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Egyptian Study Society, Inc.
P.O. Box 40754
Denver, Colorado 80204-0754
UNITED STATES OF AMERICA

In This Issue ...

The Step Pyramid Within

By Charles Rigano

Many of us have a mental image of how the Old Kingdom Egyptians built pyramids: tens of thousands of people; a ramp lying against the side of the pyramid, either rising straight to the top or spiraling around the exterior; the pyramid rising slowly, course by course, until the four sides meet at a point. Then the ramp is removed and the casing is finished from top to bottom. While this is the picture we have been provided, the evidence leads us to a somewhat different conclusion. In fact, it appears that the builders of Old Kingdom true (smoothly inclined) pyramids first constructed a step pyramid, then built a true pyramid around it. What is the basis for this conclusion and why would they build in such an inefficient manner?

Khufu's subsidiary pyramids (L to R) GI-a, GI-b, GI-c just east of the Great Pyramid

THE STEP PYRAMID WITHIN

Not all pyramids look alike today. Some appear as we expect, with a large square base rising to a sharp point like the primary pyramids at Giza and Dahshur. Others are ruined remnants of once elegant structures such as the 5th and 6th Dynasty pyramids at Saqqara and Abusir. And a few are not much more than holes in the ground as with the pits at Zawyet el-Aryan and Abu Rawash. Nor were construction methods all the same. Depending on the quality of the rock, some interiors were cut within the bedrock, as are found in the pyramids of Menkaure and Djoser, while others had chambers built within an open trench excavated into the bedrock, such as the Maidum and Bent pyramids. Core blocks were sometimes inclined towards the center, as in the Layer Pyramid at Zawyet el-Aryan; in other pyramids they were laid horizontally as in Khafre's Pyramid; and some were even built with core blocks laid both inclined and horizontally as with the Bent and Maidum pyramids. But with so many differences, within every true pyramid in which we can see the interior construction, there is a step pyramid.

After Djoser's 3rd Dynasty Step Pyramid was finished, a period of failed pyramid construction followed. Sekhemkhet started his Step Pyramid at Saqqara and the Layer Pyramid was begun, possibly by Khaba. Both remained unfinished. At Maidum, a step pyramid was completed but there is no evidence it was used for a royal burial. Then the vision of the pyramid design changed and Snefru started construction at Dahshur on what was intended to be the first true pyramid, the Bent Pyramid. His builders apparently ran into some difficulty and altered its design. Since Snefru seemed to require a true, smooth-sided pyramid, the builders filled in the steps of the unused Maidum Pyramid and covered it with a finely finished casing, thereby completing the first true pyramid (Note 1). From the beginning of the 5th Dynasty through the end of the Old Kingdom 450 years later, all cased pyramids were smooth-sided.

BUT THEY STILL BUILT STEP PYRAMIDS

Table 1 identifies 36 Old Kingdom pyramids. Six pyramids (shown in italics) are either ruined and core construction details are not evident, or construction was stopped in an early stage. This leaves 30 pyramids to consider. Of these, 22 have a step pyramid visible under what was a completed, cased, true pyramid. This includes Shepseskaf's coffer-shaped tomb which has a two-step internal structure that was filled in and cased. The remaining eight pyramids (names shown in brackets) lack data on either an interior step pyramid or an exterior true pyramid. What can we tell about these pyramids?

First consider Menkaure's subsidiary pyramids (Fig. below). The three subsidiary pyramids were left in different states of completion; only one was completed as a true pyramid and the other two were left in a stepped form.

The eastern pyramid (GIII-a) was completed as a true pyramid with granite and limestone casing blocks, a descending passage which exits on the pyramid face and was filled with

Menkaure's subsidiary pyramids (L to R) GIII-a, GIII-b, GIII-c just south of the main pyramid

plug blocks, a lowered portcullis, and a granite sarcophagus in the burial chamber.

The exterior of the middle pyramid (GIII-b) was left in a stepped form. The chambers were completed with stucco-coated walls, a portcullis found forced out of position, and a small granite sarcophagus in the burial chamber. However, the stepped-shape exterior was not cased and the entrance was not in the face of the pyramid but in the bedrock, 13 feet north of its base.

The exterior of the western (GIII-c) pyramid was also left in a stepped form. The descending passage was not plugged and the chambers are incomplete and unplastered. The step-shaped exterior is uncased and the entrance is in the bedrock 14 feet north of the pyramid (Maragioglio and Rinaldi 1967, 80-92).

Apparently, Menkaure died before GIII-b and GIII-c were completed. Since the 3rd Dynasty, every pyramid entrance had been built into the pyramid face. If these two pyramids had been completed as true, cased pyramids, their entrances also would have been on their north faces. This evidence is consistent with a conclusion that both GIII-b and GIII-c were intended to be completed as true pyramids, like GIII-a, but when their construction was interrupted by Menkaure's death, they were left with only their stepped inner construction completed.

The incomplete state of the two subsidiary pyramids is consistent with the unfinished state of the rest of Menkaure's mortuary complex. Menkaure's Valley Temple was built almost entirely of mud brick. The granite casing for the Mortuary Temple on the east side of the main pyramid was started, but was covered and finished with mud brick. The main pyramid's granite casing was finely finished only around the entrance, behind the Mortuary Temple altar, and on part of the pyramid's west side.

As was traditional, Neferefre's tomb at Abusir was started by cutting a large trench into the bedrock for the burial chamber and constructing the first step of a square base. The exterior of the first step was built of large blocks of dark gray limestone up to 50 feet long. This tomb was sited so that the northwest corner of this pyramid, and those of Neferirkare and Sahure, were aligned. There can be little doubt that a true pyramid was intended to be built over a period of many years. However, Neferefre's early death caused a change in plan to provide him a suitable tomb. The completed first step was cased and finished with fine limestone and the planned true pyramid became a mastaba-like structure with an unusual square base (Verner 1994, 135-140; 2002, 112-121).

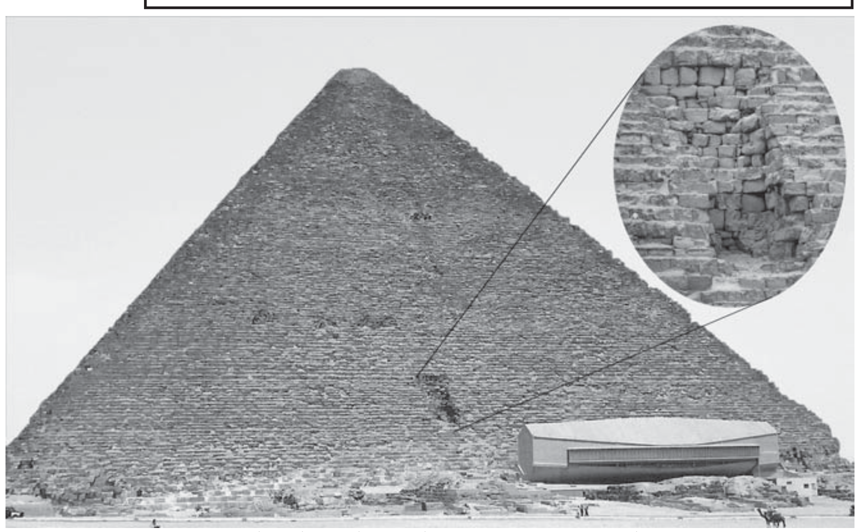
NAME	FIELD	INTERIOR	CASED?
DYNASTY IV 2498BC			
Sneferu	Maidum	Stepped	Yes
[Bent]	Dahshur	Unknown	Yes
[Bent Subsidary]	Dahshur	Unknown	Yes
[Red]	Dahshur	Unknown	Yes
[Khufu]	Giza	Unknown	Yes
Khufu GI-a	Giza	Stepped	Yes
Khufu GI-b	Giza	Stepped	Yes
Khufu GI-c	Giza	Stepped	Yes
Khufu GI-d	*Giza*	*Ruined*	*Yes*
Djedefre	*Abu Rawash*	*Ruined*	*Yes*
Khafre	Giza	Unknown	Yes
Khafre GII-a	Giza	Ruined	Yes
Unfinished Pit	*Zawyet el Aryan*	*Ruined*	*No*
Menkaure	Giza	Stepped	Yes
Menkaure GIII-a	Giza	Stepped	Yes
Menkaure GIII-b	Giza	Step Exterior	No
Menkaure GIII-c	Giza	Step Exterior	No
Shepseskaf	Saqqara	Stepped	Yes
DYNASTY V 2345BC			
Userkaf	*Saqqara*	*Ruined*	*Yes*
Userkaf Subsidary 1	Saqqara	Stepped	Yes
Userkaf Subsidary 2	Saqqara	Stepped	Yes
Sahure	Abusir	Stepped	Yes
Sahure Subsidary	Abusir	Stepped	Yes
Neferirkare	Abusir	Stepped	Yes
Khentkaues II	Abusir	Stepped	Yes
Raneferef	Abusir	Step Exterior	Yes, Stepped
Neuserre	Abusir	Stepped	Yes
Neuserre Subsidary	Abusir	Stepped	Probably
Djedkare Isesi	Saqqara	Stepped	Yes
Djedkare Isesi Subsidary 1	Saqqara	Stepped	Yes
Djedkare Isesi Subsidary 2	Saqqara	Stepped	Yes
Unas	Saqqara	Stepped	Yes
DYNASTY VI 2181BC			
Teti	Saqqara	Stepped	Yes
Pepi I	Saqqara	Stepped	Yes
Merenre	*Saqqara*	*Ruined*	*Yes*
Pepi II	Saqqara	Stepped	Yes

TABLE 1. Pyramid names in Italics—Ruined; name in Brackets—interior construction unknown. See Text

THE REST – GRASPING AT STRAWS

Of the 30 pyramids under consideration, we have identified 25 as either having, or likely planned to have, a stepped interior under a true pyramid exterior. Judging the remaining five pyramids is difficult. Significantly, four of them are the largest and most intact of all pyramids. We have no compelling evidence for stepped interiors because we cannot see beneath their exteriors.

The Great Pyramid of Khufu offers three "windows" to its interior construction. First, Al-Mamoun's Hole—actually a rough passage—was cut in 820 AD from the pyramid's north face 100 feet into the core of the pyramid. The placement of block joints along the rough passage walls provides no evidence of a face. Second, on the pyramid's south face, Howard Vyse cut a large, deep irregular gash in his search for a south entrance (Fig. right). The core blocks are coarsely



South side gash in Khufu's Great Pyramid

Vertical wall behind the Great Pyramid gables

finished with wide gaps and only roughly maintained courses. Here the construction is less like the finely cut blocks and tight fit of the Great Pyramid's exterior, and more like the interior of the Maidum pyramid (p5, Fig.). In the center of the gash there are two courses that appear to be better finished and more closely laid. These hint at a more careful construction consistent with the inner step surfaces found inside other pyramids.

Third, on the north face above the entrance (Fig. above) there are four inclined blocks set as a gable and the remains of four other sets of gables which formed a massive weight-relieving structure above the Descending Passage. Since the weight of the pyramid mass bearing on the Passage ceiling increases as the Passage descends further into the core, one might logically expect a series of weight-relieving gables down to the point at which the Descending Passage enters the bedrock. However, this is not the case. Immediately behind the full set of gabled blocks at the entrance is not another set, but a wall of tight fitting blocks which extends up and behind the inclined blocks. This may be the face of a stepped interior.

Khafre's pyramid and Snefru's Bent and Red pyramids have no openings through which we can see the internal construction. All three are still largely intact and appear to be solidly constructed in courses. This solid-looking exterior makes it appear that the pyramids were constructed throughout in courses. However, based on exterior appearance, the same conclusion could be drawn about Menkaure's pyramid at Giza. On three sides, this pyramid appears solidly constructed of blocks laid in level courses, giving us every indication that the interior is also constructed fully in courses. However the gash in the north face (Fig. below) reveals something entirely different: there is an interior, step pyramid not far below the outer, true pyramid. The gash clearly reveals two stepped faces and fill-stones both interior and exterior to the stepped faces. At Menkaure's pyramid we are reminded to not let surface appearance lead us to conclusions about interior construction.

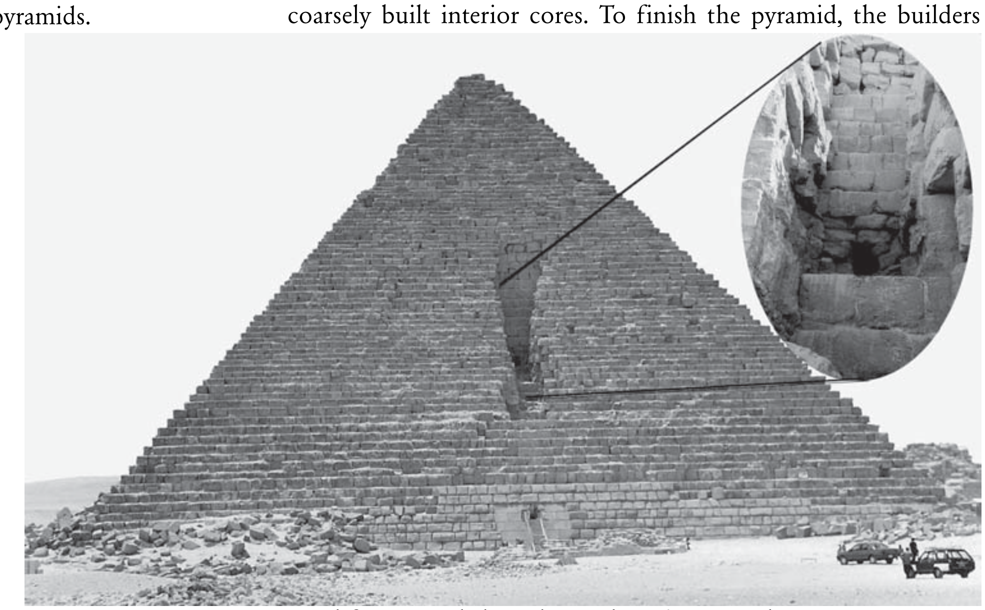
The Bent's subsidiary pyramid is in a state of ruin. It should show a stepped interior if one were present, but there is no evidence of one. Recall that this was intended to be the first small, true pyramid. The builders may have thought the stepped interior unnecessary for such a small construction.

Pyramid	True Pyramid Volume (Million Cu Ft)	Step Pyramid Volume (Million Cu Ft)	Step Volume As Percent of True Volume
Maidum	22.5	15.5	69%
Menkaure	8.5	5.2	61%
Menkaure GIII-b, c	.660	.307	47%
Khufu GI-a	.800	.500	62%
Sahure	3.4	2.6	76%
Neferirkare	10.4	8.1	78%
Neuserre	3.7	3.1	83%

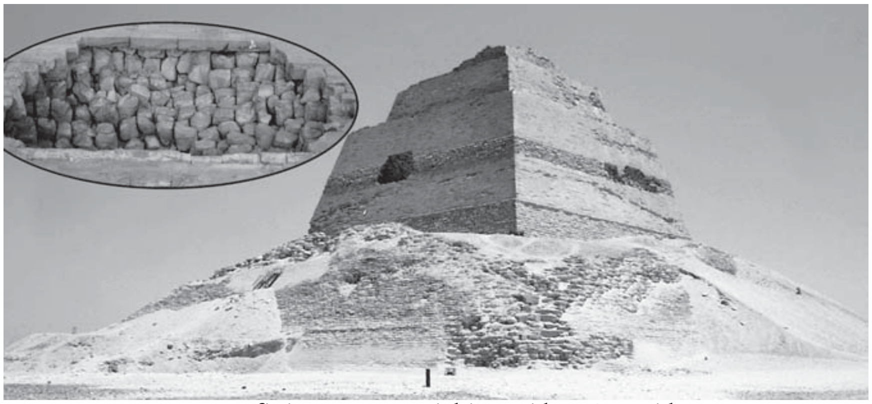
TABLE 2.

STEPPED INTERIORS SIMPLIFY CONSTRUCTION

The stepped faces enclosed the core material. From the start of the 4th Dynasty through Userkaf's pyramid (the first pyramid of the 5th Dynasty), cores were constructed of relatively large, roughly finished blocks. For the remainder of the 5th and 6th Dynasties, the cores were a combination of widely different-sized limestone chips from the quarry and other fill material; all placed without mortar to fill the spaces. The relatively large, tightly fitting blocks of the stepped faces contained and gave stability to the coarsely built interior cores. To finish the pyramid, the builders



Two stepped faces revealed inside Menkaure's Pyramid



Loose fitting core material in Maidum Pyramid

filled the steps with a relatively thin layer of inferior cut blocks which they then enclosed within well finished backing stones and very finely finished casing blocks. In this way, construction was greatly simplified, with detailed attention required only for the two finished faces. The rest of the pyramid was roughly built.

Based on available and very approximate interior step dimensions (Table 2), we can generalize that about 70% of the pyramid's volume consisted of the coarse material contained within the step pyramid core. The data indicate that, excluding Menkaure's subsidiary pyramids, there was a definite trend of including more of the pyramid within the stepped faces.

THE "SMOKING" PYRAMID

Researchers have proposed that the interior step pyramid and the exterior true pyramid were raised at about the same time (Note 2). This method makes sense since it would make the most efficient use of a long ramp built against the pyramid side or a spiral ramp encircling and covering the pyramid. But can we find any evidence for this or any other construction method? Can we find a "smoking pyramid", one that was halted during construction, to reveal the construction method?

Recall that 4th Dynasty King Menkaure died before his mortuary complex was completed. The complex illustrates the sequence of construction at his death. Pyramid GIII-a (p2, lower Fig.) has a finished, cased, inclined exterior, but GIII-b and GIII-c have uncased, stepped exteriors. Since there are no finished step pyramids dated to a time after the Maidum pyramid (Fig. above), it is very unlikely that both GIII-b and -c were designed to be step pyramids in their final form. Their stepped sides have finished surfaces, but they were not finely finished as exterior casings. There are no foundations for a stepped casing and there is no evidence to indicate that a partially completed true pyramid once existed and was removed. If the stepped interior and the inclined exterior were raised together, we should find a base apron surrounding both GIII-b and GIII-c on which the inclined exterior was initially built. Both pyramids were excavated to their bases in the areas of their mortuary temples without finding the base apron. This evidence indicates that the stepped interior was an intermediate step to the final true pyramid and that the stepped interior was completed before the exterior true pyramid was started.

From a later period, we can consider Neferefre's 5th Dynasty mortuary complex. There is no reason to believe that anything but a true pyramid was intended, but what existed at his early death was only the first step of the core construction without the surrounding true pyramid (Verner 1994, 138; 2002, 118).

Since no finished step pyramids were built after the Maidum Pyramid was converted from a step to a true pyramid, there is no reason to believe that the later pyramids were intended to be completed as step pyramids. Instead, they seem to represent stages in the construction of true, but incomplete, pyramids.

WHY INTERNAL STEP PYRAMIDS FIRST

While the evidence leads us to conclude that virtually every true pyramid contains an internal step pyramid and that the internal step pyramid was completed before the true pyramid exterior was built, there is no evidence to explain this seemingly inefficient, two-step approach. The first true pyramid, completed at Maidum, was built over an already completed step pyramid. Did the builders find some advantage to this two-stepped approach and use it in all the pyramids that followed?

Ancient architects had to lay out the pyramid bases accurately and to mark the sides and corners on the rock base to guide the builders. They also had to determine the angle of the pyramid side, measured in sekeds, and from this determined the intended pyramid height. But the apex of the pyramid—the exact point where the four sides would meet—was in the sky. While its location could be specified at a precise height above the center of the base, its position could not be marked. Without a marked place at which to aim, the builders were in significant danger of building a skewed pyramid. For the Great Pyramid, Petrie measured how far the edges of the then existing pyramid's top were from the center of the pyramid's base and determined the greatest difference between the sides to be 10.4 inches at a height of 450 feet. He attributed this to a difference in casing thickness (Petrie 1883, 43). The height of the Great Pyramid intended by the builders was 481 feet, 2 inches, which appears to have been missed by not more than a few inches (Note 3). This is amazing accuracy.

For other pyramids there is virtually no data on how accurately the apex, or the derived apex for semi-ruined pyramids, was to being directly over the center of the base. However, based on visual appearance, there are no pyramids whose apexes seem to have missed the pyramid's center. There are no obviously off-center, skewed, or misshapen pyramids.

Controlling the slope, and ultimately the location of the apex, would have been a significant challenge for the ancient builders. As a solution, Mark Lehner has suggested that the casing blocks were brought to their final position with only their bottoms accurately cut. He suggests that the remaining sides were cut after each block was placed in its final position and the slope fixed around the block edges (Lehner 1997, 221). However, the time required for the final cutting would significantly have slowed the whole building process since the next block could not have been laid until the previous block was cut. To solve this problem, an alternate theory is that all block sides would have been cut in the work yard with only the final leveling of the top occurring on the pyramid. Both proposals assume that the accurately leveled blocks, with the pyramid slope cut into the block face, could control the overall slope of the pyramid and keep it aimed at that unmarkable point in the sky which would be the apex (Lehner 1997, 221). Any errors are assumed to be offsetting. Petrie measured the heights of each Great Pyramid course at the corners and found discrepancies of 5 inches in the height of casing blocks on the same course, and he found differences of 2 inches to be very common in courses around 30 inches high (Petrie 1883, Plate viii). This data appears to be in conflict with Lehner's approach which would require very precisely sized casing blocks.

Additionally, Lehner's theory does not automatically achieve the accuracies apparent in the pyramids. The solution requires that each of the approximately 120,000 casing blocks on the Great Pyramid be perfectly finished and leveled. Given the wooden measuring tools of the day, the need to accurately construct and calibrate them to some standard, the requirement to maintain and recalibrate the tools, and the differing abilities of the many masons who worked on leveling the blocks, anything near perfection would not be possible (Note 4). To test the method for building the Great Pyramid, I assumed the masons could achieve accuracies between zero and plus or minus 10 minutes of arc in cutting and laying the blocks (Note 5). In over 100 tests, I found cumulative errors to the top of the Great Pyramid ranging from minus 6.6 degrees to plus 7 degrees; the average cumulative error was 1 degree 40 minutes, which could result in a miss of the intended height by 35 feet. In practice, each of the four pyramid sides would be built to a different cumulative error and would not meet smoothly at the apex. If the pyramid sides were enveloped by ramps as Lehner proposes (Lehner 1997, 216), this error would not be observable until the ramp material was removed and the whole pyramid could be observed. Since there are no misshapen pyramids, the builders must have found a way to control the slope of all four sides of the pyramid very exactly.

The builders were faced with this control problem on their first completed true pyramid—at Maidum. Since the second crew of builders started at Maidum with a completed step pyramid, they could actually mark the location of the true pyramid top by erecting an apex marker, possibly a brightly colored ball atop a pole, on the highest step. The pole need not have been embedded in the pyramid but could have been built on a tripod resting on the top course of the step pyramid. Then they could have built the pyramid sides towards the marker of the apex.

The simplicity of this approach is that the builders would not have had to accurately maintain the location of the pyramid center as the interior steps rose. They would only have had to locate the apex marker so that sighting from the pyramid's base to the apex marker at the desired final pyramid angle would clear all the stepped surfaces. Through a series of multiple observations from the pyramid's base to the apex marker, the outline of the pyramid base could be determined. No matter what the shape of the interior step and where its center was located, as long as the exterior of the true pyramid base was laid out and the apex marker was placed so that the angle from the base to the apex marker was the same on all four sides and always cleared the internal step pyramid, the final pyramid would be symmetrical. It would not have mattered if the inclined sides cleared the stepped interior by 1 foot or 20 feet. Also, there would have been no need to keep track of the exact center point of the step pyramid; the apex marker would define the final pyramid center.

The casing blocks would have been placed by sighting from the ground towards the apex marker. Because of the distance to the marker, the alignment would have been less accurate near the ground and would have become more accurate as the courses approached the marker. But all four sides would have met at the single point of the marker, predetermined as being directly over the center of the pyramid

While Maidum was the first true pyramid completed, the first true pyramid attempted was the Bent pyramid. The generally accepted theory is that completion of the Bent pyramid as a true pyramid was abandoned at the level where the slope changes—apparently due to settling of the structure and cracking of the chamber walls. Above that level, the builders added 720,000 tons of stone to finish the pyramid. Considering that this weight was added on top of a supposedly already-settling, cracking pyramid, the slope change did not produce a significantly smaller weight than the 1,070,000 tons that would have been added if the slope had not been changed. However, close examination of this pyramid's finished lower faces reveals they are not flat and constructed at one angle but actually undulate. Possibly the the builders changed the shape of the Bent pyramid because they realized that whatever method they used to control the angle of the four sides and bring them to an apex over the pyramid's center was not working. After completing the Maidum pyramid and perhaps the Red Pyramid, the builders may have hidden this error in the Bent Pyramid by significantly changing the slope and using the by-then-proven method of erecting an apex marker to bring the top portion of the Bent Pyramid to a single point (Note 6).

In summary, it seems probable that the architects and builders of later Old Kingdom pyramids used and improved on methods that had proven to be successful in early pyramids. They found that a stepped interior would improve building efficiency by permitting the use of inferior, unfinished and less labor-intensive core material. The size and shape of the interior step pyramid did not have to be finely controlled since it would be hidden. Building the interior step pyramid first, while possibly not the most efficient method, did provide a means for marking the apex and providing control of the true pyramid shape.

ENDNOTES

1. While at first glance the Maidum casing appears roughly worked, a close examination reveals that it was finely finished. The rough textured appearance is actually the eroded surface of the finished casing and lies below the finished surface, not above it. We assume the work of finishing the casing proceeded from the top down and we know the casing at the bottom was fully finished. Thus it appears that all work on the pyramid was completed. The same can be observed in the burial chamber. The walls and corbelled ceiling were finished, except for the top corbelled level; these are now eroded to form a rough surface.
2. Lehner 1997, 221 suggests that the cores may have been erected somewhat in advance of the casing
3. The architect appears to have intended a base length of 440 cubits and a *seked* for the pyramid of 5 palms, 2 digits which gives a rise-to-run ratio (height to 1/2 base length) of 7 to 5.5. Using a cubit of 20.62 inches, the ratio implies that the height was 280 cubits or 481 feet, 2 inches. Although the pyramid's top is now missing, estimates of its original height are about 481 feet.
4. The primary leveling device was a square level made from three pieces of wood in the shape of an "A" and a weighted string hanging from the apex and crossing the bar of the "A". The tool requires three joints and initial calibration on a known perfectly level surface. With the legs of the "A" resting upright on a flat surface, the string crosses the bar of the "A" at a calibration mark when the surface is level. Warped wood and loose joints impact the accuracy of the tool. The larger the square level, the greater the possible accuracy but the greater the opportunity for the tool to lose its calibration.

5. This represents a difference in height of up to 1 inch over a distance of 28 feet, 8 inches or an error of up to 0.1 inch over a typical block length of 3 feet.
6. There are no angular or center offset measurements of the Bent Pyramid's four sides to confirm or deny this possibility.

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Charles Rigano is a retired Air Force officer and now manages information programs for Northrup Grumman. Mr. Rigano lives in Ohio and is a Corresponding Member of the ESS. He is a frequent contributor to The Ostracon.

Stepped faces of Sahure and Neferirkare's pyramids (top L and R) and Shepseskaf mastaba (bottom) were covered by an inclined face

Bent Pyramid with the changed face angles

The Burke's Resurrection Machine

By Susan Cottman

The beginning of the 3rd Intermediate Period (1069-664 BCE) in Egypt marked political and religious changes. In the 21st Dynasty (1069-945 BCE), Deir el-Medina, for centuries home to the artisans of the royal tombs, was a ghost town succumbing to the relentless desert sands. The Valleys of the Kings and Queens lay silent, plundered of valuables by thieves and Theban officials.

Either lacking the political will or power to protect the vast Theban necropolis, the sound of workers chiseling new tombs ceased. No one knows for certain why––changes in funerary beliefs, rampant tomb robbing and economic factors are all possible explanations. Those who could afford it generally sought refuge for their dead in group burials in existing tombs. The Deir el-Bahri and Bab el-Gasus caches are the most famous examples (Taylor 2000, 351).

In the Delta, the Ramesside line had burned out and in its place a new pharaoh named Smendes (1069-1043 BCE) took the throne and proclaimed himself king of all Egypt. The political realities in Thebes tell another story. Amun's most powerful priests ruled Upper Egypt. Herihor, high priest of Amun, founder of the 21st Dynasty theocratic line in Thebes, portrayed himself as king at Karnak. One of his successors, Pinedjem I, was buried with royal honors. They acknowledged the Delta king but the theocracy of Amun reigned supreme through its priestly rulers (Taylor 2000, 346).

The mutually recognized boundary between the Theban theocracy and the Libyan Delta kings was at Teudjoi (el-Hiba), south of the entrance to the Fayum. Relations between the ruling families were apparently amicable, and they intermarried (Taylor 2000, 333).

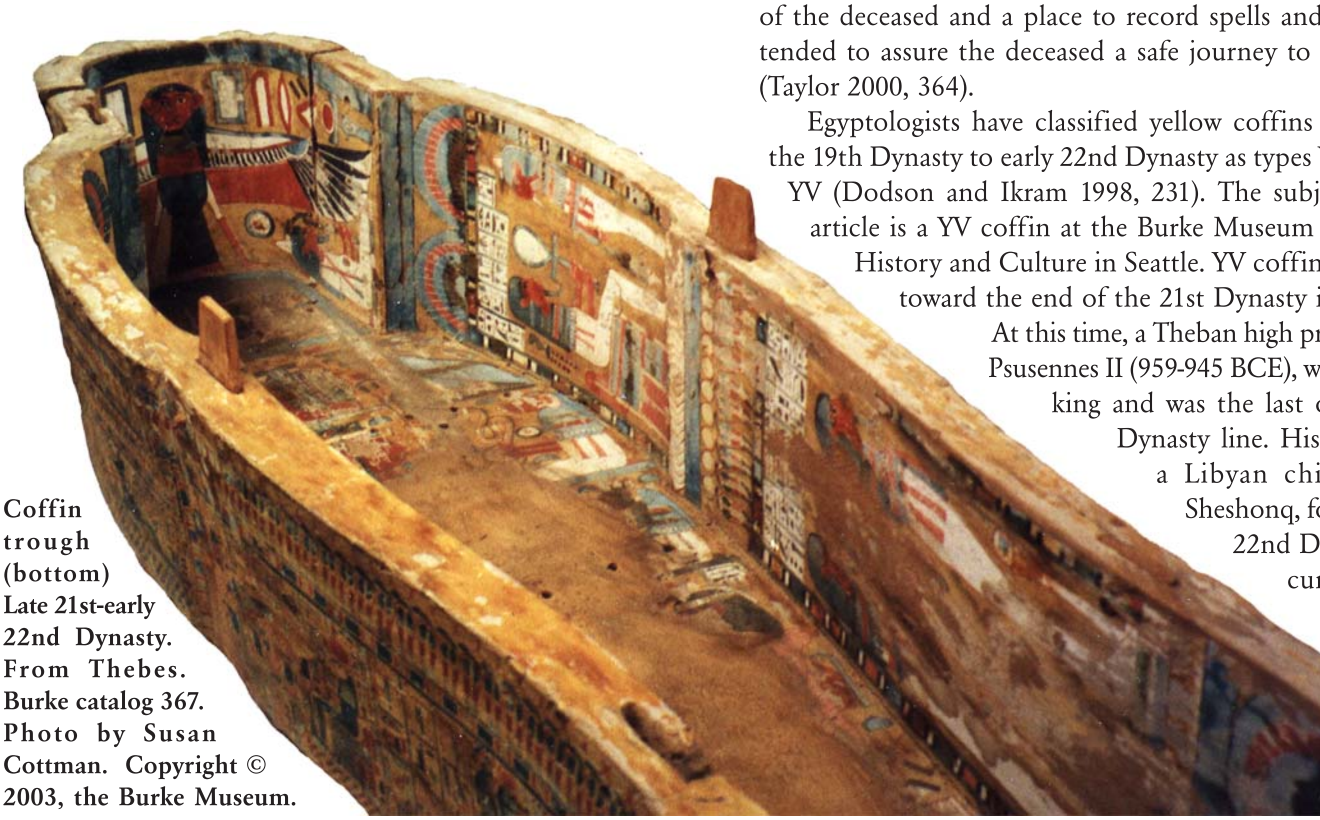
The Theban craftsmen now lived in the settlement within Ramesses III's fortified mortuary temple at Medinet Habu, for protection from the predations of Libyan tribes (Teeter 2002, 2). They lavished their talent on one of the only canvases left––coffins. They made do with softer, native woods, such as sycamore, since cedar and other luxury timbers were no longer imported.

These "yellow" coffins, characterized by a varnish or yellow paint that lent them a golden hue, became the deceased's first line of defense in this brave new world of cramped, communal burials in old tombs or holes dug in the precincts of nearby temples.

Although the earliest known coffins with yellow backgrounds date to the 18th Dynasty (Dodson and Ikram 1998, 216), the 3rd Intermediate Period examples are easily distinguished by texts and vignettes crammed into every available space. Their decoration echoes Ramesside themes of Osirian and solar unity, in contrast to the so-called daily life scenes in 18th Dynasty private tombs. John Taylor and other Egyptologists have described these yellow coffins as a substitute for the functions of the tomb and chapel––protection of the deceased and a place to record spells and scenes intended to assure the deceased a safe journey to eternal life (Taylor 2000, 364).

Egyptologists have classified yellow coffins used from the 19th Dynasty to early 22nd Dynasty as types YI through YV (Dodson and Ikram 1998, 231). The subject of this article is a YV coffin at the Burke Museum of Natural History and Culture in Seattle. YV coffins appeared toward the end of the 21st Dynasty in Thebes.

At this time, a Theban high priest named Psusennes II (959-945 BCE), was crowned king and was the last of the 21st Dynasty line. His successor, a Libyan chief named Sheshonq, founded the 22nd Dynasty and curtailed the



Coffin trough (bottom) Late 21st-early 22nd Dynasty. From Thebes. Burke catalog 367. Photo by Susan Cottman. Copyright © 2003, the Burke Museum.

Features of type YV coffins include:

Exaggerated floral collar extending to the belly.

Attached wooden hands, indicating the arms are crossed.

Sycamore and other soft, native woods were used during this era due to the unavailability of cedar from Lebanon.

Dense decoration using Osiride and solar themes on a yellow, varnished background.

Raised areas on the lid shaped in plaster, to imitate inlays of glass and semiprecious stones.

Mummy braces painted on the lid to imitate red leather originals. Deities are sometimes shown with these braces—hence the identification of the deceased with the gods.

Coffin lid. Late 21st-early 22nd Dynasty. From Thebes. Burke Catalog 367. Photo by Susan Cottman. Copyright © 2003, the Burke Museum.

independence of Thebes, enabling him to control all of Egypt (van Walsem 1997, 362). He appointed one of his sons as high priest of Amun at Thebes and mounted military expeditions in Palestine (Taylor 2000, 335).

The last YV coffins are dated to the reign of his son, Osorkon I (924-889 BCE). While Osorkon sat on the throne in the Delta, artists began producing a new style of coffin characterized by simpler decoration on a white background (Robins 1997, 203). Egyptologists do not know if both styles were used simultaneously for several years. The chronology of this era continues to be debated, so dating coffins is problematic.

While the Burke coffin cannot be dated precisely, it could have been made during the reigns of Psusennes II, Sheshonq or Osorkon I.

DECIPHERING THE BURKE COFFIN

University of Washington regent Manson Backus purchased the coffin (and a Ptolemaic mummy) from a museum showroom at Giza in 1902 for the Burke Museum on the University of Washington campus (Burke Museum 1962).

During this heady era of the Western "discovery" of ancient Egypt, European and American museums desired all things Egyptian. The rise in tourism, ground-breaking exhibits such as Giovanni Belzoni's replica of Seti I's tomb in London, and the growth of Egyptology––still a nascent discipline in the early 1900s––fueled Western fascination with pharaonic civilization. In this context, Backus' shopping trip was fashionable and philanthropic.

Although examined and studied periodically since its arrival in Seattle 101 years ago, this is the first time the Burke has launched a full-scale conservation and analysis of its Egyptian coffin.

With the kind permission of Laura Phillips, Burke Archaeology Collections Manager, the author began researching the coffin in 2001 with the aim of providing as complete documentation as possible and placing it in the greater context of Theban society in the early 3rd Intermediate Period. John Sarr, ARCE/OR chapter president and hieroglyphs scholar, prepared a translation of the coffin's texts at the author's request.

In the study of the coffin, it was helpful to apply René van Walsem's model of *architecturonisation*. In this model, several aspects of these coffins can be understood as representing and replacing features of New Kingdom decorated tombs (van Walsem 1997, 359).

Architectural features on coffins and sarcophagi are not new and persisted throughout ancient Egyptian history. Menkaure's 4th Dynasty sarcophagus, now lost, was decorated with the paneled niche facade known from the earliest elite mastabas. Other motifs, such as the concave cornice, which dates to the 3rd millennium BCE, appear as late as the Roman period (Malek 2003, 352).

A visitor to the Burke will notice that the inner and outer foot boards of the trough (bottom half of the coffin) are bare. Van Walsem suggests that the artists usually did not paint these areas because the tomb floor was never decorated. The lid's inner surface is undecorated, as is the Burke's example. The inner surface represents the blocked tomb entrance from the mummy's perspective (van Walsem 1997, 359). The backs of yellow coffin troughs, including the Burke's, are rarely decorated (Niwinski 1988, 84).

The space above and beside the mummy's head in the crown of the trough substituted for the tomb ceiling. In the Burke example, a *ba* bird, painted *en face*, stretches its wings along the curved surface with other figures and a text that reads, *Going out from the horizon* (Sarr 2003, 10).

The trough's inner floor and sides are divided into registers, which represent the tomb walls found in Ramesside tombs in van Walsem's model. The sides are oriented horizontally. On the trough floor, figures of deities and the deceased as well as texts flank a large, damaged figure of Osiris, which fills most of the space on the trough floor (see photo, page 8).

An observer will notice that some deities have ointment cones and lotus buds on their heads (see lower right photo, page 12)––an innovation of 21st Dynasty Thebes that may have struck Osorkon I as disrespectful of the gods and a symbol of Theban independence, and motivated him to introduce a new coffin style. In the New Kingdom, only the deceased had been depicted this way. This "humanization" of deities, as van Walsem calls it, "reache(d) its apex on stola (YV) coffins and contemporary papyri." The Burke coffin also could have been produced as late as Osorkon I's reign (van Walsem 1997, 352).

One characteristic that sets YV coffins apart from their predecessors are stola––red strips painted on the coff in lid as well as on the deceased and deities inside the coff in (see pages 12-13). Stola often appear on depictions of gods, and they are thought to imitate leather braces placed on mummies during the 3rd Intermediate Period. Their use may have been protective and to identify the deceased with the gods, especially Osiris (Taylor 2001, 63).

Traces of two heavily damaged cartouches are on the bottom of the coffin trough. Faintly visible hieroglyphs in the left (mummy's left) cartouche may spell Osiris. Coffins of this era often included cartouches of Osiris or defied kings––Amenhotep I and Tuthmose III (Robins 1997, 200).

There are no titles on the coffin; their absence may indicate that the coffin was a "generic" model. The ancient Egyptian who purchased it was most likely a man, since the lid once had a beard, and probably spent his entire life in Thebes, perhaps living behind the fortified walls of Medinet Habu. The original owner's name is uncertain (see "Three Possible Names" on page 11).

The political fragmentation in Egypt continued until Nubians took control of southern Egypt and established the 25th Dynasty. In 716 BCE, the Nubians conquered the Delta and reunited Egypt under one pharaoh. With central authority restored, the Theban elite resumed building grand, lavishly decorated tombs, using themes and artistic styles inspired by traditions as far back as the Old Kingdom.

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Susan Cottman *edits* Aegyptos, *the newsletter of the Northwest Chapter of the American Research Center in Egypt, and a contributing editor to* The Ostracon*. She is associate editor at Scott Publishing, Inc., and is a member of the* American Medical Writers Association *and the* Puget Sound Science Writers Association*. She and John Sarr, who translated the coffin texts, presented gallery talks at the Burke Museum in October 2003 while the coffin was on display. Website:* http://home.earthlink.net/~nfrtry/index.html

John Sarr *is president of the* Oregon Chapter of the American Research Center in Egypt*. He is a hieroglyphs scholar who has taught the ancient Egyptian language at venues including* The Seattle Art Museum *and for the exhibition* In The Fullness of Time*.*

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From the Editors:

You are looking at an experiment. Is color reproduction worth the time, trouble, and expense?

Susan Cottman wrote and did the color layout of the "Burke Ressurection Machine" for Aegyptos; she then offered it to The Ostracon. Other than different fonts a few corrections, and a slightly different layout to fit our format, the article is as she created it. The impact of this article depends so much on color that we decided to try it for one issue and ask you to comment on it. Unfortunately, color reproduction IS expensive. It costs at least three times as much as Black and White (B&W) and sometimes far more. It is much more subjective than B&W and takes longer to prepare. That can delay publication (as it has with this issue) and the results are less certain. The skill levels required to create good color layouts are higher (and rarer) than for B&W. With all those negatives, there is the unarguable fact that for some articles, color is highly desirable or even necessary. For exmple, Bonnie Sampsell's maps (following article) are much clearer in color. The "bottom line" is the printed copy. Do you like it? Is it worth it? Your reactions will determine whether we often, occasionally, or rarely use color in the future, so please do comment on it. You can contact us by e-mail (Ostracon@EgyptStudy.org); by telephone (see the membership directory); or in person. Thank you.

Above: Detail from the outside right of the coffin trough. This figure may represent the owner. It is especially intriguing because one of the names found on the coffin can be translated as a woman's name.

Right: The coffin in its case, custom-designed for public exhibition.

Below: Osiris offering life to the deceased. Inside right wall of coffin trough.

Late 21st-early 22nd Dynasty. From Thebes. Burke Catalog 367. Photos and line drawing by Susan Cottman. Copyright © 2003, the Burke Museum.

Will the Real Coffin Owner *Please Stand Up?*

That question may never be definitively answered. Even when names are visible on ancient Egyptian objects, such as the Burke coffin, identification can be difficult.

Movie scenes showing Egyptologists wiping the dust from coffins and breathlessly announcing the name of the dead paint a simple picture of the more complicated reality of deciphering ancient Egyptian texts.

For all the tombs and funerary objects clearly inscribed with their owners' names, there are even more which remain anonymous.

The Burke coffin is a case in point. A translator in 1935 mistook the inscription by the *ba* bird for the coffin owner's name. A report prepared in 1962 by Kent Weeks noted that this translation was incorrect, but did not contain additional notes. (The text actually reads *Going out from the horizon*—a reference to the flight of the *ba*, a human-headed bird—from the tomb.)

This marks the first time a comprehensive translation and discussion of the names has been published. As explained below by hieroglyphs scholar John Sarr, who translated the texts, the coffin has plenty of names to confound researchers.

Multiple names indicate the venerable ancient Egyptian tradition of usurpation may have occurred—a practice not limited to royalty.

It is also possible the first owner's name was not painted over or removed. According to Andrzej Niwinski, "in most instances the old name was left ... probably for pure (sic) religious reason (sic) ... the usurpers tried to leave as many signs of the original inscription as possible" (Niwinski 1988, 374).

– Susan Cottman

Three Possible Names

The badly damaged name that appears at the end of each column of text on the lid also appears on the outside right wall of the coffin trough. The reading of the name poses problems.

If read **Tadikhonsu,** it is a woman's name; however the coffin's emplacement for a now-missing beard and the depiction of the deceased on the coffin indicate it was originally made for a man (see photo, top).

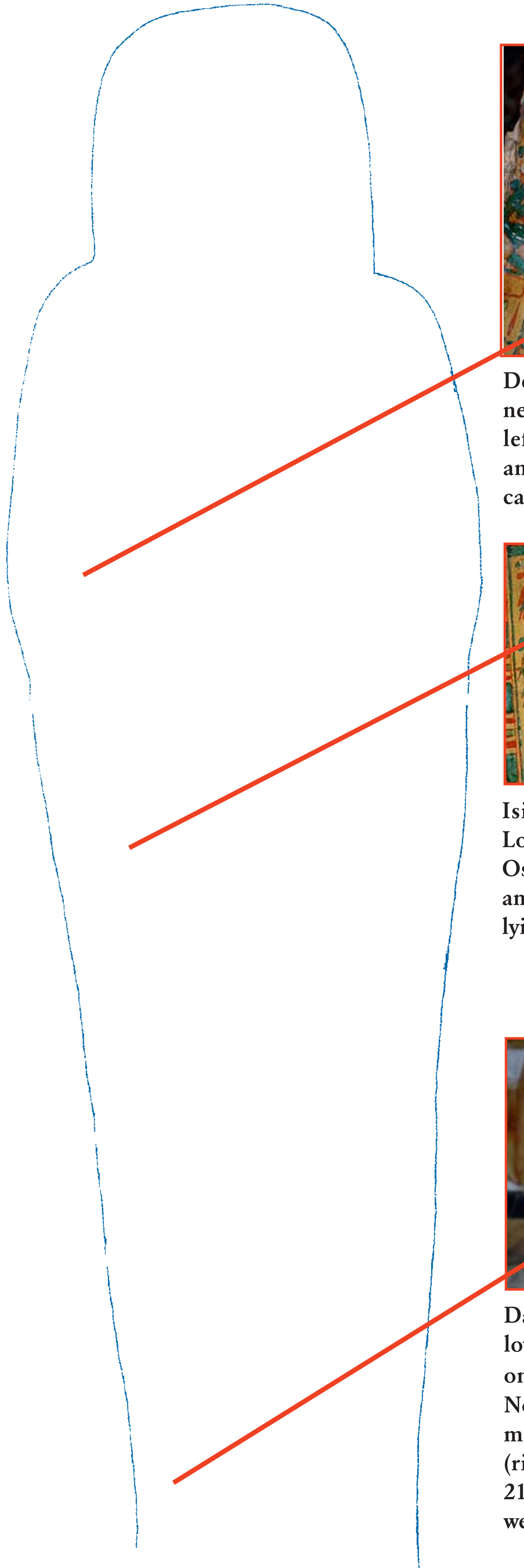
Another possible reading is **Senkhonsu,** a name which is attested in ancient Egyptian records.

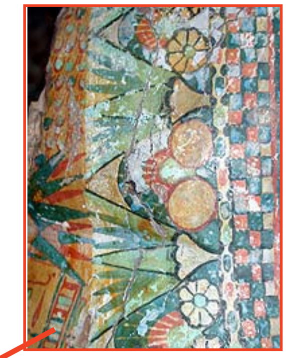
The other problem is that **Nesmehu,** the name found inside the coffin, does not match the three occurrences of the name on the outside of the coffin.

It may be the coffin was originally made for a Nesmehu and later usurped by Senkhonsu.

– John Sarr

Coffin Lid Exterior





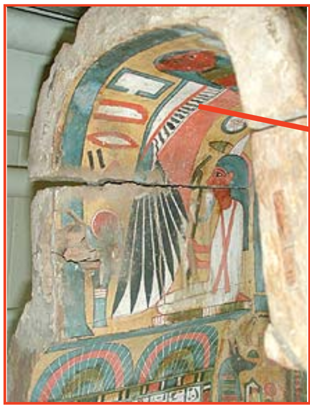
Detail of broad floral collar near right edge of lid. On the left the yellow background and text (lower left corner) can be seen.

Isis presents the crown of Lower and Upper Egypt to Osiris. Damage to Osiris' leg and throne reveals the underlying plaster layer.

Damaged inscription (left yellow box) of one of the names on the coffin: **Senkhonsu.** Note the lotus bud and ointment cone on the deity's head (right yellow box). Before the 21st Dynasty, only mortals were shown with these objects.

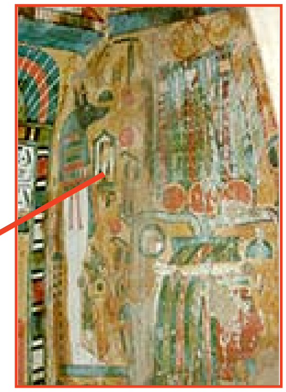
Late 21st-early 22nd Dynasty. From Thebes. Burke Catalog 367. Photos by Susan Cottman. Copyright © 2003, the Burke Museum.

Coffin Trough Interior

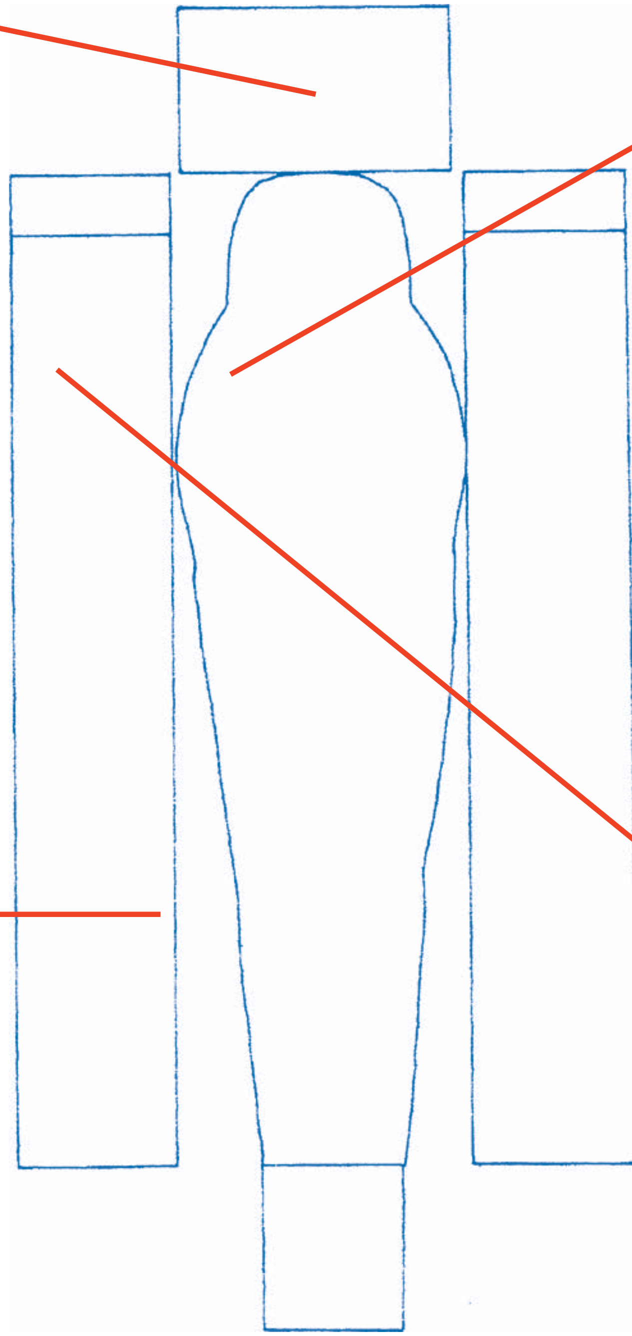


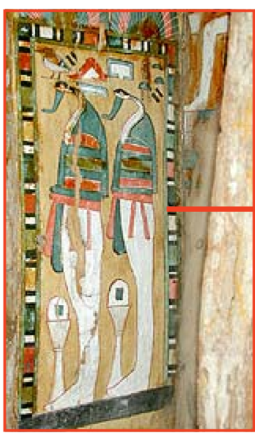
The right wing of the *ba* bird curves along the inner surface of the crown, where the deceased's head lay. *Ba* birds are common motifs in this section of type YV coffins.

The text in the upper left corner reads: "Going out from the horizon," referring to the ba bird's flight from the tomb.



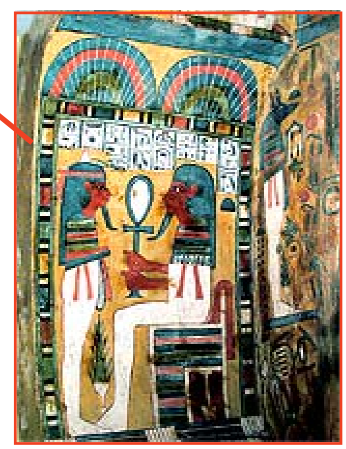
In this view, just beneath the head area of the trough floor, Anubis flanks a large and badly damaged figure of Osiris, who is wearing a *hem-hemet* crown. The hieroglyphs in front of Anubis identify him as "Foremost of the Divine Booth [embalming tent] and Chief Lector Priest."





Two registers of snake-headed mummiform deities mirror one another on inside left and right walls of the trough. Note the red mummy braces protruding from under the exaggerated collars (see page 12 for the braces on the coffin lid).

The text reads from left to right: "Going in and out of the West."



Scene on inside upper right surface, just below the shoulder curve (see line drawing, page 11). Osiris offers life, in the form of an ankh, to the deceased. Note the red mummy braces protruding from underneath the collars of both figures. This scene is mirrored on the left side.

Late 21st-early 22nd Dynasty. From Thebes. Burke Catalog 367. Photos by Susan Cottman.

The Colorado River: An American Nile

By Bonnie M. Sampsell

Looking at the data in Table 1, (next page) one might conclude that the Colorado and the Nile Rivers have little in common, but in fact there are many striking similarities. Both rivers derive the majority of their water from distant mountains with seasonal precipitation, both flow for much of their length through barren deserts, and both are the sole source of water for an expanding population. Even their geological histories display amazing parallels.

RIVER ORIGINS AND CANYON FORMATION

The Nile River enters Egypt from the south and flows north for 800 miles to its mouth on the Mediterranean (Figure 1). Along most of this course the river occupies a narrow valley that is never more than 15 miles wide. The valley is rimmed on both sides by hills or cliffs ranging up to 1,000 feet in height. We can date the formation of this valley with some certainty to an event that occurred about six million years ago. At that time the connection between the Mediterranean Sea and the Atlantic Ocean through the Straits of Gibraltar closed as a result of plate tectonic movements. Without the inflow from the Atlantic, the Mediterranean began to dry up as the seawater evaporated faster than rivers flowing into the sea replaced it.

The Mediterranean Sea basin is very deep—up to 10,000 feet deep in some places. As the seawater evaporated, an enormous gradient was created between the Egyptian coastline and the lower sea level. The increased gradient, combined with abundant runoff from the rising Red Sea Mountains, gave the Nile great erosive power and its water began to carve a canyon deep into the thick limestone plateau.

As this canyon gradually extended towards the south, it intercepted another more ancient river, termed the Qena River by Issawi and McCauley (1992). They propose that the Qena River came into existence around 24 million years ago and flowed south and west from the Red Sea Mountains of Egypt and the Sudan to a basin near Lake Chad in central Africa. When the Nile River intercepted the Qena, it offered the Qena River's water a shorter and steeper route to the sea. As a consequence, the Qena was "captured" along with one after another of its tributaries, and these added their substantial flow to the Nile's force. The Nile continued to carve its canyon to the south along the former course of the Qena River until it eventually reached the site of modern Aswan.

Six million years ago, Egypt's gigantic Nile Canyon probably looked much the way Arizona's Grand Canyon does today. On the site of modern-day Cairo it would have been about 12 miles wide and 8,200 feet deep. But the canyon was not to survive to become a future tourist attraction. Around five million years ago, the Atlantic breached the Straits of Gibraltar and refilled the Mediterranean. Seawater extended into the Nile Canyon as well. For a few million years marine sediments accumulated in the canyon. Then rivers flowing into the canyon from the Red Sea Mountains and the Nubian Desert began to create an estuary and deposit fluvial sediments. Eventually the mighty canyon was almost completely filled with only its rims left exposed to form the escarpments that border the Nile Valley today.

Another important—and much more recent—geological event occurred about 12,500 years ago when tectonic movements added Ethiopia and the lake region of Equatorial Africa to the Nile's upper drainage basin. These areas provided an increased volume of water that eventually came to be the sole source of the Nile's flow when the climate of Egypt changed from humid to arid beginning about 5,000 years ago. They also provided an abundance of silt, which has been deposited on the Nile floodplain throughout Egypt.

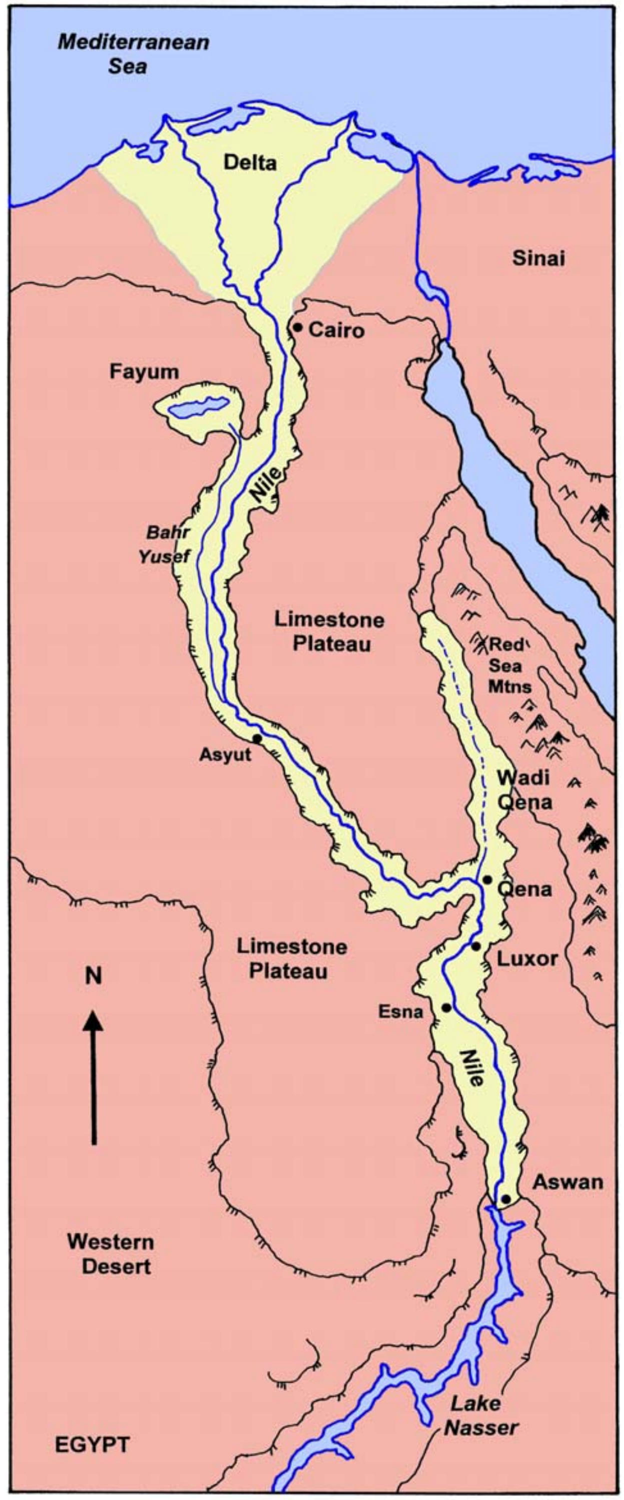


Figure 1. The Nile River Valley and Delta

	Nile River	Colorado River
LENGTH (miles)	4,241	1,450
DRAINAGE AREA (sq. mi.)	1,142,862	244,000
AVERAGE ANNUAL DISCHARGE (MAF)	57	14

TABLE 1. MAF = Million Acre-Feet, enough to cover a million acres of land with one foot of water. One million acres represent a square 40 miles on each side. 1 MAF = 325.85 billion gallons.

Like the Nile, the Colorado River has a history involving tectonic movements, erosion, and the capture of one river by another. Its story begins with the formation of the Gulf of California around 5.5 million years ago (Figure 2). At that time the westward moving North American Plate collided with the Pacific Plate; the Pacific Plate began to slide along it towards the northwest. This sliding tore off a small piece of the North American Plate that became Baja California. The motion also created a series of faults (including the San Andreas fault) running NW-SE. One crustal block isolated by these faults sank below sea level forming the ancestral Gulf of California. Initially the Gulf region stretched farther to the northwest than it does today, but river sediments have filled in part of the basin.

Among the streams that began flowing into the Gulf from the mountains on the east was the future "Lower Colorado". This stream eroded its way northward, eventually reaching the location of the modern Hoover Dam. There it encountered and captured an older, west-flowing stream: the ancestral Upper Colorado River. The upper channels of that old river had much the same pattern we see today in Wyoming, Colorado, and Utah. Its course through Arizona is much less certain.

Many geologists have studied the history of the Colorado River in Arizona and have proposed new hypotheses as additional data has become available. One of the popular theories is that a west-flowing river cut the entrenched canyons, including the Grand Canyon, to nearly their current depths during a period of abundant precipitation lasting from about 39 to 27 million years ago. When the region then became more arid, the river was no longer able to cut deeper and instead deposited sediments that nearly filled the canyons. After the Lower Colorado intercepted the ancestral Upper Colorado, the climate became wetter and greater runoff encouraged by the steeper gradient towards the Gulf of California began to remove the sediments.

During the Pleistocene Period (lasting from two million to 10,000 years ago), a series of Ice Ages saw the formation of glaciers in the Rocky Mountains. During the interglacial periods, glacial melt waters augmented the natural precipitation. This increased the volume of water carried by the Colorado River while its gradient was enhanced by two additional factors. The formation of continental glaciers lowered worldwide sea levels, so that the base level at the mouth of the river was lower than today by at least 300 ft. At the same time the entire Colorado Plateau region underwent tectonic uplift estimated at 1,000 feet in the last one million years. This rapidly-flowing, Pleistocene Colorado River was responsible for the clearance and continued down-cutting of the many canyons seen in the Colorado Plateau region today, while other types of erosion such as frost wedging and landslides increased the canyons' widths.

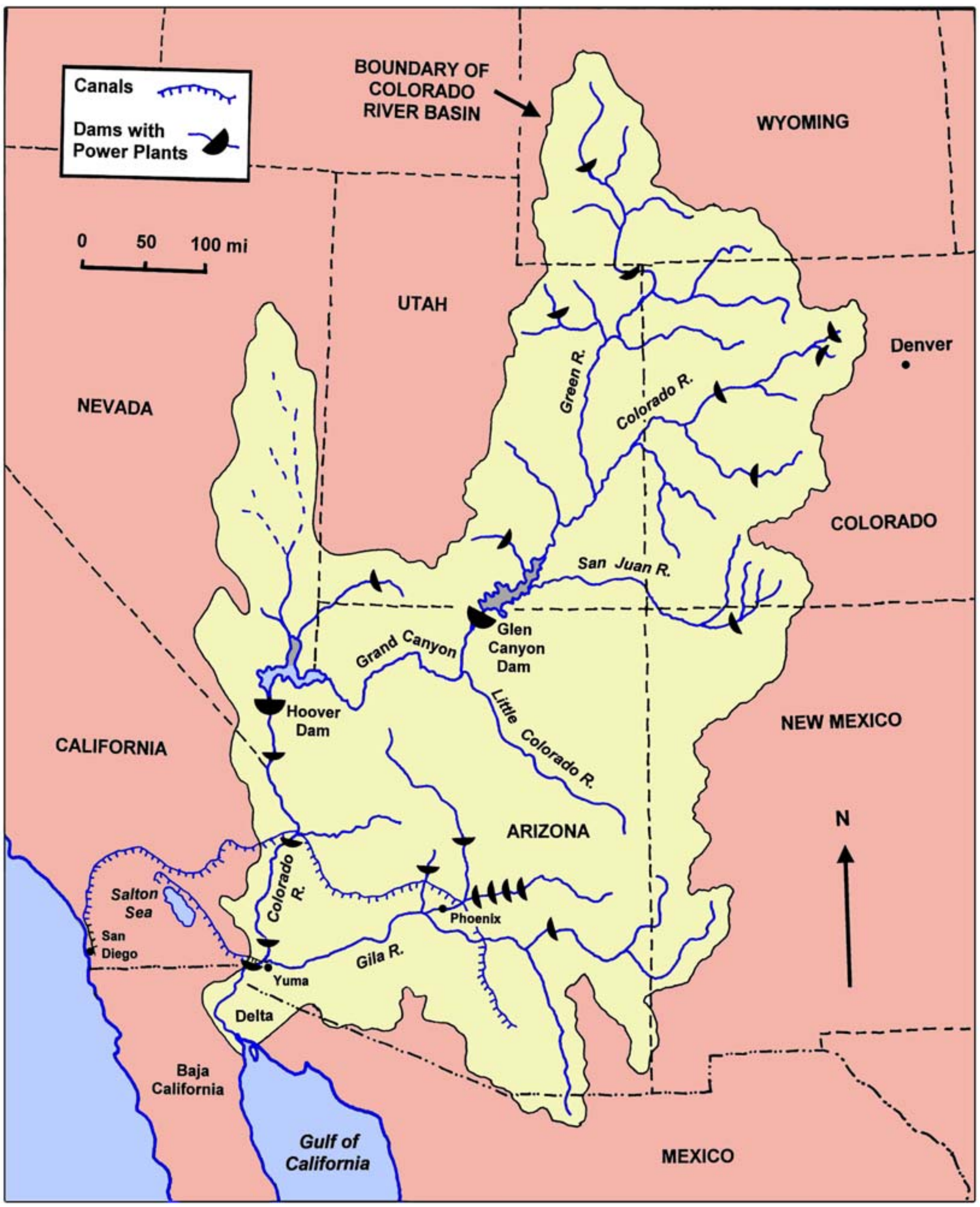


Figure 2. The Colorado River Basin

FLOODS, AGRICULTURE, AND DAMS

Monsoon rains over Ethiopia provided water for the annual Nile River floods. The rains always fell in the summer, so the Nile floods came reliably in the late summer, peaking in late August or early September. The recorded annual discharge of the river has varied during modern times from a high of 92 million acre-feet (MAF - see the caption on Table 1) in 1871 to a low of 30 MAF in 1913. Lower than average floods meant that fewer acres were flooded and for a shorter period. If these conditions persisted for several years, famines occurred. Excessively high floods were equally unwelcome, since they washed away irrigation ditches, gardens, orchards, and homes.

This pattern of late summer flooding, with sowing taking place after the flood receded in November, permitted the Egyptians to grow only a single crop each year. And they were limited to winter season crops such as wheat, barley, beans, clover, and flax—products needed to nourish humans and animals as well as to provide fiber for clothing. Although the Greek Ptolemies and their Roman successors were able to introduce agricultural improvements that resulted in a grain surplus that could be exported, for the most part Egyptian agriculture merely sustained its own population. It continued to do this very effectively for over 5,000 years despite periodic famines and floods. Because the Nile's level dropped quite low during the early summer months, the fields drained well simply by gravity and the later floodwaters washed out harmful salts from the soil. The Egyptians were thus able to avoid two problems associated with arid land irrigation that may have affected other ancient civilizations, namely waterlogging and an increase in soil salinity.

Not until the middle of the nineteenth century did the Egyptian Viceroy, Mohammed Ali, attempt to change the age-old practices. Mohammed Ali wanted to grow sugar cane and cotton to serve as cash crops that could underwrite his ambitious modernization plans. Both crops required a great deal of water and could only grow during the hot Egyptian summer. To provide water for the crops at a period of normally low Nile flow, engineers suggested damming the Nile. The first dams merely served to raise the level of the river enough to divert water into irrigation ditches.

In 1902, the first dam designed to store part of the annual floodwaters for use in the following spring and summer was built at Aswan. This dam (the height of which was raised in 1912 and again in 1934) was designed to allow the first flush of silt-laden water to pass through and flood the fields. Around November the gates were closed and approximately the last 6% of the floodwater was retained. The impounded water was released beginning in February. This "low" Aswan dam provided no protection against higher-than-average floods, nor did it permit water from one year to be carried over to the next in an effort to balance out the year-to-year variations.

Flood control and water storage to achieve a uniform flow during the winter and summer seasons were among the objectives of the Aswan High Dam completed in 1970. This dam was designed to generate electric power to expand domestic electricity use and encourage industrialization. The power is also used to pump irrigation water to areas that cannot be served by gravity canals alone. With the regulated flow, water was available for reclamation schemes along the margins of the Nile Valley and Delta and has been distributed beyond the valley across the Eastern Desert to cities on the Red Sea, along the northwestern coast to Alexandria and beyond, and into the Sinai Peninsula.

Floods on the Colorado River were more variable than those on the Nile. Snowmelt in the high Rocky Mountains generally produced a late-spring flood that crested in June. The magnitude

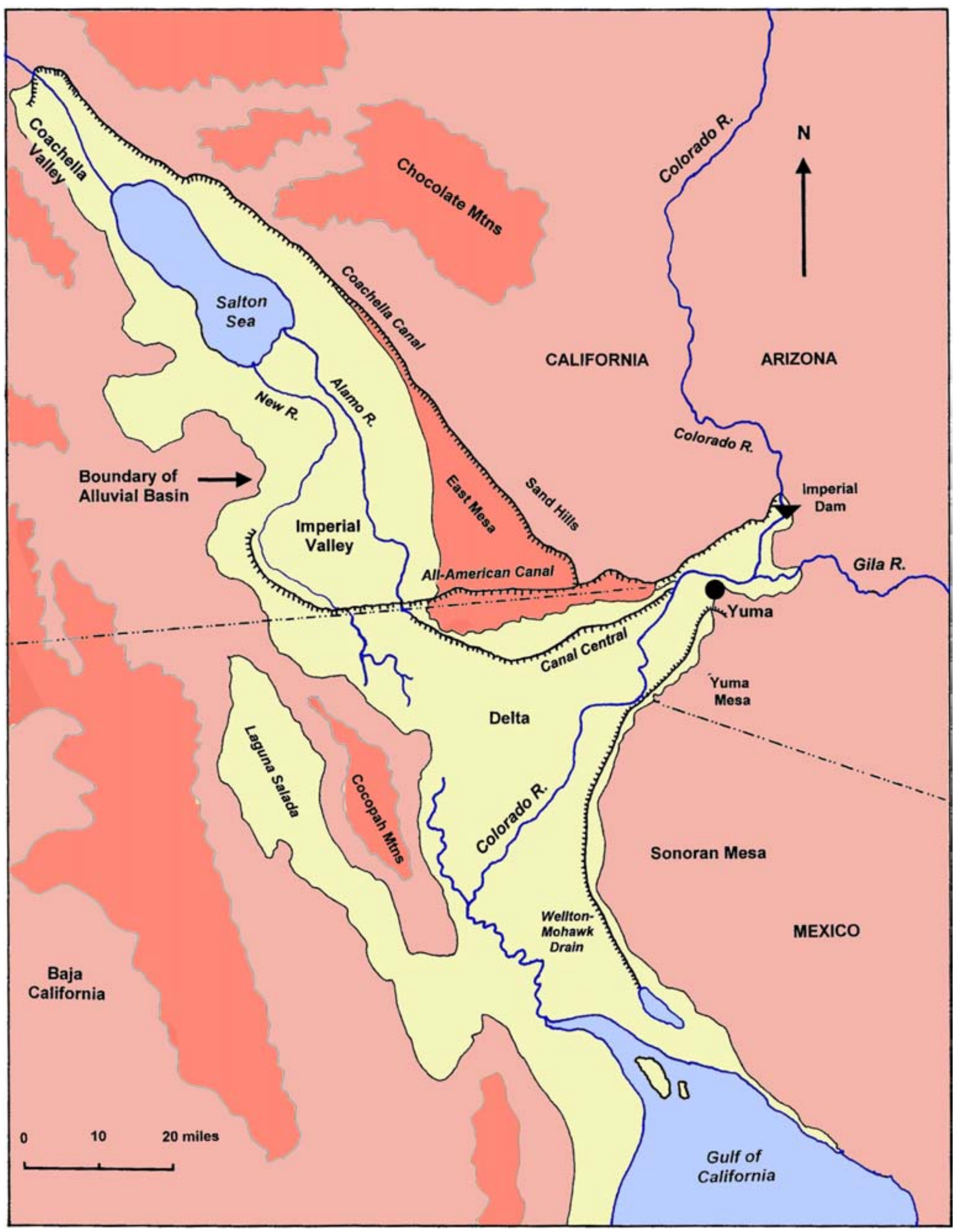


Figure 3. The Colorado River Delta and Imperial Valley

of this flood was a function of the precipitation over the mountains and was highly variable in volume from year to year. Sporadic floods have also been recorded in every other month of the year as a result of localized thunderstorms over some portions of the Colorado's drainage basin. These storms might only have increased the flow in one of the tributaries to the Colorado, but as the floodwaters rushed into the main channel, the flood plains along the Lower Colorado were usually inundated. The average annual discharge of the Colorado is about 14 MAF, but the recorded low was 5 MAF while the record high was 25 MAF.

Unlike the Nile, which has no tributaries within the boundaries of Egypt (nor for the last 1,600 miles of its length), the Colorado receives inputs of water throughout its course. Over 85% of its volume usually comes from the upper basin: that is, from the Upper Colorado, the Green and the San Juan Rivers. After passing into Arizona, it receives water from the Little Colorado, the Virgin, the Bill Williams and the Gila Rivers. On average, these contribute less than 15% of the river's annual discharge, but sporadic thunderstorms that commonly occur in December, January, or February over the huge Gila River Basin (equal to 23% of the entire Colorado drainage basin) can produce devastating floods. In 1916, for example, the Gila River discharge alone was 4.5 MAF of water.

For over two-thirds of its length, the Colorado River is confined to very narrow, high-walled canyons. The rest of the time it flows through a series of basins and narrow valleys in which it has deposited sediments that have formed fertile floodplains suitable for farming. These plains were always subject to frequent flash floods. Eventually, residents of these flood-prone areas, as well people throughout the Colorado Basin and beyond—who envisioned power generation and a reliable source of water for irrigation and cities—prevailed on Congress to begin building a series of dams.

Hoover Dam was the first "high" dam to be built on the Colorado River. Completed in 1937, it provided effective flood control for the lower Colorado basin. It also ensured a reliable source of water year round. This reliable source permitted more acres to be planted since cultivation must either be geared to the lowest flows or suffer the effects of periodic droughts. Stored water also meant that southwestern municipalities had a predictable volume of water for domestic and industrial use and could plan their growth accordingly.

Hoover Dam was designed to generate a large amount of electrical power. This was sought after to light cities, but its chief value was for pumping water from the river over intervening mountains to the cities of southern California and central Arizona. Revenues from the sale of power eventually repaid the U.S. government for its entire outlay to build the Hoover Dam. Additional dams have been built on the Colorado and on many tributaries throughout the Colorado River basin to provide additional flow management and local water and power sources.

In both Egypt and the American Southwest, a year-round and predictable supply of water, combined with a warm-to-hot climate, allows farmers to grow a wide variety of crops. The emphasis today is not on products for local consumption as it was in the past but on high-value fruits and vegetables for export to metropolitan areas and abroad. Unfortunately, farmers in both countries now face similar problems: intensive irrigation in a hot, arid environment often results in a rising water table and increased salinity of the soil. Only careful management practices involving adequate drainage and water applied to meet the minimum plant requirements can prevent these problems. Curing the waterlogging and salinity crises after they occur is costly, if not impossible.

The High Dam at Aswan and those on the Colorado River retain the sediments carried by the rivers. The build-up of silt behind the dams will limit their useful lifetimes. It also deprives the fields downstream of their annual deposits. Many writers have deplored this loss, but a closer look at the facts may surprise many readers. For example, the fertility of the Nile silt has often been overestimated. Analysis of the Nile silt has shown that it did not exceed either the quantity or nutrient value of sediments of various French rivers with which it has been compared. In fact, the nutrients supplied by the annual Nile flood were barely enough to support the single, annual winter crop. Once perennial irrigation with multiple plantings per year was instituted in the early 1900s, it became necessary to supply artificial fertilizers.

In one way, the trapping of the silt behind the dams—both in Egypt and the American Southwest—benefits the farmers who use the irrigation water. When the river water carried heavy loads of sediment, much of that sediment was deposited in the irrigation ditches before the water reached the fields. Each year, many man-hours of labor were required to clear these ditches so that the water could flow to the fields unimpeded. For example, in 1879 in Egypt, records show that nearly 120,000 villagers worked for 150 days to excavate almost 38 million cubic yards of soil from canals.

Although the annual discharge of the Colorado River is only one quarter that of the Nile, the sediment load carried by the American river was about ten times as great. This huge quantity of silt created enormous problems. Prior to the construction of Hoover Dam, farmers in the Imperial Valley were spending today's equivalent of about $21 per acre simply to dispose of silt that deposited at the heads of their canals.

THE DELTAS

About 20 miles north of Cairo, the Nile passes out of its cliff-bounded valley into the broad triangular area known as the Delta. This term was coined by the Greek historian, Herodotus (around 450 BCE), because of the similarity in shape between the triangle of land and the Greek letter, δελτα (Δ). The term has since been applied to similar formations of alluvial sediment at the mouths of other rivers regardless of their shape.

Deltas generally have a low gradient, and the river tends to breaks into a number of meandering branches. Since the water moves slowly in these branches, much of the sediment settles in the channels, which rise higher each year. When floods come, the water tends to break through the sides of the channels and seek new routes at a lower level. As a consequence, the paths of the distribution channels change frequently. Today there are only two Nile branches in the Delta whereas ancient Greek and Roman writers described seven. During the floods, more sediment is deposited on the surface of the delta, raising its level.

The Egyptian Delta contains 8,494 square miles of land compared to 5,019 square miles in the Nile Valley. Except for the brackish lagoons and dunes along the Mediterranean, the region has always been intensely cultivated. Today its agricultural potential is threatened by the high salinity of the irrigation water which is charged with runoff from Upper Egypt and industrial pollution. Nearly all the river water is diverted into irrigation canals, and only a little runoff reaches the Mediterranean through either of the two Nile distribution channels. The situation is similar in the United States: essentially none of the water of the Colorado River now reaches the Gulf of

California. Mexico diverts all that crosses the international border for irrigation and for domestic use in Baja Californian cities like Mexicali and Tijuana. The formerly lush Colorado Delta has become a barren, salt desert.

The irregularly-shaped Colorado River delta lies at the narrow upper end of the Gulf of California (Figure 3). It is about 160 miles in a NW-SE direction and 60 miles in the longest NE-SW direction; its total area is 3,325 square miles.

The topographical situation in the Colorado delta is very different from that of the Nile. The Nile encounters no obstacles where it enters the Mediterranean Sea and has thus formed a very symmetrical, fan-shaped delta. The Colorado River entered the east side of the original Gulf of California basin about 115 miles from its northern end through a valley with high mesas on each side. On the west side of the Gulf, directly across from the mouth of the Colorado, are the Cocopah mountains. This range limited the westward spread of the Colorado Delta and influenced the routes of the distribution channels.

The river's abundant sediments probably first formed a bar across the original, longer Gulf in line with the mouth of the Colorado. This bar isolated the upper portion of the Gulf and required the river to make a sharp left turn to reach the open ocean. To the northwest side of the bar the isolated segment of the Gulf formed a deep depression. Today this depression is called the Salton Sink and is occupied by the Salton Sea and the Imperial and Coachella Valleys (see Fertile Valleys below).

As discussed above, river channels crossing a delta tend to be unstable and shift often. This has certainly been true in the Colorado River delta. Surveys dating from the 1850s show the main channel running along the east side of the delta beneath the Sonoran Mesa escarpment. This continued through the nineteenth century, but then the channels began moving towards the west. By the early 1900s, irrigation canals were being dug to carry water from the Colorado River into the Imperial Valley. Initially these followed the course of the Alamo River (an old abandoned distribution channel) southwest around sand hills and a mesa, then northward into the valley. Although the canal was lined by levees, these banks were only constructed of silt and they proved inadequate to contain excess floodwaters. In 1905, heavier than usual floods broke through the northwestern sides of the canal and the entire river flowed into the Salton Sink for two years before it was finally controlled and redirected towards the Gulf.

From 1910-1930, continued deposition of silt on the Colorado River delta caused the channels to shift erratically. Human efforts were barely able to contain the flow and it was clear that these efforts could not prevail against a really large flood. The danger of flood damage, combined ironically with the threats from occasional droughts, provided powerful incentives for damming the Colorado River and achieving a long-term solution.

FERTILE VALLEYS

Besides the narrow Nile Valley and the Delta, some of the oases in the Western Desert have been cultivated in the past and represent areas for potential future growth. Reclamation in these areas presents significant challenges. The only source of water in the oases at present is ground water from the Nubian aquifer. Plans to divert Nile water to the oases are moving forward. Since these oases have no external drainage, care will always have to be taken to prevent waterlogging and excessive salinity in the soil.

One depression/oasis differs from the others: this is the Faiyum (or Fayum), which lies 45 miles southwest of Cairo (see Figure 1). The Faiyum is connected to the Nile Valley by the narrow Hawara Channel. This channel enters the depression at the prevailing elevation of the Nile valley or around 75 feet above sea level. Within the Faiyum, the ground gradually slopes downward towards the northwest to a depth of 174 feet below sea level.

Historically, a natural channel called the Bahr Yusef branched off the Nile 200 miles south of the Faiyum and ran along the valley's western escarpment and into the Hawara Channel. At various times during the last million years, higher water levels in the river resulted in the formation of a lake within the Faiyum. Prehistoric stone tools have been found on the former beaches of these lakes. During the Old Kingdom a permanent lake existed in part of the depression. Middle Kingdom kings seemed to have recognized that the Faiyum could play a part in managing the higher-than-average floods of their era and directed that the Hawara Channel be cleared. This permitted excess water to enter the depression during the peak of the floods, thus sparing the Delta. The water then drained back to the Nile after the flood.

By the time of the Ptolemaic kings, flood control was no longer deemed necessary and those rulers began to exploit the agricultural potential of the Faiyum. Irrigation water was carried into the depression by the Bahr Yusef channel and then dispersed by canals across the fields. Gravity conveyed drainage water into the deepest part of the depression along its northwestern margin, and there it collected in Lake Qarun. Ptolemy II (reigned 285-246 BCE) gave parcels of Faiyum land to his Greek and Macedonian veterans. Water wheels were introduced to raise water to fields on the desert edge. Intensive cropping of wheat produced the excess that was exported to Greek cities and eventually to Rome and Constantinople.

Today, the 570 square miles of the Faiyum continue to be among the most heavily cultivated and productive areas in Egypt. The amount of available irrigation water determines the productivity of the land, which can grow several crops each year. Because the drainage water flows into land-locked Lake Qarun, introducing irrigation water faster than it can evaporate from the lake would raise the water level in the lake and inundate nearby fields. In order to increase irrigation without raising the lake level, some of the drainage water is now pumped southward into the Wadi Rayan, an adjacent depression, where it has formed two lakes. Water in the upper lake is still sufficiently fresh that it can be used for further irrigation, and it is pumped to the southern edge of the Wadi Rayan where several desert reclamation projects are underway. Lake Qarun has been stocked with several kinds of marine fish that can survive in its highly saline waters. The lake is now a popular weekend destination for residents of Cairo.

Southern California's Imperial Valley presents an almost exact parallel to the Faiyum. As described above, the Salton Sink (or depression/oasis) was formed when the sediments of the Colorado River blocked off the upper end of the original Gulf of California. The seawater evaporated, but at intervals, wandering distribution channels diverted river water into this depression, which still lies 275 feet below sea level, and formed freshwater lakes. The last of these prehistoric lakes, Lake Cahill, existed as recently as 300 years ago and American Indians lived along its shores.

Because of the deep layers of river sediments deposited in the Salton Sink over the past two million years, the ground is very fertile although the climate is extremely arid and the surrounding land is rocky desert and mountains. The river sediments have also been mixed with wind-blown sand and sediments washed down from the surrounding mountains. Interestingly, more recent Colorado River sediments are not very desirable amendments on fields, as they tend to form a clay surface that inhibits the penetration of water to the soil below. But despite the sediment, the river water is essential for agriculture in this area.

The present Salton Sea (the latest lake to occupy the depression) was formed in 1905-1907 when floodwaters from the Colorado River broke through the banks of the old Imperial Canal and flowed into the Imperial Valley. Damage in the valley was immense. But after the river finally returned to its original channel, the water gradually evaporated and the level of the lake fell. Like Lake Qarun in the Faiyum, the Salton Sea now serves as a popular recreation area and a wildlife refuge.

STATE	ALLOTMENT OF COLORADO RIVER WATER (MAF)	RIVER WATER USAGE IN 1990 (MAF)	POPULATION BY STATE IN 2000	POPULATION INCREASE 1990 - 2000
Colorado	3.105	2.359	4,301,261	30.6%
Wyoming	0.840	0.498	493,782	8.9%
Utah	1.380	0.997	2,233,169	29.6%
New Mexico	0.675	0.548	1,819,046	20.1%
Nevada	0.300	0.177	1,998,257	66.3%
Arizona	2.840	2.294	5,130,632	40.0%
California	4.403	5.271	33,871,648	13.8%
Baja California, Mexico	1.500	1.542	N/A	N/A
TOTALS	15.043	13.686	49,847,795	19.6%

TABLE 2. Water Allotments and Population in Colorado River Basin States and Mexico

POLITICS AND POPULATION

Rivers attempt to flow according to natural forces, but dams can check their progress and treaties can apportion their water. A 1959 treaty between Egypt and the Sudan provides for the distribution of the water (estimated to be 57 MAF) collected annually in Lake Nasser as follows: Egypt is allotted 66%, the Sudan 22%, and12% is lost to evaporation. Egypt's water is entirely dependent on the Nile; it can only increase its supply by drawing on its ground water and aquifers, or by recycling. When the 1959 treaty was negotiated, none of the eight upper basin countries (Burundi, the Democratic Republic of the Congo, Eritrea, Ethiopia, Kenya, Rwanda, Tanzania, and Uganda) depended on the Nile for irrigation or power generation. In each country rainfall was adequate for agriculture. Now these eight countries want to store water behind new dams within their borders for power generation and to divert water for irrigation. Egypt, at the end of the Nile "pipeline," is concerned that some of these plans will reduce its own supply. As a consequence, Egypt is taking the lead in talks among the Nile basin countries. With a population of 70 million (in 2000 CE) and an increase of one million people every ten months, the country cannot afford to lose a single drop of water.

Likewise, population is also increasing rapidly in the states within the Colorado River Basin. The states' allocations of Colorado River water remain fixed, however, according to past laws and treaties.

Faced with growing water scarcity, the states have adopted a variety of responses. Arizona is attempting to "bank" some of its currently-unused allotment by diverting excess water at the end of the Central Arizona Project Canal at Tucson into ponds. Water in the ponds will gradually sink into the ground and replenish an aquifer, which can be tapped at a future date. Trade-offs among the users are also occurring. For example, the Metropolitan Water District of Southern California has contracted to waterproof irrigation ditches in the Imperial Valley in exchange for rights to irrigation water that would be conserved. As some of the oldest users of Colorado River water, farmers in the Imperial Valley have claim to an astonishing amount of water: 3 MAF each year. Competition between agriculture and urban needs will certainly continue since agriculture is a major consumer of water in all the states.

In Egypt and in the American Southwest, geologic and climatic factors, acting over millions of years, have been responsible for the development of the Nile and Colorado Rivers. The two rivers have many parallels in their ancient and recent histories. Their futures may also follow similar paths since in both countries rapid population increases are placing heavy demands on a the limited resource: the amount of water available. In the last two centuries, humans have attempted to supplement or counteract the natural processes using technology. These artificial efforts will probably increase, as the rivers are crucial to the survival of their respective regions. For residents of the two river basins, and even for some of their neighbors, these issues are not merely of academic interest.

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Dr. Bonnie M. Sampsell is a long-time member of the ESS and a frequent contributor to The Ostracon. *Her book,* A Traveler's Guide to the Geology of Egypt, *was published by The American University in Cairo Press in 2003.*

House Of Scrolls

Whose Pharaohs? Archaeology, Museums, and Egyptian National Identity from Napoleon to World War I

By Donald Malcolm Reid

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Readers of Egyptological books are familiar with the discoveries and adventures of the first Egyptologists. Jean-François Champollion, Auguste Mariette, Gaston Maspero, Flinders Petrie ... the list goes on. To a man (and an occasional woman) they were European and, later, American. Their relationships with Egyptians are rarely examined in depth. The Egyptologists directed the excavations; the Egyptians provided the labor.

In *Whose Pharaohs?*, Donald Malcolm Reid shows Egyptologists from the era of Napoleon to World War I in a rather different light, that is, their perception of and reaction to Egyptians who aspired to study their pharaonic heritage.

Today it seems unthinkable, yet at one time Egyptians were hard-pressed to find schools in Egypt to learn hieroglyphs and other skills essential to Egyptology. The director of the antiquities department was French, and Egyptians lived in the shadow of the British Empire. Not until the 20th century did Egyptian Egyptologists find acceptance in the science of deciphering their own ancient past.

How things have changed. The Supreme Council of Antiquities' (SCA) Secretary General, Zahi Hawass, is probably the most visible Egyptologist today and a National Geographic Explorer in Residence. Every year, Egyptians train at the ARCE Field School. Egyptian teams excavate ancient sites and publish and speak alongside their foreign colleagues.

In *Whose Pharaohs?*, Reid shows readers the other side of the development of Egyptology, its effect on the growth of tourism and its entanglement with Egyptian and European ambitions. *Whose Pharaohs?* is ideal reading for anyone interested in the ramifications for a society when politics, archaeology and nationalism collide.

The tale of Napoleon's scientific expedition has been told many times and need not be repeated here. Reid mentions notable Western Egyptologists such as Flinders Petrie, but his focus is on the development of Egyptian Egyptology and how foreign control of Egypt's past helped give birth to Egyptian nationalism.

The earliest Egyptian pharaonic scholars, such as Rifaa al-Tahtawi and Ahmad Kamal, endured treatment as second-class citizens by their Western peers, who literally carted away their past to distant museums and private collections. Egypt was in the grip of a gold rush fueled mainly by European museums and collectors.

Cultural and religious differences, as well as different perceptions of the past, further widened the gulf between Western and Egyptian scholars. Egyptian culture and perceptions were reduced to stereotypes and overshadowed by the all-encompassing behemoth of Orientalism, a Western creation.

Eventually the likes of Petrie, Howard Carter and George Reisner began to supplant treasure hunters masquerading as archaeologists. While this development benefited Egypt's heritage, it did not necessarily benefit contemporary Egyptians. For example, until the 20th century, Egyptians might aspire to be a reis, but not the excavation director.

Reid deftly ties together Egyptian and Western nationalism, tourism and colonialism to demonstrate how they shaped the Egypt and the state of Egyptology we know today. The furor over Tutankhamun's tomb marked the beginning of the end of Western domination of Egyptian antiquities. Rather than allowing the traditional 50-50 split between excavator and government, the Egyptian authorities claimed the entire contents. Carter, Lord Carnarvon and the West in general may have felt that the nationalist movement was the real curse of the pharaohs, but it was the first step in Egyptians' achieving what Western nations took for granted—equality with other nations and control over their past. Reid also devotes chapters to the study of Egypt's Coptic and Islamic heritage.

One might have a sense of déjà vu in light of the media coverage of Hawass' efforts in recent months to recover legally and illegally acquired antiquities. And Egypt and Egyptology still collide. Today, the discipline is as mired in politics, nationalism, tourism and international relations as it was when the French had to surrender the Rosetta Stone to the British in 1802. Witness the controversy over the bust of Nefertiti and the artists who temporarily joined it to a modern statue in the name of art.

This is not a tale of good versus evil; rather it is a recounting of individual and national ambitions and rivalries tempered by an Egyptian perspective. Reid gives a voice to the earliest predecessors of Hawass, Fekhri Hassan, Farouk el-Baz and other Egyptian Egyptologists; he places them in the context of an ancient land struggling to find its identity and sovereignty in the modern world.

–Susan Cottman