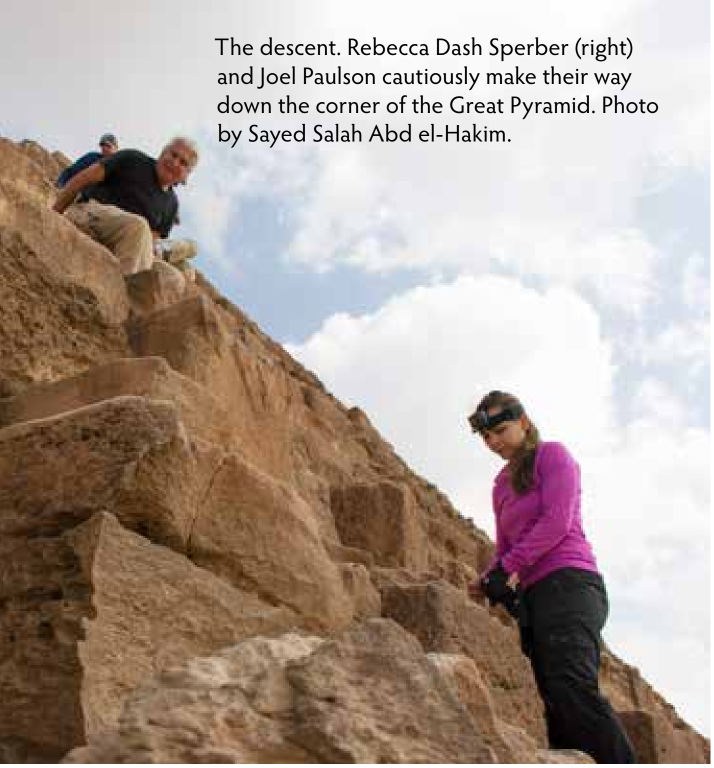
On the Summit

We had arrived on the best of days. There was no appreciable wind, rain, fog, dust, or sand. The top of the Great Pyramid is a most pleasant place. The course upon which we stood formed a platform about 10 by 10 meters. It was flat except for a few stones from higher courses. There was plenty of space to move. There was also plenty of evidence left by visitors who had been here before us, particularly in the 19th century. Nearly every square inch of the top was covered in graffiti.

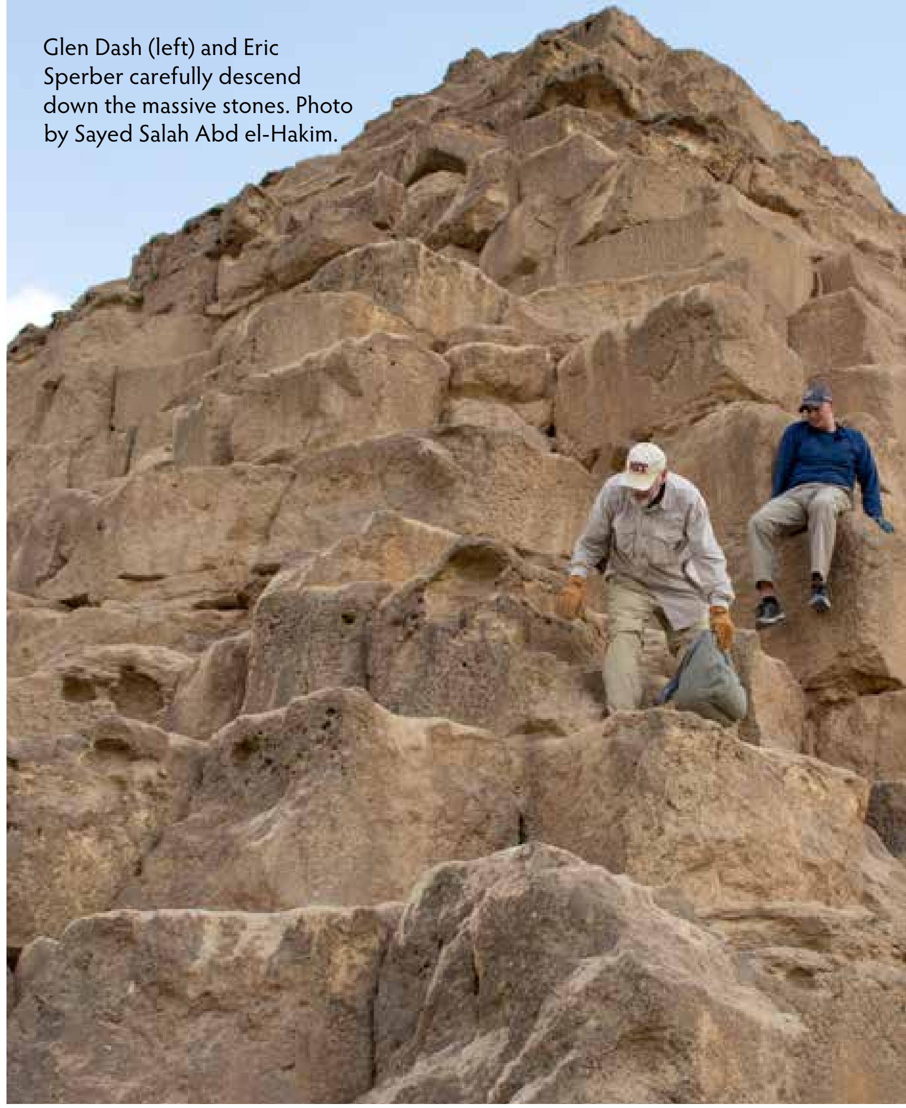
Our first task was to recover the control monument at the top of the Great Pyramid, known as Station E1. We immediately spotted a sand-filled depression and cleared it, revealing a copper marker. Joel set up his GPS equipment and began monitoring. It would take two hours of monitoring to achieve the accuracy we desired.

Station E1 is what is known as a “first order” control monument. Originally accurate to around one part in 150,000, it serves as a kind of lynchpin in the Survey of Egypt control network. We also measured the angle and distance from Station E1 to the center of the base of the mast. We found it lay directly northeast of Station E1 at a distance of 2.413 meters.

After two hours our work was complete, and it was time to descend. Climbing down is harder than climbing up. Each step reminds you of where one misstep can lead. On the way up, gravity works with you, securing your foot to each step. On



The descent. Rebecca Dash Sperber (right) and Joel Paulson cautiously make their way down the corner of the Great Pyramid. Photo by Sayed Salah Abd el-Hakim.



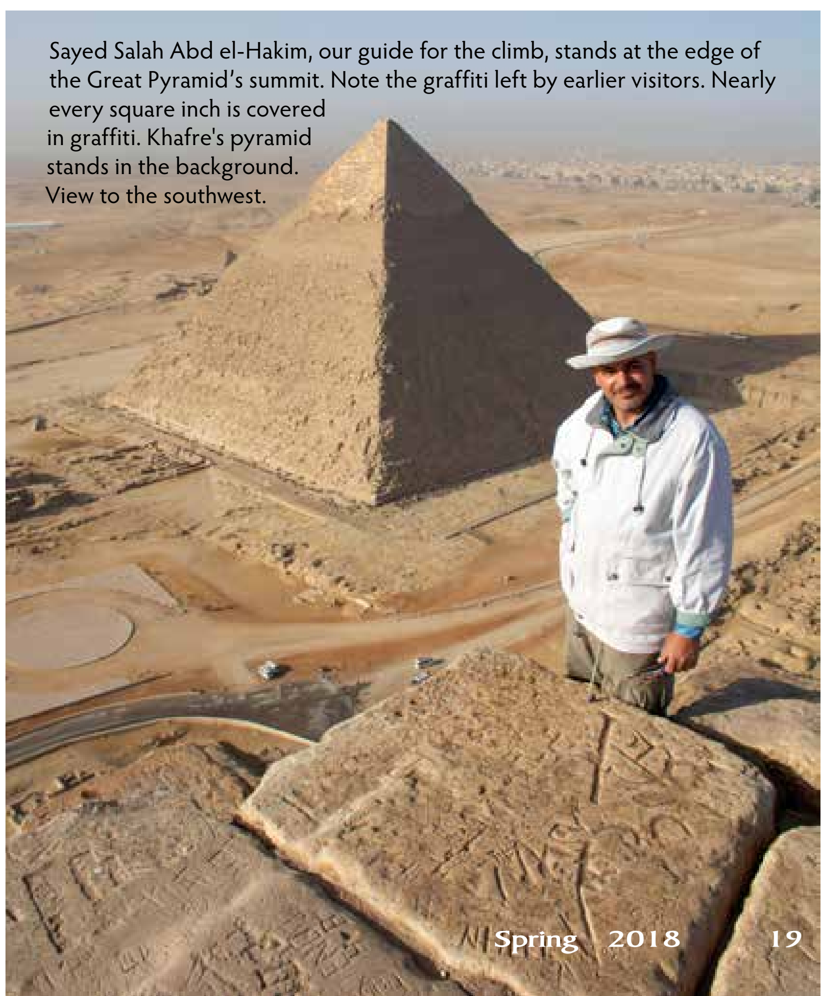
Glen Dash (left) and Eric Sperber carefully descend down the massive stones. Photo by Sayed Salah Abd el-Hakim.

the way down, gravity works against you, pulling you along a little faster than is comfortable. It took us 45 minutes to descend, about the same amount of time it had taken us to climb.[7]

The Results

After analyzing the data, we found that the location of E1, the first order control monument at the top of the Great Pyramid, is Latitude 29° 58' 45.00041" North and Longitude 31° 08' 03.05680" East. As noted, the base of the mast is 2.413 meters due northeast of E1. In terms of longitude and latitude, 2.413 meters northeast is equal to .05529 seconds of arc north and .05529 seconds east.[8] We add .05529 seconds to the latitude and longitude of Station E1 and find that the center of the base of the mast rests at Latitude 29° 58' 45.05570" North and Longitude 31° 08' 03.11209" East.[9]

We also set out to establish its position on our own reference map, the Giza Plateau Mapping Project (GPMP) control grid. Longitude and Latitude coordinates are difficult to work with at a small scale, so archaeologists and surveyors often set up their own local control grid. Our local control grid assigns every place on the plateau coordinates, like addresses for houses on a city map. The grid's origin is the center of the base of the Great Pyramid. Every place is then assigned an address which represents the number of meters north and east that place is from the origin. For example, we know that the northeast corner of the Great Pyramid is 115.278 meters north and 114.974 meters east of the center of the base of the Great Pyramid. If the center of the base of the Great Pyramid is assigned an



Sayed Salah Abd el-Hakim, our guide for the climb, stands at the edge of the Great Pyramid's summit. Note the graffiti left by earlier visitors. Nearly every square inch is covered in graffiti. Khafre's pyramid stands in the background. View to the southwest.

address of (0, 0), then we can assign an address of (115.278 N, 114.974 E) to the location of the northeast corner. As it turns out, surveyors like to avoid using negative numbers to locate places to the south and west of the origin, so they randomly assign a positive address to the origin. In the case of our control grid at Giza, David Goodman, the California Department of Transportation master surveyor who set up our control grid, assigned an address of (100,000 N, 500,000 E) to the origin, making the northeast corner (100,115.278 N, 500,114.974 E).

On our GPMP control grid, we know from our previous surveys that Station E1 (also known as GPMP control monument G1.5) is located at N 99,998.554 and E 499,997.917. If we account for the distance and direction between Station E1 and the center of the base of the mast, that places the center of the base of the mast at N 100,000.260 and E 499,999.623.

Conclusions

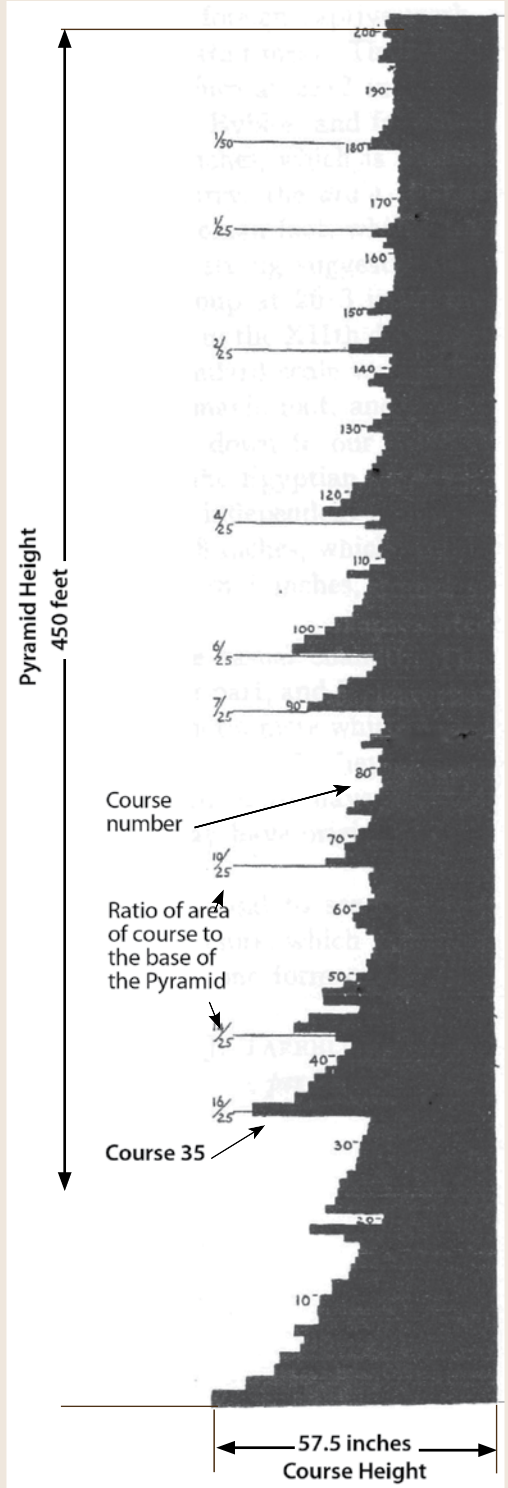
Our 2018 ascent allowed us to precisely locate Station E1 on the WGS 84 reference ellipsoid and restore its integrity within the Survey of Egypt control grid. We also located the center of the base of the mast on the WGS ellipsoid and, in addition, located it on the GPMP control grid.

The Curious Case of the Great Pyramid's Alternating Course Heights: An Unsolved Mystery

At course 35, we had encountered one of the mysteries of the Great Pyramid. The mystery is illustrated in Flinders Petrie's graph of the course sizes, which we show on the right. The courses get smaller as you ascend, but then at regular intervals get larger again, and the cycle repeats. About that, Petrie wrote:

> The position of the remarkably thick courses, which start afresh at the beginning of a new diminishing series, at so many points of the Pyramid's height…; they do not seem to have any connection with the levels of the Interior…, nor any relation in the intervening distances or number of courses.[10]

Nonetheless, Petrie did find a complex pattern to the courses. The pattern is tied to the area of each course of stone. The area of the base is 440 cubits squared or 193,600 square cubits. (One cubit is 52.37 centimeters.) As the pyramid rises the area of each course is less than the one before. When the reduction in area of a given course is some multiple of 1/25th of the base area, the course height tends to change. One such change is at course 35. There the area of the course is 16/25ths the area of the base. Similar changes occur at courses whose areas are 14/25ths, 10/25ths, 7/25ths and 6/25ths the area of the base, and at other places following the same pattern. This pattern must reveal something about the physical construction of the pyramid, or the logistics used to build it, but we do not know what that is.



Changes in course heights as one climbs the Great Pyramid. The heights change in a complex but regular pattern noticed by Flinders Petrie, as shown in his figure, adapted by Tarrell.[11]

1. De Sélincourt, A., *Herodotus, The Histories*, London: Penguin Group, page 146, 2003.
2. Lehner, M., *The Complete Pyramids*, London: Thames and Hudson, page 44, 1997.
3. Petrie, W. M. F., *The Pyramids and Temples of Gizeh*, London: Field & Tuer, page 43, 1883.
4. Dash, G., "The Great Pyramid's Footprint: Results from Our 2015 Survey," AERAGRAM 6-2, pages 8–14. Fall 2015.
5. Goodman, D., "The GPMP Surveying and Mapping Control-Datums," In *Giza Reports,* Volume 1, edited by Mark Lehner and Wilma Wetterstrom, Boston: Ancient Egypt Research Associates, page 98, 2007.
6. http://glendash.com/downloads/archaeology/working-papers/The-Man-and-the-Mast.docx
7. For a video of the climb, see http://www.DashFoundation.org/PyramidClimb.htm
8. The average circumference of the Earth is very near 40,000,000 meters. Dividing by 360 yields 111,1111 meters per degree. Dividing further yields 1,851.852 meters per arc minute and 30.864 meters per arc second. A distance of 2.413 meters to the northeast equals 1.707 meters to the north and 1.707 meters to the east. A distance of 1.707 meters equals .05529 seconds of arc.
9. Errata to this article, if any, can be found at http://www.DashFoundation.org/PyramidClimbErrata.docx
10. Petrie, *Pyramids and Temples of Gizeh,* page 184, 1883.
11. Tarrell, J., "The Great Pyramid Courses," *Ancient Egypt*, Part II, page 37, June 1925; Petrie, *Pyramids and Temples of Gizeh,* plate viii, 1883.

Sphinx Archive Project, a Headliner

The American Research Center in Egypt (ARCE) released the first issue of its new member magazine, *Scribe*, this spring, with AERA's Sphinx Archive Project featured on the cover.[1]

The Project, described in the last issue of *AERAGRAM*,[2] conserved, digitized, and made available online the vast trove of material produced by the 1979–1983 ARCE Sphinx Project, including photos, field notes, drawings, maps, and documents. Funded by an Antiquities Endowment Fund grant from ARCE, the Sphinx Archive Project was completed this past winter.

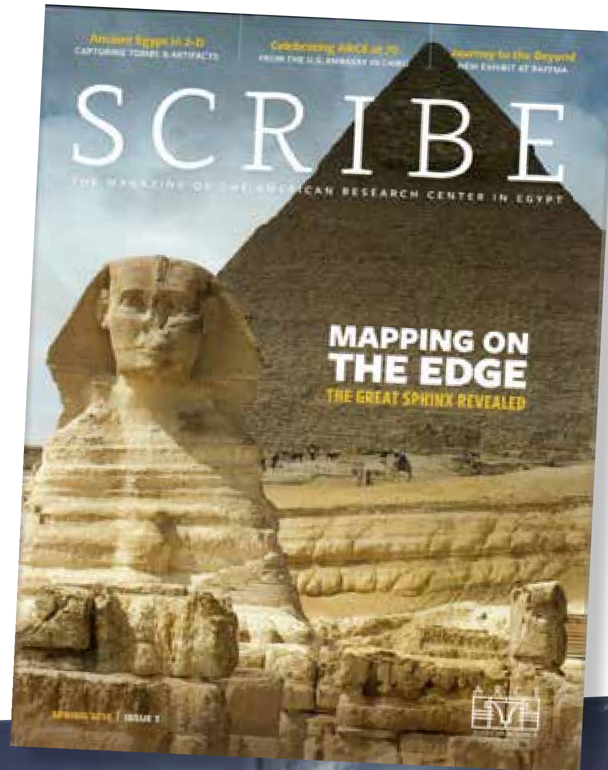
The *Scribe* article, compiled and edited by David Everett, tells the fascinating story of how the Sphinx Project team, with James Allen as Director and Mark Lehner, Field Director, carried out its goal of creating a detailed scale map of the Sphinx (top plans, sections, elevations), along with surveying and mapping the adjacent temples and the structural geology of the site. The ultimate goal of this ambitious program was to unravel the history of the Sphinx.

With the completion of the project, all of its work—on paper, mylar, or photographic film—was stored away and largely inaccessible.

Some 30 years later all of this material is in digital form and available for free on the Open Context website: https://opencontext.org/projects/141e814a-ba2d-4560-879f-80f1afb019e9.

It was no easy task preparing this material for the digital world and life online, and Everett explains the challenges the team faced.

His article can be read online on ARCE's website: https://www.arce.org/sphinx-map. The final report on the project, which Everett drew upon in compiling his article, can also be accessed on the ARCE website: https://www.arce.org/sites/default/files/documents/AEF%20Reports/New%20Light%20on%20an%20Old%20Archive.pdf.



1. "New Light on an Old Archive," edited and compiled by David Everett, *Scribe*, Issue 1, pages 14–25, Spring 2018. Available online on ARCE's website: https://www.arce.org/sphinx-map.

2. "Sphinx Archive Project: It's a Wrap," *AERAGRAM* 18-2, pages 25–29, Fall 2017. Available for free download from our website, aeraweb.org.

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Learning Animal Bone: AERA-ARCE Field School Training

by Mohamed Hussein Ahmed[1] and Mohamed Raouf Badran[2]

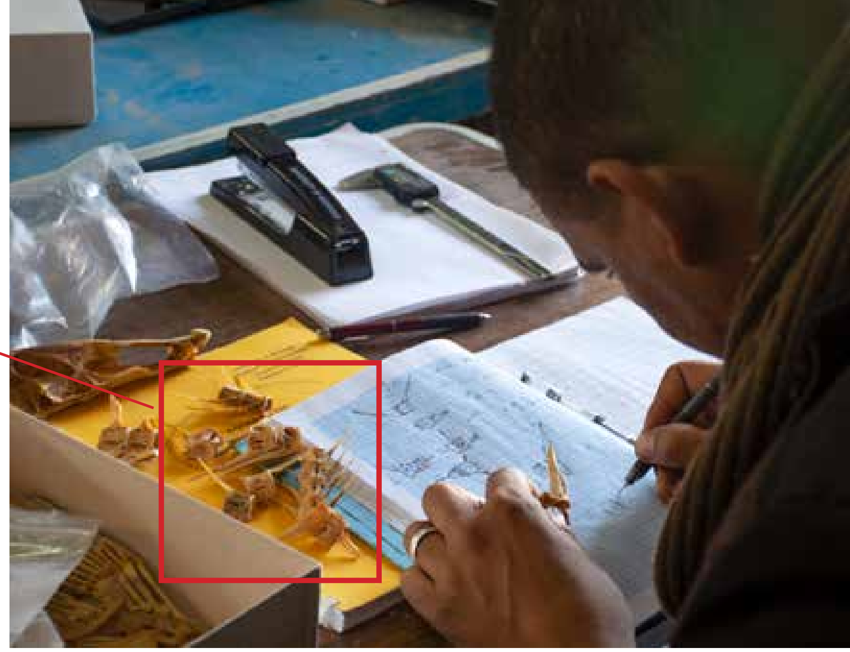
Editor's Note: As AERA continues its mission of education and outreach, we delight in sharing our staff's knowledge with new generations of students and scholars. This is especially rewarding when we have the chance to delve more deeply into an area during an Advanced Field School session with students who have a passion for a particular topic. Here, two enthusiastic new students of AERA's Archaeozoologist Dr. Richard Redding, Mohamed Hussein Ahmed and Mohamed Raouf Badran, share their experiences and impressions of their recent training session during the Giza 2018 field and lab season. We feel that the best way to train students is a hands-on approach to our current research topics. Mohamed and Mohamed did just that this season, jumping right in on new material from this season's Kromer excavations.

The 2018 AERA-ARCE Field School training was a dream come true. It is important that people know that becoming an animal bone specialist in Egypt is not an easy thing. To even find such training in a university in Egypt is difficult, if not impossible. Both of us had an urgent need for this specialist training right now, as we are both working on our theses, and animal bone is a key component of our topics.

We each had an interest in animal bone and the information we can receive from studying it before we came to the field school. We both knew of Dr. Redding through his writings or his lectures, but there was not a chance to have this one-on-one specialist training with him. During our research, we would send emails to Dr. Redding asking for copies of articles or books, advice, opinions, or other help that we needed in our work, but it was not enough. It was hard to read the articles and understand them because they were full of difficult Latin terms and scientific abbreviations, and we needed help just to understand the specialist language. We told Dr. Redding we would be eager to have in-depth training, and he worked to make it possible during this year's excavation season.

Overview of Our Work

Over six weeks of intensive training, Dr. Redding gave us all the support we needed—comprehensive explanations,



Facing page: In the AERA Field Lab Richard Redding teaches Mohamed Hussein (far left) and Mohamed Raouf the basics of archaeozoology as part of the AERA Advanced Field School. Photo by Mark Lehner.

Above right: Mohamed Raouf draws fish vertebrae from Richard Redding's reference collection. The inset shows the vertebrae. Photo by Richard Redding.

articles to read, reports and references to use in writing, tools for our future work, and practical applications and demonstrations through magnificent research trips that helped us in understanding archaeozoology. He used different ways of teaching, like his great presentations with the white board, his unbelievable comparative collection in the lab, regular exercises to test our identifications, using manuals for mammals, birds, and fish, and training in equipment like scales and calipers.

He began with a general introduction about the mammals, birds, and fish of ancient Egypt. Then he focused on the most common of each category that we might find archaeologically in our future work. It was not easy for us at the beginning as we received a good deal of new Latin and English terminology in this course, but Dr. Redding did his best to deliver the information with his easy approach. By the end of the course we were on the same page, meaning that we succeeded in understanding these very difficult Latin words even if we did not know their Arabic meaning.

By the end of the first two weeks of training we were not only able to identify small fragments of bird and fish, but also which part of the body they came from. Dr. Redding's vast comparative collection played an important role in identifying the fish. Ancient Egyptians caught many types of fish, and without the comparative collection we would face difficulty in identifying it. This is especially true with the very small fragments of bone recovered from the wet-sieve process, where the soil from excavation is washed through a series of fine sieves after it is rough-sifted on site. But, with practice, we were able to identify the more common fish without using the comparative materials, in particular those of catfish and Nile perch.

For mammals, we quickly set to work identifying the fragments of cattle, sheep-goat, and pig. With more training we moved to more advanced tasks, like identifying sheep from goat, determining male from female, and recognizing the fusion on some elements of the bones. One amazing thing is that we were able to differentiate between the milk teeth and the permanent teeth by studying the eruption process, and we learned how to differentiate between herbivores and carnivores by their teeth!

Within this intensive course we learned the name of each bone in the body; we were able to recognize if a bone fragment is from the right or left side of the body; and we learned the terminology to describe bone fragments and their condition in the appropriate ways. By the end of the course we were able to give our own interpretation about the faunal remains that we identified and recorded. We enjoyed every moment of this training.

Beyond the Basics

We started our real work by identifying faunal remains from the BBHT area of the main site.[3] We did our best, but unfortunately the bone fragments from this area are small, very fragmented pieces. By this time, Dr. Redding had begun to receive the bone from the new Kromer excavations (see article starting on page 2). He was very excited at how complete and numerous these bones are (see photo on page 24). When we saw the Kromer bone, we were both thinking how great it would be to work on this material, so we asked, "Can we work with you, Dr. Redding, on the Kromer bone?" And he answered "Yes, of course!" We were very happy to work on such amazing and unique material, and started working right away with him to identify and record the faunal remains from the Kromer excavations.

Unfortunately, after four weeks Dr. Redding had to leave to return to the US. But the work continued as if he was still with us. Dr. Mark Lehner visited us almost every day, following and supporting us, and asking questions and taking photos. We were very happy that they relied on us to complete the work. We did it together through good cooperation. Together we succeeded in identifying, recording, and entering the information in the database. Together we wrote and sent our weekly reports to the other AERA staff, and we even began to write the final report of this season.

Field Trips

Outside of the lab, there were other activities that we also found very informative. The weekly site tours of the ongoing work at the Kromer, Lost City, and Khentkawes Town sites helped us have a better understanding of each area, which is important for our interpretations in the final faunal report. Many research trips were arranged for us. These were diverse and covered several aspects of archaeozoological work, including visits to the Giza Zoo and Zoological Museum, the Giza Fish Market, the tombs of Saqqara, and a scientific conference where Dr. Redding presented a paper on the material from the Heit el-Ghurab site.

A Trip to the Zoo

While we were learning mammals we took a trip to the Giza Zoo, where we had a good chance to see many of the animals we may find in the archaeological remains of Egyptian sites. We had a good overview from Dr. Redding on animals like lions, tigers, giraffes, monkeys, and birds.

The trip also included a short visit to the Zoological Museum—a great museum with many animal skeletons on display. It was a very interesting and important visit for us. We talked with the Zoological Museum's manager about their collection and where and how they obtain the skeletons for the museum. Seeing such a large collection, we wondered if it would be possible for us to practice with and study this bone in the future. It would be a great opportunity for us to handle and identify these different animal bones, especially the animals that we might encounter archaeologically. In thinking about that, we approached the Ministry of Antiquities about having a joint understanding so that we might work with the Zoo and the Zoological Museum for future study. The Ministry agreed and we now have an approval letter for future cooperation. We made a good connection with the Zoo and museum staff, and found them very friendly and helpful.

Fish Week

Fish week was both wonderful and difficult because we received so much information about fish that we needed more time than the one week allowed. We discovered that "fish" are

A *muktaf* (basket made of old tires) of animal bones brought in to the Giza field lab from the Kromer site. Photo by Claire Malleson.

not only the five common types of fish that we consume in modern Egypt, but that it is a big tree or a whole community of fish that we did not know about before this field school. Dr. Redding explained to us the different types of fish, their families, species, and sex, and many other facts about the science of fish. Then we started to learn the most common species of fish that are found archaeologically and how to identify the bones recovered from the site using the AERA comparative collection.

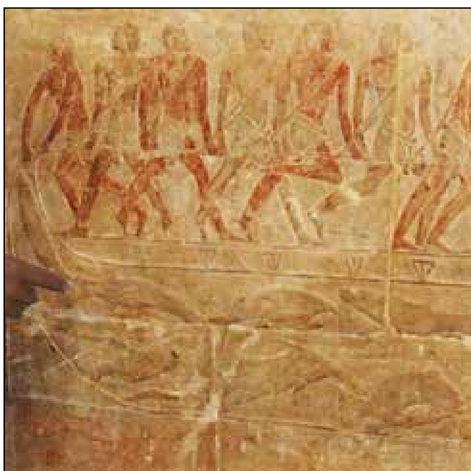
Dr. Redding arranged a fantastic trip to the Giza Fish Market. There we saw different types of Nile fish that are commonly found in archaeological sites, and some marine fish as well. We were fortunate to be guided by Dr. Redding as he gave us information for each kind of fish in the market. At the end of our trip he selected various kinds of fish for us to start our own comparative collections.

We spent a half day in the fish market before returning to the AERA-Egypt Center to begin skeletonizing fish for our collections. We skeletonized our fish by removing as much of the meat as possible without damaging the bones, then sealing the remnants in a container with flesh-eating beetles that will finish the work on the more delicate pieces. Dr. Redding brought out knives, saying "Start now to remove the meat carefully, keep the bones as they are, and skeletonize your own fish comparative collection." We did this work with our own hands, and enjoyed it very much. After we finished the cleaning process, we hung the fish in the garden of the villa for a couple of days while waiting for the beetles to come, and then we saved the fish in a closed box. This process might take three months or more, depending on how fast the beetles work.

The market trip and this skeletonization process that we made had given us a great help and is key to learning the anatomy of the fish skeletons and developing our skills for differentiating the most common species of fish we would find archaeologically.

Above left: At the Giza Fish Market, Mohamed Raouf (left), and Mohamed Hussein have a conversation with the head of the market about the price of fish and patterns of consumption. Photos on this page by Richard Redding.

Above right: In the garden of the AERA-Egypt Center, they prepare fish for the skeletonizing process—the first step in making their own comparative collections. Mohamed Hassan, AERA Lab Assistant and a fish expert, stands ready to advise.



Right: Examining a fishing scene in the Tomb of Mereruka at Saqqara. From left: Rasha Safaan, one of the MoA Inspectors for the AERA field lab in 2018; M. Raouf; and M. Hussein.
The inset shows a detail of this scene of fishermen hauling their catch with a large net. The students were surprised that the depiction of the fish was so accurate they could identify them: mugil, sharp-tooth catfish, elephant-snouted fish, moon fish, electric catfish, common eel, schall, and cichlid.

Why Study or Support Archaeozoology?

As archaeozoologists most of our information on animal use by humans comes from excavated bone fragments. These bone fragments form an important source of information on human behavior. Archaeozoologists identify each fragment to animal and body part, and record additional information on age, sex, signs of butchering, evidence of burning, and pathologies.

Most of the animal bones from archaeological sites are the remains of human consumption, so they provide direct information about our subsistence behaviors. What animals did the population consume? Did they have a preference for certain species? How did they prepare the meat?

Animal bone provides evidence of the economy of the past. Were the

In the AERA Field Lab, Mohamed Raouf Batran (center) explains to ARCE Deputy Director for Research and Government Affiliations Mary Sadek and ARCE Egypt Director Dr. Louise Bertini how archaeozoologists identify animal bone remains, as a camerawoman films him for a promotional video that ARCE showed at its annual meeting in April 2018. Photo by Mark Lehner.

Researching in Tombs

Dr. Redding also arranged an important field trip for us to visit Saqqara to see the tombs of Kagemni, Mereruka, and Ty. These three tombs are very rich in fish and fishing illustrations and show many of the same types of fish we had seen in the Giza Fish Market. Also there we examined the fish scenes and recognized the fish of the pharaohs from their representations.

We met Rasha Nasr, Archaeozoologist, and a student of Dr. Redding's from the 2010 AERA-ARCE Field School. She offered us great help in visiting the tombs and also visiting the site of the excavations there, where they found a large amount of both human and animal bone, including dog mummies. Dr. Redding discussed with us how to deal with and study the dog mummies, including how to preserve them for the future.

Attending the "Food and Drink" IFAO Conference

Dr. Redding also supported our academic progress. He took us to a scientific conference titled "Food and Drink in Ancient Egypt and Sudan," held at the Institut Français d'Archéologie Orientale (IFAO) and the Polish Center of Mediterranean Archaeology in Cairo. There were great lectures based on the faunal and floral remains found at various sites. In addition to learning a great deal about ancient food and drink, we had opportunities at the conference to mix and mingle, form new relationships, and strengthen existing ones.

Filming

During this training we also participated in filming with Dr. Redding and Dr. Lehner. They encouraged us to speak on camera, and we both had an interview with an ARCE film crew to be shown in ARCE's 2018 Annual Meeting in the US. We were happy to answer the questions of Dr. Louise Bertini, the Director of ARCE Egypt, about the field school training and how we benefitted from this course. Both Dr. Redding and Dr. Lehner encouraged us to speak in front of the camera, and this helped us to feel confident in doing so.

Acknowledgments

We would like to express our gratitude to our great teacher, Dr. Richard Redding, for his support, patience, and encouragement throughout this field school. It is not often that one finds a teacher who always finds the time for listening. We greatly appreciate all that he has done for us. He put us on the right

residents of ancient settlements hunters or herders? Using age and sex information we can determine how the domestic animals were herded and the goals of the herders. Were they herding the animals primarily for meat. milk, fibers, or some combination of resources? Using age structures and body part distributions we can determine the economic infrastructure. Were the animals herded locally or were animals moved around from production areas to consumption areas?

Animal bone provides evidence of the social organization of the past. Looking at the distribution of animal species and body parts at a site we can determine whether some residents had better access to certain meats. Are certain species of animals more desirable? Are these desirable species occurring more frequently in certain areas of the site? All of these questions provide archaeozoologists with information to attack the bigger questions of archaeology.

Think about the garbage you throw away each day! What does it say about you? Your garbage reveals your economic status, your job, your broader relationship to your community, and even your ethnicity.

It is important for students of archaeology to understand what information animal bone can provide us, and how to use that information responsibly. While we teach the basics to our Beginning Field School students, Advanced sessions like this one are crucial to training the next generation of specialists. This session was made possible by an ARCE Antiquities Endowment Fund (AEF) grant. We thank both ARCE and our AERA donors for their generous financial support in making this season possible.

- Richard Redding

This AERA Field Training program for inspectors in the Egyptian Ministry of Antiquities was made possible by the generous support of the American people through the United States Agency for International Development (USAID). The contents of this article are the responsibility of AERA and do not necessarily reflect the views of USAID or the United States Government. Support was provided by the American Research Center in Egypt (ARCE) through an Antiquities Endowment Fund grant with funding provided by USAID.

track with a great amount of help, and trusted us with his own tools and comparative collection. Our thanks also go to Dr. Mark Lehner for closely following our training, providing many valuable comments, and sending helpful materials that improved our work. We are grateful for his support.

We would also like to show our gratitude to Dr. Bassem Gehad, Assistant to the Minister of Antiquities for Capacity Development and Human Resources. We also thank Dr. Mohamed Ragaey, the General Director of the zoos all over Egypt for his offer to study any skeletons in the museum, and Dr. Mervat, Director of the Zoological Museum of the Giza Zoo, for her hospitality and cooperation.

1. Mohamed Hussein Ahmed is working on the faunal remains from the Early Dynastic-period bone from the South Abydos excavations and is a student at South Valley University. He serves as the archaeozoologist for the South Abydos Excavation, Early Dynastic Cemetery and Settlement (SAEEDCS) Project, and after the conclusion of this year's work was named the head of the archaeozoology department of the Scientific Center for Archaeological Field Training of Upper Egypt.

2. Mohamed Raouf Badran is a student at Mansoura University in the Department of Egyptology, where he is writing his thesis on nutrition in workmen's communities in ancient Egypt. Following the training with Dr. Redding, he participated in another in-depth AERA-ARCE workshop on archaeological data management (see article on back cover). He is currently an Inspector at the Giza Pyramids Inspectorate.

3. BBHT (Biggest Backhoe Trench) was gouged out for sand in 1991, leaving early levels of the site exposed. Located in the northeast quadrant, it destroyed portions of the settlement, but gave us a glimpse of an earlier configuration of the town.

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DATA The AERA-ARCE[1] Archaeological Data Management Workshop[2]

The hard copy archives in the AERA-Egypt Center. All photos by Claire Malleson unless otherwise indicated.

A four-day workshop in May at the AERA-Egypt Center brought together a group of Egyptian Ministry of Antiquities (MOA) Inspectors, along with AERA staff, to discuss archaeological data and archive management in Egypt.

The workshop aimed to improve the participants' understanding of databases, archive management, and data security, and to also formulate recommendations for training and support that would help all MOA individuals and teams, in museums, administration, and excavation.

Dr. Claire Malleson,[3] with AERA staff, organized the workshop, recognizing how crucial data management and archives are for MOA inspectors for the protection and management of artifacts as well as for research. AERA staff members Mohamed Saied,[4] Dan Jones,[5] and Rebekah Miracle[6] gave presentations on, respectively, database design, archaeological archive management, and GIS applications and, along with Claire, led discussions.

The participants came from varied backgrounds and with varied needs for organizing, archiving, and sharing their data (such as a system of unique coding for artifacts in different locations). They actively engaged in discussions and in developing recommendations. They proposed that each site location have a unique ID to help solve the problem of artifacts losing provenance information when they are moved.

All the participants found the workshop very useful and concurred on our major recommendation: apply for small grants to fund data management field schools that would be open to inspectors working on excavations as well as in museums, storage magazines, and ministry offices.

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1. Ancient Egypt Research Associates-American Research Center in Egypt, 2. The Workshop was made possible by a grant from ARCE. 3. Giza Lab Director and Archaeobotantist, 4. IT Director, 5. Senior Archaeologist, 6. GIS Director.

Below left: Dan Jones explains how AERA manages its archive of reports, field notes, drawings, etc. in hard copy form at the AERA-Egypt Center. Nour Hassan and Mohamed Raouf Badran listen attentively.

Below right: Participants work in small groups developing recommendations for training and support. From left: Hend Mohamed, Nour Hassan, Aya Ismail Elsayed, Reham Mahmoud, Samar Mahmoud, and Mohamed Raouf Badran.

Participants display their certificates at the completion of the AERA/ARCE Archaeological Data Management Workshop. From left: Mohamed Raouf Badran, Claire Malleson, Hend Mohamed Hussein, Aya Ismail Elsayed Mohammed, Reham Mahmoud Zaki el-Sayed, Samar Mahmoud Mohamed, Nour Hassan Salem, Mohamed Saied, and Dr. Basem Gehad (Assistant to the Minister of Antiquities for Capacity Development and Human Resources). Photo by Sayed Salah Abd el-Hakim.

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