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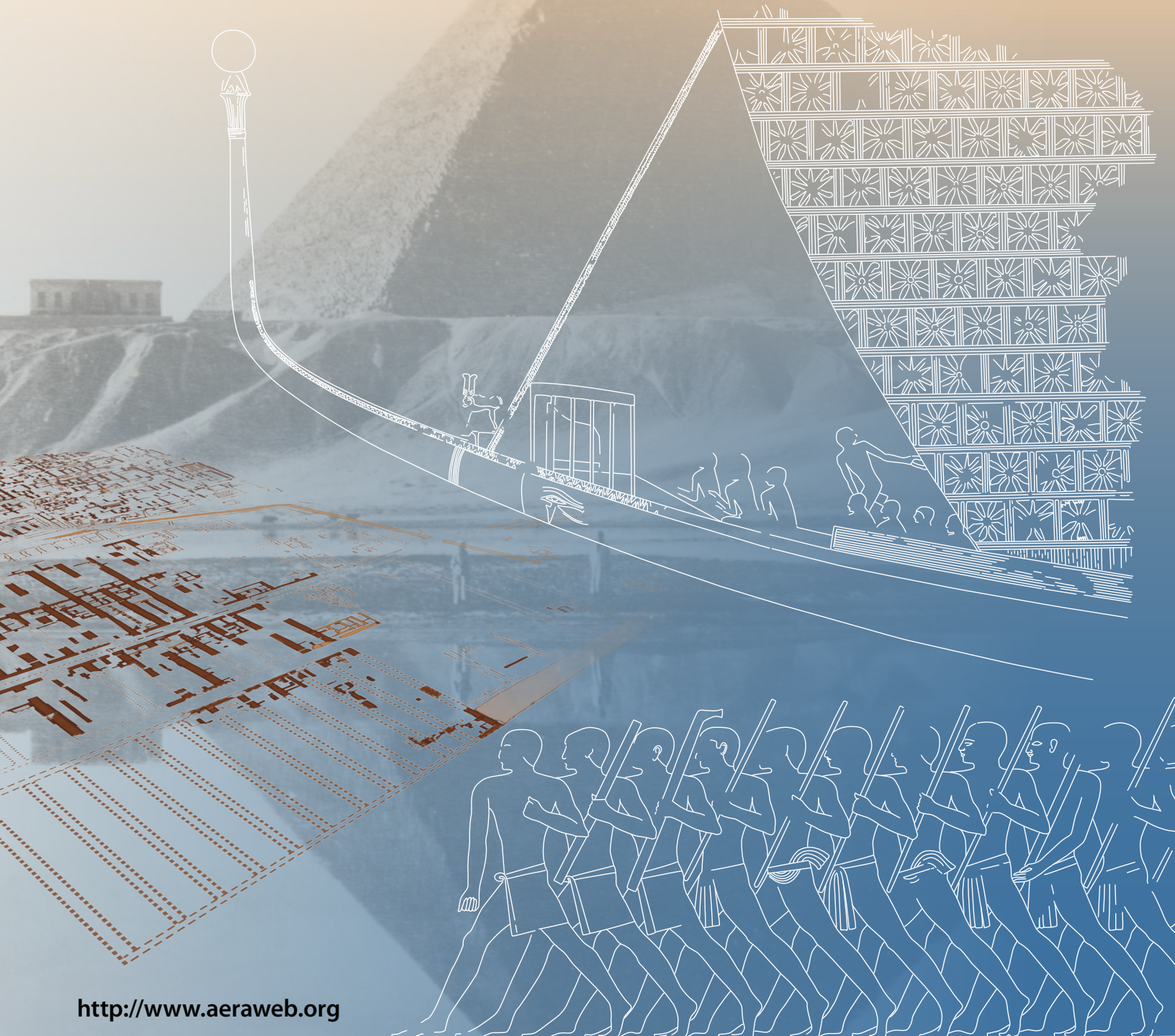
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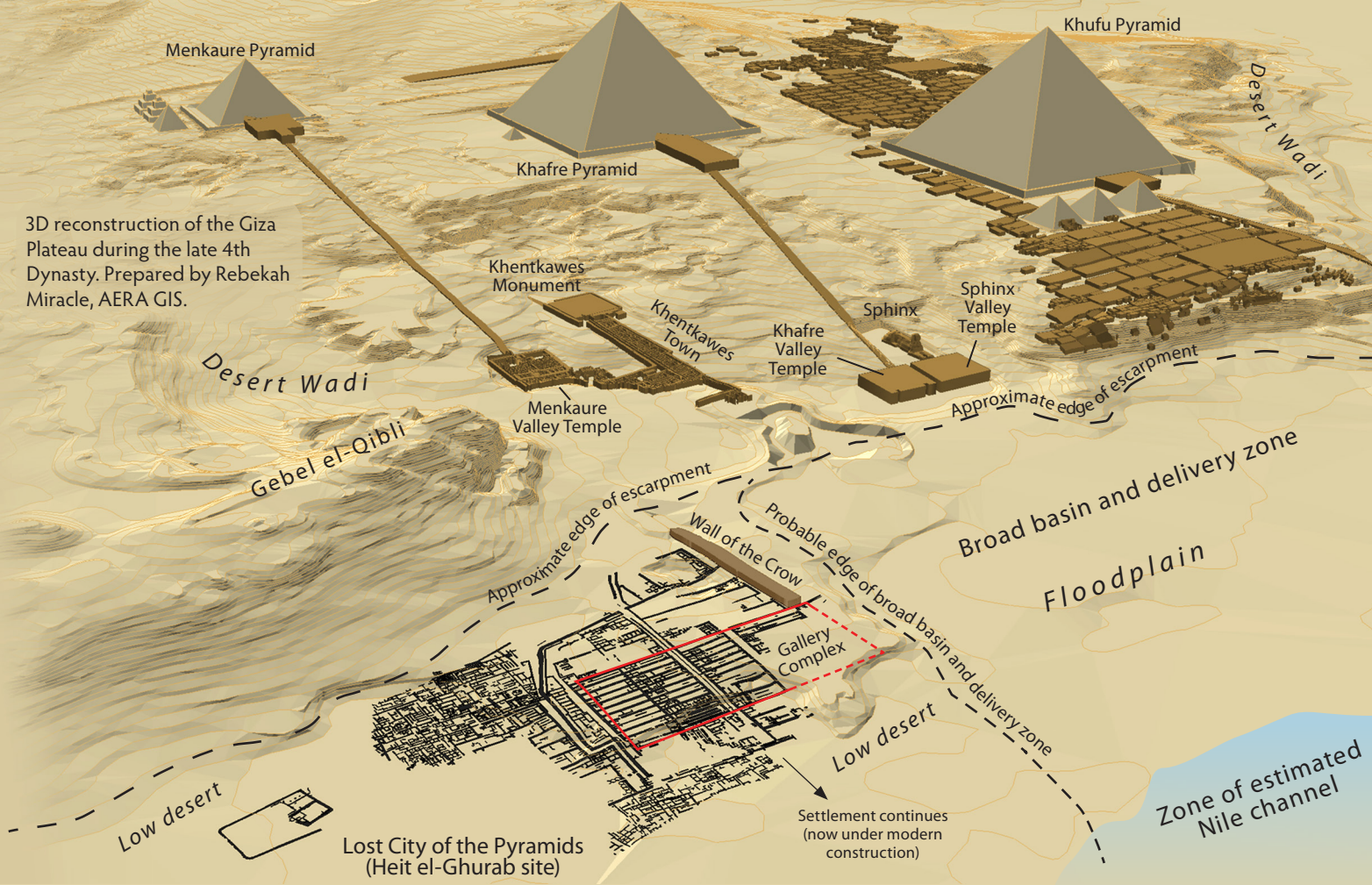
## The Lost Port City of the Pyramids

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## The Heit el-Ghurab Site Reveals a New Face: *The Lost Port City of the Pyramids* by Mark Lehner

During Season 2013 AERA team members took a break from field excavations for a study season. Without new findings emerging every week from the field, I took the opportunity to pan back and reconsider the mass of data from the Lost City of the Pyramids site (also called Heit el-Ghurab) in the wider context of Old Kingdom Egypt and its 3<sup>rd</sup> millennium BC world.

A new working hypothesis emerged. Far more than a workers' town, which we had been calling Heit el-Ghurab for years, the site and its Gallery Complex belonged to a major Nile port and harbor, with basins, off-loading quays, timber stockpiles, warehouses, and possibly even shipyards. The Gallery Complex as a barracks housed members of expeditions who brought goods from the Levant in the north and from Aswan in the south, as well as construction material from quarries and foodstuffs from farms and ranches throughout the Nile Valley and Delta.

### Ports for Dead and Living

We know that the Giza Necropolis served as a magical port city for the Afterlife. Ships buried next to the pyramid of Khufu and large pits cut in the shape of barks or containing actual wooden funerary vessels next to the pyramid of Khafre and the

tomb of Queen Khentkawes were meant to convey the deceased rulers to the Netherworld.

But a real harbor must have been located nearby for delivering the vast quantities of materials and supplies used in building and supporting labor for the three Giza pyramid complexes over a period of nearly 80 years. If only for this reason, we might expect a major Nile port, the Old Kingdom equivalent of Nile ports such as Tell el-Daba and Memphis during the Second Intermediate Period and New Kingdom.

We have evidence of a man-made harbor at Giza. Field logs of drill cores taken in the floodplain show what might be a huge cut through the natural layers of Nile silt and sandy outwash from the desert wadis. The cut is filled with deep clay and silt. Here, to make a harbor, the pyramid builders may have excavated deep down into the floodplain. I present the data from these cores in the second part of this story, which will appear in the next issue of the newsletter.

It seems obvious that a harbor at Giza was essential for pyramid building. Given the great weight of the granite and limestone blocks, which were transported by ship on the Nile, Egyptians would have unloaded them as close as possible to the construction sites. The massive stone Wall of the Crow, stretch-

ing 200 meters to the east of the escarpment (or slope) between the Giza Plateau and the low desert and floodplain, formed the southern boundary of a delivery zone in front of the Khafre Valley Temple and Sphinx. The Heit el-Ghurab settlement lay directly south, and stretched at least another 150 meters farther east on a spur of low desert, like the peninsular settlements at the Tell el-Daba port.

We know that the Old Kingdom Egyptians also brought by boat large quantities of timber, olive oil, and probably wine and resin from the Levant, the region bordering the eastern end of the Mediterranean. We also know that some of these products ended up at Heit el-Ghurab. Specialists analyzing material in our Giza Field Lab have been identifying bits of Levantine pottery and Levantine wood in charcoal samples we have collected over the years. Although the need for a major delivery facility to receive building supplies was obvious, looking at all these imported items sparked the port hypothesis.

### The Old Kingdom Byblos Run

AERA ceramicist Anna Wodzińska identified Levantine combed ware pottery vessels amidst the vast numbers of Heit el-Ghurab ceramics. Altogether she found a total of 18 sherds. The name combed ware derives from its decoration: the potters striated or dimpled the surface as though by a comb. During the Old Kingdom (the equivalent of Early Bronze III in the Levant), potters made combed ware throughout the Levant, but not in Egypt.

Egyptians, however, shipped combed ware jars back to Egypt, no doubt for their contents.

Archaeologists who work in the Levant consider these jars, with loop handles, as the “commercial maritime container,” developed by Early Bronze Age Levantine potters “for the rigors of transport” and “long periods of

time at sea.”<sup>21</sup> In Egypt excavators have found most combed ware jars in the mastaba tombs of high officials in the royal cemeteries next to pyramids at Giza, Meidum, and Dahshur. The importation of these vessels reached a peak in the 4<sup>th</sup> Dynasty—the very time that people occupied the Heit el-Ghurab settlement. The 18 sherds we found at our site are the oldest combed ware from a settlement.

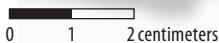
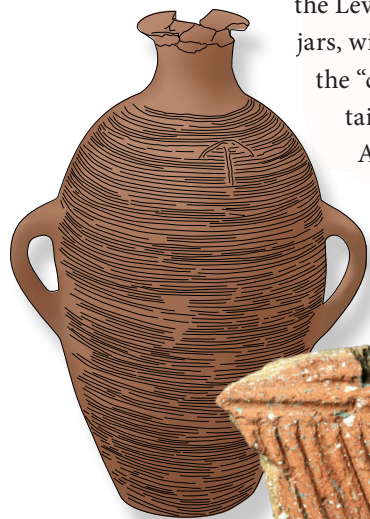


Egypt and the Levant showing the routes of the Byblos run and the Aswan run with Giza as the terminus.

On the cover: Detail of a scene in Sahure's mortuary temple at Saqqara. Returning from Punt, the king's ship of state, sail up, greeted by troops dockside. (After *Das Grabdenkmal des Königs Sahu-re'*, Band II, *Die Wanderbilder*, L. Borchardt, Leipzig, J.C. Hinrichs'sche Buchhandlung, 1913, plate 9). On the left, the Heit el-Ghurab settlement after a map by Rebekah Miracle, AERA GIS. In the background an old photo of the Great Pyramid from an undated postcard.

Combed ware two-handled jar. Drawing based on a photo of a jar from the Western Cemetery at Giza, Pit G 4630; 36 centimeters (14 inches) high. The “T” inscribed on the pot is a maker's mark. MFA accession number: 19.1456.

Combed ware sherd from the Heit el-Ghurab site. Photo by Hilary McDonald.



Whatever the jars contained—most likely resin, wine, or olive oil—it was precious and worth trekking or navigating hundreds of kilometers to obtain. In the Levant, the association of these jars with olive oil production equipment—limestone basins, presses, hearths, and large combed ware vats—favors olive oil.

Additional evidence at Heit el-Ghurab may also point to olive oil. Our wood analyst, Rainer Gerisch, identified bits of burned olive twigs from several areas at the Heit el-Ghurab site.<sup>†</sup> These bits of wood might have come along with shipments of olive oil as some sort of packing material between the jars and eventually ended up as firewood.

Curiously, they came from the Gallery Complex, a set of four blocks of elongated structures, and from the adjacent industrial areas. If the galleries served as barracks for lowly workers, why do we find costly imports in these facilities?

Through petrographic analysis Mary Ownby traced the origin of the Heit el-Ghurab combed ware to the region around Byblos, a major ancient port just north of modern Beirut.<sup>2</sup>

An entrepôt during the Old Kingdom and later, Byblos gathered goods from smaller sites upland and inland, making it the major port power on the Eastern Mediterranean. Because of a preponderance of evidence for trade between Byblos and Egypt in the Old Kingdom, Levantine scholars coined the term “the Byblos Run.” They suggest that corresponding home ports must have existed somewhere on the Nile.

<sup>†</sup> The olive wood finds are described in “Egypt’s Oldest Olive,” *AERAGRAM* 9-2, Fall 2008, page 3. All back issues of *AERAGRAM* are available for free download at our website: [aeraweb.org](http://aeraweb.org).

### The Ubiquity of Cedar

Perhaps the most compelling motivation for the pyramid builders to run to Byblos: procure timber, primarily the fabled, towering cedars of Lebanon. They could also harvest cypress, pine, and oak, none of which grew in Egypt, a land with a sparse tree cover and limited variety of native woods.

Working his way methodically through thousands of charcoal bits—probably the remains of fuel—picked from Lost City deposits by our excavators, Rainer Gerisch found that it was mostly (93.3%) local Nile acacia. But, in addition to olive wood, other Levantine wood kept turning up in almost every excavation area: cypress, pine, and oak. Cedar, however, was the most abundant import. It occurred in every part of Gallery III.4 (see map on page 7), which we excavated in 2002,<sup>‡</sup> and with a relatively high frequency in other Gallery Complex excavations.

We know that cedar was used for ships and palace doors. The pyramid builders used tall cedar beams as framework in pyramid construction. But would people have burned cedar in hearths?

### Parallels with Proven Ports

For clues that might help answer that question we turn to proven Pharaonic ports excavated recently on the western Red Sea coast at Wadi Gawasis, Ayn Soukhna, and Wadi el-Jarf. All three sites include industrial and other settlement structures as well as long, narrow gallery caves hollowed out of bedrock and

<sup>‡</sup> The excavations of Gallery III.4 are described in a “Gallery Unveiled,” *AERAGRAM* 6-1, Fall 2002, pages 4-5.

Galleries in the Heit el-Ghurab Gallery Complex, Galleries III.3 (right) and III.4, view to the south. One massive gallery sidewall can be seen running between the two galleries. The large open area in the foreground may have served as a barracks or storage area. The back portion appears to have been a house, perhaps for an overseer. Excavation team members give a sense of scale. Photo by Yaser Mahmoud.





Dressing the hull of a wooden boat; detail from a scene in the 5th Dynasty tomb of Ti at Saqqara. The men standing in the ship use two-handed hammers similar to one found at the Heit el-Ghurab site (right). (After H. Wild, *Le Tombeau de Ti*, Fascicule II, Institut Français



d'Archéologie Orientale, Cairo, L. Épron, F. Dumas, and G. Goyon, 1953, plate cxxix.)

Right: A two-handed hammer made of indurated limestone from the Heit el-Ghurab site, Gallery II.4. Photo by Emmy Malak.

used for both storage and living quarters. Within the last year an Egyptian-French mission directed by Pierre Tallet discovered that the Wadi el-Jarf port dates to the 4<sup>th</sup> Dynasty reign of Khufu, whose name is inscribed on stones blocking the entrances to some of the galleries.<sup>3</sup>

For now, I draw attention to the Middle Kingdom, 12<sup>th</sup> Dynasty port at Wadi Gawasis and the discoveries of the mission under Kathryn Bard and Rodolfo Fattovich.<sup>4,5</sup> Unlike the damp Heit el-Ghurab site where all plant materials decomposed except charred remains, Gawasis's hyper-arid climate favored excellent preservation of organic material. Indeed, the team recovered thousands of wood fragments, over 40 wooden cargo boxes, and disassembled ship timbers, including more than 100 hull components, as well as coils of rope. Some of these pieces had been left for storage in the rock-cut galleries.

The Gawasis excavators also found many wood chips and fragments left "when ancient workers disassembled ships whose shipworm-riddled timbers suggest substantial sea journeys."<sup>6</sup> Shipwrights trimmed and cleaned the parts. Expedition members then used scrap wood to fuel hearths, sometimes for warmth or for cooking inside the galleries. In addition to scrap wood trimmings, the Gawasis expedition members also burned ship timbers in hearths within the galleries, perhaps after they had been used as gallery flooring and deteriorated irreparably.

When he analyzed the Gawasis wood, Gerisch found that as at Giza most of it was native Egyptian species, but the second or third most abundant type was cedar, which must have originated in Lebanon.<sup>7</sup> Could the cedar charcoal at Heit el-Ghurab similarly have resulted from men trimming and reworking ship parts and reusing the scrap as fuel in hearths? Did Heit el-Ghurab workers incorporate, as at Gawasis, wooden planks into the thresholds, floors, or upper reaches of their galleries and other buildings? Perhaps this is why we find cedar residues in the charcoal almost everywhere we have excavated down to gallery floors.

### Expeditionary Template

We know, mostly from Gawasis so far, of other, broad similarities between Heit el-Ghurab and the Red Sea port settlements, including an embayment adjacent to the site, an industrial area with evidence of bread-baking, and imported pottery (Canaanite/Minoan ware at Gawasis).

Andrea Manzo<sup>8</sup> noted similarities between the rock-cut galleries of Gawasis and the mudbrick galleries at Heit el-Ghurab. He suggested that the Red Sea port galleries represent transpositions of the pattern built in mudbrick at Heit el-Ghurab. Cut from natural conglomerate rock, the Red Sea galleries are consequently less formal than the Giza galleries, but expeditions to Sinai and the southern land of Punt may have adapted a kind of standard template to the Red Sea coast terrain. We might consider the Heit el-Ghurab and Gallery Complex as a more formal expression of a template for expeditionary forces that the Egyptians transplanted and accommodated to other ports.

### Ports and People

Traces of the Levantine products at the Lost City site suggest that these products were delivered and stored here, with some ultimately going into elite Giza tombs. Structures where shipments can be immediately and temporarily stored before distribution are a standard feature of ports. The long galleries in the Gallery Complex could well have served in part as warehouses for some of these goods.

We should consider that during two generations, the reigns of Khafre to Menkaure (and possibly since Khufu), the Heit el-Ghurab site became part of the homeland hub and entrepôt of the Byblos run for resin, wine, oil, and hundreds of tons of timber, and the Aswan run for thousands of tons of granite and African products, as well as the Red Sea–Sinai run for minerals.

Then we also have to reconsider the class and status of people who lived and worked here. The men who traveled abroad for wood and other products were members of expeditionary

forces. They and their goods traveled and stayed together until the final destination. Thus we can imagine that the galleries also housed crews along with wood, pottery, and olive oil, and other products they had procured.

Moreover, the men of the expeditionary forces may have enjoyed some of the spoils, perhaps as a reward. Scenes from later pyramid temples and causeways show young men rewarded with gold and other goods at the end of expeditions, as in the scene from Sahure's causeway at Abusir (on the right). Traces of "high-status" goods in the Giza galleries could reflect benefits, such as olive oil, granted to members of expeditionary forces.

In addition, we have recovered large quantities of animal bone in the Heit el-Ghurab site suggesting the inhabitants ate an extraordinary amount of meat—the diet we might expect for expeditionary force members of somewhat higher status than the most common workers.

At the same time, seeing the inhabitants of the Gallery Complex as members of expeditionary troops and nautical crews does not negate the possibility that many of them labored at the most basic skills and exertions. Studies of Nile navigation through time show much punting, pushing, and towing from the banks, the same basic exercise needed to move blocks for building pyramids, tombs, and temples. Recently published scenes from the Sahure causeway show, in fact, that some nautical crews of ships of state, escort boats, and expeditionary ships bear the same gang names as found in workers' graffiti on the monuments.<sup>9</sup> Crews, apparently nautical, and workers compete in rowing, wrestling, and archery.

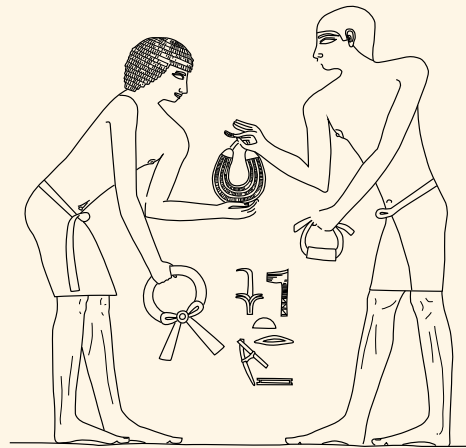
What is the larger theme of these recently published Sahure causeway scenes? It is an expedition to the southern land of Punt, arriving at homeport with Puntites and incense trees (frankincense or myrrh) to be received by the king and his family, along with crews of workers who drag the capstone to crown and complete the pyramid. A celebratory feast ensues, perhaps a special feast out of the many regular feasts that we know so well from tomb and temple texts. We see racks of hanging meat, to be shared and consumed for the occasion. We think in terms of such feasting when considering our evidence for an abundance of cattle, sheep, and goat consumed at the Lost City and realize that "workers' town" and "port city" of the pyramids were not mutually exclusive.

Do we in fact find evidence of a major port at Giza? In the next issue we look at evidence of water transport infrastructure under the floodplain along the base of the Giza Plateau.

## REFERENCES

(Please note: references are numbered sequentially in the order in which they are cited in the text.)

1. Marcus, E. S., "Early Seafaring and Maritime Activity in the Southern Levant from Prehistory through the Third Millennium BCE," In *Egypt and the Levant: Interrelations from the 4th through the Early 3rd Millennium BCE*, ed.



Detail from a scene in the pyramid causeway of Sahure at Abusir. A high ranking courtier (right) named Merynetjernisut rewards a member of Sahure's expedition to Punt. With his right hand he presents the man with a broad collar of three rows of beads, while holding a cylinder seal in his other hand. The recipient holds a decorative fillet (headband or wreath) in his right hand. (After a drawing by J. Malátková in *Abusir XVI, Sahure - The Pyramid Causeway: History and Decoration in the Old Kingdom*, T. El Awady, Charles University in Prague, Prague, 2009, plate 7.)

by E. C. M. van den Brick and T. E. Levy, London: Leicester University Press, 2002, pages 410–411.

2. Ownby, M., "The Importance of Imports: Petrographic Analysis of Levantine Pottery Jars in Egypt," *Journal of Ancient Egyptian Interconnections* 4.3, 2012, pages 23–29.

3. "Egypt's King Khufu's harbour in Suez discovered," ahramonline, April 11, 2013. <http://english.ahram.org.eg/NewsContent/9/40/69024/Heritage/Ancient-Egypt/Egypt-King-Khufus-harbour-in-Suez-discovered.aspx>.

4. Bard, K. A., and R. Fattovich (eds.), *Harbor of the Pharaohs to the Land of Punt: Archaeological Investigations of at Mersa/Wadi Gawasis, Egypt, 2001–2005*, Naples: Università degli Studi di Napoli "L'Orientale," 2007.

5. Bard, K. A., and R. Fattovich, "Spatial Use of the Twelfth Dynasty Harbor at Mersa/Wadi Gawasis for the Seafaring Expeditions to Punt," *Journal of Ancient Egyptian Interconnections* 2.3, 2010, pages 1–13.

6. Ward, C., "Building Pharaoh's Ships: Cedar, Incense, and Sailing the Great Green," *British Museum Studies in Ancient Egypt and Sudan* 18, 2012, page 221.

7. Gerisch, R., A. Manzo, and C. Zazzaro, "Finds: Other wood and wood identifications," In *Harbor of the Pharaohs to the Land of Punt: Archaeological Investigations of at Mersa/Wadi Gawasis, Egypt, 2001–2005*, ed. by K. A. Bard, and R. Fattovich, Naples: Università degli Studi di Napoli "L'Orientale," 2007, pages 173–174.

8. Manzo, A., "Typological and Functional Remarks on Some Structures at Mersa Gewasis (Red Sea, Egypt)," In *Recent Discoveries and Latest Researches in Egyptology*, ed. by F. Raffaele, M. Nuzzolo, and I. Incordina, Wiesbaden: Harrassowitz, 2010, pages 157–175.

9. Verner, M., "The Abusir Pyramid Builders' Crews," in *Es werde niedergelegt als Schriftstück: Festschrift für Hartwig Altenmüller zum 65 Geburtstag*, ed. by N. Kloth, K. Martin, and E. Pardey, *Studien zur Altägyptischen Kultur Beihefte* 9, 2003, pages 445–451.

Facing page bottom left: Cargo boat from a scene in the 5th Dynasty tomb of Ti at Saqqara. (After *Le Tombeau de Ti*, Fascicule II, Institut Français d'Archéologie Orientale, Cairo, L. Épron, F. Daumas, and G. Goyon, 1939, plate xxiv.)

Bottom right: Cattle boat from a scene in the 5th Dynasty tomb of Akhetotepher (Hetepherakhet) at Saqqara. (After *The Ships of the Pharaohs, 4000 Years of Egyptian Shipbuilding*, B. Landström, Garden City, Doubleday, 1970, page 56.)

## Research Implications

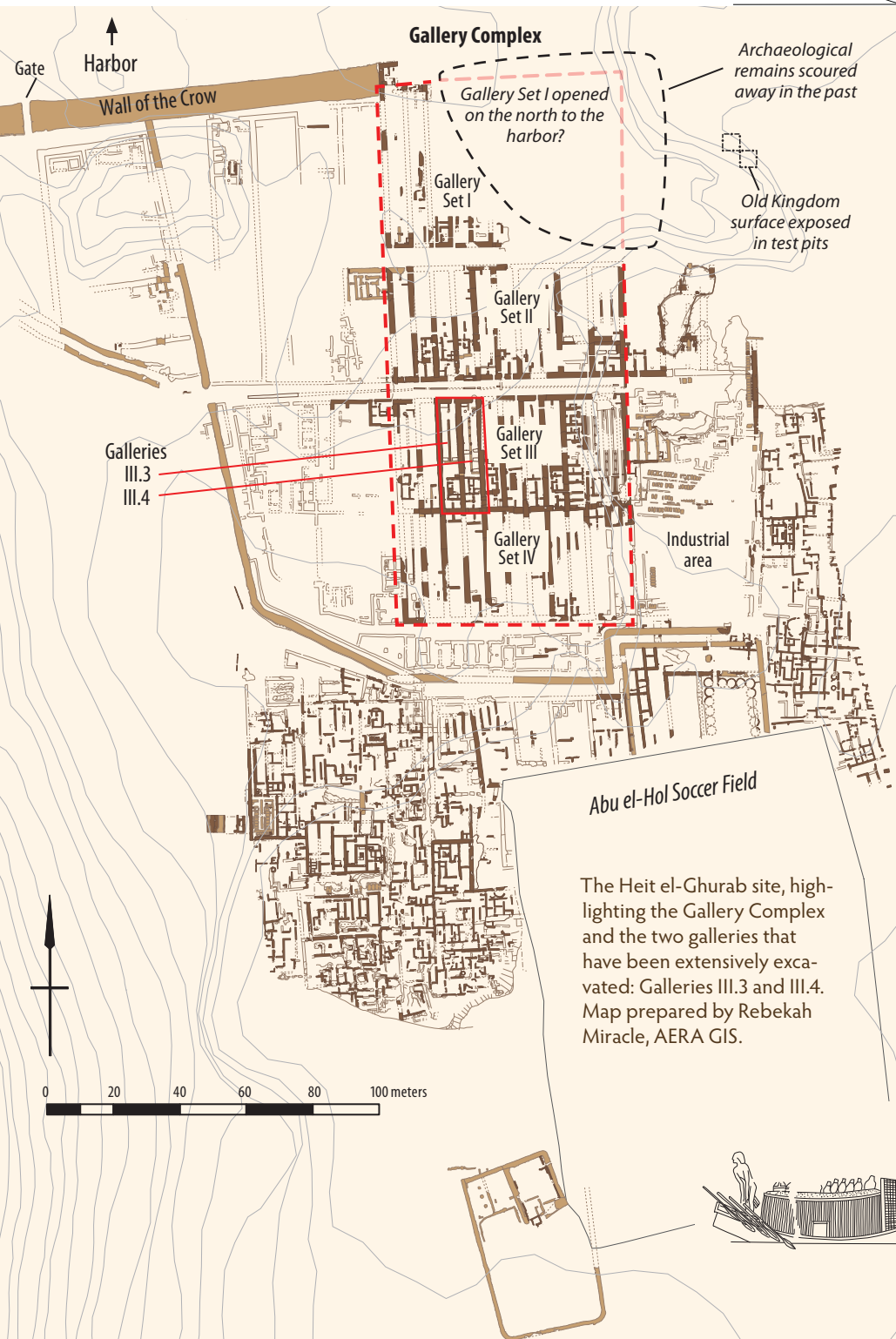
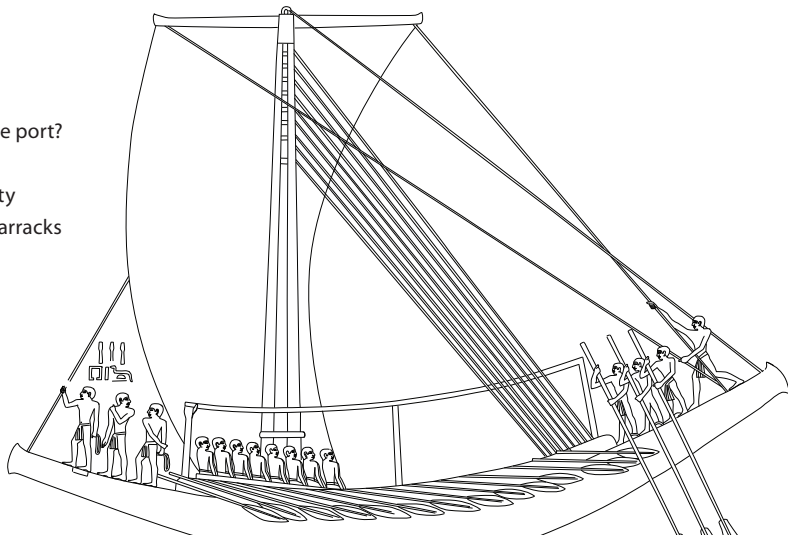
How can we test the hypothesis that the Heit el-Ghurab site was part of a major Nile port?

Evidence so far includes:

- Building stones in large quantities imported to Giza requiring a harbor facility
- Galleries that could have been warehouses—a standard port feature—or barracks
- Levantine combed ware
- Levantine woods, especially cedar, reflecting the “Byblos run”

What other archaeological evidence should we expect? I list some examples:

Right: A scene from the 5th Dynasty tomb of Ti at Saqqara: a sailing ship returning from one of the cities of the funerary estate in Lower Egypt. (After *Le Tombeau de Ti*, Fascicule I, Institut Francais d'Archéologie Orientale, Cairo, L. Épron, F. Daumas, and G. Goyon, 1939, plate xlvi.)



The Heit el-Ghurab site, highlighting the Gallery Complex and the two galleries that have been extensively excavated: Galleries III.3 and III.4. Map prepared by Rebekah Miracle, AERA GIS.

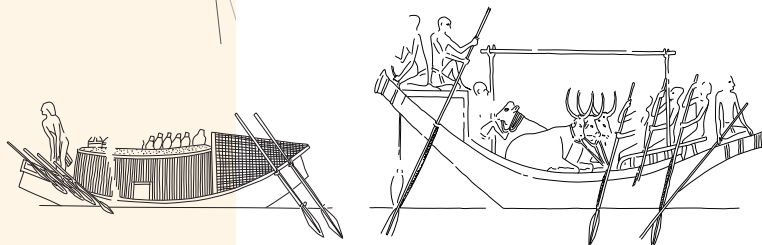
\* **Stone anchors.** Thus far we have found none, but some may turn up in areas that we have not yet intensively excavated, particularly the northern area of the site. We should reexamine our corpus of broken groundstone objects on the chance that some could be fragments of anchors, especially portions of the loop to which the anchor cable attached.

In the far northeast corner of the site we did find large, heavy limestone weights probably used for fish nets (illustrated in *AERAGRAM* 6-2, Fall 2003, page 1).

\* **Large open areas for repairing ships.** We might further explore the northeast corner of the site where we found evidence of an Old Kingdom trodden surface, which appeared to be just outside the main occupied area of the town. If the area had been a repair yard, we might expect to find scrapers and debris from sharpening them. Traces of ramps for sliding ships to and from the harbor might be preserved in compacted surfaces sloping downward toward the north.

\* **Tools used for ship repairs.** Scrapers were used to clean ship hulls. But we probably cannot associate any particular examples with ships, as scrapers are used for many tasks. Nonetheless, comparisons with scrapers from Wadi Gawasis might offer clues. Also, we might find evidence in wear patterns and residues that scrapers dressed down cedar, the lumber used for seagoing ships.

\* **Galleries as storage/barrack facilities.** We have intensively excavated only two entire galleries, but we know that the modular gallery template was built out in a variety of configurations, possibly to serve different needs of shipping and trade, such as storage of different products. Or perhaps different crews had their own galleries, as seen at Wadi el-Jarf in the gang labels on gallery entrances.



# How the Pyramid Builders May Have Found Their True North

by Glen Dash

In 2011–2012 AERA began a comprehensive resurvey of the base of the Great Pyramid, the Sphinx, and some of the other great monuments of Giza. We excavated our own archives as well, and with that data AERA associate Glen Dash attempted to answer some of the fundamental questions that scholars have puzzled over for more than a century: What are the exact dimensions of the base of the Great Pyramid? How well is it oriented to true north?\* In this issue, he addresses another question scholars have debated: how did the ancient Egyptians manage to orient their pyramids so accurately to true north?

The builders of the Great Pyramid of Khufu aligned the huge monument to true north to within six minutes of arc, or one tenth of a degree.<sup>1</sup> Scholars have described that achievement as extraordinary, astonishing, and brilliant. How they managed to do that has long been debated. In this article we will examine four prominent theories and test one.

Old Kingdom texts, pictorial representations, and surviving tools offer us few clues as to how the Egyptians built their pyramids, let alone how they aligned them. In his book *The Pyramids of Egypt* (1947/1993), I. E. S. Edwards summed up the situation: “Extant Egyptian records, whether written or pictorial, throw no light on the methods employed by the builders of the pyramids either in the planning or in constructing their monumental works.”<sup>2</sup> Scholars, therefore, have had to formulate theories without much help from the Egyptians themselves.

## The Imperishable Ones

Why did the Egyptians need to align their pyramids with cardinal points? The answer may lie in their vision of the Netherworld. The *Pyramid Texts*, first inscribed on the walls

of the burial chamber of 5<sup>th</sup> Dynasty king Unas (c. 2356–2323 BC), describe eternity and the deceased’s connection to the celestial world. The king was to “go forth to the sky among the Imperishable Ones” and “go around the sky like the sun.”<sup>3</sup> The “Imperishable Ones” were the circumpolar stars, so named because they never set below the horizon.<sup>4</sup> The king’s spirit may have been guided on its journey by the orientation of the pyramid’s inner spaces.<sup>4</sup> At their northern end, the corridors of many pyramids lead to a “descending passageway” angled up at the circumpolar stars “like a telescope.”<sup>3</sup>

While the *Pyramid Texts* may help us understand why the Egyptians aligned their pyramids to cardinal points, we do not know why they needed to do it with such precision. As Mark Lehner has said, “For the royal designers, such exactitude may have been imbued with symbolic and cultic significance that now eludes us.”<sup>3</sup>

## The Vault of the Heavens

To astronomers, due north and south are said to lie on the meridian line, a line that connects the geographic South Pole to the North Pole (facing page, top left). An observer standing anywhere on the earth’s surface looking north finds the meridian line running between his or her feet. The location directly above the observer’s head is known as the zenith. The meridian circle arcs overhead connecting north, south, and the zenith.<sup>5</sup> The meridian circle lies in a plane perpendicular to the observer’s horizon.

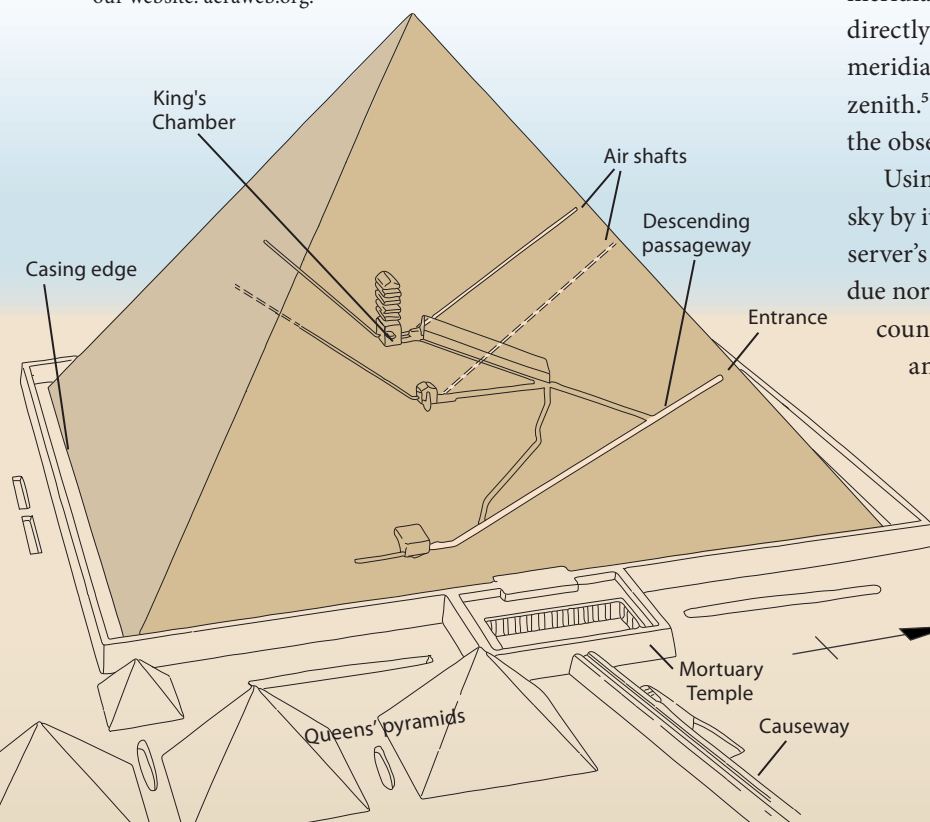
Using these lines and circles, we can locate any star in the sky by its elevation—the vertical angle of the star above the observer’s unimpeded horizon—and its azimuth—its angle from due north along the horizon. A clockwise angle is positive, and counterclockwise, negative. We measure angle in degrees and minutes of arc, with 60 minutes in one degree.

## Edwards’s Circle

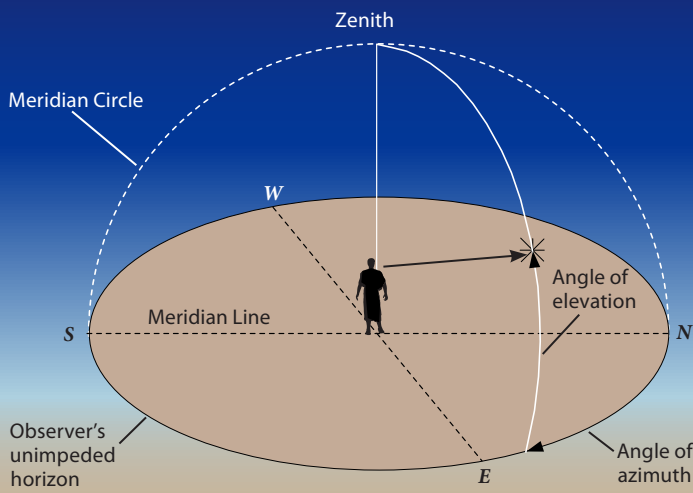
Edwards claimed that the Egyptians located the meridian with the aid of an artificial horizon—a

Inside the Great Pyramid. The body of the king was laid to rest in the King’s Chamber. Its spirit moved among its internal spaces and may have exited out via the descending passageway. Scholars have attempted to determine the pyramid’s intended alignment by examining the orientation of its casing and its passageways. (After *The Complete Pyramids* by Mark Lehner, London, Thames & Hudson, 1997.)

\*Glen Dash, “New Angles on the Great Pyramid,” *AERAGRAM* 13-2, Fall 2012, pages 10–19. All back issues of *AERAGRAM* are available for free download at our website: [aeraweb.org](http://aeraweb.org).

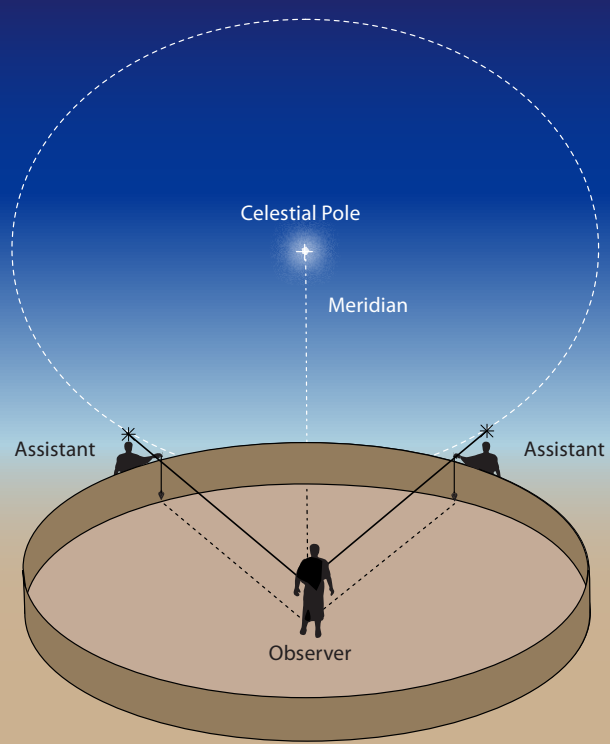






Above: Mapping the sky. The meridian line lies in the direction of due north. Any object in the sky can be located by its azimuth and elevation.

Right: Edwards's method. Edwards theorized an observer placed inside a circular wall that served as an artificial horizon. An assistant marked the location where a certain star rose and then, hours later, set. The observer bisects the angle formed in order to locate the meridian.



circular wall built around an observer, tall enough to exclude all but the night sky from view.<sup>2</sup> The observer stood at a fixed spot at the center of the circle and watched over a pole or through a sight as a particular star rose over the wall in the east. An assistant marked the location where the observer saw the star rise. Later the observer watched the same star as it set over the wall in the west. The assistant marked that spot as well. The locations of the two spots were extended to the ground through the use of a plumb bob. Bisecting the angle formed by the two locations and the observer's position derived the meridian.<sup>3</sup>

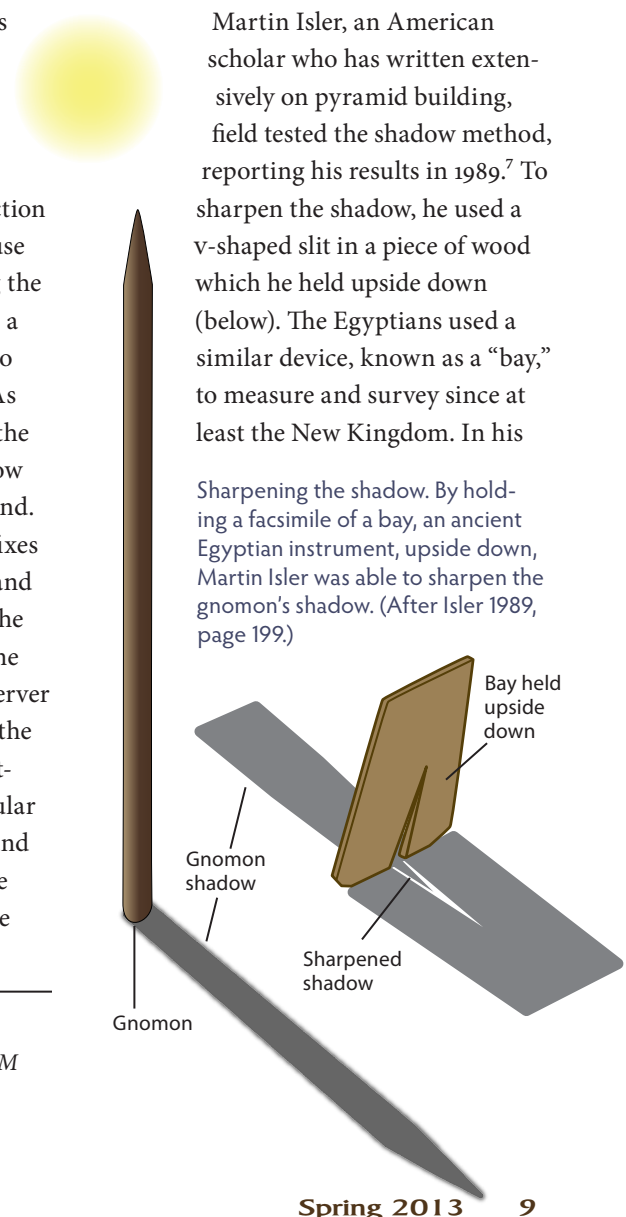
However, Edwards never field tested his theory. If he had, he may have found it difficult. To achieve an accuracy of 6 minutes of arc, he would have needed to establish the relative positions of the star's rising, setting, and the center of the circle accurately to better than 2 parts in 1000. If his circle were 3 meters in diameter, that translates to a total error of just 6 millimeters. Edwards acknowledges that in order to achieve that, the wall would have to have been almost perfectly round and level, a feat other

scholars have doubted the Egyptians could have achieved.<sup>6</sup>

#### Isler's Shadows

Perhaps the most ancient instrument we have for determining direction is the simple vertical pole. We can use a pole to find the meridian by using the "shadow method."\* An observer sets a pole—a *gnomon*, Greek for "one who knows"—vertically in the ground. As the day passes, the observer marks the location of the tip of the sun's shadow as it moves in an arc along the ground. At the end of the day, the observer fixes a string to the base of the gnomon and draws a circular arc which crosses the shadow pattern at two points. If done over perfectly level ground, the observer will find that a line drawn through the intersecting points runs exactly east-west. The meridian runs perpendicular to this east-west line and can be found by bisecting the angle formed by the two intersections and the base of the gnomon.

\* The shadow method is described in "North by Northwest: the Strange Case of Giza's Misalignments" by Glen Dash, *AERAGRAM* 13-1, Spring 2012, pages 10–15.



Martin Isler, an American scholar who has written extensively on pyramid building, field tested the shadow method, reporting his results in 1989.<sup>7</sup> To sharpen the shadow, he used a v-shaped slit in a piece of wood which he held upside down (below). The Egyptians used a similar device, known as a "bay," to measure and survey since at least the New Kingdom. In his

Sharpening the shadow. By holding a facsimile of a bay, an ancient Egyptian instrument, upside down, Martin Isler was able to sharpen the gnomon's shadow. (After Isler 1989, page 199.)

tests, conducted in Wilton, Connecticut, on September 7, 1988, Isler achieved an accuracy of 19 minutes of arc using a gnomon just 60 centimeters high.

### Petrie's Elongations

Flinders Petrie, whose seminal 1880–1882 survey of the Great Pyramid is still widely used today, believed the pyramid builders found due north by following the pole star. In his 1883 book, *The Pyramids and Temples of Gizeh*, he tersely described the method he thought they used:

The setting out of the orientation [of the Great Pyramid]... would not be so difficult. If a pile of masonry 50 feet high was built up with a vertical side from North to South, a plumb-line could be hung from its top, and observations could be made, to find the places on the ground from which the pole-star was seen to transit behind the line at the elongations, twelve hours apart. The mean of these positions would be due South of the plumb-line and about 100 feet distant from it; on this scale 15 [seconds] of angle would be about 1/10 inch, and therefore quite perceptible.<sup>8</sup>

A version of Petrie's method is illustrated below and on the facing page. A plumb line is suspended from Petrie's north-south masonry wall. An observer watches for the pole star to transit behind the plumb line from beyond a low bench which holds a moveable sight. The bench and sight, suggested by the Czech archaeologist Zbyněk Žába,<sup>9</sup> make the observer's task easier.

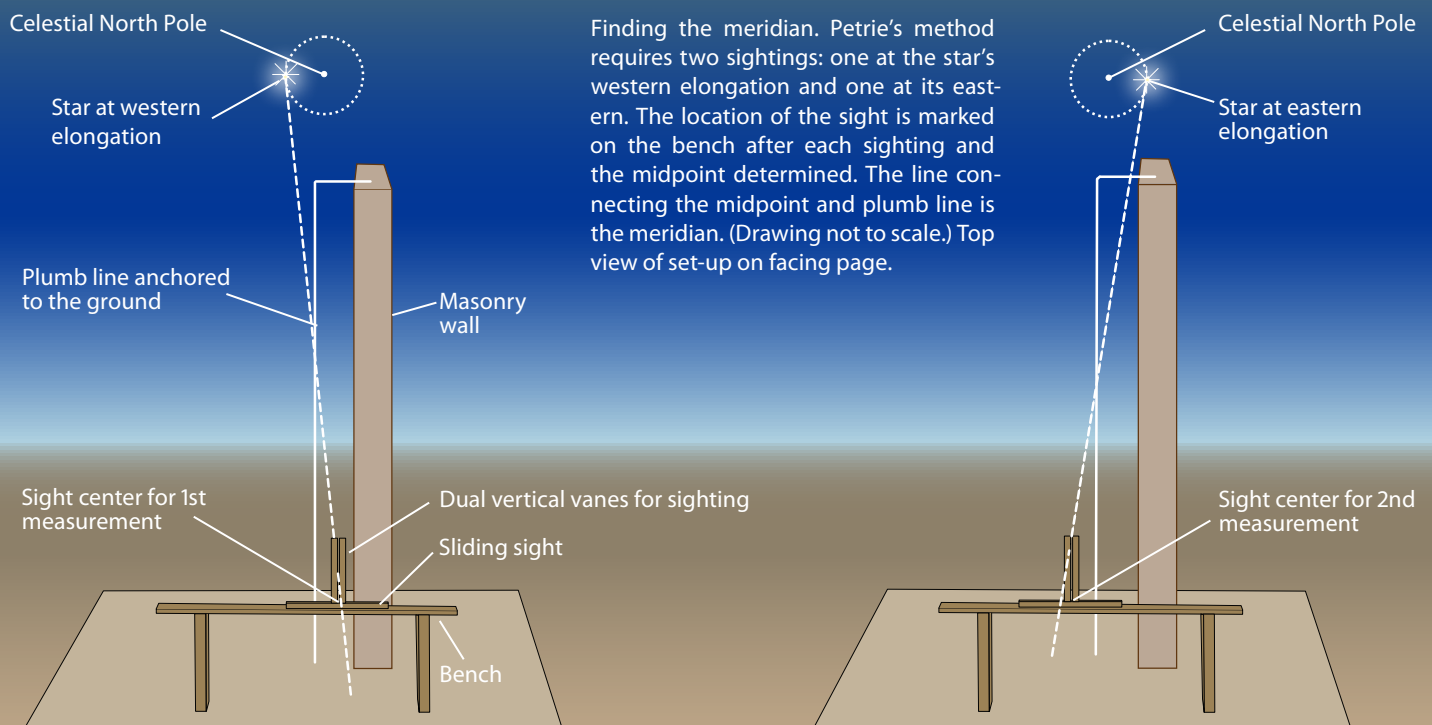
The purpose of the whole arrangement is to record the extreme movements of the pole star, as shown below. Like all other stars of the northern hemisphere, the pole star circulates

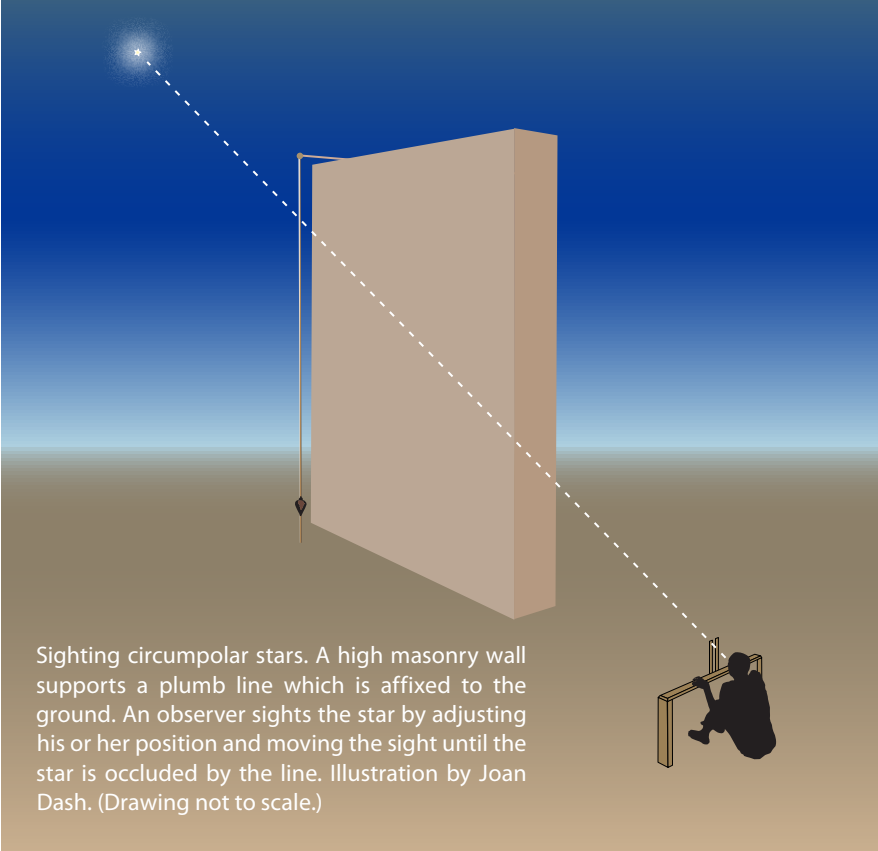
around the north celestial pole counterclockwise. Today, the pole star is Polaris, about one degree distant from the celestial pole. At the time the Great Pyramid was built, it was Thuban, about 2 degrees distant. As the pole star rotates around the north celestial pole, it passes sequentially through its highest point in the sky (upper culmination), its westernmost point (western elongation), its lowest point (lower culmination), and its easternmost point (eastern elongation).

Viewing the pole star through the sight's parallel vanes, the observer tracks the movement of the star by moving the sight along the bench from east to west or west to east until the pole star disappears behind the rope. The star eventually reaches one of its elongations, and when it does, the observer marks the location of the center of the sight on the bench. The observer continues to watch until the pole reaches its other elongation and then marks that location as well. The observer then makes a third mark on the bench precisely between those two. A line drawn between this third mark and the rope should lie on the meridian.

### Testing Petrie's Theory

Petrie never field tested his theory. Therefore, in the fall of 2012, I did so at my home in Pomfret, Connecticut. Instead of a 50-foot masonry wall, I used a wooden support mounted on a second story porch which held a 3/16 inch-diameter rope about 10 meters long. The rope was secured near the ground and plumbed vertically using a total station, a survey instrument. The observer's bench stood approximately 8 meters south of the plumbed line and was aligned roughly east-west by eye. The sight was constructed from two carpenter squares and wood,





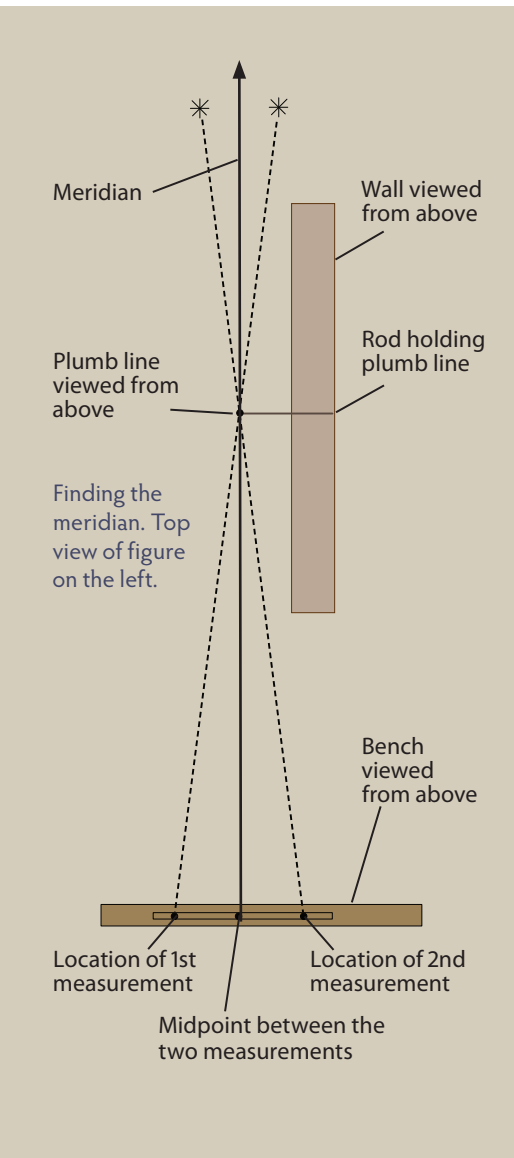
with a ½ inch separation set between the vertical legs of the carpenter squares for viewing.

The arrangement proved easy enough to use. I moved the sight from side to side and repositioned myself until Polaris disappeared behind the rope as viewed through the sight. Then, to ensure that the sight was centered on the rope and the star, I used “parallel sighting.” I moved my head from side to side to make sure I could see Polaris emerge from behind the rope with either side movement of my head. When I could, I knew the sight was centered.

On the night of October 16, 2012, I waited for Polaris to move to its eastern elongation, performed the sighting and marked the location of the center of the sight on the bench with a small nail. On that date, Polaris would not reach its western elongation before dawn. I waited until November 4, 2012, when Polaris would reach its western elongation in darkness. I performed the second measurement, marking that location on the bench as well. I measured the distance between the two nails, divided that in two and placed a third nail at that point. The angle between the third nail and the base of the rope was my estimate of the meridian.

A total station can be used to locate the meridian to an accuracy of better than 20 seconds of arc. Using the total station to evaluate my results, I measured the horizontal angle between the base of the rope and each of the three nails. Nail 1, representing Polaris’s eastern elongation, lay on a line 55.83 minutes east of due north. According to data from the US Naval Observatory, Polaris was at 55.01 minutes east of due

Below: Finding the meridian. Petrie’s method (on the facing page) shown from above.



Below: Testing Petrie’s method in Pomfret, CT (latitude N 41 degrees, 54 minutes, 7.3 seconds; longitude W 71 degrees, 58 minutes, 13.6 seconds; elevation 182 meters above mean sea level). A wooden pole set up on a second story porch substituted for Petrie’s masonry wall. The pole held a plumb line that was fixed at its base. The observer sights a star through the vanes of the sliding sight. Photo by Joan Dash.



north when I measured it. My measurement error was 0.82 minutes. Nail 2, which recorded Polaris' western elongation, lay on a line 55.70 minutes west of due north. At the moment I measured it, Polaris, according to the Observatory, was 54.61 minutes west of due north for an error of -1.09 minutes. As it turned out, these errors nearly canceled. The horizontal angle formed by Nail 3 and the base of my rope, my predicted meridian, was in error by just -0.14 minutes of arc.

The fact that the errors from the two measurements nearly canceled out was probably fortuitous. Nonetheless, I had recorded both eastern and western elongations of Polaris to just over 1 minute of arc. The Egyptians, of course, would not have had the advantage of my modern ropes and would have had to have used Thuban, which was dimmer and farther away from the pole. Nonetheless, I believe they could have used Petrie's method to find due north to within 1 to 2 minutes of arc.

Nor would the Egyptians have needed a wall and plumb line 50 feet high. Petrie wanted to prove that the Egyptians could have located the meridian to within 15 seconds of arc—one quarter of one minute. However, as we shall see, the Great Pyramid is 5 to 6 minutes of arc from due north. They could have achieved that accuracy with a far shorter plumb line.

### Spence's Transits

Kate Spence, of the University of Cambridge, thought that the Egyptians may have used a technique known as "simultaneous transit" (facing page) to orient the pyramids. She noted that two bright stars—Kochab in the Little Dipper and Mizar in the Big Dipper—straddled the celestial pole in the pyramid age.<sup>10</sup> In fact, in 2467 BC a cord drawn through them would have

passed directly through the pole. An observer in 2467 BC could have held up a plumb line and waited for the two stars to transit behind it. At that moment, the line between the observer's pupil and the plumb line would have been the meridian.

For any two stars, however, this technique only works perfectly in one particular year. Owing to precession—a wobble in the Earth's orientation as it spins on its axis—the celestial pole moves relative to the stars. In the case of the simultaneous transit of Kochab and Mizar, this movement amounts to 31 minutes of arc per century or about 3 minutes of arc per decade.<sup>11</sup> Therefore, if the observer repeated the same measurement ten years later in 2457 BC, his or her results would have been off by about 3 minutes of arc.

To Spence, however, this was an advantage. The effect of precession on the movement of Kochab and Mizar relative to the celestial pole could be used to provide the very date the Great Pyramid was started. To calculate that date, Spence used Josef Dorner's measurement of the azimuth of the lower edge of the casing on the pyramid's west side.<sup>12</sup> Dorner, an Austrian surveyor and archaeologist, measured it as 2.8 minutes of arc west of north.\* The two stars aligned 2.8 minutes of arc west of north in 2476 BC. According to Spence, that date, plus or minus five years, was the date the Great Pyramid was started.

We can use Spence's theory to calculate the commencement date of other 4<sup>th</sup> Dynasty pyramids as well. Egypt's 4<sup>th</sup> Dynasty (c. 2575–2465 BC) was the pinnacle of its pyramid-building age and included all three pyramids at Giza (Khufu, Khafre, and

\*This measurement was likely in error by about 30 seconds of arc making it -3.3 minutes, as discussed in "New Angles on the Great Pyramid," *AERAGRAM* 13-2, Fall 2012, page 17. I have used the number Spence cited here.

Commencement Date of 4th Dynasty Pyramids Based on the Angle of the Casings and Calculated using Spence's Theory<sup>1</sup>

PYRAMID	SNEFRU-MEIDUM	SNEFRU-BENT	SNEFRU-RED	KHUFU	KHAFRE	MENKAURE
Spence's Tabulated Azimuths of Casings (Minutes of Arc) <sup>2</sup>	-18.1	-11.8 <sup>5</sup>	-8.7 <sup>6</sup>	-2.8	+6.0 <sup>7</sup>	+14.1
Date of Commencement According to Spence's Theory <sup>3</sup>	2525 BC	2505 BC	2495 BC	2476 BC	2448 BC	2422 BC
Date of Commencement According to Spence's "Currently Accepted" Chronologies <sup>4</sup>	2598 BC	2583 BC	2572 BC	2552 BC	2520 BC	2487 BC
Difference in Years	73	78	77	76	72	65
Order of Commencement	1	2	3	4	5	6

1. The theory is described in Spence, K., "Ancient Egyptian chronology and the astronomical orientation of the pyramids," *Nature*, 408, 16 November 2000, pages 320–324.

2. Spence used the west side of each pyramid except for the Red Pyramid, where there was no data on the west side. She used the east side instead.

3. These dates of commencement differ from Spence's tabulated dates of accession by two years since she assumed (as I did here) that the Meidum and Giza pyramids were started in the second year of the king's reign.

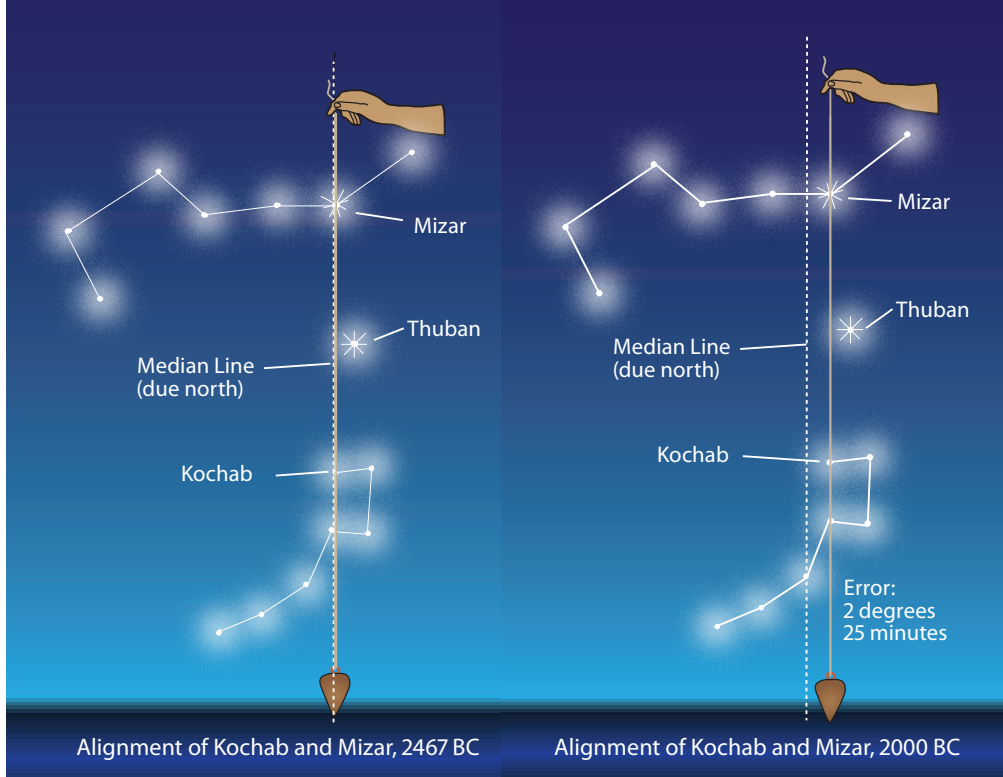
4. Spence derived her "currently accepted" chronology by using "von Beckerath's chronology (lower estimates) with the exception of the length of Snofru's reign and the dates of construction of his pyramids ... which follow Stadelmann" (page 320).

5. Spence cited Dorner for this number. He, however, says that due to settling,

the original lines of the Bent Pyramid could not be determined. Dorner was able to determine the original azimuth of the north side as -8.4 minutes off due east-west. If we assume the base of the pyramid was square, then the best estimate we have for the west side would be -8.4 minutes as well. Dorner, J., "Form und Ausmaße der Knickpyramide" *Mitteilungen des Deutschen Archäologischen Instituts*, Abteilung Kairo, 42, 1986, page 51.

6. Dorner, J., "Neue Messungen an der Roten Pyramide," in *Stationen: Beiträge zur Kulturgeschichte Ägyptens*; Rainer Stadelmann Gewidmet, ed. by H. Guksch and D. Polz, Mainz: Von Zabern, 1998, page 23.

7. The actual azimuth of the east side of the Khafre Pyramid is -6.0 minutes of arc according to Dorner. Spence reversed the sign based on her theory that the measurements for this pyramid were made when Kochab was in upper culmination and Mizar was in lower.



Spence's simultaneous transit. An observer holding up a plumb line in 2467 BC would find Mizar and Kochab aligned with the meridian. By 2000 BC, the alignment would have shifted east. Spence used this not only to explain pyramid alignments, but to predict the dates the pyramids were built.

Menkaure) and the three pyramids of Snefru, Khufu's father, the first at Meidum, and the second and third, the "Bent" and the "Red," at Dahshur. The table on the facing page compares calculated dates for the commencement of these six pyramids using Spence's methodology with more traditional dates based on the work of von Beckerath<sup>13</sup> and Stadelmann.<sup>14</sup> Spence cites their work in her paper as a "currently accepted" chronology.

Spence's analysis places the 4<sup>th</sup> Dynasty pyramids in their correct order of commencement. On average, Spence's dates are 74 years later than those of the currently accepted chronology.†

Spence defends the difference stating that, "[E]xisting Egyptian chronologies of this period [which are] based primarily

on cumulative reign lengths can only be considered accurate to about ±100 years."

Thus the casings may have been aligned with due north using simultaneous transit. However, by applying the same analysis to the descending passageways we can show that these passageways were aligned using some other method. The descending passageways of the Bent and Red Pyramids are aligned to due north with extraordinary precision, -0.5 and +2.9 minutes of arc respectively, even better than that of the Great Pyramid. As seen in the table below, applying the simultaneous transit analysis to the azimuths of the descending passageways produces an order of commencement that is wrong. The analysis would have the Great Pyramid construction starting before Snefru's last two pyramids. Such an order of commencement cannot be reconciled

with the historical record. Whatever method the Egyptians used to align the descending passageways of these pyramids with due north, it was not simultaneous transit.

In 1981 Josef Dorner said that the pyramid's extraordinary alignments could only have been achieved by measuring a circumpolar star at its elongations.<sup>12</sup> In 1998 he noted that the

†The gap of 74 years has troubled some. Juan Antonio Belmonte has proposed that the Egyptians might have used Megrez and Phekda in the Big Dipper instead of Kochab and Mizar. Using those stars moves the commencement date for the Great Pyramid to approximately 2550 BC. Belmonte, J. A., "On the Orientation of the Old Kingdom Egyptian Pyramids," *Archaeoastronomy* 26 (JHA, xxxii, 2001), pages s1-s20.

Commencement Date of 4th Dynasty Pyramids Based on Based on the Angle of the Descending Passageways and Calculated using Spence's Theory<sup>7</sup>

PYRAMID	SNEFRU-MEIDUM	SNEFRU-BENT	SNEFRU-RED	KHUFU	KHAFRE	MENKAURE
Azimuths of the Descending Passageways (Minutes of Arc)	-21.6' <sup>2</sup>	-0.5' <sup>3</sup>	+2.9' <sup>4</sup>	-5.8' <sup>5</sup>	+5.6' <sup>6</sup>	+13.3' <sup>7</sup>
Date of Commencement According to Spence's Theory	2537 BC	2469 BC	2458 BC	2485 BC	2449 BC	2424 BC
Date of Commencement According to Spence's "Currently Accepted" Chronologies	2598 BC	2583 BC	2572 BC	2552 BC	2520 BC	2487 BC
Difference in Years	61	114	114	67	71	63
Order of Commencement	1	3	4	2	5	6

1. The theory is described in Spence, K., "Ancient Egyptian chronology and the astronomical orientation of the pyramids," *Nature*, 408, 16 November 2000, pages 320-324.

2. Petrie, W. M. F., *Medum*, London: David Nutt, 1892, page 11.

3. Dorner, J., "Form und Ausmaße der Knickpyramide" *Mitteilungen des Deutschen Archäologischen Instituts, Abteilung Kairo*, 42, 1986, page 42.

4. Dorner 1998, page 27. See note 6, table on facing page.

5. Petrie, W. M. F., *The Pyramids and Temples of Gizeh*, London: Field and Tuer, 1883, page 125.

6. Petrie 1883, page 125. We have reversed the sign. As noted, Spence reversed the sign based on her theory that the measurements for this pyramid were made when Kochab was in upper culmination and Mizar was in lower.

7. Petrie 1883, page 117.

sloping surface of the descending passageways actually made that easier.<sup>15</sup> Instead of needing a plumb line 10 to 15 meters long, the pyramid builders only needed to suspend a short plumb line from the top of the passageway to its base (as shown on the right). A shorter plumb line is more stable, producing more accurate measurements. To lay out the descending passageways in the Bent Pyramid, the builders would first have cut a trench into the desert floor roughly aligned north-south. They then could have used the circumpolar method to draw a meridian line down the center of the trench. Finally, they would have laid masonry walls into the trench parallel with the meridian line to finish the passageway. At Khufu, things were a bit more complicated since the entire pyramid is built over a bedrock knoll. Here, the Egyptians could have first built a rough masonry passageway over the bedrock knoll roughly aligned with due north. Then they could have taken the meridian and finished the masonry portion of the passageway with fine stone laid parallel with the meridian. To finish the lower portion of the passageway, they then would have had to bore into the bedrock along a line defined by the angle of the upper passageway. Dorner believed that the Egyptians could have aligned the casings using the same method, but with a longer and less stable plumb line. He speculated that the use of the longer plumb line could account for the greater error in the casing's azimuths.

### Conclusions

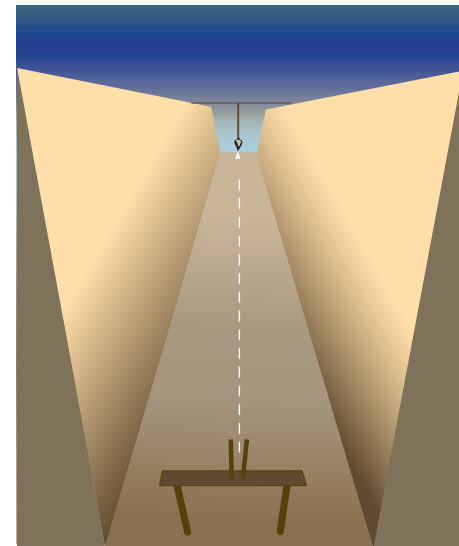
The Egyptians most likely used a circumpolar star to align the descending passageways of the Bent, Red, Great, and Khafre Pyramids with due north. Petrie believed the Egyptians used Thuban, the pole star of their time. Using Polaris, I have demonstrated that Petrie's technique is practical.

As for the casings, the Egyptians may or may not have used the same method. If they did, the longer plumb line required may explain why the casings are not aligned with due north as well as the descending passageways. On the other hand, Spence's data does seem to demonstrate a link between the orientations of the casings and the movement of stars in simultaneous transit. Finally, we cannot completely exclude the possibility the Egyptians aligned at least some of their pyramids with due north by using the sun, particularly those in error by 20 minutes of arc or more.

### ACKNOWLEDGEMENTS

I would like to thank Dr. Joan Dash for her patient reading and re-reading of the text, her many suggestions, and her illustrations. I am also indebted to Dr. Juan Antonio Belmonte for his expeditious review of this paper and his comments. I also thank Dr. Peter der Manuelian of Harvard for hand-scanning and providing me a copy of Zbyněk Žába's important, but hard to find text.

Sighting the descending passageway. Petrie's method works best when sighting the descending passageway while it is being constructed. The plumb line required is short due to the passageway's upward angle of about 26 degrees, which lessens error. Once laid out, the passageway can be roofed, as was the case with the Bent and Red Pyramids, or extended into the bedrock, as was the case with the Great Pyramid.



### REFERENCES

(Please note: references are numbered sequentially in the order in which they are cited in the text.)

1. Dash, G., "New Angles on the Great Pyramid," *AERAGRAM* 13-2, Fall 2012, pages 10-19.
2. Edwards, I. E. S., *The Pyramids of Egypt, rev. ed.*, London: Penguin Books, 1993.
3. Lehner, M., *The Complete Pyramids*, London: Thames & Hudson, 1997.
4. Allen, J., *The Ancient Egyptian Pyramid Texts*, ed. by Peter Der Manuelian, Atlanta: Society of Biblical Literature, 2005.
5. Shaltout, M., and J. A. Belmonte, "Introduction: Under Ancient Egyptian Skies," *In Search of Cosmic Order: Selected Essays on Egyptian Archaeoastronomy*, ed. by J. A. Belmonte and M. Shaltout, Cairo: Supreme Council of Antiquities Press, 2009, pages 13-26.
6. Isler, M., *Stick, Stones and Shadows: Building the Egyptian Pyramids*, Norman: University of Oklahoma Press, 2001.
7. Isler, M., "An Ancient Method of Finding and Extending Direction," *Journal of the American Research Center in Egypt* 26, 1989, pages 191-206.
8. Petrie, W. M. F., *The Pyramids and Temples of Gizeh*, London: Field and Tuer, 1883.
9. Žába, Z., *L'Orientation Astronomique dans L'Ancienne Égypte, et la Précession de l'Axe du Monde*, Prague: Czechoslovak Academy of Sciences, 1953.
10. Spence, K., "Ancient Egyptian chronology and the astronomical orientation of the pyramids," *Nature* 408, 16 November 2000, pages 320-324.
11. Rawlins, D., and K. Pickering, "Astronomical orientation of the pyramids," *Nature* 412, 16 August 2001, pages 699-700.
12. Dorner, J., "Die Absteckung und astronomische Orientierung ägyptischer Pyramiden," Ph.D. dissertation, Innsbruck University, 1981.
13. von Beckerath, J., *Chronologie des pharonischen Ägypten*, Mainz: von Zabern, 1997.
14. Stadelmann, R., *Die grossen Pyramiden von Giza*, Graz: Akademische Druck- und Verlagsanstalt, 1990.
15. Dorner, J., "Neue Messungen an der Roten Pyramide," *In Stationen: Beiträge zur Kulturgeschichte Ägyptens; Rainer Stadelmann Gewidmet*, ed. by H. Guksch and D. Polz, Mainz: Von Zabern, 1998, pages 23-30.



Field Season 2012, Giza.  
Photo by Mark Lehner.



Advanced Field School 2009, Giza.  
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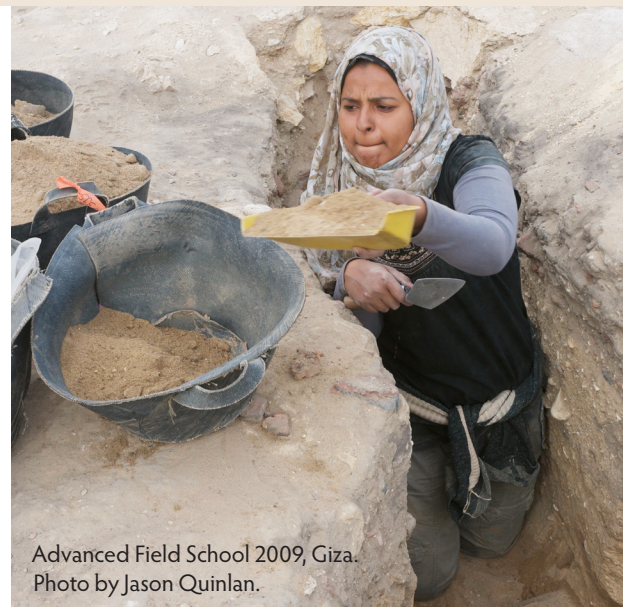
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# First Photos Taken from the Great Pyramid Summit

by George L. Mutter and Bernard P. Fishman

Last December our annual AERA holiday card featured an 1882 stereoview photo (with 3D glasses included)—the first photographic record of the site where the Lost City of the Pyramids settlement (Heit el-Ghurab) lay buried. The image (shown on the right) is even more notable as the first photo ever taken from the summit of the Great Pyramid. George L. Mutter and Bernard P. Fishman, creators of Photoarchive3D, a vast digital archive of original 19th and 20th century stereoviews, kindly provided the image along with background information. As we were able to include only a few lines about the photographer, E. L. Wilson, inside our holiday card, we asked Mutter and Fishman to write an article about Wilson and this historic photographic undertaking in January 1882.

## The Ascent of Khufu

It was a big production, but then Edward Wilson was a flamboyant showman. Escorted early in the morning to the Giza Plateau by his friend Emil Brugsch, Wilson and his crew were placed in the hands of eight Egyptians directed by Abraham Hamed, the Sheik of the nearby Pyramid Village. Wilson sat them all down on the sand just to make the foreground a bit

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*We waved our American flags, emblems of the youngest nation, on the monuments of the oldest in the world.*<sup>1</sup>

~ William Rau, chief photographer to Edward Livingston Wilson, 1882

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more interesting for a quick 3D stereophotographic long shot of the angular horizon. Sun to his back, his shadow reached towards the Great Pyramid he intended to climb.

An ant-like column of porters lined up along the northeast edge of the Great Pyramid while wooden boxes of extra film plates were unloaded for the ascent.

“You are not allowed to ascend alone... your right hand man and your left help you in your long steps, and the other gives you a “boost.”<sup>2</sup> Climb they did, with some extra tourists thrown in to liven up the composition.

It all was caught by the camera, in sequence, so that in parlors across America the experience could be relived, virtually. The pyramids had been photographed extensively since the 1850s, but always from the ground. This day was different though, because the camera and ready-made plates (no portable darkroom required) would go all the way to the summit.

Conveniently, there were staggered blocks at the top where his growing entourage could pose for the first aerial image at Giza. Huddled around the base support of a 40-foot vertical wooden survey marker erected by General Charles Pomeroy Stone Pasha for an 1879 government tax survey, the scene uncannily resembles a contemporary tour group posing under a radio tower on a skyscraper roof. Having satisfied his immediate audience, and mindful of the historic moment, it was time to hoist the colors. The American flag, emblazoned on specially made vests, was displayed in portraits of Wilson with two Egyptians, and then by a solitary William Rau, a professional photographer Wilson had worked with at the Centennial Exhibition. In the E. L. Wilson photo the Sphinx appears just above his tarboosh in the background far below. Dead center in this same image the Wall of the Crow cuts a jaunty angle across the otherwise featureless plain to the southeast.



With a stereoscope, also called a stereo viewer, one could look at stereocards, such as the one shown here that E. L. Wilson created, and see a 3D image. Stereocards were very popular in the US in the late 19th–early 20th century.







Above: E. L. Wilson sits atop the Great Pyramid, wearing a vest fashioned from the American flag, flanked by two Egyptians. Top right: Wilson's team and tourists climb the Great Pyramid with help from guides. Far right: After reaching the summit of the monument, the group poses for a photo.

The 40-foot wooden survey marker was supported by a tripod of bracing supports, one of which appears in the photo. Based on the numbering of the photos, the photo on the far right was the first one taken at the top of the Great Pyramid.

Immediate right: The top of the Great Pyramid taken in the 1990s. Photo by Mark Lehner.



### On the Giza Plateau

After making their descent back down to the ground, the group then completed its “pyramidal perambulation.” The Khafre Valley Temple, first excavated by Auguste Mariette in 1853 and 1858, was a sunken hole of monoliths that lined up nicely with the Sphinx and Khufu Pyramid. Within that buried temple, a prominent then-underground doorway facing towards the Sphinx was rumored to be the entry point for a mysterious connecting tunnel. When cleared of its overburden, it later became obvious there was nothing subterranean about the door in the Old Kingdom, and no tunnel.\*

The group then entered the Great Pyramid to take a few flash photos. It was a messy affair. The burning “magnesium...caused a great consternation amongst the bats.”<sup>2</sup> “After duplicating the exposures [in the King’s Chamber]

\* The dark doorway was the opening of a corridor winding from the lower causeway corridor up to the open second level terrace.





we found the chamber so full of smoke that we were forced to leave.”<sup>1</sup> Charles Piazzzi Smyth had exactly the same problems when he made the first successful magnesium wire flash pictures of the pyramid’s interior in 1865.

### Were These Really the First Summit Photographs?

We know of no earlier photos from the summit of the Great Pyramid, but would be delighted to be proven wrong. There were plenty of talented photographers who recorded the Giza Plateau in the 1850s through 1870s. Outstanding professional series were first produced by the Englishmen Francis Frith (1856–57, 1857–58, and 1859–60), Francis Bedford (1862), and Frank Good (about 1865). These show now-lost structures, such as the Khufu causeway that was mostly destroyed by 1869 and topographical features later obscured by excavation tailings, but no views from pyramid tops.

The quality and scale of their work is remarkable considering that the light-sensitive photographic emulsions they used had to be poured fresh onto glass, then exposed and developed within minutes while still wet. This required a portable darkroom tent, outfitted with

Top: The Sphinx projecting above the sand, long before it was fully excavated. View to the northwest.

Left: The entrance to the Great Pyramid, the descending passage.

Facing page:

Top: The Khafre Valley Temple, the Sphinx, and the Great Pyramid; view to the northwest. Until the facade of the temple was excavated in 1909, no one knew that it was free-standing rather than a subterranean structure. It was sometimes called the Temple of the Sphinx until the real Sphinx Temple, was excavated just to the north between 1926 and 1936.

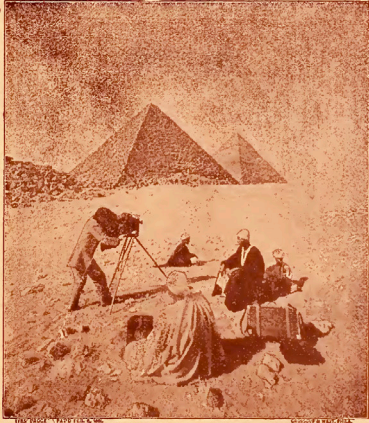
Bottom left: View of the pyramids from the south (rather than the east, as the caption on the card reads). The small, stepped structures in front of the large pyramids are Menkaure’s queens’ pyramids.

Bottom right: Members of Wilson’s team contemplate the Great Pyramid before their ascent.



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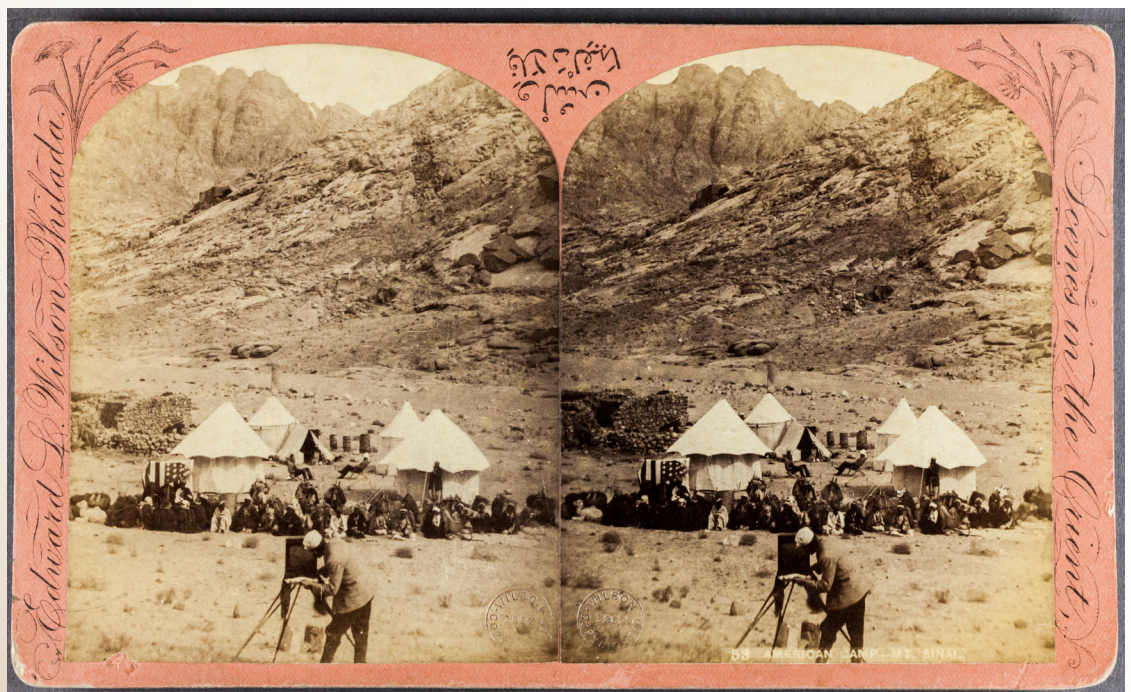
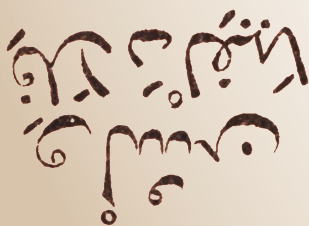
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Above: An ad for Wilson's stereo cards, which appeared in his *Philadelphia Photographer* magazine.

Right: E. L. Wilson photographing his encampment in the Sinai, 1882. Left-right stereo pair mounted on card.

Below: Wilson's logo "Wilson Philadelphia" in Arabic, upside down. It appears on the stereo card in the center at the top.



highly volatile chemicals that were prone to boiling in the heat. Not something easily managed on a stone surface 455 feet off the ground, which probably explains why the early photographers never ventured any summit shots. Late in the 1870s a stable dry plate with long-sensitive bromide-based emulsion was invented, and as E. L. Wilson was the first to bring these to Egypt, he had a distinct advantage over his predecessors. Plates were prepared in Philadelphia in November 1881, "carried on the sea, overland by rail, across the desert on camelback, and over the mountains on horseback for nearly 12,000 miles...and then back to America where they were developed during July, August, and September (1882)."<sup>3</sup> All that was needed was a dry lightproof box of plates and a camera that could be loaded quickly in the field. Mobility and spontaneity of composition were greatly enhanced, and Wilson and Rau made the most of it. With the new technology, Wilson and his assistant were full of confidence. Based on the numbering of the plates, the group portrait under the survey marker was their first taken at the summit.

**Edward Livingston Wilson (1838–1903)**

E. L. Wilson was an avid popularizer of early photographic processes in America, founding in 1864 the first us photographic journal, *The Philadelphia Photographer*. In Philadelphia he met Emil Brugsch, who had come to install the Egyptian display at the 1876 Centennial Exposition, where Wilson had a monopoly on official photography. Brugsch later became secretary of the Boulaq Museum and an official of the fledgling Antiquities Service under Mariette and Maspero, where he had occasion to apply his photographic talents learned directly from Wilson himself. Wilson's motivation to go to Egypt was primarily commercial, with the goal of "publishing" stereo and lantern slide photographs for edu-



George Mutter (left) and Bernard Fishman (right). Wet plate ambrotype, 2011, by Mark Bingham of Portsmouth, NH.

## ABOUT THE AUTHORS

George Mutter is a Harvard- and Columbia-educated Professor of Pathology at Harvard Medical School. Bernard Fishman was trained as an Egyptologist at the University of Pennsylvania and worked in Luxor at the Oriental Institute's Epigraphic Survey. He now leads the Maine State Museum. Meeting by chance at a photo trade show in 2009, Mutter and Fishman subsequently recognized that their collections of some 30,000 19th and early 20th century photographs, including many early images of Egypt, constituted an important historical archive of general interest. They founded Photoarchive3D (<http://www.photoarchive3d.org>) to publicize these rare examples of early photohistory and use them to better comprehend the past.

cational and entertainment use. He landed at Alexandria in January 1882, and lists 463 numbered Egyptian views (30 from Giza) as far as Abu Simbel, before turning to the Sinai where he took another 195.<sup>4</sup> While in Luxor he photographed Maspero, Brugsch, and "reformed" thief Mohammed el-Rassoul at Deir el-Bahri tomb #320, site of the 1881 discovery of the cache of the royal mummies. Although Wilson was head of the expedition, many of the images were taken by William Rau. Both wrote separate journals, which were published in serialized form in the *Philadelphia Photographer*, detailing their experiences in Egypt. They departed Alexandria in July 1882, passing the English fleet which had just arrived to bombard the city in order to suppress anti-Western riots. A busy lecture circuit awaited on return to the USA, but sales of the expensive photographic paper prints mounted on card were declining, as half-tone photomechanical reproduction made photographs easy to reproduce in books and periodicals. Leftover stock was sold in bulk to a successor, Roberts and Fellows. The rare original photographs printed from negatives, mounted as right-left stereo pairs on ornate peach cards labeled "Wilson, Philadelphia" in Arabic letters, are illustrated here.

## REFERENCES

(Please note: references are numbered sequentially in the order in which they are cited in the text.)

1. Rau, W. H., "Photographic Experiences in the East." *The Philadelphia Photographer*, vol. 19–20, serialized, 1882–1883.



Above: William Rau sits atop the Great Pyramid wearing another American flag vest. The Khafre Pyramid stands in the background. Rau wrote in his serialized account of the trip to the Egypt in *The Philadelphia Photographer*, "we ... arrived at the foot of the great pyramid about 8.30. One is so filled with wonder and admiration that it takes a few minutes to bring one's self to work."<sup>1</sup>

2. Wilson, E. L., "Echoes of the Orient." *The Philadelphia Photographer*, vol. 19–20: serialized, 1882–1883.

3. Wilson, E. L., *Photographic Mosaics*. Philadelphia, 1883, pages 26–27.

4. Wilson, E. L., *Catalogue of Stereoscopic Views of Palestine, Arabia Petraea, and Egypt*, Philadelphia, 1882.



## Weeds and Seeds: On the Trail of Ancient Egyptian Agriculture by Claire Malleson

In 2009 AERA excavated House E, a priest's home in Khentkawes Town, the settlement attached to the tomb of 4th Dynasty Queen Khentkawes.\* As in all our excavations, we systematically collected samples of room deposits in order to recover plant remains. We have been recovering and studying plant remains since our first season at Giza in 1988 as part of our ongoing research on the ancient economy. When we began to examine the House E samples we were very excited to discover that they are far richer than any we have ever analyzed, containing up to 100 times more seeds and plant parts than samples from the nearby Lost City of the Pyramids (also called the Heit el-Ghurab site). The samples also include a wider variety of species and much better preserved specimens. In short, they offer a better chance than we have ever had to open a wider window onto the economy at Giza. In order to take full advantage of this opportunity, AERA archaeobotanist and Director of Archaeological Science Claire Malleson is focusing on these rich samples during the 2013 season at Giza. Here Claire discusses what the House E plants might reveal about farming methods, based on her first month's work in the Giza Field Lab.



0 1 2 3 millimeters

Ancient Egyptian fields were full of weeds as depicted in the scene from the 6<sup>th</sup> Dynasty tomb above. The borders between fields and rivers and water channels were home to a wide variety of wild plants.

Farmers gathered the field weed seeds along with the cereal harvest. They had to remove these seeds as well as the cereal chaff through a series of laborious steps—winnowing, sieving, pounding, and hand sorting—before they could use the grains for bread or beer. The by-product of cleaning—the mixture of chaff and weeds—was a valuable commodity, frequently used as domestic fuel. Because this material was burned in hearths and ovens, we often find it preserved in the archaeological record, counterintuitive as that may sound. Once plant material is charred—but not burned to ash—it does not break down readily and can last in the soil for millennia. By looking at the plant

Above: Charred seeds of prickly caterpillar (Latin: *Scorpiurus muricatus*) from House E in the Khentkawes Town. Some of these weedy legume seeds are still encased in their segments of the spiny, coiled pod. Having the distinctive pod remains with spines and tubercles allows us to confirm the identification as the species *muricatus*. Photo by Claire Malleson.

Top: Harvesting scene in the tomb of Mereruka at Saqqara showing weeds growing in the field with the cereals. Photo by Claire Malleson.

\* The House E excavations are described in *AERAGRAM* 10-2, Fall 2009, pages 10-13. All back issues of *AERAGRAM* are available for free download at our website: [aeraweb.org](http://aeraweb.org).

species in the burned remains we can determine which plants were growing among the crops.

Because of the remarkable preservation of the House E remains, I can identify them to species, rather than simply to broad categories, which is all that we have been able to do with most of the plant remains from the Lost City of the Pyramids site. This provides me with more detailed information and will enable me to say much more about the local ecology and agriculture than we have previously been able to and will provide valuable information about how people used plants at the Khentkawes Town.

With the wide range of well preserved plant parts we learn more about the methods farmers used to harvest the crop and what they planned to do with it. How they harvested their cereals depended on how they planned to use the “waste” products (straw and weeds). The House E samples contain not only all parts of the cereal spike, or “ear,” but many culm-bases (the base of the stalk to which the roots attach) and culm-nodes (the “joints” along the stems), and very large volumes of straw fragments, as well as the chaffy parts of many other plants including wild grasses and low-growing clover species. This mixture indicates that the entire crop, including all the weeds, may have been uprooted rather than harvested with sickles, perhaps in order to maximize the amount of “waste” available for use as fuel.

By carefully counting and recording the exact numbers of each type of plant I will be able to suggest which species were the most prevalent weeds in that particular crop. Ryegrass and canary grass, *Lolium* sp. and *Phalaris* sp. (sp. indicates the species was not determined), are the two most common wild grasses from archaeological sites across Egypt and may have caused significant losses in the cereal crop grain yields. I have been able to determine that many of the *Lolium* grains in the House E samples are *Lolium temulentum*, “darnel,” which, when fully mature, is toxic to cattle. The presence of this species in the samples might indicate that the waste was used as fuel because it was unsuitable as animal fodder.



At her microscope AERA head archaeobotanist and Director of Archaeological Science Claire Malleson sorts flotation samples, pulling out and identifying seeds and other plant parts. Each of the Petri dishes on her right holds a different type of seed, stem, pod, or other item. Photo by Alexandra Witsell.

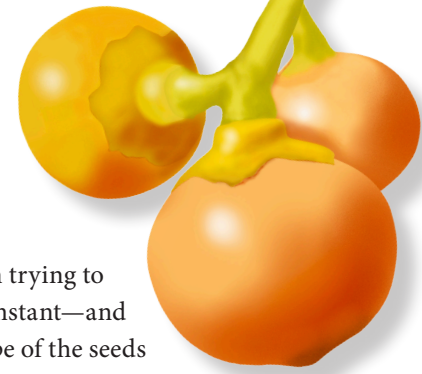
Another weed that I have identified from House E, *Scorpiurus muricatus*, or prickly caterpillar (shown on the facing page) was both a common crop weed of ancient Egypt as well as an excellent fodder for cattle, although we do not know if it was ever cultivated.

Look for a report on my results in the next issue of *AERAGRAM*, Fall 2013.



Canary grass growing in modern wheat fields in the Delta. Inset: House E canary grass grain enclosed in chaff. Photos by Claire Malleson.

# Egypt's Earliest Olive Pit Reconsidered: A Case of Mistaken Identity? by Claire Malleson



*Cordia myxa* fruit

In *AERAGRAM* 13.2 we reported on the discovery of what I identified as an olive pit, found during our 2012 excavations in Gallery III.3 in the Gallery Complex (see map, page 7) of the Lost City of the Pyramids site (also called Heit el-Ghurab).<sup>†</sup> This season I had a chance to compare the olive pit with modern reference specimens of fruit stones—which were not available in 2012—and I am now reconsidering this identification.

## Reassessing Our Conclusions

A standard practice in archaeobotany is to reexamine our materials periodically and reassess our identifications and interpretations based on the knowledge we are continually gaining. Hence, with a tinge of doubt about the “olive pit,” I returned to it this season.

So, what is our olive-like stone? The internal structure looks like an olive pit, but the external features are closer to the stone of the Egyptian plum (Latin: *Cordia myxa*), a small, bitter orange fruit. Consider the photos below.

How is it possible that what I thought was an olive pit I now believe might be a plum stone? Archaeobotanists face all sorts of complications in trying to identify ancient plant remains. The ones from the Lost City are not only more than 4,000 years old, but they are also charred. They were probably burned as fuel for cooking or as waste discarded in a fire. Charring often leaves plant material well preserved. But the effects of burning can make identification tricky at times. The seeds/grains/stones are likely to shrink, but they may also swell and even burst. Sometimes features—such as color—are lost entirely.

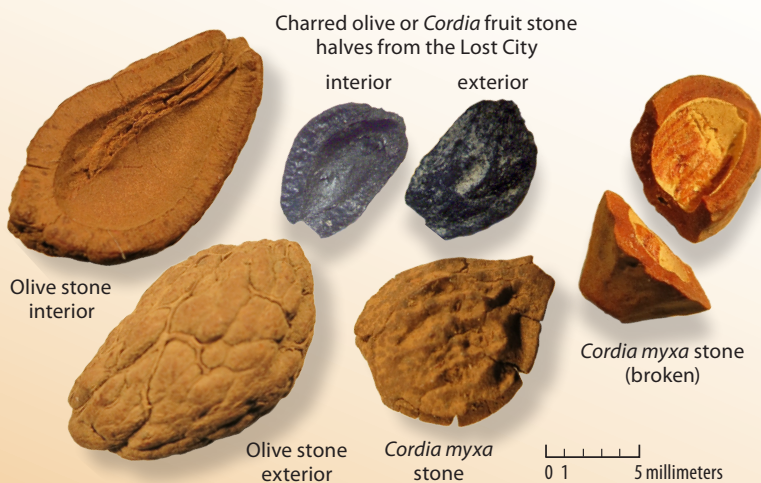
Another challenge we face in trying to identify plant material is the constant—and frustrating—overlap in the shape of the seeds and fruits of different species. It is only by looking at thousands of examples of seeds/grains/stones that archaeobotanists learn to identify ancient plants.

## *Cordia*: An Unlikely Find

Despite the name “Egyptian plum,” scholars generally believe that this tree is indigenous to the Indian subcontinent. The fruit stones only became common at archaeological sites in Egypt from the Late Period (724–333 BC) onward. Earlier finds are rare, and some may in fact be another species, *Cordia sinensis*, which is native to Africa, including far southern Egypt. The oldest example of a *Cordia* stone comes from the Step Pyramid of Djoser at Saqqara and is identified only as *Cordia* sp.<sup>‡</sup> (sp. indicating that the species was not determined). Several *Cordia* stones were also found in the 5<sup>th</sup> Dynasty funerary complexes at Abusir. The oldest settlement example comes from New Kingdom-era Deir el-Medina, home to craftsmen building tombs in the Valley of the Kings.

Given that *Cordia* was so rare in Egypt before the Late Period, it did not come to mind as a possible identification for my specimen, particularly since the inside of the stone suggested olive. I would have rejected olive as an identification, recognizing that the 4<sup>th</sup> Dynasty is exceptionally early for olive in Egypt. But we had already recovered 15 specimens of olive wood at the Lost City site (see page 4). So it seemed probable that an olive fruit might have arrived at the settlement still attached to an olive twig. In addition, my task was confounded by the fact that fruit stones are very rare at the Lost City. I had to rely on a single specimen for the characteristic features of the genus and species. I could not look to other finds from our site for supporting evidence. It was only when I reexamined the stone, and consulted with my colleague Dr. Claire Newton, of the Institut français d’archéologie orientale in Cairo, and compared it with her reference material that I was able to reassess my original identification. But I am still not 100% certain if the stone is olive or *Cordia*.

The challenge of identifying this single specimen as one of two rare species means that we probably can never be certain if we have either the oldest olive pit in Egypt or the oldest Egyptian plum from a town!



Desiccated olive and Egyptian plum (*Cordia myxa*) stones from the site of El-Hibeh (Ptolemaic levels) and the charred fruit stone from the Lost City site originally identified as olive. We are now uncertain of the olive identification and believe the specimen could be Egyptian plum. The interior looks like olive but the exterior is closer to Egyptian plum. Note that the charred specimen was probably larger in its original state; charring most likely caused it to shrink. Also, olives from later periods tend to be larger than those from earlier periods.

<sup>†</sup> “Egypt’s Oldest Olive Pit at the Lost City of the Pyramids,” *AERAGRAM* 13-2, Fall 2012, page 24. All back issues of *AERAGRAM* are available for free download at our website: aeraweb.org.

<sup>‡</sup> Täckholm, V., “Botanical Identification of the Plants Found at the Monastery of Phoebammon,” In *Le Monastère de Phoebammon dans la Thébaïde*, Tombe III, ed. by C. Bachatly, Cairo: La Société d’archéologie copte, 1961, page 29.





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