VOL. 13 NO. 1
Spring 2012

# AERA GRAM

ANCIENT EGYPT RESEARCH ASSOCIATES

*Groundbreaking Archaeology*

ISSN 1944-0014



http://www.aeraweb.org

# Memphis, a City Unseen:

## *Joint AERA-ARCE-EES Beginners Field School Excavates Oldest Part of Egypt's Ancient Capital City*


Last fall, AERA, the American Research Center in Egypt (ARCE) and the London-based, Egypt Exploration Society (EES) collaborated on an archaeological field school, excavating the oldest part of Memphis, the ancient capital of Egypt.[1] The EES, through its Survey of Memphis (SoM), has carried out 30 years' work on the monuments and ancient landscape of Memphis.[2] Twenty kilometers to the south of Giza, the modern village of Mit Rahina lies at the core of the ancient capital. Here, 17 years ago, ARCE launched its first archaeological field school. AERA carries forward this tradition with the 2012 Mit Rahina Field School (MRFS) for inspectors of the Ministry of State for Antiquities (MSA). AERA fielded this major program between two full Giza field seasons, all within the year of Egypt's recent political transition.

The MRFS was a Beginners Field School, the first part of the AERA-ARCE Field School program, a progression through Beginners, Advanced, Salvage, and Analysis and Publication Field Schools. As in previous Beginners Field Schools, we taught the basic skills needed to record and excavate a site: excavation techniques, survey, site recording, illustration, photography, and burial excavation. Students also spent a week in the field laboratory, a series of tents on the edge of the site, being introduced to conservation, archaeological illustration, object recording, and botanical, faunal, and ceramics analysis.

Given the modern encroachments on the site, we ran the MRFS in the mode of salvage archaeology. A large excavation team, consisting mostly of graduates from previous AERA-ARCE Field Schools, recorded as much data as possible in a short two-month season. With two exceptions, the laboratory classes were taught by field school graduates. The MRFS team excavated and processed material culture with endless enthusiasm, despite the heat, dust, and strenuous physical work.

### The "Capital Zone"

Our 2011 work at Memphis follows from AERA's collaboration with colleagues researching the ancient landscape and settlement patterns in the "Capital Zone," the narrow stretch of Nile Valley tying Upper and Lower Egypt together—the area between the wider valley of Middle Egypt and the expanse of the Delta. For millennia the center of power seems to have moved about in this stretch of restricted floodplain.

We chose the MRFS site, Kom el-Fakhry, the oldest known part of the ancient city, in response to a direct appeal from local MSA officials and in collaboration with the EES. Memphis is scheduled for heritage and tourism development, and the site required urgent archaeological work given the rapid urban expansion in the area. Kom el-Fakhry seemed tailor-made for a field school. The mudbrick settlement remains had been previously excavated and partly published, allowing the students to integrate previous excavation results and determine an appropriate excavation strategy. Ancient settlements have always been the focus of AERA's excavation methodology. And Kom el-Fakhry has a cemetery, providing a chance to record tombs. Most importantly, the site provided the opportunity to teach augering and survey as part of the long-standing Survey of Memphis (SoM) project, which has tracked the movement of the river and the expansion of the city of Memphis across millennia. The MRFS was the first AERA-ARCE Field School to fully incorporate off-site regional, environmental survey.

### A City Emerges, the Work of the Survey of Memphis

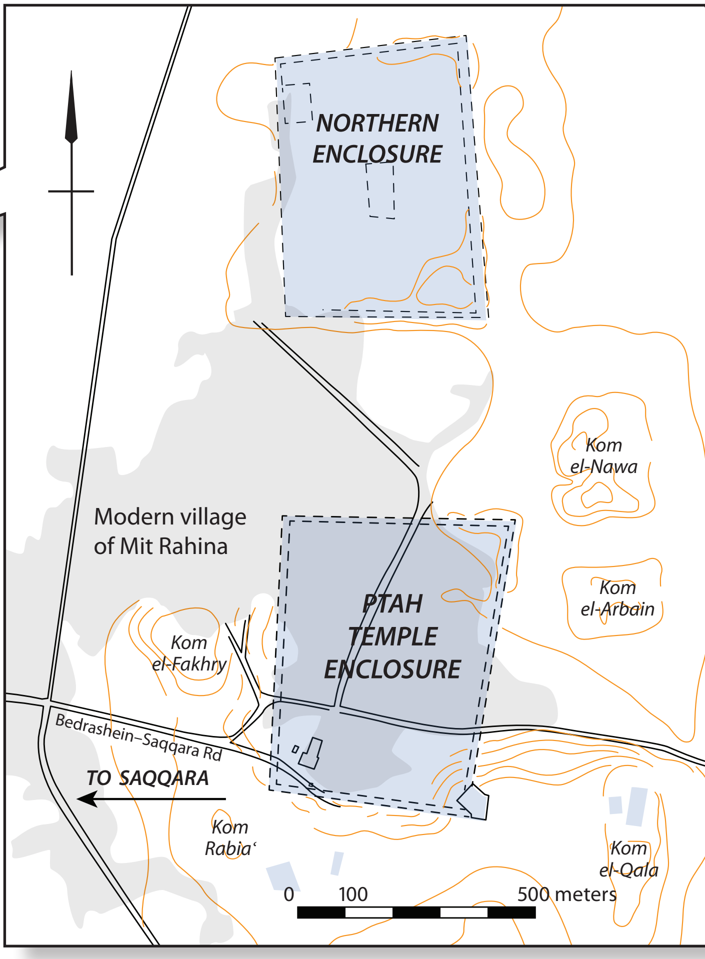
We were privileged to collaborate with the EES. In 1981 to mark their centenary they launched the SoM project, under Harry Smith and directed by David Jeffreys and Lisa Giddy. Their team mapped the disparate city ruins and reconstructed the ancient environment, particularly the movement of the river. In their excavations at Kom Rabia', another mound southeast of our present site, the SoM documented two distinct phases of the city: a priestly quarter of the New Kingdom and an artisan quarter of the late Middle Kingdom.

The current EES team brought to the field school their knowledge of core sampling, geomorphology, and landscape reconstruction—a process that Jeffreys describes as "thinking in four dimensions;" that is, understanding the ancient environment not only at any given period, but also over very long stretches of time.

A special thanks to the Charles and Lisa Simonyi Fund for Arts and Sciences and Susan Hutchison for their support of the Mit Rahina Field School and the AERA Geographical Information System.

1. "New Cycle, New Site: The Mit Rahina Field School." *AERAGRAM* 12-2: 18–19. All back issues of *AERAGRAM* are available at our website, www.aeraweb.org, for free download.

2. D. G. Jeffreys. 1985. *The Survey of Memphis* I. London: Egypt Exploration Society.




Map of Memphis, based on B. Porter and R. L. B. Moss, 1960, *Topographical Bibliography of Ancient Egyptian Hieroglyphic Texts, Reliefs, and Paintings*, 2d ed. Oxford: Clarendon Press, plate LXXI.

### Discovered Mostly by Accident

Memphis is a difficult site to grasp. Its remains are scattered, often obscured by urban development or lying in cultivated fields inaccessible to even the most intrepid visitor. Many parts of ancient Memphis have been discovered accidentally, by farmers, the army, or during building and road work. Kom el-Fakhry is no exception. The cemetery was discovered during construction of the Bedrashein–Saqqara road in 1951, and excavated three years later by Mohamed el-Hitta. The adjacent settlement, generally dated to the Middle Kingdom, was excavated by Mohamed Ashery in 1981, while to the northeast, Gaballa Ali Gaballa excavated large granary silos and an industrial area dated to the New Kingdom.

### Kom el-Fakhry

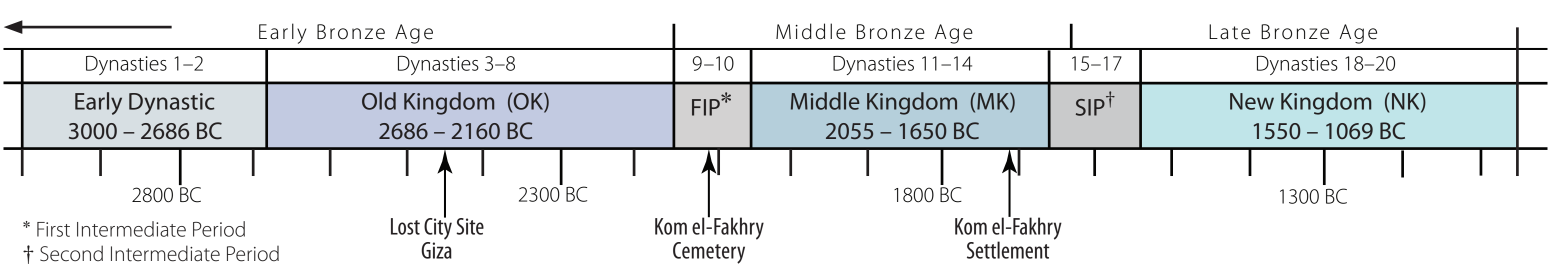
Although the ancient topography is now obscured by modern buildings, Kom el-Fakhry was bounded by the lower ground of the Birka (Arabic for "lake") on the east, and by a cultivated plain on the west. The ruin mound originally continued to the south into Kom Rabia‘. Digging for mudbrick and saltpeter has reduced the mound since antiquity. The ancient ruins once stood much higher as evident on the southern edge of the cemetery, where the SoM recorded walls dated to the Late Period (4th – 8th century BC) just under modern ground level. Kom el-Fakhry has the oldest *in situ* remains found at Memphis: a cemetery dated to the First Intermediate Period and a settlement dated later to the Middle Kingdom. But to the north of Kom el-Fakhry, on the southern edge of the Mit Rahina village mound, Old Kingdom sherds have been recorded. This area would be well worth investigating before further urban development covers the early town (or temple?).

### What Lies Below

We began work by surveying the site. Thanks to a collaboration with the French Archaeological Institute,[3] their surveyors, Olivier Onezime and Mohamed Gabr, set up base points in Kom el-Fakhry using Global Positioning System equipment to transfer values from a base station in Saqqara. The MRFS surveyors then recorded the excavation results throughout the season and integrated them into a Geographic Information System set up by the MRFS team specifically for this project.

During the first three weeks, the SoM team taught students how to gather evidence to reconstruct the ancient environment: its landforms, settlement patterns over time, climate change, and river movements. From sediments brought up by core-sampling augers with precisely determined depths in absolute elevations above sea level, we can profile deep layers beyond where we are currently able to dig. By matching profiles, we get some idea of the buried landforms. All students worked one day with the hand auger. They measured the depth of each core, then recorded color, sediment, and inclusions for each sample. To get a comprehensive profile of the deposits under the site, the team drilled six bore holes, four in an east-west line along the axis of the site and a further two to the north and south of this line at the center of the settlement area. Most cores reached depths of 11 meters below the surface, about 10 meters above sea level, showing considerable depth of occupation as well as

3. We are grateful to Dr. Béatrix Midant-Reynes, Director of the Institut français d'archéologie orientale, for the survey collaboration.



deposits indicative of river activity. An uneven sand of fluvial origin, recorded between 9 to 13 meters above sea level may represent an island, or a bank of a palaeo-river channel, on which the settlement was founded. At the end of work, we dropped a coin to the bottom of each core so future archaeologists would know that we created the holes and then filled them with clean sand. The MRFS augers closed one of the few data gaps in the extensive coring project carried out in the greater Memphis area by the SoM.

### The Town

The field school's excavations on the settlement site, an area approximately 30 by 20 meters, provided a wealth of new information on a poorly known part of Memphis. We excavated at least two large buildings on either side of an east-west street, the southern one resembling the large residences of the Middle Kingdom pyramid town of Lahun. The Kom el-Fakhry settlement is orientated north to south, as is the Middle Kingdom settlement at Kom Rabia', in contrast with the orientation of New Kingdom remains which follow the Great Temple of Ptah enclosure. The early town may have respected topographic features or aligned to an older version of the Temple of Ptah.

The field school identified and excavated three major chronological phases from the 12th to the late 13th Dynasties. Our work revealed a complex sequence of mudbrick walls, floors, and storage installations. The possible residences have large rooms with well-carved limestone thresholds across the entrances. We excavated and recorded a series of silos; an oven room, used over a long period of time; an area of brick paving; and a room with red-painted walls and sheet collapse from a vaulted ceiling with red and black painted plaster. We excavated two infant burials, interred in a small abandoned room on the southeast of the site. This part of the ancient city may have been built on an ancient island, the lack of lateral space forcing the inhabitants to build vertically. They often re-used earlier walls, creating a compressed and complex stratigraphic sequence.

The field school provided a glimpse into daily life in early Memphis. The Middle Kingdom corresponds to the Middle Bronze Age, when copper and bronze were used, but for everyday activities chipped-stone tools prevailed. Large quantities of these tools, made *(continued on page 6)*


Sayed Salah holds the double statue, possibly part of a household cult (see page 6). As foreman, Sayed had the Herculean task of supervising the removal of many cubic meters of rubbish from the site ahead of the season. He supervised the workers during excavation and oversaw the backfilling process at the end of the project.


Mark Lehner

Essam Shehab trowels a surface in the painted room, which he excavated with Mike House.


Mark Lehner

Rabee Eissa maps features in a complex of rooms, which he excavated with Ibrahim Mitwalli.


Mit Rahina Field School excavations at Kom el-Fakhry. View to the southeast.

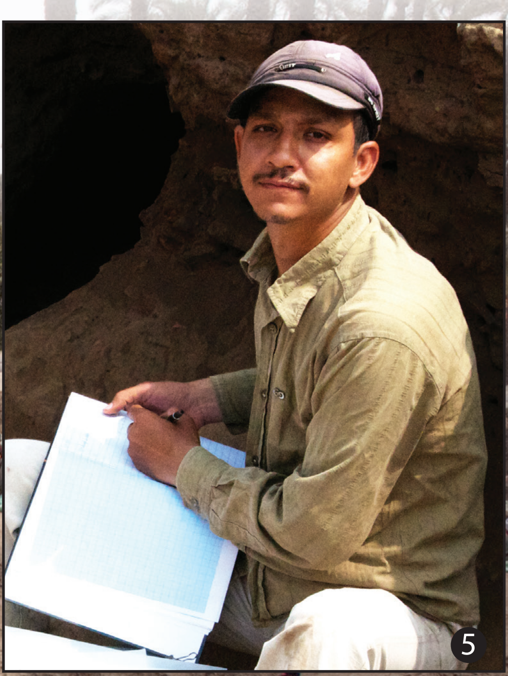

Conservator Lamia el-Hadidy glues together pieces of a pot recovered during excavations. In addition to conserving objects, she also introduced students to conservation techniques.

## Not a "Lost City"… Just Temporarily Misplaced

Memphis, the first capital of unified Egypt was founded according to Classical sources, by King Menes around 2990 BC. The city was named *Ilneb-hedj*, the "White Walls." Although it was known that Memphis was the Old Kingdom capital of Egypt, its precise location was lost, leading David Jeffreys to describe it as a city "temporarily misplaced." In the 14th century AD the Arabic name for the town, *Manf*, disappears from the sources. During the 15th – 16th centuries, travelers debated the location of the ancient city. Finally, in 1799, the Napoleonic expedition identified the ruins of Mit Rahina with ancient Memphis.

A Memphite monument gives Egypt its modern name. The ancient Egyptian name for the Great Temple of Ptah at Memphis, *Hutkaptah* ("The Enclosure of the Ka of Ptah"), became *Aegyptos* in Greek and eventually "Egypt."

The city of Memphis was not restricted to this central area over its history. As the river migrated east, an ongoing process until recent times, parts of the city expanded eastward into low-lying, newly reclaimed land, as attested in the New Kingdom and Roman periods. Already in the Old Kingdom the city developed north and south from the nucleated core established in the Early Dynastic period.


Mark Lehner

Hassan Ramadan maps a section in the cemetery. With Osama el-Nahas, Freya Sadarangani, and Ashraf Abd el-Aziz he recorded the link between the settlement and the cemetery.

## A Household Cult?


This stela, offering table, and small statute of a man and a woman were probably used in a household cult. The stela shows a seated couple before an offering table. The statue belonged to a man, N(y)ka, and a woman, Sat-Hathor (blow up of the statue below, about half actual size). For the photograph (left) the objects were arranged together as they most likely stood in antiquity. In the same room we found fragments of a limestone statue of a dwarf that was used as a lamp (shown below). Petrie* discovered similar dwarf statues at the Middle Kingdom town of Lahun, where he thought they were part of household cults.

*W. M. F. Petrie. 1891. *Illahun, Kahun and Gurob, 1889-90,* London: Egypt Exploration Society.

*(continued from page 4)*

from chert, take on a wide range of shapes. They include large bifacial knives, scrapers, many blades of all sizes, a few sickle blades, and burins (chisel-like tool used for carving). We also collected numerous tiny flakes (debitage) which are a by-product of tool manufacture or re-sharpening. Other objects excavated by the field school provide a glimpse of the range of activities across the site. Querns, pottery vessels, lids, and stoppers were used to process and store food. Stone polishers, grinders, and drills were used for crafts, while bone points and spindle whorls are evidence of spinning and weaving. Administration, accounting, and possibly gaming are indicated by stone weights, clay sealings, cylinder seals, scarab seals, and tokens. One unusual assemblage suggests a household cult (see box above).

### Tombs in the Town

One of the main contributions of the field school was a new understanding of the interface between the cemetery and the town. The cemetery consists of rectangular, north-south, mudbrick tombs lined internally with large limestone slabs, which also form a flat roof, itself topped by brick vaulting. Although initially tombs were laid out in a grid of streets, the cemetery developed into a massive block of at least six adjacent tombs east to west and two to three tombs north to south. The cemetery has been dated by comparison with tombs in Ehnasya el-Medinah (see map, page 2), the capital of the 9$^{th}$ – 10$^{th}$ Dynasties, whose rulers considered themselves the legitimate successors of the Memphite pharaohs. A thick wall bounded a lane we named Cemetery Street, running along the eastern side of the cemetery, offering frontage for the tombs. Originally 15 offering tables were set at the base of this face of the cemetery. To the south we found traces of a mudbrick chapel which had held two funerary stelae that were removed during the 1954 excavations along with the offering tables. As time went by the settlement expanded into Cemetery Street. People made walls, floors, and a kiln over the offering tables, burying them and the funerary chapel, eventually expanding over the tombs themselves. We were able to record this important stratigraphic link between the cemetery and the town.

Why, during the First Intermediate Period, did Memphites choose to be buried in the town, rather than in the usual burial ground, on the western desert edge, at Saqqara? River movement, and the resulting change in landscape, as well as the contraction of the city during the First Intermediate Period, enabled the inhabitants to use this central area for burials. A similar situation may have occurred during the Third Intermediate Period when another cemetery was built within the town, just southeast of Kom el-Fakhry. Interestingly, Ehnasya's two cemeteries, within that town, also date to the First and Third Intermediate Periods. Following the First Intermediate Period, during the 12$^{th}$ Dynasty the national capital was established at Itjy-Tawy, located to the south near the site of Lisht (see map, page 2), reducing further the importance of Memphis and Saqqara.

Head and feet of a limestone dwarf, fragments of a statue that served as a lamp. Shown about one-third actual size.

Below: Everyday objects from Memphis. Clockwise from left: a crocodile clay toy, a phallic amulet, a tiny square steatite bead, and a clay sealing stamped with a characteristic geometric design.

## Barley and Big Fish

The field school is the first project since the excavations at Kom Rabia' to provide information on the diet of the inhabitants of early Memphis. Archaeobotanist Mary Anne Murray found far more barley than emmer wheat in the botanical samples, which also contained linseed, grape, date, and the edible tubers of tigernut sedge, a cultivated grass-like plant. Common Egyptian field weeds were present throughout, especially the wild grass *Lolium*. The Middle Kingdom deposits from Kom el-Fakhry did not include as many wild and wet-loving plant species as those from the same period at Kom Rabia'. This and the high proportion of barley may reflect higher and drier fields. Outside the botany tent we posted a list of the plants found in the samples. The students kept up their interest in the botany results as the list grew to over 27 species.

Animal bone samples indicated a high status diet, mostly cattle and pig, with few sheep and goat. The most common fish, catfish, Nile tilapia, and Nile perch, were all very desirable. One interesting find was gilthead seabream, a highly prized fish, imported, salted or dried, from the Mediterranean or the Red Sea.

## A Little More Light

The MRFS recorded data that would otherwise have been lost and shed new light on the early occupation of this once great capital, and much neglected, heritage site at Memphis. Before departing, we covered the cemetery and settlement with sand, protecting them from deterioration. Clearly we stand on the shoulders of the Survey of Memphis's 30-year investment in the archaeology of Memphis, in a collaboration which we are keen to continue.

A quick poll on the last day established that the MRFS staff thought this the hardest site they had ever encountered. Such complex settlement stratigraphy is a challenge and they are eager to return for further work. We hope for other Mit Rahina Field Schools in the future, so that little by little we get a glimpse of everyday life in one of the preeminent cities of the ancient world. ***~ Ana Tavares and Mohsen Kamel***

Photo credits: All photos by Yaser Mahmoud, except where otherwise indicated.

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).

Lamia el-Hadidy

Excavators lift a large storage jar, made of marl (desert) clay. This type of jar is characteristic of the Middle Kingdom.

## Acknowledgements

We thank Dr. Mostafa Amin, Secretary General of the Ministry of State for Antiquities (MSA); Mr. Atef Abu el-Dahab, General Director of Pharaonic and Coptic Monuments; Dr. Mahmoud Afifi, General Director of Cairo and Giza; Mr. Osama Shimy, General Director of the Giza area; Mr. Kamal Waheed, General Director of Saqqara; and Mr. Shabaan Ahmed, Chief Inspector of Mit Rahina. The project was initially facilitated by Mr. Ahmed Salah, the former Director of Mit Rahina. For help with the field school we thank Shabaan Abd al-Gawad and Dr. Mohamed Ismaiel, Permanent Committee Secretary at the Zamalek office. Mohamed Abdel Moneim served as our MSA inspector during the field work.

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# AERA Field School Grads Take the Lead

*The graduates of our AERA-ARCE Field School program for inspectors in the Egyptian Ministry of State for Antiquities (MSA) are now running their own excavations in Egypt, teaching in our field school, and leading their own field schools. Hanan Mahmoud and Yaser Mahmoud, Field School graduates and AERA team members, describe the all-Egyptian field schools that they recently helped organize and teach in Giza and Luxor. The MSA Giza Field School taught basic skills at the MSA excavation site south of the Khafre Valley Temple. The AERA-ARCE Luxor Study Field School processed material recovered by the Luxor Salvage Archaeology Field School when they excavated the last of the Old Luxor Town Mound in 2010.*

## Giza Inspectorate Field School 2011

For archaeologists it is important to know stratigraphic excavation methods. They help us determine the dating and stratigraphic sequence at archaeological sites and that helps us understand our ancient history. Unfortunately, most Egyptian universities do not include fieldwork courses in their curriculum, so Egyptian archaeologists do not learn stratigraphic excavation as students.

### Life School

So we consider ourselves very lucky to have had an opportunity to learn fieldwork methods through the AERA-ARCE Field Schools. When we joined the field school we took the challenge to start our first steps in our archaeological career. We learned a lot, not only about archaeology and Egyptology but also about people and how to work with others. So we think it is not only a field school, but it is also a life school.

A short time before the 2011 Egyptian Revolution, the MSA directors asked Egyptian inspectors who had trained in field schools to run their own excavations at sites all over Egypt, such as in Alexandria, Giza, Abydos, Luxor, and Aswan. After the revolution, we inspectors insisted on following up on our duty to share our knowledge by training other inspectors. We decided to run our own Egyptian field school following the AERA system (which uses the best excavation and recording systems).

The year 2011 was not only a social revolution in Egypt, but also a revolution in archaeology. MSA inspectors trained by AERA succeeded in running two field schools, an MSA Egyptian Field School in Giza and an AERA-ARCE Field School in Luxor. Now we are running a second one in Luxor. Our main aims are training inspectors to think, to test, and to record with the best scientific methods (guided by the motto "idea comes first"), and create a new generation of Egyptian archaeologists who can run their own projects.

### Teaching Basic Skills

The Giza Inspectorate of the MSA successfully ran a short Beginners Field School for Giza inspectors from November 26 to December 22 at a site to the south of the Khafre Valley Temple. Ali el-Asfar, director of the Giza Inspectorate, announced the school on November 9. Forty-two inspectors were chosen from the 120 inspectors who filled out the application. The students were divided into six groups, each consisting of seven students, and each had one supervisor who had been through the AERA-ARCE Field School and one assistant.

AERA team member Ashraf Abd el-Aziz gives a lecture to the Giza Inspectorate Field School. Photo by Mohamed Adel.

We were determined to run a field school in Giza, in spite of the fact that we had no budget, no equipment, and only a short time. But the field school was very successful, and most of the students were chosen to be part of the AERA team for the 2012 field season.

The students learned the basic archaeological skills of excavation and recording during five-day weeks, six hours per day. The students learned survey basics and how to set up the auto level, draw plans and sections at 1:10 and 1:20, and identify different feature types (cuts, fills, and structures). In addition to learning excavation skills, each group spent one day in the lab with the ceramics specialist and one day learning the basics of excavating and recording human skeletal remains. The students also attended lectures given by team members or visitors on various subjects in archaeology.

On February 4 Minister of Antiquities Mohamed Ibrahim Ali awarded graduate certificates. ~ ***Hanan Mahmoud***

Mohamed Naguib teaches students in the Luxor Study Field School how to examine the composition of a pot sherd. Photo by Yaser Mahmoud.

Giza Inspectorate Field School students draw an elevation for a mudbrick wall. Photo by Mohamed Adel.

## Luxor Study Field School 2011

It was my honor to help lead the AERA-ARCE Luxor Study Field School (LSFS 2011), which ran from March 9 to June 3. It was AERA's eighth field school, and the first time an Egyptian team ran a field school under the overall supervision of AERA director Mark Lehner and field school directors Mohsen Kamel and Ana Tavares.*

It is a great feeling when the people who trained you trust you to run a big project. And, of course, it was not an easy job, but everything we did in this field school we learned from our teachers. In the LSFS we got a very good chance to apply what we had learned.

The main aim of our study season was to analyze material left from the daily life of ancient Egyptians over the two millennia they occupied the Luxor Town Mound site. One of the main things we learned from AERA's field schools is how to get information from archaeological remains: a piece of bone, an oil lamp, amulets, and even very tiny artifacts. The field schools taught us how to find information, not to seek out antiquities for their own sake. We learned to look for information about the everyday life of people in the past, how they lived in their houses, what kind of artifacts they used every day, what kind of food they ate, and so on. The LSFS 2011 team had a chance to document ceramics, decorated blocks, and other artifacts that came from the Old Luxor Town Mound from Roman up to modern times. Finally I hope that our work will be helpful to all the people who will read and see our work in future publications. ~ ***Yaser Mahmoud***

*For more information about the LSFS 2011, please see "The Luxor Study Field School," *AERAGRAM* 12-1 (2011): 6–8.

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The AERA-ARCE Luxor Study 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).

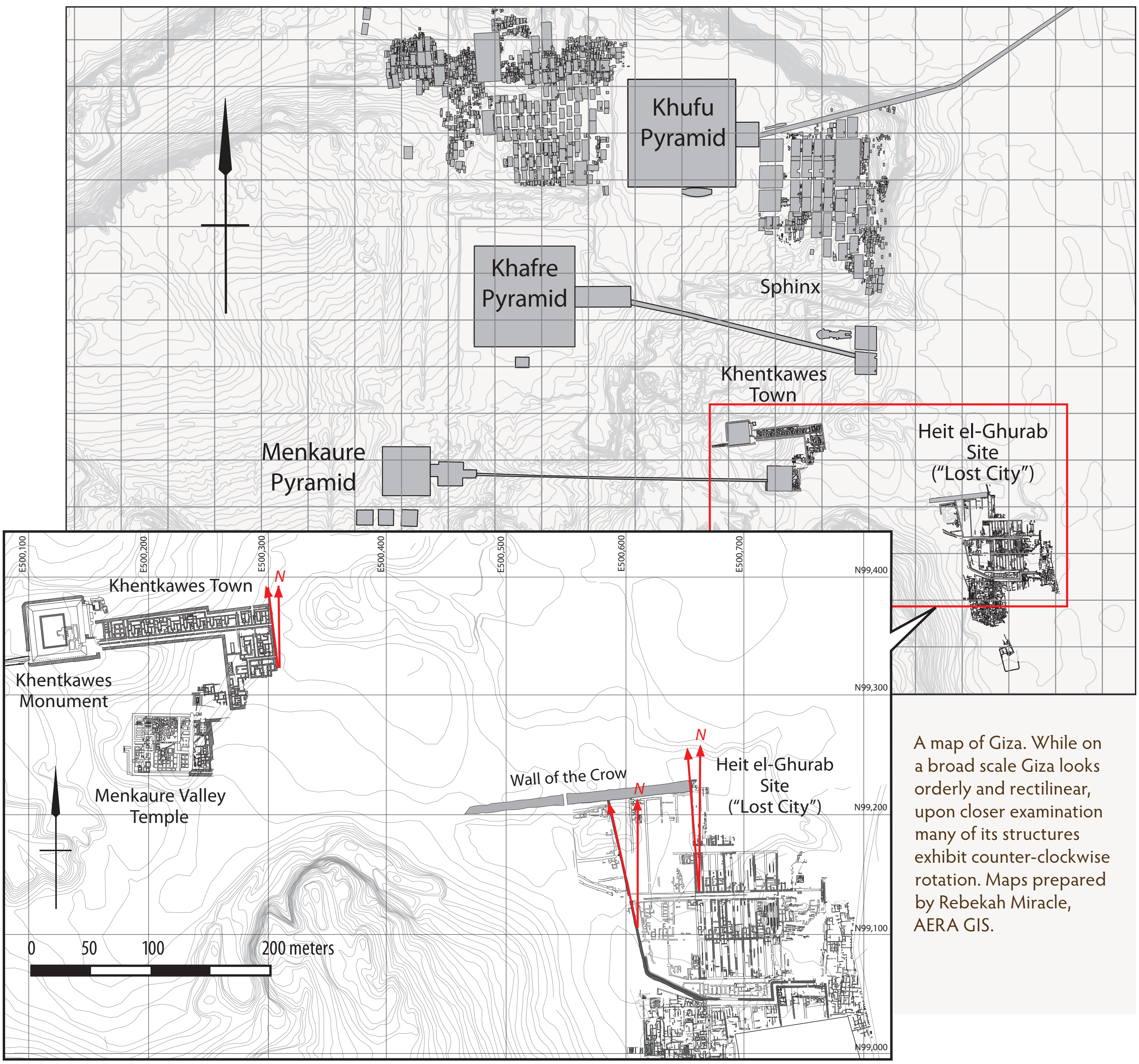
# North by Northwest: The Strange Case of Giza's Misalignments

*The Giza Pyramids are aligned to cardinal points with uncanny precision. But many of Giza's other monuments share a strange, systematic alignment error.*

The first impression made by a map of Giza is one of order. The bases of the pyramids appear perfectly square and precisely aligned with cardinal points. Yet a closer look at some of Giza's other monuments and structures, including Khentkawes and the Lost City of the Pyramids site (aka Heit el-Ghurab), reveal something different. Many seem to share a common pattern of misalignment; on a map they are rotated a few degrees counter-clockwise from cardinal points. It is as if the Egyptians thought that north was a little to the west of where it really was. Nor is the effect confined to Giza. We find the same turn, north by northwest, at many other places in Egypt's pyramid fields.

The Egyptians chose the orientation of their tombs, temples, and civic buildings for both practical and ceremonial reasons. They aligned many of their structures to the Nile. Others they built along ridge lines. Sometimes they chose cardinal directions for alignment (often to the east, the direction of the rising sun).

At Giza, cardinal orientations prevail. The Great Pyramid of Khufu is oriented to cardinal points to better than seven minutes of arc, an extraordinary achievement in the age before optical instruments. Only within the last few hundred years have builders been able to do better. Working at night, sighting on Polaris and using special star charts known as ephemeris




A map of Giza. While on a broad scale Giza looks orderly and rectilinear, upon closer examination many of its structures exhibit counter-clockwise rotation. Maps prepared by Rebekah Miracle, AERA GIS.

### The Shadow Method for Finding North

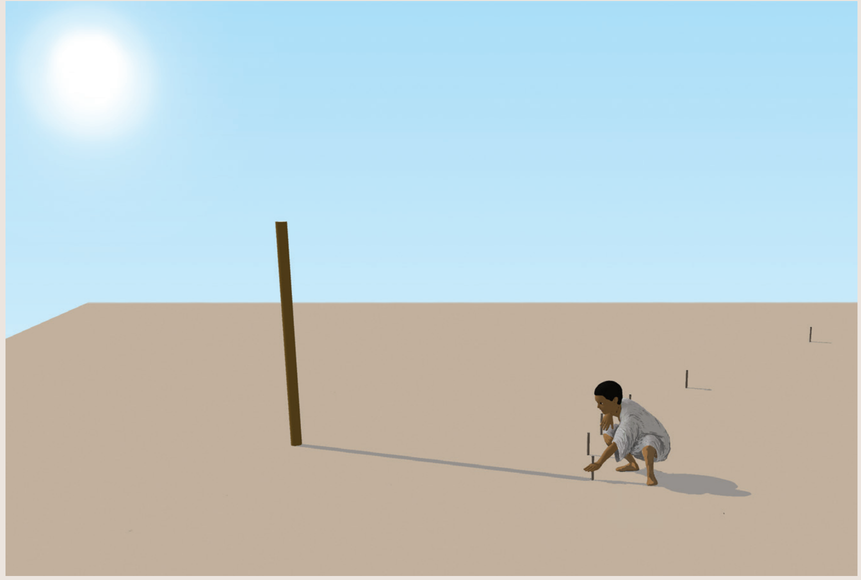
1. Set a rod set vertically in the ground.
2. As the day passes, mark the tip of the shadow as it moves in an arc along the ground. Here it is shown marked at one-hour intervals with sticks.
3. Fix a string to the base of the rod and draw a circular arc across the shadow pattern. The circular arc will cross the shadow arc at two points.
4. Draw a line through these points. It will run east-west.
5. Bisect the line and draw a ray to the base of the rod. That line will run north-south.

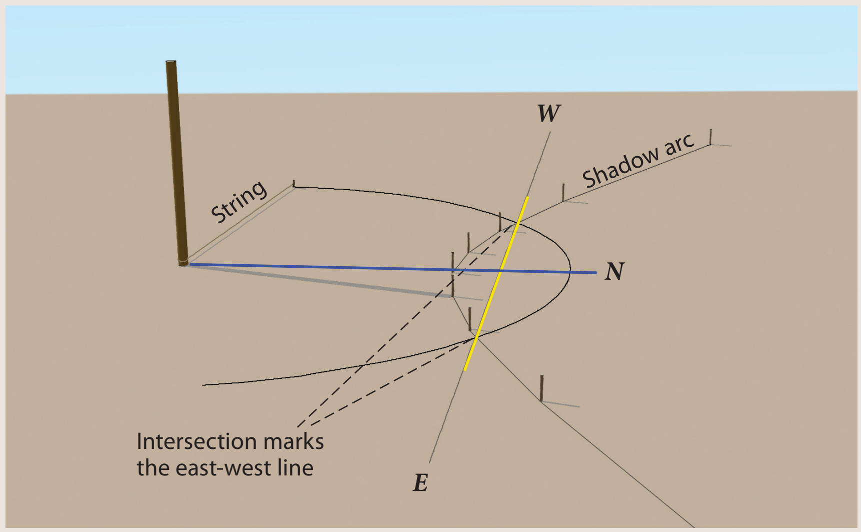
tables, a surveyor today using a Total Station can lay out a line accurate to better than 20 seconds of arc.

Such precision, though, is only required for certain structures. Today that might mean a highway or a capitol building. More ordinary structures do not require such precision. To lay out a residence or office building, a builder might choose to align the new building with an existing building, a nearby road, or a natural feature such as a river. Absent those, the builder will need some instrument to provide orientation. A magnetic compass is a common choice. However, even adjusting for magnetic declination, a builder using a handheld compass can achieve an accuracy of no better than about two degrees of arc. That is, however, good enough to orient a building aesthetically, allowing for sunlight to stream in at the right time of the day or to catch the cooler breezes.

The Egyptians faced similar choices. They appear to have reserved precision alignments for royal structures. Other structures called for no such precision. But the Egyptians had no magnetic compasses to guide them. Instead, they may have used the sun.

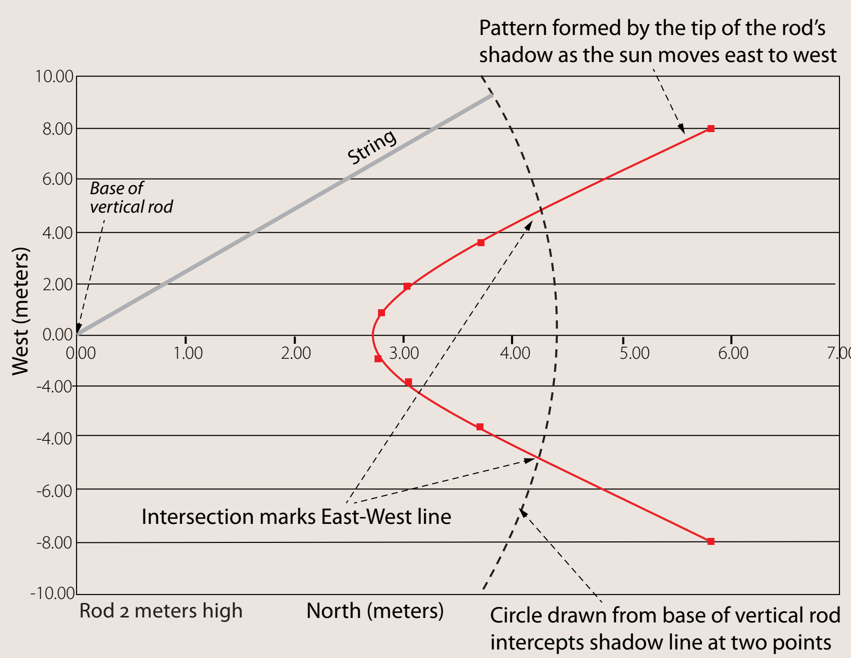
All it takes to determine true north, and therefore all cardinal points, is an upright rod or pole. Even today, Boy Scouts are taught the "shadow method," shown on the right. The method uses a rod set vertically in the ground. As the day passes, one marks the tip of the






Above: The shadow method and shadow arc shown graphically.

Below: The values for the shadow arc mathematically calculated.



shadow as it moves in an arc along the ground. The next step is to fix a string to the base of the rod and draw a circular arc across the shadow pattern. The circular arc will cross the shadow arc at two points. Draw a line through these points and it will run east-west. Bisect the line and draw a ray to the base of the rod and that line will run north-south. Do this with care, and you can achieve an accuracy of better than one-half of one degree.[1]

If we were to leave our vertical rod standing over the course of the seasons and track the movement of the sun on the winter solstice, summer solstice, and the equinox, we would create the pattern shown below and on the right. On the summer solstice, with the sun high in the sky, the tip of the shadow's trace forms a curve pointing away from the rod. On the winter solstice the opposite is true. In between, on the equinoxes, the shadow traces out a straight line. Over a precisely leveled surface, this line runs almost exactly east-west.

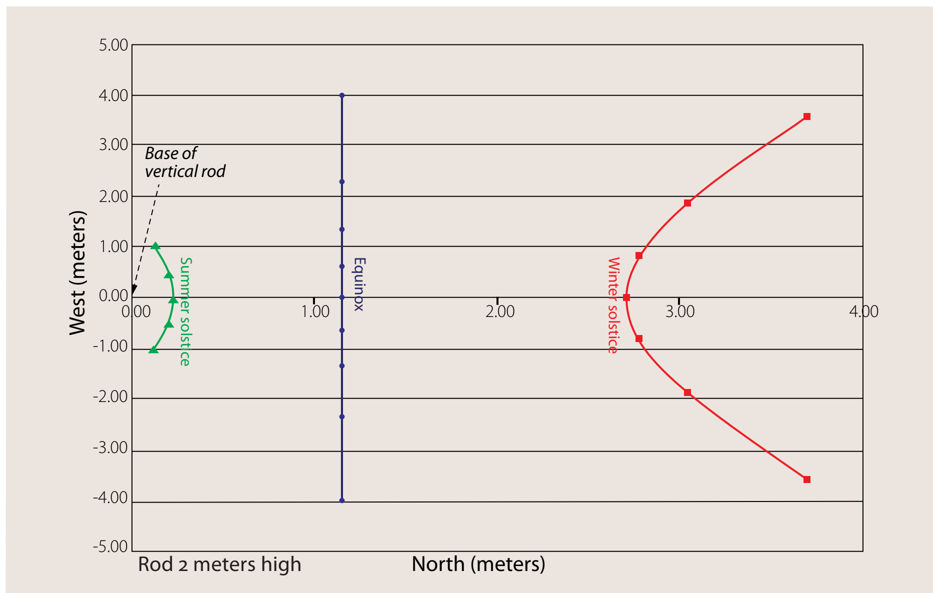
An error, however, results when we try the same experiment on sloping ground. We see the results most clearly on the equinox (on facing page). On ground sloping down from west to east our formerly east-west line now runs from the southwest to the northeast. (It is only the west-to-east or east-to-west slope that causes error. A north-to-south or south-to-north slope simply shortens or elongates the shadows.[2])

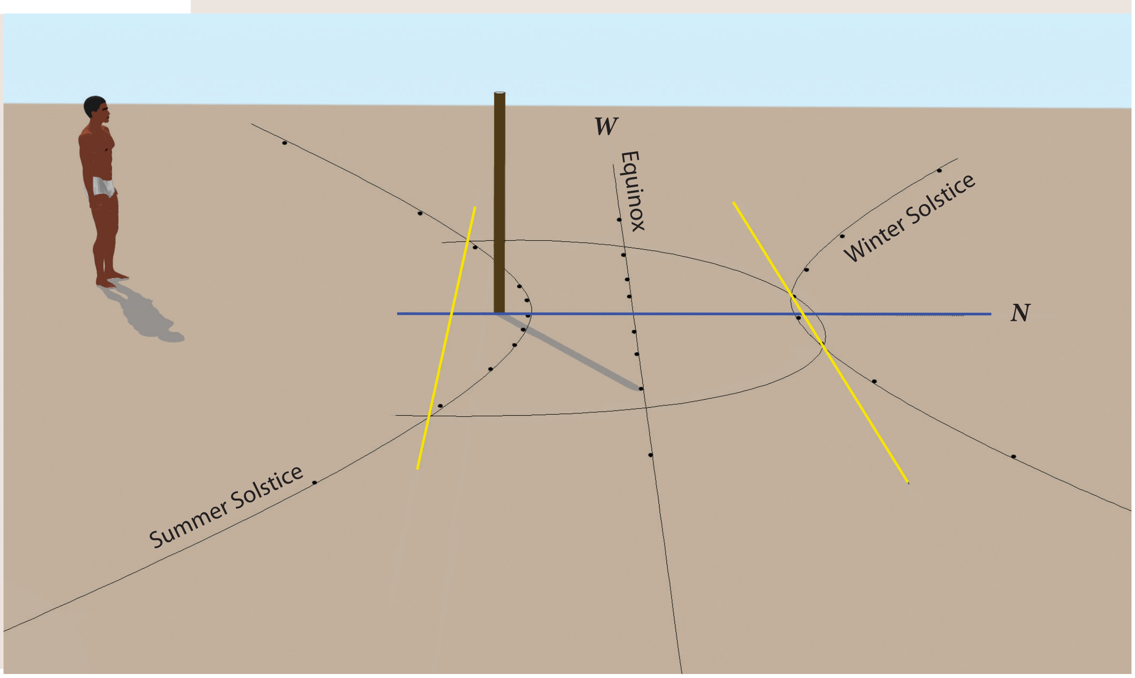
The pyramids, along with Giza's mastabas and the Khentkawes Town, sit on a limestone plateau that dips from northwest to southeast at an average of 6.° The east-to-west component averages about 3.° Prior to building their structures, the Egyptians cleared the overburden to bedrock. Then they may have used the shadow method to orient their structures. As is the case today, often all they needed was a general orientation. Since accuracy beyond a few degrees was not necessary, they did not have to level the bedrock first. The result was a slight rotation of the structure.

We see such rotations on our maps of Giza. In the map on page 14, the Khentkawes Monument and

1. C. Ghilani. 2004. "Astronomical Observations." *Astronomical Observation Handbook*, Pennsylvania State University. http://surveying.wb.psu.edu/sur351/CelestialCoords/ASTRO.pdf, Accessed August 25, 2011.

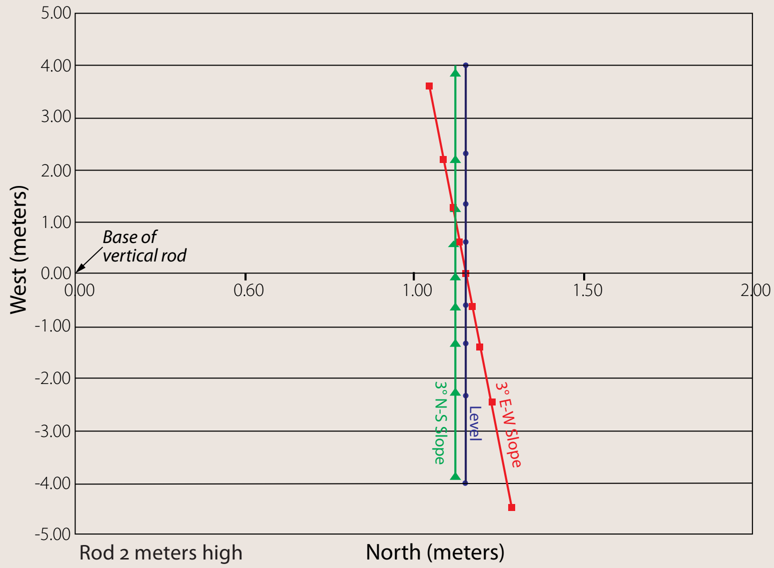
2. G. Dash, 2011. "North by Northwest: The Strange Case of Giza's Misalignments," Dash Foundation. http://www.DashFoundation.org/North_by_Northwest.pdf. This version includes supporting mathematical formulas.




**Seasonal Shadows**
The pattern produced by the shadow method varies with the seasons.

Above right: Plot of the shadow method seasonal patterns derived by mathematical calculations.

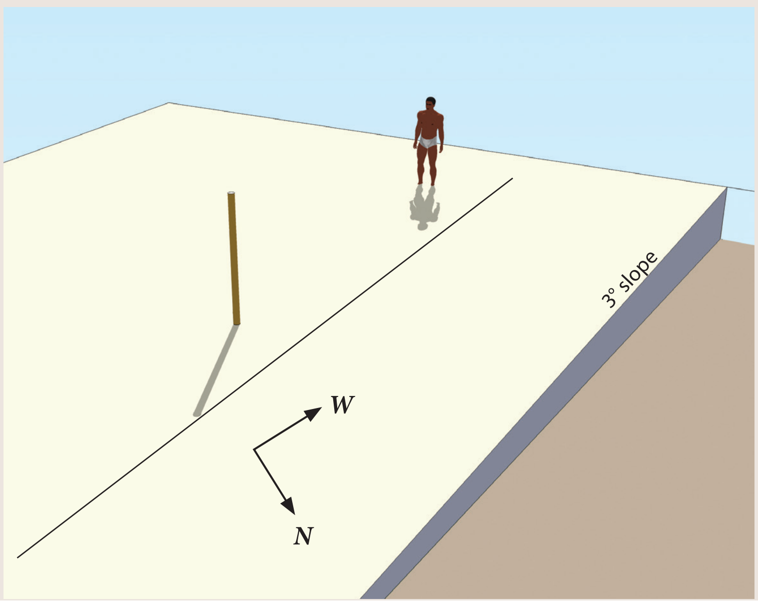


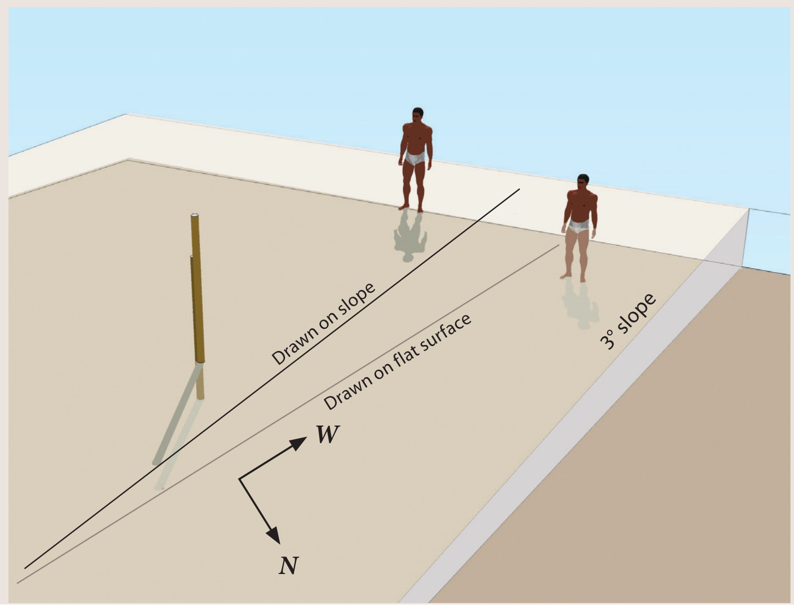

### The Effect of a Slope on the Shadow Method

On the left: a plot of the distance of the equinox sun shadow arc mathematically calculated. The results (in green) show that a north-south slope does not affect the line. True north is still derived correctly using the shadow method.

However, the sun shadow arc taken on an east-west slope of 3° causes the tip of the shadow to rotate counterclockwise (in red). Thus, deriving north from data accumulated over a west-east slope will result in an error.

Below: on the left the shadow method used on the equinox on a 3° slope. On the right, the image of the shadow method on the 3° slope is superimposed over the shadow method used on level ground on the equinox.



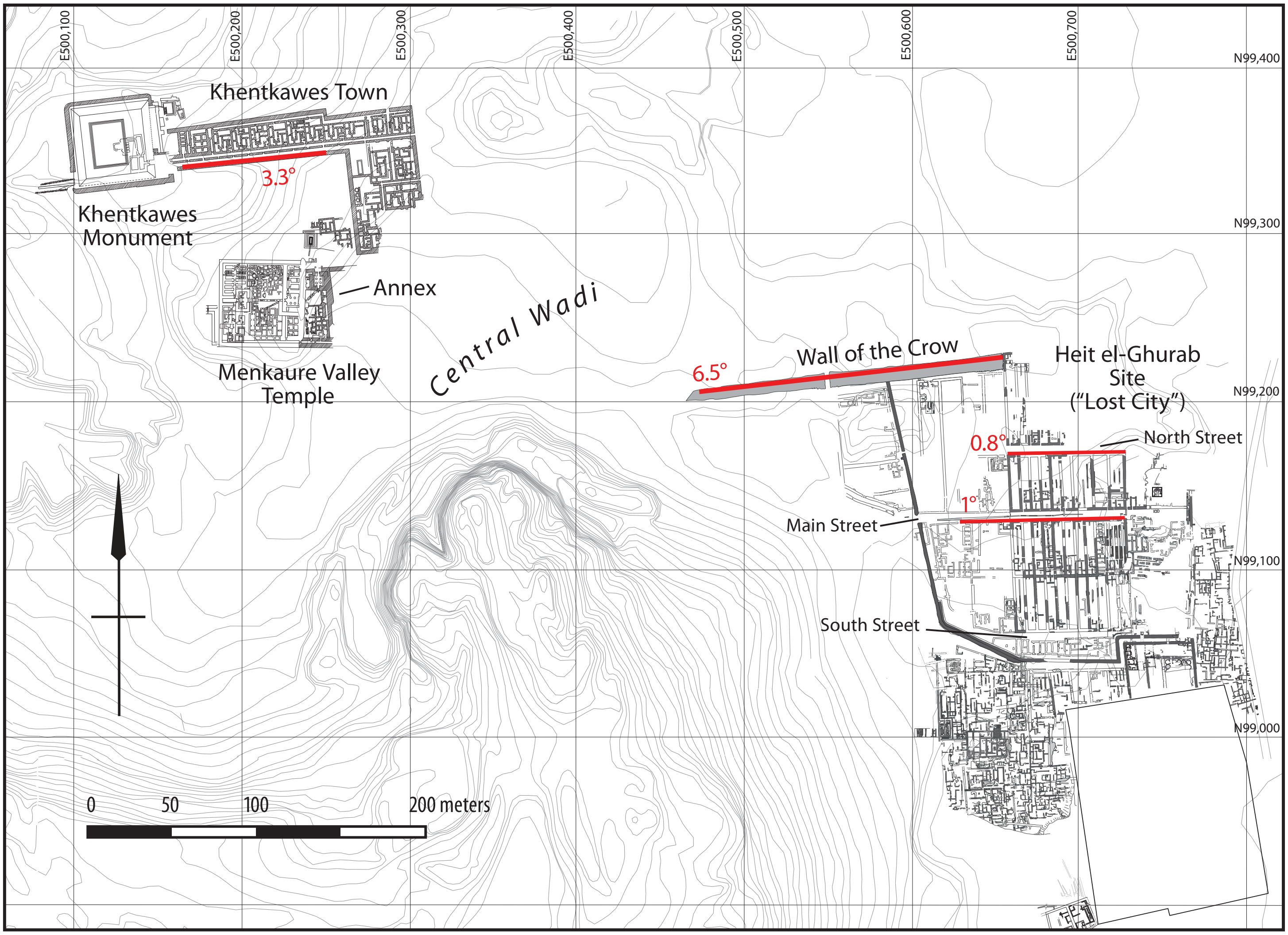

Khentkawes Town are rotated counter-clockwise by a little more than 3.° However, the Khentkawes Monument was the tomb of a queen, and the reason Khentkawes did not end up with a precise orientation may have to do with the monument's history. Mark Lehner believes that Khentkawes was originally a "quarry cube," a section of the plateau channeled out on four sides in order to prepare it for further quarrying into building blocks.[3] A lowly quarry cube did not call for precise alignment. When Khentkawes Town was built, it was aligned to the Khentkawes Monument and shared its misalignment.

Standing on the ground at Giza these misalignments are hardly noticeable. They only become plainly visible in a bird's eye view, such as on a map. For the Egyptians, they may only have become a problem when one set of structures met another. One such case was in the so-called Annex of the Menkaure Valley Temple. Here, the foot of Khentkawes Town meets the temple, which is oriented to the cardinal directions. The floor plans of intermediate structures needed to adjust for the difference.

The main thoroughfares of the Lost City, Main Street and North Street, are also rotated slightly, but only by a degree or so (see map, page 14). The Lost City was not built on bedrock like Khentkawes Town, but on the low desert terrace, which slopes gently down to the Nile floodplain. Thus, the Lost City exhibits a slight dip to the east which resulted in a one degree or so rotation off the cardinal points.

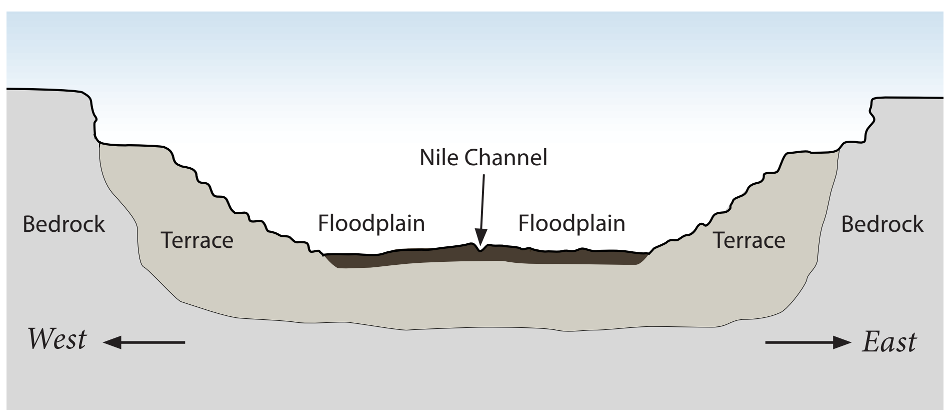
The Wall of the Crow runs 6.5° north of east. This deviation is so great that it is probably not a product of the shadow method. While we do not know the exact purpose of the Wall, it may have functioned in part as a flood diversion dam. As such, it may have been deliberately built to parallel the course of the Central Wadi, rather than being oriented to the sun or aligned to the rest of the Lost City.

3. M. Lehner. 2008. "Khentkawes and the Great Circle of Quarrying." *AERAGRAM* 9-2: 14–15.




Different features of the Khentkawes Town and the Lost City site have differing rotational magnitudes. The angle that they diverge from the cardinal directions is shown in red.

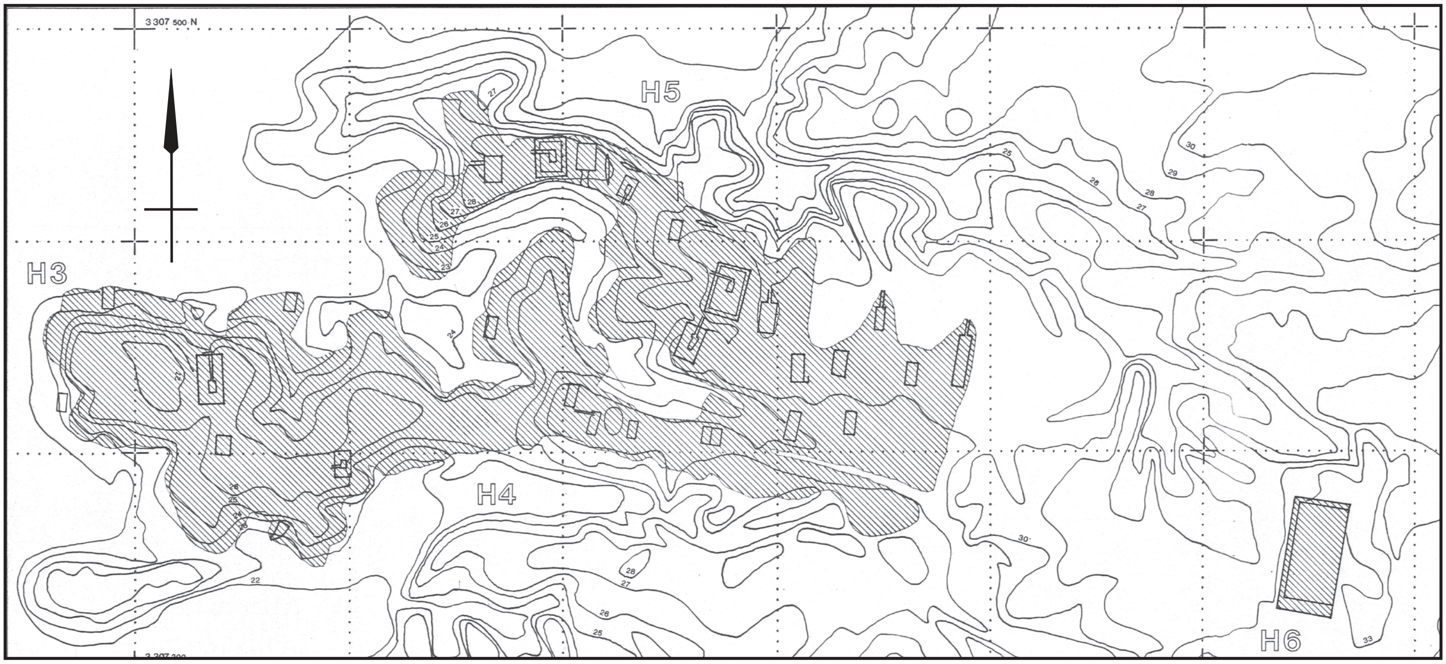
The figure on the right shows the Nile Valley in cross-section. For the most part, on the west side of the river the terrace above the floodplain dips to the east. Likewise the terrace on the east of the river dips to the west. This offers us a way to test our hypothesis. While structures built to the west of the river exhibit a counterclockwise rotation, those to the east of the river should be rotated clockwise.




Cross-section of the Nile Valley. The terrace on the east side of the Nile River, slopes down to the west toward the floodplain, while on the west side, the terrace slopes down to the east. Cross-section at Beni Suef, about 75 miles south of Cairo (map on facing page). After M. S. Abu al-Izz (trans. Y. A. Fayid), 1971, *Landforms of Egypt*, Cairo: American University in Cairo Press, page 129, fig. 28.

Most Old Kingdom settlements and cemeteries lie to the west of the Nile. A few, though, do lie to the east. Helwan, for example, is a cemetery that lies opposite Saqqara on the Nile's east bank. At Giza, mastabas close to the Great Pyramid are aligned with it and to the cardinal points. Mastabas farther away tend to exhibit rotations. At Helwan, there is no pyramid for the Egyptians to have used for alignment, so tombs do exhibit rotations off the cardinal points. For the most part these are clockwise, opposite that at Giza, as our theory would predict.[4] The Egyptians may have

4. D. Jeffreys, and A. Tavares. 1994. "The Historic Landscape of Early Dynastic Memphis." *Mitteilungen des Deutschen Archaeologischen Instituts Abteilung Kairo*, vol. 50, page 143.





Detail of the northern part of Helwan Cemetery. Hatching indicates the extent of the cemetery. Contours are at 1-meter vertical intervals and grid values at 100-meter intervals. The grid is oriented to the cardinal directions. The rectangles are large tombs.

The Helwan Cemetery lies on the east bank of the Nile, where the prevailing slope is opposite that at Giza, resulting in a prevailing clockwise rotation of features. Figure from D. Jeffreys and A. Tavares, 1994, "The Historic Landscape of Early Dynastic Memphis," *Mitteilungen des Deutschen Archaeologischen Instituts Abteilung Kairo*, vol. 50, fig. 11. Used with permission.

used the shadow method the way today's builders use a compass. A compass is not a precision instrument. If more precision is required, the builder can use a Total Station and sight Polaris at night. The Egyptians had similar options. When precision was required they could sight on the stars. But where precision was not required, and there were no local landmarks to align with, they may have used the shadow method. The evidence of that is preserved today in the errors they left behind. ***~ Glen Dash***



AERAGRAM

Volume 13 Number 1, Spring 2012

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

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# GPMP Full Circle

Thanks to the inspiration and support of the Glen Dash Foundation, we have come full circle, returning to the mapping of major Giza Plateau monuments for the first time since David Goodman and I laid out the basic survey control in 1984. That year we initiated the Giza Plateau Mapping Project (GPMP), aspiring to produce a comprehensive topographic and archaeological map of the plateau and its monuments. As the acronym for our project was the GPMP for years, many people still write asking for exact coordinates on the corners of the three large pyramids and precise positions of temples, tombs, and major walls (see page 19).

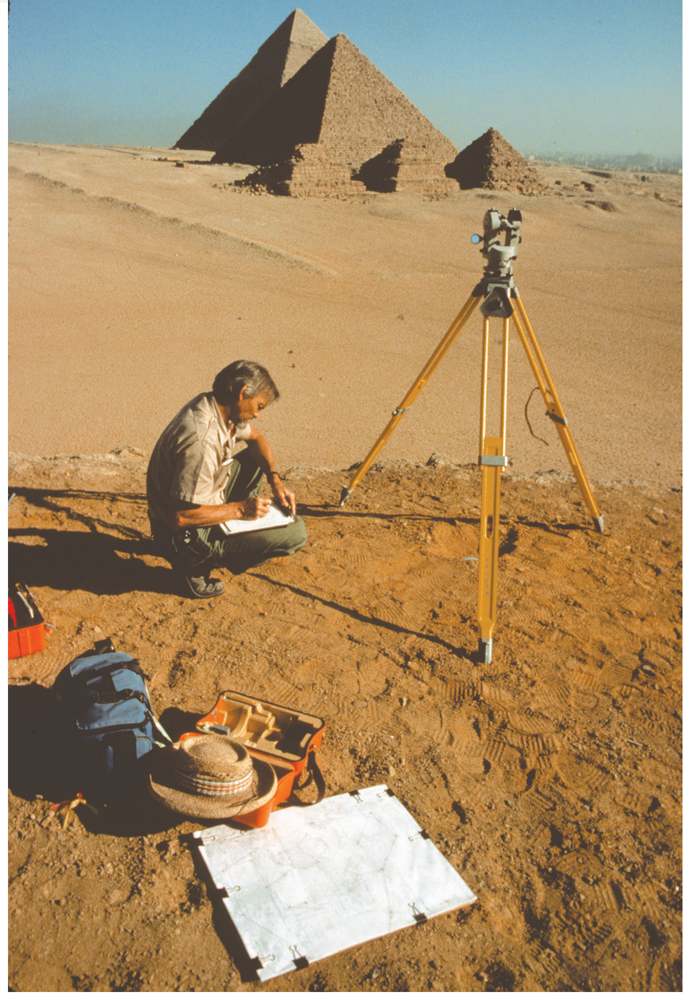
### Point of Beginning

David, longtime senior surveyor for the California Highway Department, directed us as we set and measured control points on a closed loop traverse around the entire Giza Plateau. We intended to produce the overall map with aerial photogrammetry—stereoscopic pairs of photographs from which 3-D elevations and contour lines could be plotted showing shapes and forms of the landscape. Before LIDAR (Light Detection and Ranging, laser scanning) and widespread use of GPS (Global Positioning System), David's protocol was the professional way to set control for surveying a map of such a large area. David plotted the flight lines on the best existing maps for overlapping photo pairs. But we never obtained permission for the aerial photography.

So the best maps of Giza, and most of the other pyramid sites from Abu Roash to Dahshur, remained a 1:5,000 series produced in 1977 by aerial photogrammetry for the Egyptian Ministry of Housing and Reconstruction (MHR). These map sheets show the surface contours at one-meter intervals as of 1977. In 1991 Peggy Sanders at the Computer Lab of the Oriental Institute, University of Chicago, digitized, under my guidance, the contour lines from the two MHR map sheets that covered the Giza Plateau.

In overall maps of the Giza Plateau that we have since published, the locations of the "Lost City," the Khentkawes Town, and the Menkaure Valley Temple are precise. But the positions of pyramids, temples, and tombs on the high plateau are based on the MHR map sheets, maps prepared by the major excavators of the first half of that century—George Reisner, Hermann Junker, Selim Hassan—and other published sources. Except for the MHR maps, the other maps have no vertical information (spot heights or contours).

Our maps, like most maps, reconstruct neat, highly schematic outlines of the ancient monuments from ruins on the ground. For example, in our maps the Menkaure causeway, straight and bold, is a graphic reconstruction that does not exist as far as we know for much of the distance between the Menkaure Upper Temple and the Valley Temple.



Mark Lehner

1984: the beginning of the Giza Plateau Mapping Project. David Goodman records survey data for the control network that he and Mark Lehner set up across the Giza Plateau.

### Busy: Lost City and Field Schools

Over the years, it would have been easy for our surveyors to satisfy numerous requests for exact coordinates of the pyramids—once we decided where the original corners were, corners that have not existed for thousands of years (see page 19).

But we got busy. We salvaged, excavated, and mapped the urban sprawl of the Lost City and conducted nine field schools, all of which took us away from locating precise points on pyramids. As I have explained to many petitioners, our mapping project became less about the exact relations between pyramids, the Sphinx, tombs, and temples, and more about adding major missing components to the archaeological map of Giza—principally, the settlements where people lived while building and servicing the great necropolis.

In fact, in 1984–85 David Goodman and I did survey the base points of the Khufu Pyramid. We did not publish the survey, but used the corner points, marked with brass plugs (see page 19) to calculate a center for the Khufu Pyramid and define it as N100,000 and E500,000, setting the values for the GPMP grid. And over the years, we have used the GPMP grid to survey and hand-map many other features of the Giza Necropolis. With this season's work we now pull together many years of disparate maps.

### Giza Plateau Parts: Mapping Here and There

Through the years, the GPMP survey control network has provided invaluable points for establishing a local grid over the entire Giza Plateau and for locating any feature to great accuracy in terms of the grid. The GPMP survey control was indispensable for recording the remains of the Lost City and for teaching best standard practice in archaeological excavation and recording.

In addition to mapping our own sites with great precision and detail, we have mapped sites for Dr. Zahi Hawass and the Supreme Council of Antiquities (now Ministry of State for Antiquities): the AMBRIC trenches that hit the foundations of the Khufu causeway (1991), the remains of the Upper Temple of the Khufu Pyramid (1995), the Khufu satellite pyramid (1995), the pyramids of Khufu's queens (1995), the eastern Khufu boat pits (1995), the area east of the Khafre Valley Temple (2002), the Menkaure causeway ramp (2004), and the construction ramp along the southern wall of the Western Cemetery (2005).

We mapped some of these features by measuring many points with Total Station survey instruments. We mapped others by hand, as we do our excavation squares, by offset measures from datum lines strung between grid control points. My pre-GPMP hand-mapping included the Sphinx, Sphinx Temple, and Khafre Valley Temple, where I used my own local grid and control points. These facsimile maps represent reality on the ground. Most of the resulting maps are at very large scales: 1:20, 1:50, and 1:100. They all have many spot heights with respect to meters above sea level.

### GPMP and GIS: A Layered Archaeological Map of Giza

Now, as part of the Glen Dash Foundation Survey (GDFS), in collaboration with the Boston Museum of Fine Arts/Harvard University Giza Archives Project directed by Peter Der Manuelian, we are bringing all of our survey data and hand-drawn maps together with maps of previous missions into one single map in our Geographic Information System (GIS). When finished, it will encompass a large percentage of the archaeological map of Giza—the initial goal of the GPMP.

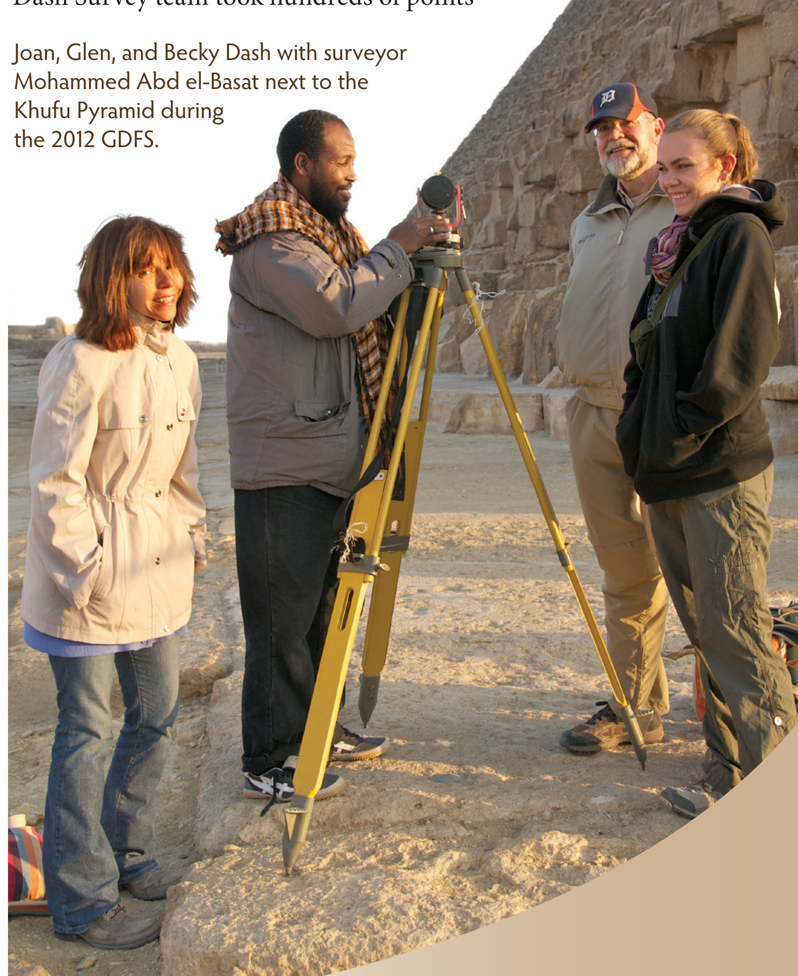
In 1984 neither David Goodman nor I dreamt of AERA owning our own GIS. Thanks to Farrah Brown, Camilla Mazzucato, and Rebekah Miracle developing and growing our own Giza GIS since 2005, the newly comprised overall map is itself layered like a stratified archaeological tell. We can turn on and off the various layers: older maps, the Ministry of Housing and Reconstruction maps, our own survey points, as well as plot the distributions of anything from fish bone (in the settlements) to titles (tomb texts and clay sealings).

With support from the Glen Dash Foundation, Rebekah Miracle, AERA GIS director, visited the Boston office in 2011. Together we assembled all of our survey points and hand-maps of features, sites, and monuments for Rebekah to subsume this decades of data harvest into the best compilation and map of Giza that exists.

And finally, after so many years, during Season 2012 we aimed our Total Stations on the major monuments, capturing additional points to geo-rectify the pyramids, temples, causeways, and major tombs as we also maintain our survey control network. In February, Joint Field Director Mohsen Kamel and I spent several mornings with the 2012 survey team: Surveyor Mohammed Abd el-Basat, Apprentice Surveyor Amer Zakaria, Assistant Surveyor Mohamed Hilmy, Documentation Recorder and Photographer Yaser Mahmoud, and Assistant Photographer Osama Hassan.

We reconnoitered each major pyramid, temple, causeway, and tomb to decide where best to take points on what we believe to be original builders' lines. As the team subsequently carried out the survey, they gave each point (of thousands) a number and documented it with a photograph, description, and date. Team members sketched each corner and wrote notes on where and why they took particular points.

In the third week of February, Glen, Joan and Becky Dash and James Bishop joined the survey team, working to establish closed loop surveys for the Khufu Pyramid and Sphinx for greater confidence and accuracy. The Dash Survey team took hundreds of points



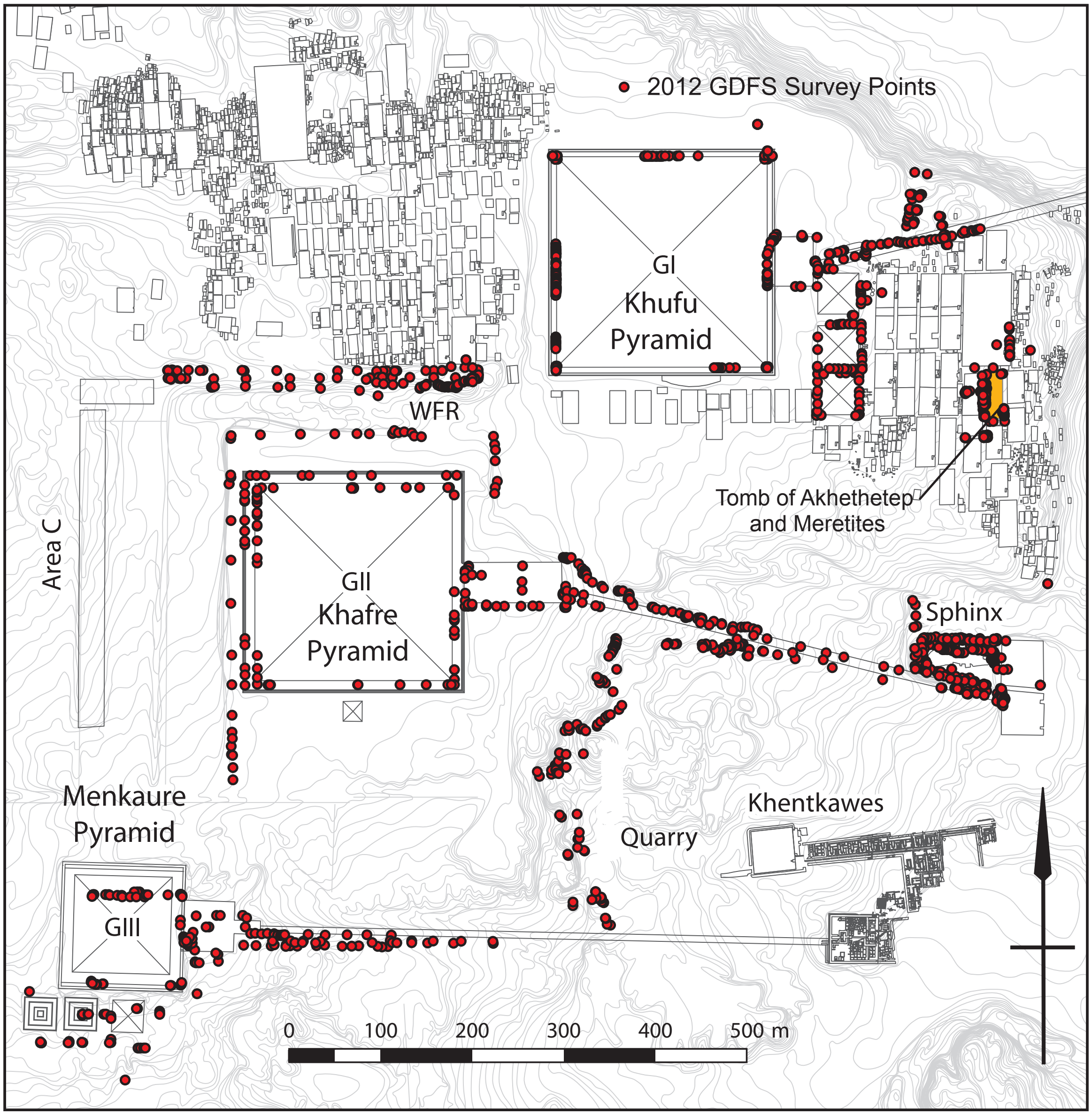
Joan, Glen, and Becky Dash with surveyor Mohammed Abd el-Basat next to the Khufu Pyramid during the 2012 GDFS.

Mark Lehner

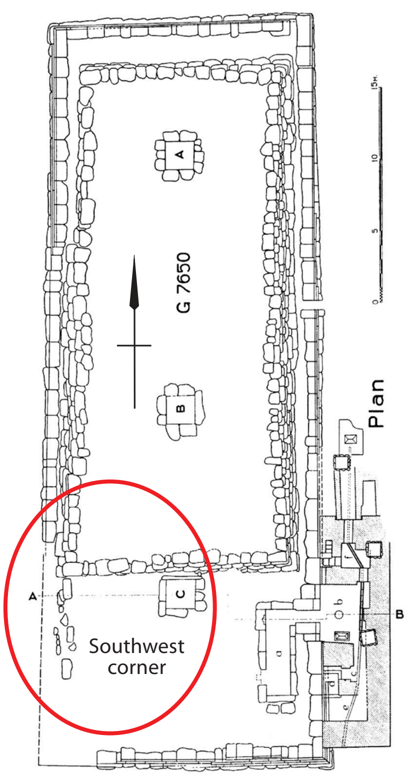
with a Total Station on the remnants of Khufu's builders' original lines, allowing precise coordinate and distance measurements with an infrared beam.

We thank the Glen Dash Foundation for bringing us back to our point of beginning (as surveyors call the opening and closing point of a traverse loop), and look forward to contributing to a new and comprehensive map of the ancient Giza Necropolis.

~ ***Mark Lehner***



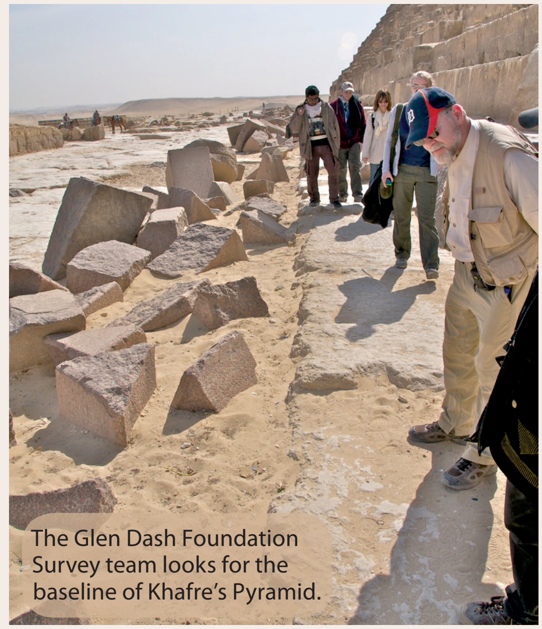

Right: Survey points taken by the 2012 Glen Dash Foundation Survey Project, shown in red. The 2012 survey reveals a need to shift southward the Menkaure Pyramid (GIII), temple, and causeway. WFR stands for Western Field Ramp, an ancient construction embankment along an unfinished colossal stone wall. Map prepared by Rebekah Miracle, AERA GIS.




Left: George Reisner's map of mastaba G7650, the 4th Dynasty tomb of Akhethetep and Meretites in the Eastern Cemetery at Giza, marked in yellow on the map above. From G. A. Reisner, 1942, *A History of the Giza Necropolis*, Vol. 1, Cambridge: Harvard University Press, page 47, fig. 9.

Below: Recent photo of G7650. View to the northeast. The dashed line on the photo shows the extrapolated southwest corner. When Reisner mapped the tomb, the southwest corner and portions of the west and south sides were already gone. View to the northeast. Photo by Yaser Mahmoud.

Mark Lehner


The Glen Dash Foundation Survey team looks for the baseline of Khafre's Pyramid.
Mark Lehner

# Corner Conundrum: A Mapping Mantra

If we had clear-cut lines and corners, we could give precise coordinates for the pyramids to those who believe this is meaningful in terms of the builders' intentions. But, could the builders have measured distances to an accuracy of millimeters or centimeters over hundreds of meters, given sighting by eye without our telescopic instruments and challenges such as the stretch and sag of a rope?

Maps are by nature abstractions based upon assumptions, estimates, and interpretations. Mapmakers transform complicated physical realities into neat lines. Maps of the Giza Necropolis represent pyramids, tombs, and temples with clean rectangles, features that ceased to exist centuries ago and in some cases never existed as such.

Khufu's Great Pyramid is a good example. First, the original finished corners, and most of the original baselines, are missing completely. When David Goodman and I surveyed the Khufu Pyramid in 1984, we took measurements from points marked with bronze plugs at three of the corners. The people who set the plugs must have meant them to mark the corners, which they would have established by extrapolating from patches of *in situ* masonry in the foundation platform. Or they may have extrapolated from the line of the platform still visible in the bedrock floor. But this extrapolated line was *not* the baseline of the pyramid. As shown in the photo above, the bottom of the casing, set back from the upper edge of the platform, became the true baseline. But of the original 921.44 meters of this baseline only 54.44 meters remains, less than 6%. Most of this is near the centers of the sides, which makes extrapolations far less accurate than if we had segments closer to either end. With most of the original builders' lines gone, the baseline and dimensions of the Great Pyramid are now our own extrapolation.

When we read of the cosmic significance that some authors place on the exactitude of the Great Pyramid dimensions, we should bear in mind that the original builders' lines are reconstructed from less than 6% of the base.

Mapping the baseline of Khafre's pyramid is no easier. Petrie, who in 1881–82 surveyed the Giza pyramids according to professional standards of his time, went into the issue: what do we take as the baseline?* It turns out that Khafre's builders created the baseline of his pyramid simply as a vertical cut in the foot of the bottom course of casing stone, which was granite, so that the slope of the pyramid met the top surface of the pavement of the court surrounding the pyramid. Khafre's builders' custom-cut the natural limestone base underneath the casing to bring the granite blocks flush at the top (it was easier to cut away the limestone than the much harder granite). Only four casing blocks remain in place: two side by side at the far western end of the southern side and another pair near the center of the northern side. We therefore need to take as the baseline the outer edge of the emplacement cuttings, or socle, for the missing casing stones.

The builders never finished making the baseline of the Menkaure Pyramid, as we know from trenches dug into the debris covering most of the base. They shaved the tops of the lowest casing course even and flush, while leaving the bottoms at different levels, accommodating the slope and irregularity of the rough foundation. Maybe they intended, like Khafre's builders, to trim the baseline by cutting a vertical, lower face into the bottom of the slope of the casing blocks. Since they never completed this task, there is no straight and square baseline. Recently the Giza Inspectorate excavated through the debris at the western end of the northern side and showed that Menkaure's builders set the lowest casing here down into a trench cut into bedrock, several meters wide and 1.70 meters deep! We do not know the exact location of the corners, still embedded in debris, but like the pyramids of Khufu's queens, the base footprint is almost certainly a trapezoid.

Mastaba tombs (Arabic for "bench") look like flat-topped, stretched-out pyramids with sloping sides, and they present similar issues. During the Glen Dash Foundation Survey, "Where's the corner?" became a mapping mantra, and even "Where's any good stretch of straight [builders'] line?" For those theorists who demand high precision for pyramid points, we wondered, just what is the point?

*W. M. F. Petrie. 1883. *Pyramids and Temples of Giza.* London: Field and Tuer, pages 96–99.




# Honoring Our Benefactors

Without our benefactors AERA would not be the strong, vibrant organization it is today. We are pleased to honor them at our AERA-Egypt Center in Giza.

First, we recognize the benefactors who made it possible for us to buy and renovate the Center property. The walkway around the villa and garden is now Lurie Lane, named for Ann Lurie. The intellectual focus of the AERA-Egypt Center we have named The Ted Waitt Library and Lecture Hall. Our computer lab now bears the name The Charles and Lisa Simonyi Synergy Center. We gather to discuss work and relax in Koch Commons, named after David Koch. The upper floor of the main building complex we dub Villa Giuseppe Ferlini, after the explorer who lobbed tops off Nubian Pyramids, per Peter Norton's wish. We designate the main floor *Bayt* Susan* for Susan Hutchison for all her counsel. One of these names we will transfer to the new building that will house our administrative offices and director's quarters. The Fisher Garden honors Marjorie Fisher.

We name the villa fountain (shown on the left) after longtime AERA board member and legal counsel the late George Link. Our Donor Wall of Honor, flanking the fountain, recognizes all our major donors, each acknowledged with a bronze Trowel of Honor. In our next issue of *AERAGRAM* we will feature a more complete story on the fountain and the Wall of Honor.

Finally, we would like to announce that, at the request of Ann Lurie, the AERA-Egypt Center will be named The Mark Lehner Center.

To all of our donors and supporters we say, thank you.

**Bayt* means "house" in Arabic, and "Susan" derives from the ancient Egyptian word for lotus.

The original villa fountain midway through reconstruction. When finished, a fishing mosaic will grace the fountain basin. Water will spurt from four frogs on the low wall and the hippo goddess Taweret high on the back wall. The Fisher Garden, named for Marjorie Fisher, faces the fountain.

Left: Sayed Salah hangs the Lurie Lane sign. Below, he displays the Koch Commons plaque in the area we are naming for David Koch.



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Signature________________________________

Please send application with payment to AERA at:
26 Lincoln Street, Suite 5, Boston MA, 02135 USA