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Bedrock outcrop reserved from original plateau surface, location of GPMP Survey Point GCF1, north of Khentkawes monument, and the center of a great circle of quarrying (AERAGRAM 9-2: 15). Story on page 3.

AERA's POB, a Unified Map, and a Quest

The articles by Glen Dash and Rebekah Miracle starting on the facing page and page 10, respectively, bring AERA back to our “point of beginning” (POB) in the Giza Plateau Mapping Project (GPMP). In survey, a POB is a mark at the location where wide-scale land survey starts. In the survey control network that David Goodman designed and set up for us at Giza in 1984, our POB was GP1 (Giza Plateau 1), a point on top of the *Gebel el-Qibli*, the “Southern Mount” of the Maadi Formation outcrop towering above our Lost City site on the southeast and the Khentkawes Town on the northwest.

David’s polygon of precisely measured points allowed us to project across the Giza Plateau a theoretical grid, anchored at the center of the Great Pyramid and assigned the coordinate values East 500,000 and North 100,000. We linked this local grid to earth’s latitude and longitude through measurements to a Survey of Egypt point at the top of the Great Pyramid. The GPMP grid allowed us to locate with our total stations any point on the plateau to an accuracy of millimeters.


With the coordinating, unifying GPMP grid, we pulled in plateau contours from previous surveys, added our own, and plotted grid square by grid square all the architecture of the Lost City, and, later, the Khentkawes Town. Rebekah reports how the grid, through a GIS (Geographical Information System), also uni-

fies and coordinates not just survey and mapping data, but literally hundreds of thousands of points of information on ancient artifacts and bits of material culture.

In a larger sense, the GPMP is the POB of all that AERA has accomplished and become. That AERA’s work began in broad site survey is not only, if I may say so, exemplary archaeological method; it allows us to carry on explorations of the questing sort that brought me to Giza in the first place.

Glen Dash reports on one of his own quests. Working in the Western Valley of the Kings in Luxor, he became intrigued with alignments between the Tomb of Ay in the valley and the Great Karnak Temple, and between both of them and the setting sun at summer solstice. Returning to Giza, he picked up on alignments between the summer solstice sunset and the pyramids that I had observed in my early years at Giza, before the GPMP. I could only guess if the ancient surveyors and builders really intended the gigantic configuration, a writing of the hieroglyph for *akhet*, “horizon” (a sun disk between two mountains) on the scale of acres. Using the GPMP control, Glen put the Giza solstice alignment to the test. He reports results here. His attention turned to a prominent bedrock outcrop (our point GCF1, seen on our cover) that might have been the ancient Egyptian surveyors’ POB when they laid out the Giza Plateau for quarrying.

~ Mark Lehner



The summer solstice sunset viewed from the lower terrace in front of the eastern niche of the Sphinx Temple. Glen Dash’s observation point OPI (see pages 4–5) would have been on the roof—now missing—5 to 7 meters (16.4 to 23 feet) above this spot on the floor. Photo by Mark Lehner.

Solar Alignments of Giza by Glen Dash

The Giza temples provided for the worship of dead kings. But they may also have served the living as solar observatories.

With the end of the Sphinx Project in 1983, Mark Lehner had completed his hand-drawn-and-measured plans of the Sphinx, the Sphinx Temple, and the Khafre Valley Temple. In a 1985 article, he collected some of his thoughts and observations. One of those concerned the summer solstice, as viewed from a niche at the eastern end of the Sphinx Temple:

At this time, and from this advantage, the sun sets almost exactly midway between the Khufu and Khafre Pyramids, thus constructing the image of the akhet (“horizon”) hieroglyph on a scale of acres. The effect is ... best seen from the top of the Sphinx Temple colonnade, or an equivalent height to the east of the temple where the sand rises. ... Even if coincidental, it is hard to imagine the Egyptians not seeing the ideogram. If somehow intentional, it ranks as an example of architectural illusionism on a grand, maybe the grandest scale.¹

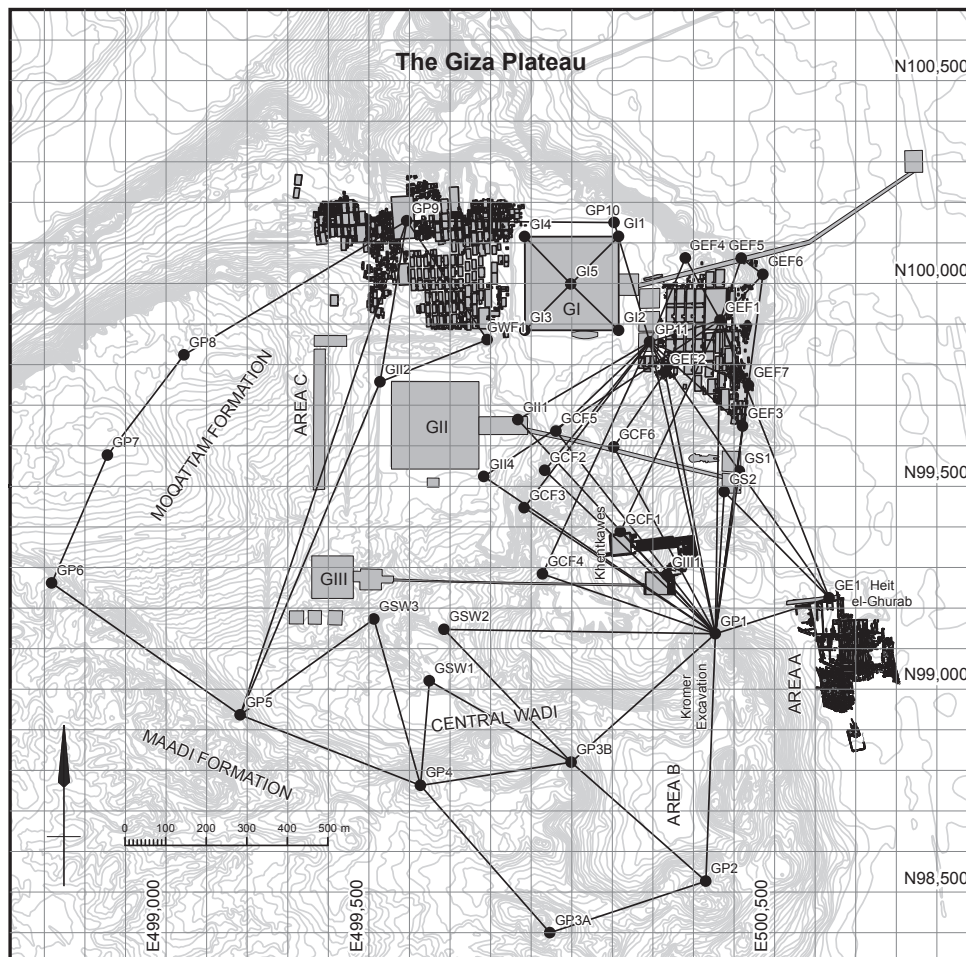
Indeed, the very name of the Sphinx suggests such an association. In the New Kingdom and perhaps before, the Sphinx was known by the name *Hor-em-akhet* or “Horus in the Horizon.”

In the same paper, Lehner set forth the goals of a newly envisioned “Giza Plateau Mapping Project”:

In future seasons we would like to survey the Giza Plateau with the primary goal of producing a topographical map of a scale of 1:1000. ... The map is seen as a tool for a functional, spatial, and ecological study of the building of the Giza Necropolis, in addition to its purely descriptive value. It will be possible to check for the accuracy of the apparent alignments mentioned here.²

Within three years, that goal had been substantially achieved. The Giza Plateau Mapping Project (GPMP) had established a primary control grid on the plateau accurate to one part in 320,000 and oriented to true north to better than ten seconds of arc.³

This data, now combined with years of additional GPMP survey work, allows us to produce maps of unprecedented accuracy, and with them identify those places on the plateau where the Egyptians, by design or coincidence, might have observed the solstices (shown below, left). Our goal here is to test the hypothesis that Giza might have functioned not only as a funerary complex to serve the dead king, but also to serve the living Egyptians as a platform for observing the solstices. In ancient times, the winter solstice was celebrated throughout the Mediterranean as the time of the sun’s birth. In Egypt, the summer solstice was associated with the return of the inundation.⁴



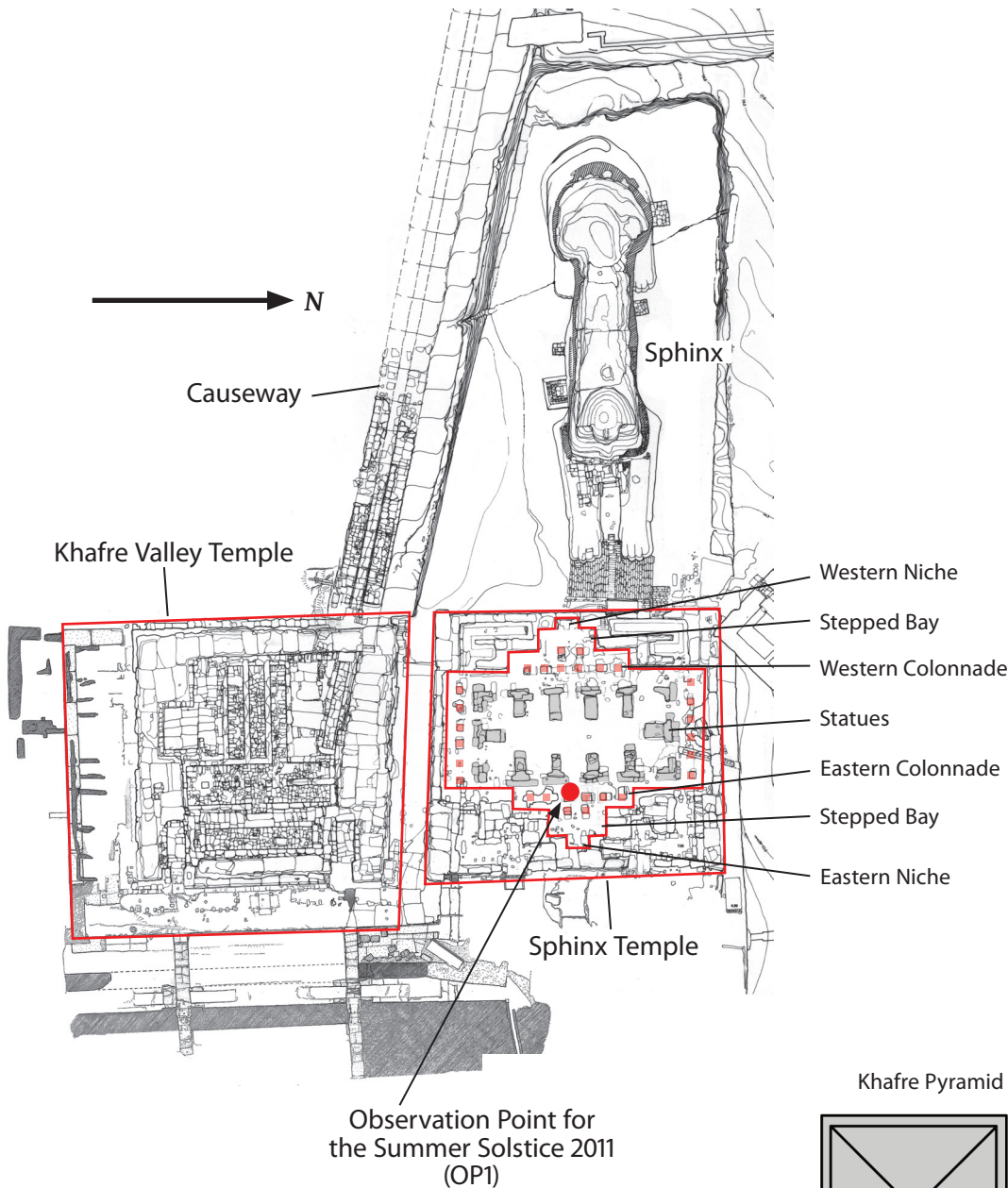
1. M. Lehner, “Giza, A Contextual Approach to the Pyramids,” *Archiv für Orientforschung* 32 (1985): 139.

2. *Ibid.*, 147.

3. D. Goodman and M. Lehner, “The Survey: The Beginning,” *Giza Reports, Volume 1*, M. Lehner and W. Wetterstrom, eds. (Boston: Ancient Egypt Research Associates, Inc, 2007), 97–98.

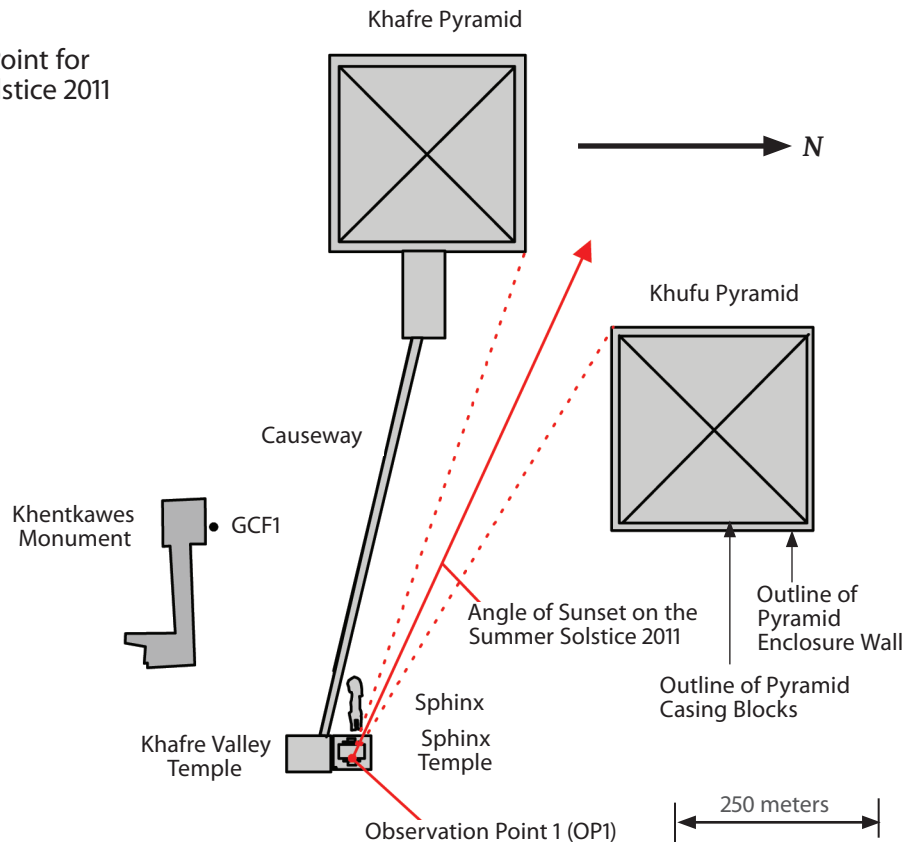
4. J. A. Belmonte, M. Shaltout, and M. Fekri, “Astronomy, Landscape and Symbolism: A Study of the Orientation of Ancient Egyptian Temples,” *In Search of Cosmic Order*, 1st ed. J. A. Belmonte and M. Shaltout, eds. (Cairo: Supreme Council of Antiquities Press, 2009), 229.

GPMP Map of the Giza Necropolis. To construct this map, AERA’s principal surveyor David Goodman first laid in an outer, closed loop of eleven primary control monuments, GP1 through GP11, each serving for both horizontal and vertical (elevation) control. He surveyed these and established their positions relative to one another to an accuracy of better than one part in 320,000. He then established secondary control monuments, and their location relative to GP1 through GP11 using the transects shown. Finally, Goodman picked the center of the Khufu Pyramid as the origin of his map and assigned to it coordinates of North 100,000 meters and East 500,000 meters. Map prepared by Rebekah Miracle, AERA GIS.



Above: Mark Lehner's map of the Sphinx Complex with key areas within the Sphinx Temple and an observation point (OP1) for the summer solstice.

Right: The sunset on the summer solstice can be seen today from the top of the eastern wall above the eastern colonnade, slightly east of observation point OP1, on the actual colonnade roof, now missing. From this vantage point, elevated several meters above the temple floor, the sun appears to set directly between the pyramids of Khafre and Khufu.

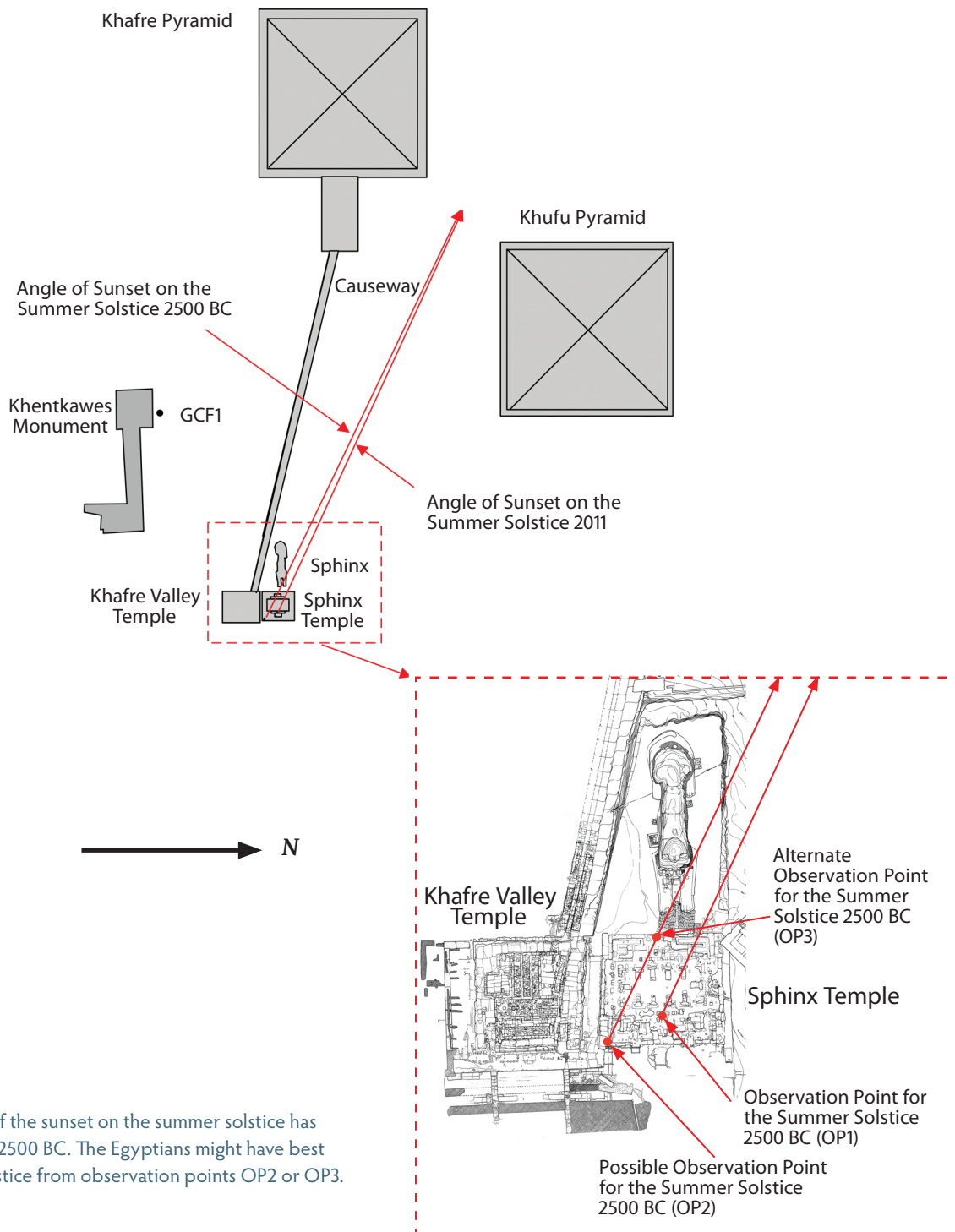


In exploring our hypothesis, we will start where Lehner observed the summer solstice, in the Sphinx Temple (facing page, top). Within the temple, twenty-four granite pillars surrounded a central courtyard which once contained ten to twelve colossal statues. Two additional pillars flanked niches set at the back of stepped east and west bays.⁵ These niches flooded with light during the rising and setting of the sun on the equinoxes.

To test whether the colonnade above the eastern niche could have been intended as an observation point for the summer solstice sunset, we need to measure the angle of a ray drawn from

there to a point directly between the pyramids of Khufu and Khafre (facing page, bottom). We draw rays from the colonnade (observation point OP1 on facing page, top) to the northeast corner of the Khafre Pyramid and the southwest corner of Khufu. Next, we draw a ray bisecting the two. The bisecting ray runs at an angle of 24.7 degrees north of true west, or, more properly stated, at an azimuth of 294.7 degrees clockwise of true north.

5. H. Ricke, "Der Harmachistempel des Chefred, Giseh," *Beiträge zur ägyptischen Bauforschung und Altertumskund* 10 (1970): 1-43.



The direction of the sunset on the summer solstice has changed since 2500 BC. The Egyptians might have best viewed the solstice from observation points OP2 or OP3.

The predicted azimuth of the sunset on the summer solstice is 294.9 degrees, agreeing well with Lehner's observations.⁶

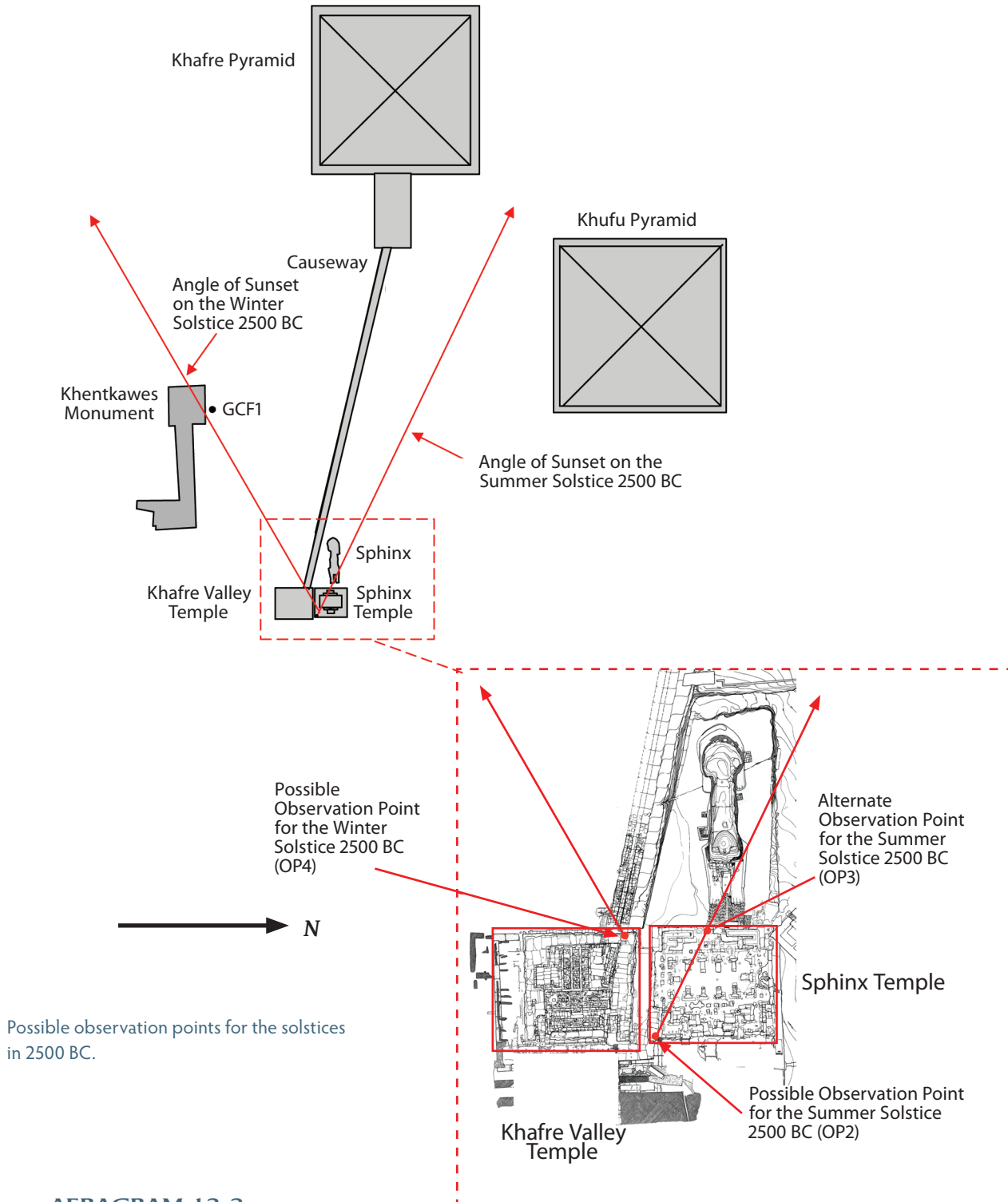
However, the position of the sunset has changed since 2500 BC due to changes in the Earth's obliquity, or tilt. Then, the sun set 0.6 degrees to the north, or at 295.5 degrees, a little more than one solar diameter away. The change causes us to consider the possibility that the priests stood elsewhere on the temple roof (shown in figure on previous page).

If we draw a ray from the Sphinx Temple to the center point between the pyramids at an angle of 295.5 degrees, we end up moving our observation point to OP2 in the figure on the previ-

ous page. The priests could have observed the sun setting on the solstice directly between the pyramids from this point, or from a vantage point near the center line of the Sphinx Temple at its western edge (OP3).

Indeed, had the Sphinx Temple been completed the priests could have observed both the summer and winter solstices from observation point OP2. The calculated azimuth of the sunset on the winter solstice in 2500 BC is about 240 degrees or 30 degrees south of due west. If we draw a ray at this angle from OP2 to the south and west, it passes just to the north of

6. G. Dash, Solar Alignments of Giza, <http://DashFoundation.org/SolarAtGiza.doc>





Survey point GCF1 is located at the top of this prominent outcrop of Member III rock. The 4th Dynasty builders left this bedrock, and the bedrock forming the pedestal of the Khentkawes Monument, when they quarried stone for the pyramids. The northwest corner of the Khentkawes Monument shows at the far right. View to the east-northeast. Photo by Mark Lehner.

the Khentkawes monument and near GPMP control monument GCF1 (facing page). The bedrock knoll supporting GCF1, seen above and on the cover, is plainly visible from the Khafre Valley and Sphinx Temple complex today and, as it turns out, has a particular importance to our understanding of the history and geology of the plateau.

The surface layers of the Giza Plateau consist of alternately hard and soft members. We see this most clearly in the layering of the head and body of the Sphinx. A hard layer, known as Member I, supports the base of the Sphinx. The core of the Sphinx's body was cut from the softer Member II and has much eroded over time. Fortunately, the iconic head of the Sphinx was cut from the harder, topmost Member III and is well preserved. Before the pyramids were built, the surface of the southern portion of the plateau consisted mainly of Member III stone. A hard and uniform limestone, it was mostly quarried away. One place it does conspicuously remain, however, is at GCF1, where it lies, intact, beneath even older strata. The Egyptians may have used GCF1 as a control point; it has 360

degree views and good site lines. (Forty-five hundred years later, we did the same thing.) For the Egyptians, GCF1 could also have functioned as a fore sight for the winter solstice.

On the other hand, the Sphinx Temple was likely never finished, and the view from OP2 to the south and west may have been blocked by the taller Khafre Valley Temple. The priests might have better viewed the sunset from OP4 in the figure on the facing page, the point just above where the Khafre causeway enters the Valley Temple.

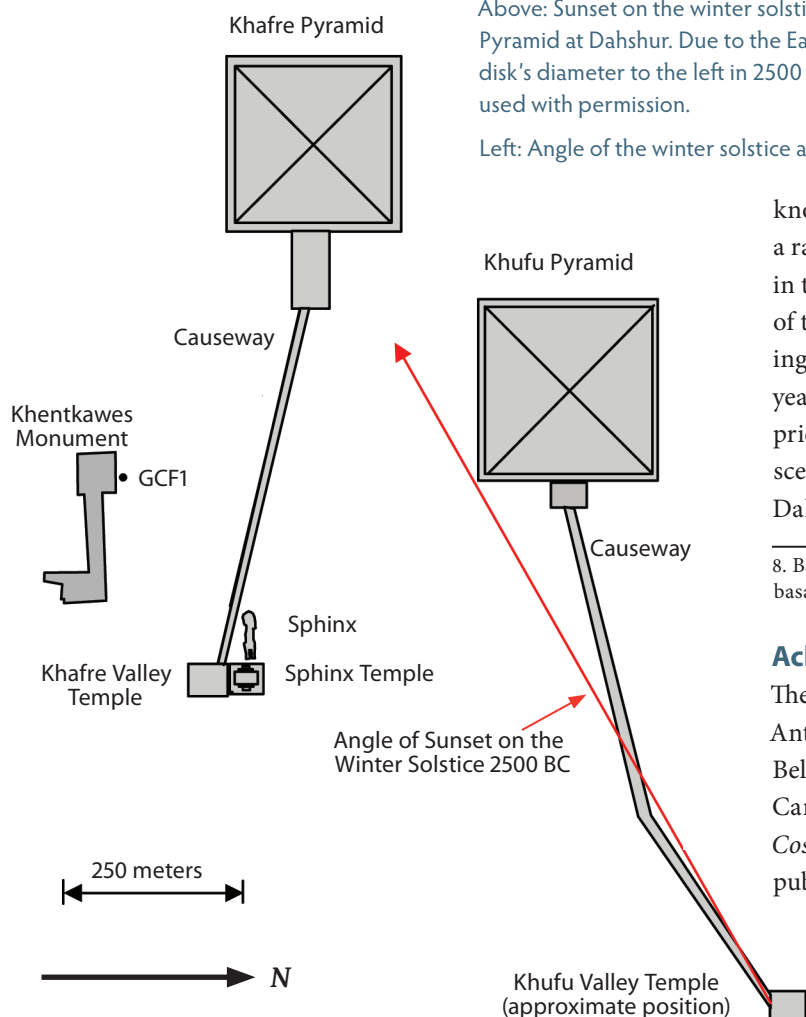
Thus far our discussion has been limited to the Khafre Pyramid complex. We find another possible alignment, however, between the Khufu Valley Temple and the Great Pyramid of Khufu. We draw inspiration from Juan Antonio Belmonte's observation of the winter solstice at Dahshur, where he found the sun setting at the northwest corner of the Bent Pyramid as viewed from its lower temple (next page, top).⁷ While we do not

7. J. A. Belmonte, "The Egyptian Calendar: Keeping Ma'at on Earth," *In Search of Cosmic Order*, 1st ed. J. A. Belmonte and M. Shaltout, eds. (Cairo: Supreme Council of Antiquities Press, 2009), 98.



Above: Sunset on the winter solstice observed from the center line of the lower temple of the Bent Pyramid at Dahshur. Due to the Earth's changing tilt, the sun would have set a little more than one sun disk's diameter to the left in 2500 BC, clipping the pyramid's northwest corner. Photo by J. Belmonte, used with permission.

Left: Angle of the winter solstice as seen from the presumed position of the Khufu Valley Temple.



know the precise position of the Khufu Valley Temple, we draw a ray at an azimuth of 240 degrees from its presumed position⁸ in the drawing on the left to the Great Pyramid. It clips a corner of the pyramid, in this case its southeast corner. Thus, standing on the Khufu Valley Temple on the winter solstice in the years before the pyramid of his son Khafre was built, Khufu's priests might have seen the sun set at a corner of the pyramid, a scene reminiscent of what his father's priests might have seen at Dahshur a generation before.

8. Based on the spot where the late 1980s AMBRIC Waste Water Project found a basalt pavement presumed to belong to the Khufu Valley Temple.

Acknowledgements

The author gratefully acknowledges the help of Dr. Juan Antonio Belmonte in the preparation of this article. Dr. Belmonte is an astronomer at the Instituto de Astrofísica de Canarias in Tenerife, Spain, and a co-editor of *In Search of Cosmic Order: Selected Essays on Egyptian Archaeoastronomy*, published in 2009 by the Supreme Council of Antiquities Press.



The Horizon at Giza



That the sun should set very close to midway between the two largest Giza Pyramids when viewed from the Sphinx Temple on the summer solstice (June 21–22) is intriguing by itself (see previous story by Glen Dash). Adding to the intrigue: the ancient Egyptians wrote the word for “horizon,” *akhet*, as the sun setting between two mountain peaks.

And we find this word in a number of contexts at Giza. First, the very name of the Great Pyramid was *Akhet Khufu*, “The Horizon of Khufu,” but written with the crested Ibis, another glyph for *akh*, and sometimes



Detail from Thutmose IV’s Dream Stela (photo on the lower right) showing signs for “Horemakhet.”

used in the writing for horizon. Some Egyptologists believe Khufu declared himself one with Ra, the sun god, and so needed his own horizon in which to rise and set. His supposed sons and successors, Djedefre and Khafre, were the first pharaohs to add a “Son of Ra” name as the first of a standard set of names and epithets that every king thereafter took on.

Akhet was also part of the name of the Sphinx in the New Kingdom, when pharaohs, princes, warriors, and common folk worshiped the giant statue as the god Hor-em-akhet (Horus in the Horizon), a combination of the god of kingship (Horus) and the sun (in the horizon). The 18th Dynasty pharaoh Amenhotep II etched the name in limestone on a temple dedicated to the Sphinx, just off its left forepaw. His son Thutmose IV inscribed

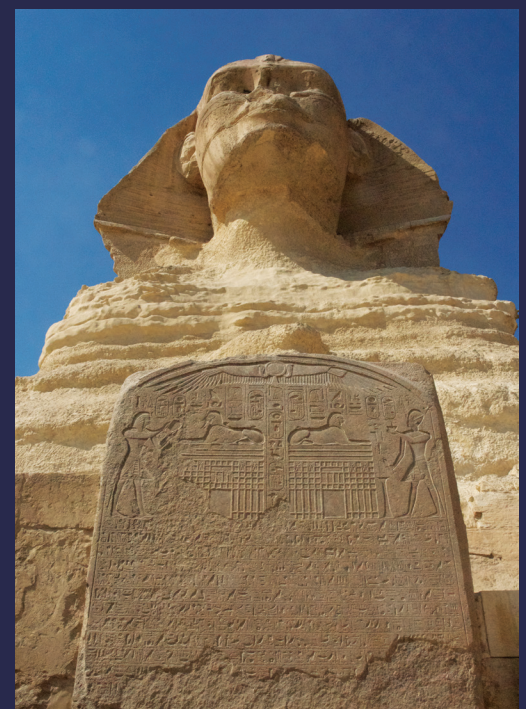
the name in the granite of his “Dream Stela,” which he erected at the base of the Sphinx’s chest to record a story that Horemakhet—the Sphinx, the sun god—chose him to be king over historically known older brothers.

Every year, when the configuration of the *akhet* hieroglyph appeared on the scale of acres, with the Khafre and

Khufu Pyramids standing in as the horizon mountains, on the summer solstice, the “wave” of the annual Nile inundation was just hitting Egypt’s traditional southern border at Aswan. Did Khafre’s pyramid planners

position his artificial mountain just so it would write, with that of Khufu, the ideogram for *akhet*, on the scale of acres? If this configuration came about by chance, could the Egyptians of his time have missed it? We are not certain. But any summer solstice that I am in Giza, I stand east of the Sphinx to watch in wonder as the sun sets between the two silhouetted mountains of the horizon. ~ Mark Lehner

Clockwise from top: The sun setting between the Khafre and Khufu Pyramids as seen from the Sphinx Temple on the summer solstice. The name Horemakhet, detail from photo just below. Amenhotep II Temple doorway, inscribed with the name Horemakhet. The Dream Stela inscribed with the story of Horemakhet selecting Thutmose IV to rule (detail in the center of the page).



Something Old, Something New, Something Borrowed in Map View: GIS Brings It All Together *by Rebekah Miracle*

While looking at the maps in our publications you may have noticed that many were produced by members of the AERA Geographic Information System (GIS) team. While using a GIS allows us to produce accurate maps, even more important is its ability to integrate spatial information from many different sources and time periods. By merging cartography with database technology, a GIS allows us to archive, analyze, and visualize different types of geographically referenced data in a single map.

Initially funded by a generous grant from the Charles Simonyi Fund for Arts and Sciences, our GIS project began in 2005 with the goal of digitally archiving and integrating our work, first at the Lost City site (aka *Heit el-Ghurab* [HeG]) and later at the Khentkawes Town (κκτ) site. With this in mind, we began to collect new excavation data in ways that make it easy to enter into the GIS—survey data is input directly from its coordinates, specialists' databases are uploaded as new database tables, and excavation drawings are digitized (traced) and turned into vector lines and polygons.

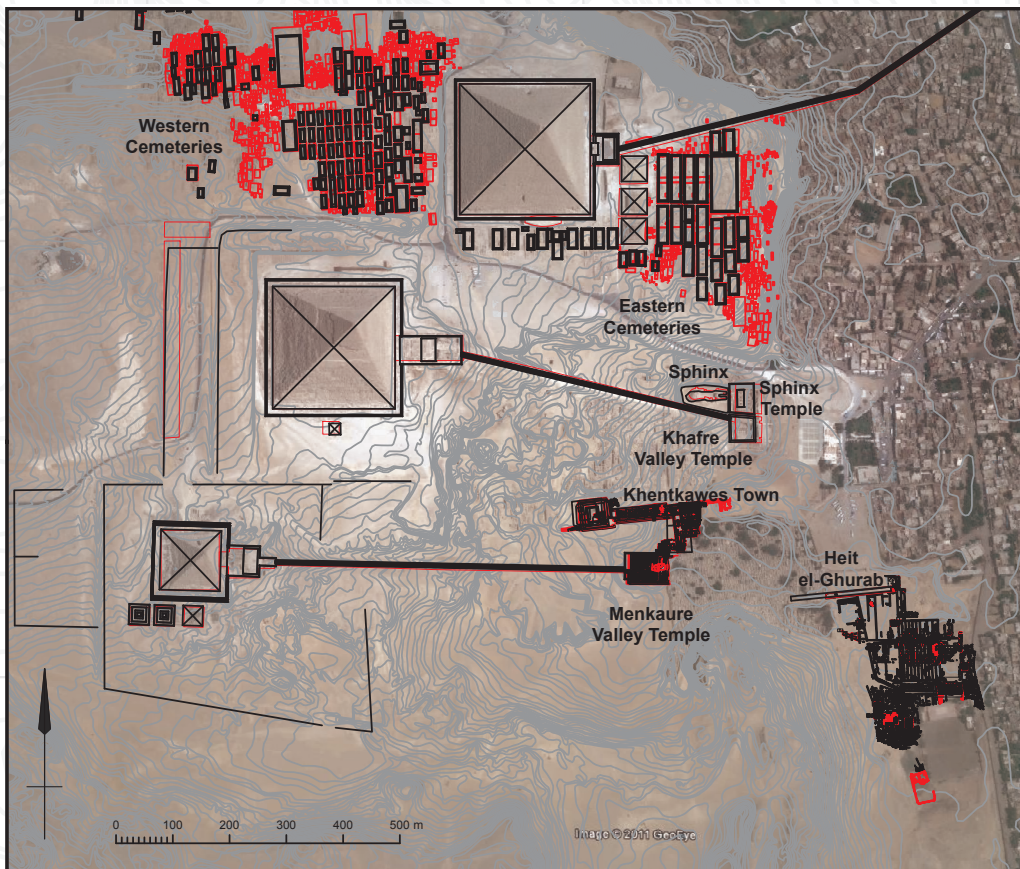
While new data is now seamlessly integrated into the GIS (see page 12), things become more complicated when we work with older data. GIS accuracy depends upon source data and any maps we produce are only as accurate as their least accurate

component. In our archives, we have AERA excavation data dating back to 1988, Giza Plateau Mapping Project (GPMP) survey notebooks from the 1980s, Sphinx maps from the 1970s, Royal Air Force photography from the 1930s, and maps documenting previous archaeological activity at κκτ and the Menkaure Valley Temple (MVT) back to 1910. Many challenges arise when attempting to combine such disparate datasets, scope and depth of excavation, and methods of archaeological recording. All of this data has to be prioritized, analyzed, and digitized. Anything that predates the establishment of our survey grid in 1985 must also be translated into the GPMP coordinate system before it can be input into our GIS. This process of historical data integration can be time-consuming.

As our excavations have expanded outward from HeG to κκτ, and now farther out to MVT and the areas east of the κκτ basin, our focus for the GIS has started to expand back to the original mission of the GPMP—mapping the entire Giza Plateau with the most accurate technology available.

While Giza Plateau data has existed in some form in the GIS since 2005, it was often digitized from maps of unknown accuracy, few of which were originally tied to our GPMP coordinate system. Much as in a game of telephone, each time maps are copied or manipulated, errors can be introduced, and while

the data was accurate enough for our purposes at the time, it was not reliable enough to use for maps that required a high level of precision. Now that our GIS data is being relied upon for both digitally reconstructing the plateau as well as planning the physical reconstruction of Old Kingdom structures, extremely accurate data is a necessity. And in order to have *truly* accurate data, we must tie everything to the most definitive data possible—survey points measured at ground truth.



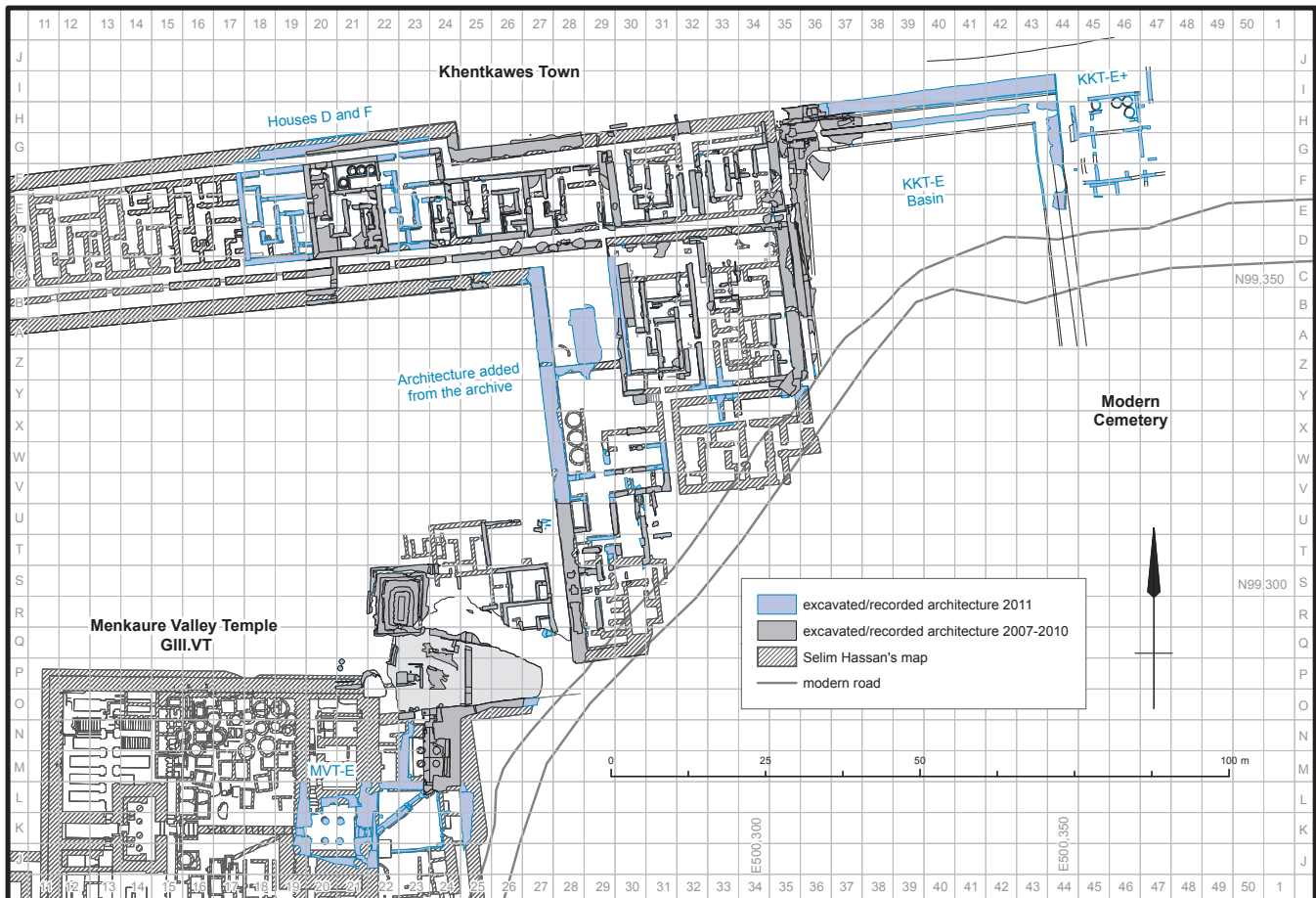
Excavation data, satellite imagery, contour lines extracted from survey data, and digitized historical maps are all combined to illustrate the Giza Plateau. Areas in red were added or edited in 2011. The structures in the Eastern and Western Cemeteries were added in collaboration with Dr. Peter Der Manuelian.

With a grant from the Glen R. Dash Charitable Foundation, we have been able to start the process of tracking down and entering Giza Plateau survey data from our archives. In some cases, this data is only available in the original surveyor's notebooks. So this past September I spent a week in the Boston office sorting through our archive room with Mark Lehner. We found dozens of maps and thousands of survey points recorded by Dr. Lehner and his team, but never before entered into the AERA GIS. Now we are using these records to more accurately locate major monuments at Giza. I have already updated locations for the Sphinx, the Sphinx Temple, and the Khafre Valley Temple, but there are still many additional monuments to be re-examined. In January of 2012, we will use the second portion of the Dash Foundation grant to carry out a new survey on the Giza Plateau so we can continue filling in missing gaps in the data.

Where survey points are not immediately available for an area, we must rely on georeferencing. To georeference something is to define its existence in physical space. Without direct survey data, this is done by visually matching a map or other image to an area within the existing GIS data. Using our expanded excavation data, this season I was able to re-georeference Selim Hassan's 1943 map of his KKT excavations

with a much greater degree of accuracy. Additionally, this summer I worked on a project in coordination with Dr. Peter Der Manuelian of Harvard University and director of the Giza Archives Project at the Museum of Fine Arts Boston to georeference 66 historical maps from their archives to our GMP coordinate system. As a result of this project we now have over 1,500 more mastaba tombs visible both on our own maps as well as on Dr. Der Manuelian's forthcoming 3D model of the Giza Plateau. In addition to future use, these more accurate maps have already made new areas of inquiry possible, including a study of the solar alignments at Giza (see page 3).

Besides our 2012 Giza Ground Truth Survey Project (GGT), we have several other projects planned for next year that will continue to improve our Giza Plateau maps. These include digitizing Dr. Lehner's stone-by-stone Sphinx plans (the only existing large-scale maps of the Sphinx), adding survey data from our archive in Giza, and continuing to work on our 3D modeling projects. While never perfect, as more data is gathered and technologies evolve, each year we will continue to expand and improve our dataset as we strive to produce the most accurate maps possible of one of the largest and most complex archaeological sites in the world.



Khentkawes Town before and after the 2011 field season, showing the four new KKT excavation areas as well as newly digitized architecture from previous seasons.

GIS in the Field

While our off-season efforts focus on integrating archival data into the GIS geodatabase and producing illustrations for publication, during the excavation season our priority is the daily digitization of new finds as they come out of the ground. This immediate integration of new data into the AERA GIS provides archaeologists, surveyors, and other team members with a quick, accurate, and integrated visualization of the entire site. This helps them to solve problems that arise during fieldwork, reconstruct stratigraphic relationships, test hypotheses, and fix errors before they enter the archive. During excavations, we also continue to produce highly detailed maps to aid in the ongoing excavations, help develop plans for our projects to conserve and replicate Old Kingdom structures, and illustrate the end of season excavation reports.

Each season we train excavation members and assist them with digitizing archaeological features, such as hearths, walls, pits, floors, or soil layers, as they are recorded in the field. This system of direct and immediate digitization at the level of the archaeological feature



In the GIS-Computer Lab at our AERA-Egypt Center in Giza, AERA team members digitize information for the AERA GIS. GIS analyst Rebekah Miracle (center, looking toward camera) oversees their work.

is uncommon in archaeology, but it enables us to quickly create a digital excavation archive, produce highly detailed maps, and assign accurate spatial information to the finds (ceramics, bones, burials, etc.) that are associated with the archaeological features.

This Season 2011, when we had to temporarily halt our excavations due to events surrounding the January 25th Revolution, every single seat in our computer lab (as well as many of the seats in the dining room) was taken by someone digitizing data into the GIS. With this increased effort, this year was the first season that we were able to digitize not only every single excavated feature, but also every brick and stone in the newly dug walls—not a small feat considering that over 750 archaeological features and over 17,000 bricks and stones were digitized. Since I was the sole GIS analyst on site, this was only possible with the assistance of many other team members, especially Dr. Delphine Driaux and Brittany Hughes.

Now that the excavation season is over, we are able to produce detailed illustrations of this season's work for our publications, members of our team can access and refine their data from around the world, and the archaeological specialists' datasets can be fully integrated with the most recent excavation data, allowing us to place their finds in a visual context and highlight intra-site differences in the use of space. Then, starting in January when we return to Giza, the whole cycle will begin again...

~ Rebekah Miracle

New walls emerge from Standing Wall Island (SWI), a cattle corral and possibly a butchering place we discovered in Season 2011 (*AERAGRAM* 12-1: 2-5). Normally we only digitize the details of clearly defined walls, but it is not always easy to immediately tell what constitutes a wall. Since this year was our first season of intensive excavations in SWI, and we had a slightly shortened field season, we made the decision to digitize everything, and then digitally separate the walls from the collapse within the GIS at the end of the season. Fully half of the bricks and stones we digitized this year were in the walls of SWI!





Stews, Meat, and Marrow: Extracting Protein and Fat for the Lost City

During its heyday we imagine the Lost City of the Pyramids bustling with a veritable army of people working in the service of the pharaoh: laborers, craftsmen, masons, foremen, scribes, and administrators. In addition, a large cast of “backroom” people—such as cooks, bakers, brewers, water boys, washer women, cleaners, basketmakers, weavers, leatherworkers, and potters—must have provided goods and services to keep the operation running. A major challenge for this backroom staff must have been feeding everyone. One of our research goals since the first field season has been to find out how.

Over the years we have been progressively uncovering the gross outlines, and sometimes the fine details, of food procurement, storage, production, and distribution in the Lost City. We draw upon a range of archaeological data from the site including plant and animal remains; pottery; stone tools; and archaeological features, such as hearths, ovens, and pits; as well as artistic representations from tombs.

Cooking meat in a pot, from a scene in the tomb of Antefoker. After S. Ikram, “Meat Processing,” in *Ancient Egyptian Materials and Technology*, P. T. Nicholson and I. Shaw, eds. (Cambridge, Cambridge University Press, 2000), 656.

We realized early on that the raw ingredients of the Lost City diet came from a net cast far and wide. Richard Redding, our faunal analyst, determined that a central authority provisioned the town with cattle, sheep, and goats, most likely from large state-owned herds.¹ During Season 2011 we uncovered a sizable corral on the outskirts of town where livestock were probably kept before being slaughtered and processed in an adjacent facility (map on facing page).²

Central authority likewise provisioned the settlement with cereals. AERA archaeobotanist Mary Anne Murray discovered in her first work at Giza that barley and emmer wheat grains, the staples of the diet, arrived at the town nearly ready to use. The cereals appear to have been threshed, winnowed, and sieved elsewhere—probably in agricultural villages up and down the Nile that had to supply their quota. These grain shipments most likely went into silos in a large walled facility that we call the Royal Administrative Building, on the east side of the settlement, before being distributed.³

1. R. Redding, “Treasures from a High Class Dump,” *AERAGRAM* 8-2 (2007): 6–7. All back issues of *AERAGRAM* are available at our website, www.aeraweb.org, for free download.

2. R. Redding, “Standing Wall Island Mystery, Solved,” *AERAGRAM* 12-1 (2011): 2–5.

3. “Pharaoh’s Storeroom and Counting House,” *AERAGRAM* 6-1 (2002): 6–7.

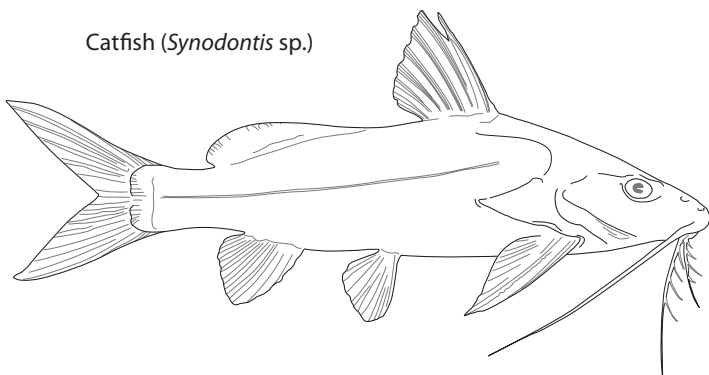
We have various lines of evidence suggesting food processing and preparation methods. For meat, Richard believes that stews were used to feed the large numbers of rotating laborers who stayed at the city while performing their service to the pharaoh. These one-pot dishes efficiently feed large groups and allow the cook to “stretch” the meat. Indeed, Richard discovered through library research that stews were widely used in the past to feed armies and crews on ships.

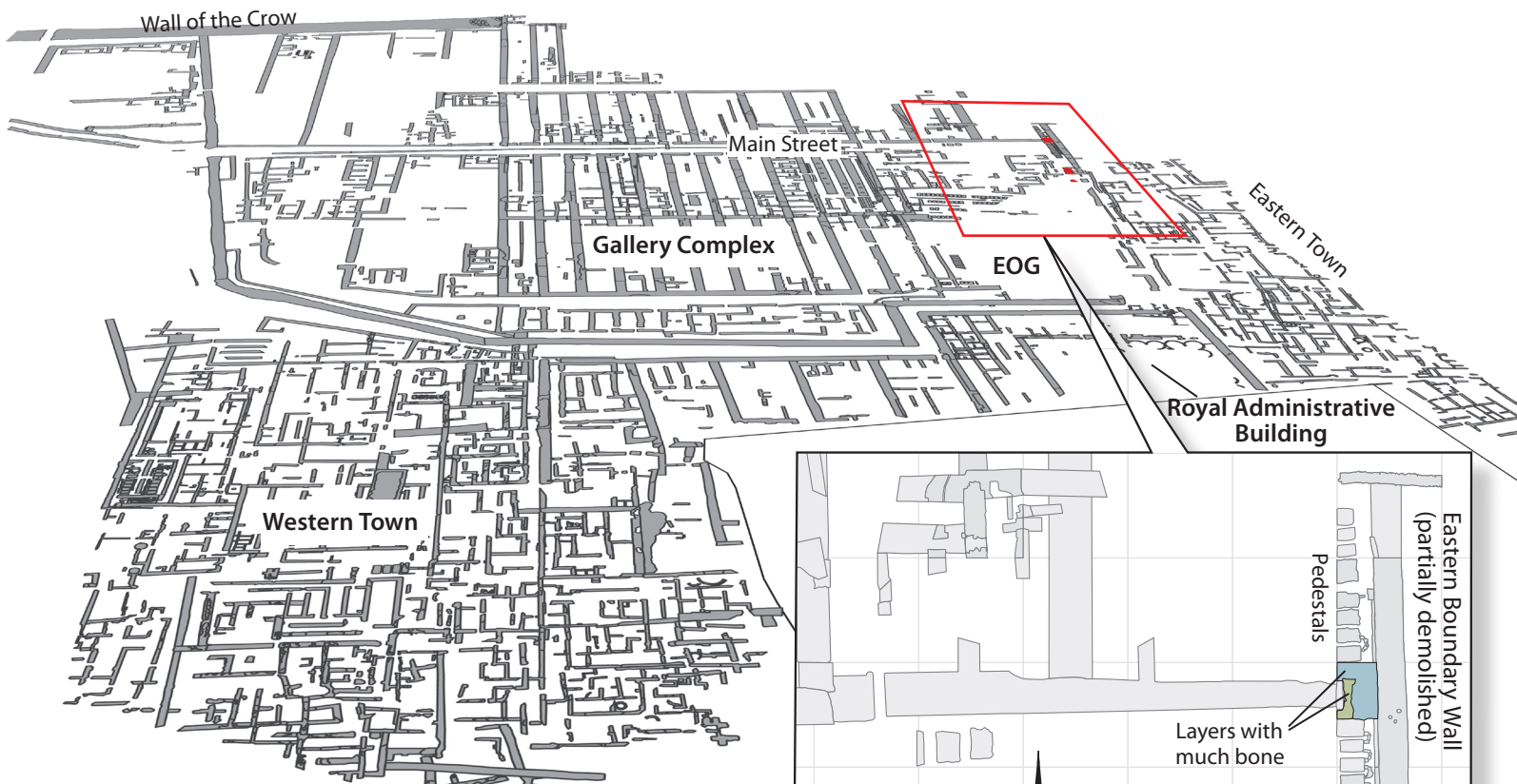
This season, Lisa Yeomans, AERA excavation supervisor and faunal analyst, shed more light on the processing of sheep and fish. She saw evidence in a collection of animal bone from trash deposits that residents eked the most out of sheep and goat carcasses. The trash came from an area immediately east of the block of galleries that we believe housed rotating laborers. AERA archaeologists recovered the bones while excavating the far eastern end of the central artery we call Main Street, which ends up against a thick Eastern Boundary Wall. This area, Main Street East (MSE), featured a row of curious small pedestals. Area MSE extends off the northern end of Area EOG (East of the Galleries), a large production yard with many bakeries (map next page).

Frugal Cooks, Careful Fish Handlers by Lisa Yeomans

In analyzing deposits of animal bone excavated in Area Main Street East I found evidence for intensive and specialized processing of sheep and goats. A large assemblage of bone came from the later part of the town’s occupation, after the mudbrick Eastern Boundary Wall had gone out of use and been partially demolished (see map on following page). But the presence of Old Kingdom pottery indicates that the activities were contemporary with continued occupation in other parts of the settlement. As the structures within this part of the settlement were no longer used, the area formed a suitable location for the

Catfish (*Synodontis* sp.)





Above: The Lost City of the Pyramids, *Heit el-Ghurab*, "the Wall of the Crow," the Arabic name of the site.

Right: Detail showing location of the deposits with smashed bone. The pedestals and Eastern Boundary Wall were partially demolished and no longer in use when the bone was dumped here. Map prepared by Rebekah Miracle, AERA GIS.

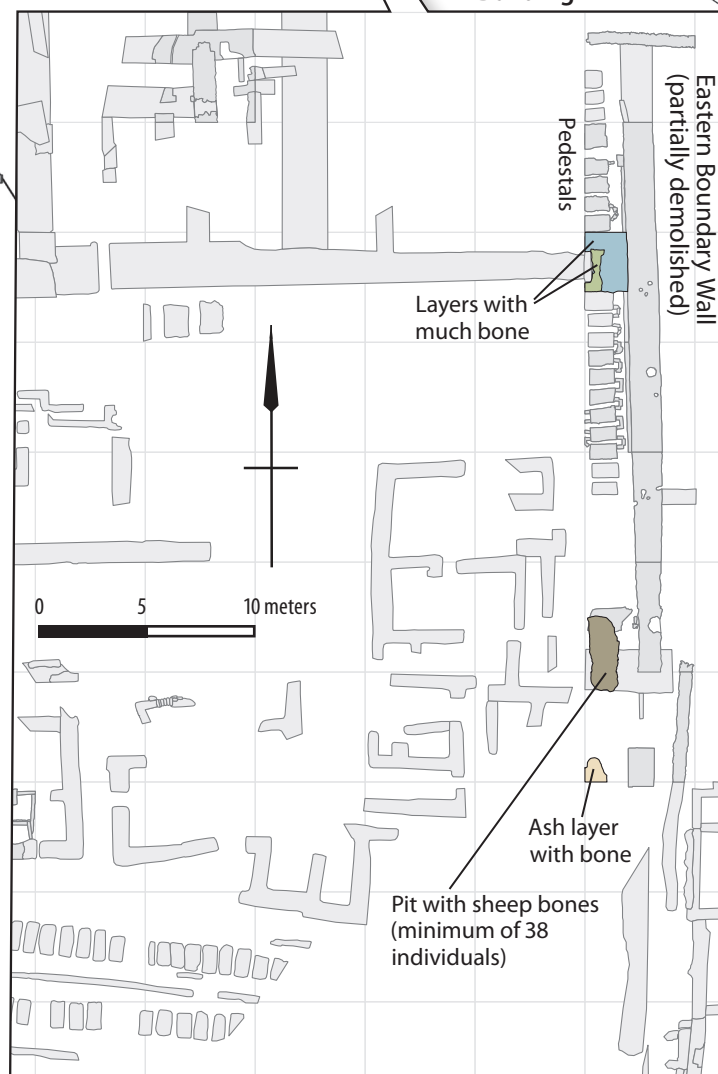
smelly and unpleasant aspects of animal butchery and carcass rendering.

After butchery, animal bone was dumped or discarded in pits. The collection is particularly interesting because there was not the wide range of species typically found among discarded rubbish; the bone is mostly just the refuse generated by butchering sheep and goats.

In total, 1,081 identifiable bone fragments came from these deposits, and 98.9% of these were sheep or goat bones. One pit contained numerous sheep and goat bones that had been heavily fragmented and represented at least 38 animals.

Among the bone remains, there were few feet. These are often left attached to skins removed from carcasses before they are butchered, suggesting that the hides here were frequently removed and used by leatherworkers in a different part of the settlement. Additionally, very few ribs or vertebrae fragments were found in the assemblage. These bones would probably have been left attached to the meat and discarded elsewhere.

Long bone shaft fragments were very abundant and small (typically about three-quarters to slightly over an inch long); the bones were undoubtedly broken up in order to extract marrow. Marrow is a fat-rich substance stored in the central cavity of the long bones and in the mandible (lower jaw) of healthy animals. To access the marrow, people smash the long bones



and mandibles, resulting in splinters of long bone shaft, such as those found at Main Street East. On the other hand, we sometimes found the fronts of mandibles missing. Butchers may have chopped some mandibles at the back between the incisors and molars, perhaps to remove the tongue.

In addition to marrow, grease is stored in bone, specifically within the spongy ends of bone. But extracting this nutritious material is a time-consuming process that involves smashing the ends of bones into small fragments, boiling them, and skimming the grease from the water. The animal bone assem-



Sheep molars under analysis in the Giza Field Lab. Lisa Yeomans found the fronts of some sheep mandibles missing, suggesting that butchers may have chopped the mandibles at the back between the incisors and molars to remove the tongue. The mandibles were a source of marrow.

blage from Main Street East is typical of waste resulting from this process: many small fragments of the articular ends of long bones along with bone bits smashed beyond recognition.

From the discarded animal bones we can estimate the ages of the sheep and goats at the time they were slaughtered. Few of the bones were from young animals, fewer than generally found across the Lost City site. Since not much fat is stored in the bones of young animals, the carcasses of these animals would not have been processed for marrow and grease. Most of the animals were slaughtered as young adults, similar to the general trend across the site of the sheep and goat being culled when they reached maturity, providing a maximum amount of meat.

The evidence for rendering marrow and grease from sheep and goats shows that the butchers intensively processed the carcasses to gain as much nutrition from the livestock as possible.

Further evidence for the use of the area for specialized butchery was found in another interesting feature. A layer rich in pottery debris also contained the cleithrum and pectoral spine bones of at least 12 catfish, all of the same type (*Synodontis* sp.), but few bones of other fish. The cleithrum forms the pectoral girdle of the fish, to which spines are attached. So these bones may represent the initial butchering of fish during which the spines were removed before gutting so as to avoid injury.

This evidence fortifies our impression that the areas East of the Galleries (EOG) and Main Street East were primary areas of production and food processing.

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Des Moines

May–August 2012
Museum of Science
Boston

Now In Des Moines! At the Science Center of Iowa: *Lost Egypt* exhibition, featuring AERA as an exemplary archaeological mission. The show highlights AERA's use of science and technology to understand the people and culture of ancient Egypt.

Look for AERA featured in *Lost Egypt* at the Museum of Science, Boston, May through August 2012!

Lost Egypt was created and produced by COSI (the Center of Science and Industry in Columbus, Ohio) and built by the Science Museum of Minnesota.

Season 2012: Food and Housing, Town and Temple

In mid-January we will return to Giza to excavate our flagship Lost City of the Pyramids site and, roughly 300 yards to the northwest, the Khentkawes Town and Menkaure Valley Temple. We have our sights set on six targets:

Special Affections: The Menkaure Valley Temple

Why on earth did later pharaohs care so much about this king, Menkaure? Why expand, embellish, and renew with care and add accouterments many centuries after Menkaure died and was buried in his pyramid, which his own workers left unfinished like his temples and the smaller pyramids of three of his queens? We find signs of this caring for Menkaure deep into later generations as we re-explore for the first time in 100 years the Menkaure Valley Temple.

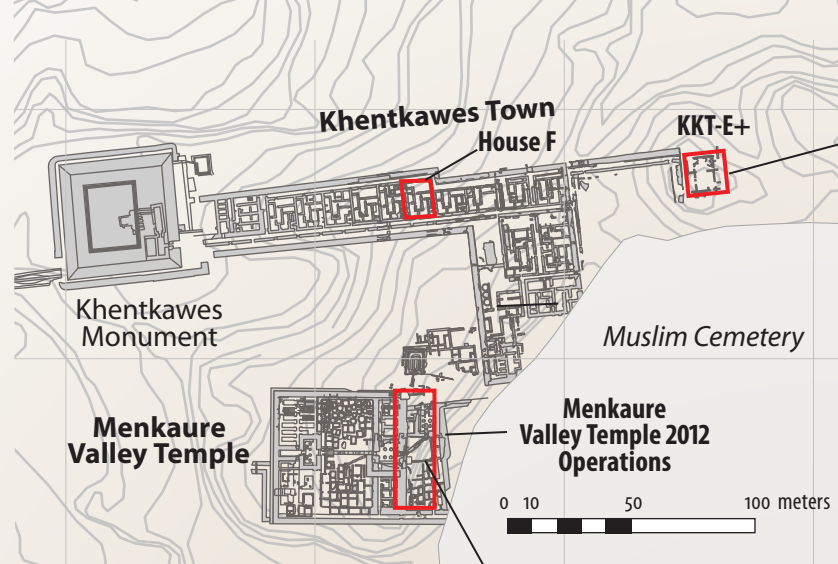
Valley temples were those additions at the eastern end of a long causeway that every Old Kingdom pyramid complex included. The valley temple was the portal to the king's memorial pyramid complex. In Menkaure's Valley Temple people did a sit-in. They built houses, bins, and granaries to ensure their cut of the endowments lavished by later kings on the memory of king Menkaure of old. Why was he special?

Stay with us next season as we penetrate further into the temple interior, focusing our detective story with the best of modern archaeological techniques not available to George Reisner, the last to excavate the temple 100 years ago (though his methods were exemplary for his time). Major discoveries may well have been missed.

Town with No End: Khentkawes Running East

Does the Khentkawes Town ever end? Our path of discovery takes us ever farther east, and lower and deeper from the ground level of the enigmatic queen's mighty monument and town stretched along its causeway, all known and mapped as long ago as 1932. Between 2007 and 2011 we have followed the queen's complex ever farther east, and lower, descending via ramps, stairs, corridors, and a deep basin (once flooded as a harbor?).

Last season we found the eastern edge of that possible harbor, and thought that might be the end of the Khentkawes Town. But no, the town carries on. Walls, courts, magazines, and grain storage silos on a terrace stretching east appear to be for delivery and redistribution at the edge of the harbor. Can we expect a waterway connecting to the Nile, which must have run nearly a kilometer more to the east at best?



What Was a House?

Do we even understand what was a “house” in the Giza pyramid settlements? Where did a house end and begin? In the Khentkawes Town—where we think that the initial plan comprised modular, repeating house units—we have discovered that doorways connect a series of houses. At the same time walls seal off rooms that stretch across what we think to be separate units. Walls with no doors seal off courts and chambers, making them exclusive to one “house,” but not to those who lived “next door.” This is what we found in House E. A large court on the north end of House E—a court that eventually sheltered grain storage silos—was totally accessible to House F next door (east), but not at all to those who moved about in House E.

So now we want to know more about House F, and those who lived within. Why did they enjoy such privileged access to grain, a measure of wealth in the pre-money Old Kingdom?

Going after Another Gallery (III.3)

Are we on the right track thinking that the Gallery Complex was a barracks for a royal guard or workforce?¹ We have based this hypothesis on a number of lines of evidence, not least of

1. M. Lehner, “Of Gangs and Graffiti: How Ancient Egyptians Organized Their Labor Force,” *AERAGRAM* 7-1 (2004): 11–13. “Zau of What? The Royal Guard,” *AERAGRAM* 7-1 (2004): 14–15.



KKT-E+ 2011. Clearing and mapping walls

which is our complete excavation of Gallery III.4, the only one we exposed in its entirety. What about the others? Are they similar in plan? Do they feature sleeping platforms in the long front porch-like colonnade, the critical evidence that multiple people slept here? Next season we hope to know more.

What Was Brewing in an Official's House?

A microbrewery within the house of one of the highest officials of government? So our work has led us to suspect in the largest structure we have found in the Western Town, which we prosaically call, House Unit 1. It included a reception hall, a master bedroom, work areas, storerooms, and courtyards, as well as the ash-filled “bakery” located on the eastern end. Was this also a brewery? High-ranking titles on clay sealings, used to seal bags, boxes, and jars, and discarded in a garbage heap² outside, tell us that this structure was likely home to a high-ranking scribe, who may have hosted a scribal workshop in his residence. Was he brewing beer on the side? Next season we will excavate this messy “kitchen”—bakery, brewery, or both?

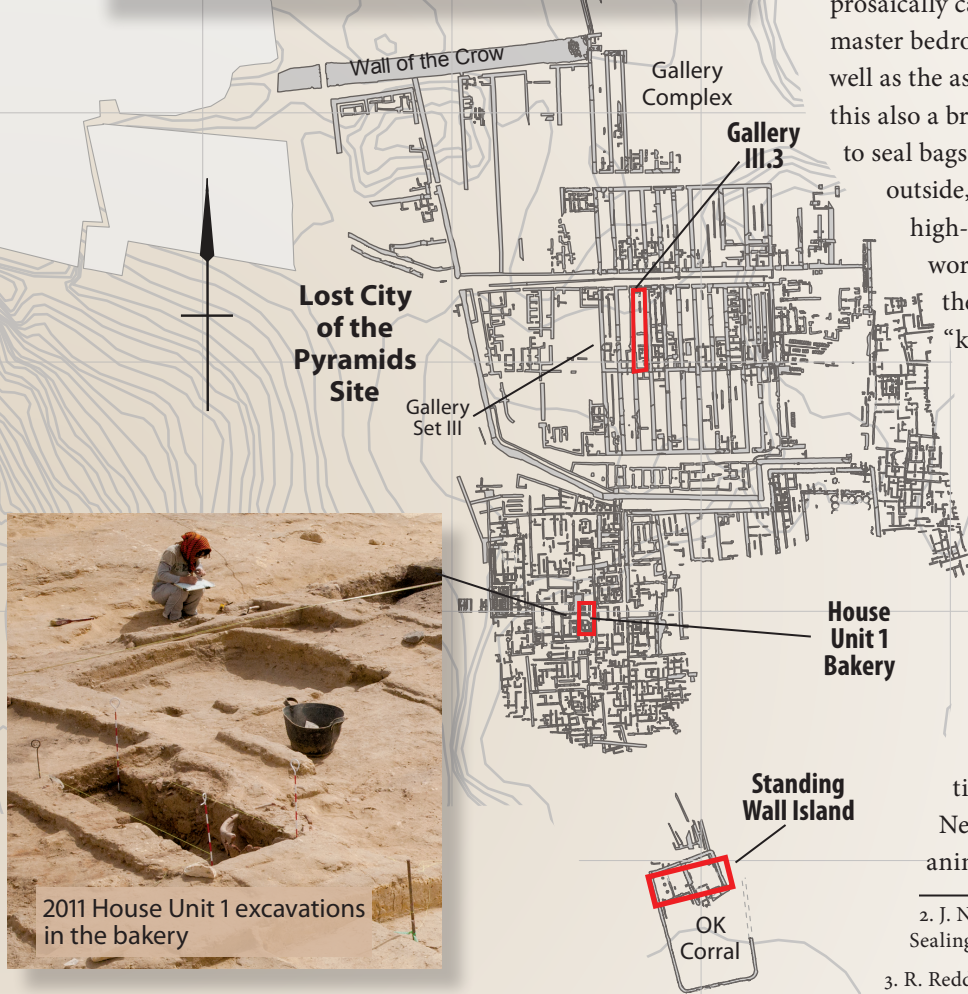
Blood and Guts: Meat for the Lost City

Where did all the cuts of meat cooked at the Lost City come from? We suspect that livestock was held in the OK Corral, a large enclosure we discovered last season,³ and butchered in pens in the adjacent enclosure we call Standing Wall Island (swi). We will be excavating swi looking for tethering stones for retaining animals and signs of butchering (see sidebar below).

Over the years we have found enormous quantities of cattle, sheep, and goat bones across the site. Next season we may finally learn where most of these animals were dispatched and butchered.

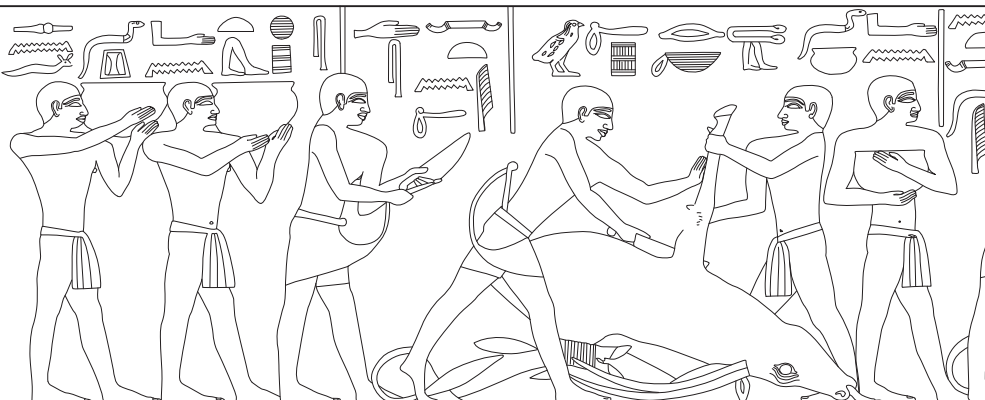
2. J. Nolan and A. Pavlick, “Impressions of the Past: Seals and Sealings from Pottery Mound,” *AERAGRAM* 9-1 (2008): 2-4.

3. R. Redding, “Standing Wall Island Mystery, Solved,” *AERAGRAM* 12-1 (2011): 2-5.



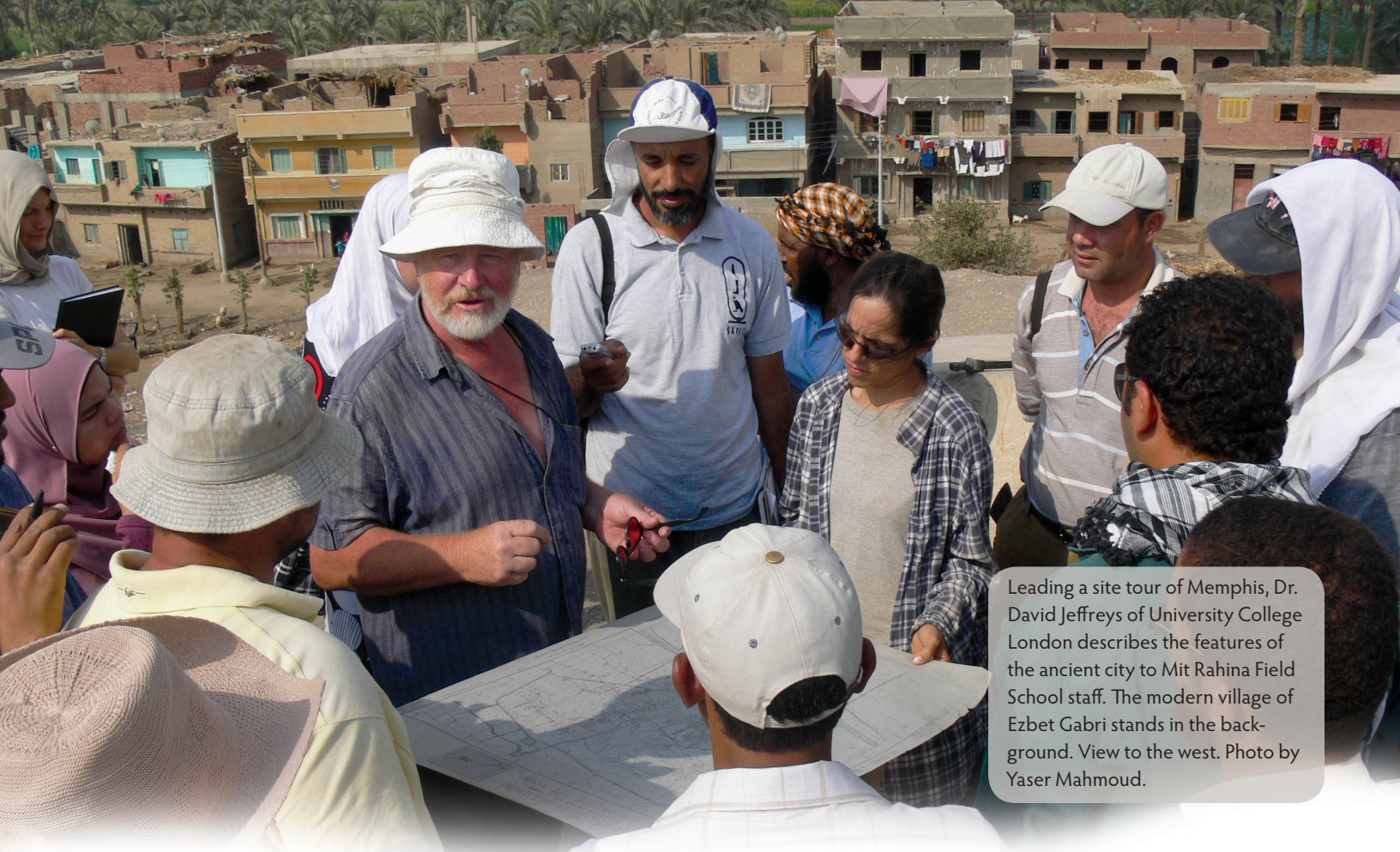
2011 House Unit 1 excavations in the bakery

The Telltale Signs of an Old Kingdom Slaughterhouse: Blood Bowls, Knives, and Flakes



This scene from the 5th Dynasty tomb of Ti at Saqqara suggests the kind of remains that might have been left at Standing Wall Island if it had been a slaughterhouse. On the left and far right, men carry large bowls that were used to collect blood from the ox after its throat was slit. We could expect to find the sherds of the occasional broken bowl. Behind the butcher, a man sharpens a flint knife by pressing off small flakes from the cutting edge. Large numbers of the tiny flakes would be a good indicator of butchering. In the center, a butcher cuts into the ox with a large flint knife, something we probably would not find unless broken.

After L. Épron, *Le Tombeau de Ti*, Cairo: Institut Français d'Archéologie Orientale, 1939.



Leading a site tour of Memphis, Dr. David Jeffreys of University College London describes the features of the ancient city to Mit Rahina Field School staff. The modern village of Ezbet Gabri stands in the background. View to the west. Photo by Yaser Mahmoud.

New Cycle, New Site: The Mit Rahina Field School*

In September, just a few months after completing the Luxor Study Field School,¹ we launched the third cycle of our Field School program at the site of ancient Memphis, modern Mit Rahina, about 14 miles south of Cairo. With support from the American Research Center in Egypt (ARCE), we are running the eight-week Beginners Field School in collaboration with the venerable London-based Egypt Exploration Society (EES). The session is our ninth field school for Antiquities Inspectors working for Egypt's Supreme Council of Antiquities (SCA) (see page 20 for an overview of our field school program).

Memphis

Memphis, located strategically just above the apex of the Nile Delta—the junction of Upper and Lower Egypt—was Egypt's administrative capital for most of the Pharaonic period and one of the preeminent cities of the ancient world. Today the ruins sprawl north-south 2.5 miles and about 1.5 miles east-west, a vast site but a mere 10% of the city in its heyday. The ruin field encompasses ten mounds rising above low, damp areas that used to flood during the annual Nile inundation. Much of the site lies under fields and modern urban spread from an original five villages and towns.²

Thirty years ago Prof. Harry Smith of the EES launched the Survey of Memphis, directed by Dr. David Jeffreys of University College London and Dr. Lisa Giddy of Sydney University, in order to map and record the remnants of the ancient capital and trace how the environment and the town changed over its long duration. They found that as the Nile migrated east the town followed.

In collaborating with the EES we had the opportunity to draw upon their expertise and extensive work on the environment at Memphis. As a result, our curriculum for the first time included training in ways to gather and interpret evidence of environmental change over very long stretches of time. Memphis also gives students the opportunity to work on a complex settlement site with layered deposits representing a long time span.

The AERA-ARCE Mit Rahina Field School (MRFS) takes place in *Kom al-Fakhry*, the oldest known part of Memphis. The MRFS site includes mudbrick settlement structures dating from the Middle Kingdom and a cemetery dating to the First Intermediate Period or early Middle Kingdom (2134–2040 BC).

* A special thanks to the Charles Simonyi Fund for Arts and Sciences and Susan Hutchison for their support of the Mit Rahina Field School and the AERA GIS program.

1. "The Luxor Study Field Season," *AERAGRAM* 12-1 (2011): 6–8.

2. D. Jeffreys, "Memphis," In *The Oxford Encyclopedia of Ancient Egypt*, Vol. 2, D. B. Redford, ed., (Oxford: Oxford University Press, 2001), 373–376.



Students and Staff

Field School Directors Mohsen Kamel and Ana Tavares selected 29 students from among 200 applicants that they interviewed on June 6. In the MRFS now in progress, they oversee an excavation teaching staff of ten Egyptian (graduates of the AERA-ARCE Field School program) and four non-Egyptian supervisors. Another ten Egyptians (eight field school grads) and one non-Egyptian teach specialties—illustration, osteoarchaeology, archaeobotany, ceramics, objects, conservation, and faunal analysis—and handle survey, photography, and archiving. That so many of our former students (many students of the entire cycle of courses) take on the task of teaching others reflects the success of the field school program.

The EES team is headed by Dr. David Jeffreys, assisted by Dr. Judith Bunbury and Pedro Goncalves.

Training

Our Beginners Field School trains students in the basic skills needed to scientifically excavate and record an archaeological site: excavation techniques, survey methods, site recording, illustration, photography, and burial excavation. For six weeks the MRFS students, divided into five teams, work eight hours on site, then attend afternoon lectures. In the evenings they complete paperwork and contribute to the scientific archive. They



Mit Rahina Field School supervisor Sara Sabr and student Mohamed Abd el-Fatah draw a cut through the ancient street. Photo by Yaser Mahmoud.

write weekly interim reports and give weekly site tours and presentations of their work—all meant to encourage critical thinking about their data, their collection methods, and how they might share their work with the scholarly community. In addition, the students spend one week rotating through the laboratory where they are introduced to the study of ancient ceramics, archaeological illustration, object recording, conservation, and analysis of animal bone and plant remains. During the last week they will write a final report, among the most critical tasks for any archaeologist.

The students will return home better prepared for the variety of challenges they face in their jobs with the SCA. We look forward to seeing them in a future session of our Advanced Field School where they can concentrate on a specialty and hone their skills.

Look for a full report on the MRFS in the next issue of *AERAGRAM*.

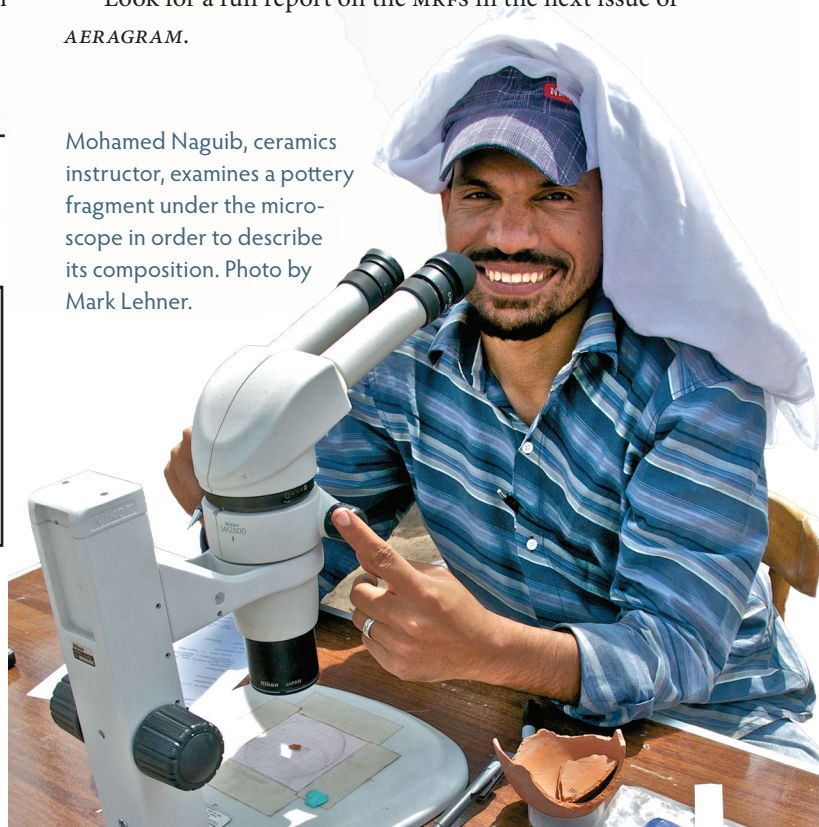


The AERA-ARCE Mit Rahina Field School was made possible by the generous support of the American people through the United States Agency for International Development (USAID). The contents of this article are the responsibility of



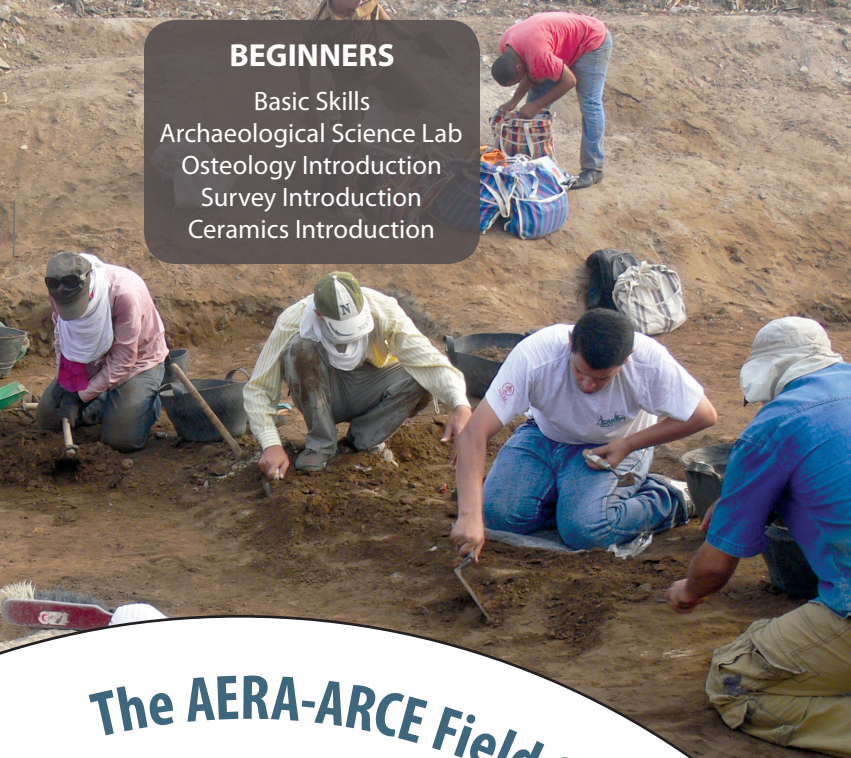
AERA and do not necessarily reflect the views of USAID or the United States Government. Funding was provided through the American Research Center in Egypt (ARCE) USAID grant (No. 263-A-00-04-00018-00).

Mohamed Naguib, ceramics instructor, examines a pottery fragment under the microscope in order to describe its composition. Photo by Mark Lehner.



BEGINNERS

Basic Skills
 Archaeological Science Lab
 Osteology Introduction
 Survey Introduction
 Ceramics Introduction



ADVANCED

Osteoarchaeology
 Survey and Mapping
 Archaeological Illustration
 Ceramics
 Advanced Excavation



SALVAGE

Rescue Archaeology
 Strategy
 Sampling
 Archive



ANALYSIS & PUBLICATION

Report Writing
 Graphics Preparation
 Publishing Osteology
 Publishing Ceramics
 Lecture Preparation Training

The AERA-ARCE Field School Program, 2005-2011

9/7 = 1/9.3

By the time this newsletter goes to press we will have completed the ninth session and the third cycle of our AERA-ARCE Field School (see page 18) since launching the program in 2005. Nine field schools in seven years equals one session nearly every nine months!

Over six years the field school has grown and expanded into a comprehensive training program. When we launched the first field school in 2005 we aimed to teach inspectors in the Supreme Council of Antiquities (SCA) standard techniques of scientific excavation. With the encouragement of Dr. Zahi Hawass, then head of the SCA, we designed a program that includes lectures, exams, and practical experience in the field working side by side with AERA archaeologists. Students learn basic skills needed to excavate and record an archaeological site including survey, excavation techniques, site recording and illustration, photography, and burial excavation. They are also introduced to archaeological illustration and conservation as well as the study of ancient ceramics, animal bone, and plant remains. Since that first session the field school has developed into a full training program with four components: 1) basic skills, 2) advanced training in specialties, 3) salvage archaeology, and 4) analysis and publication.



The AERA-ARCE Field Schools are made possible by the generous support of the American people through the United States Agency for International Development (USAID). Funding is provided through the American Research Center in Egypt (ARCE) USAID grants.





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