

The Akhet environment depicted by the Pyramid Texts – A comparison to the Atlas Basin hydrology during the Green Sahara time

Abstract

The Pyramid Texts contain vivid, specific, and consistent details of the Akhet and its surrounding lakes, canals, and farmlands. This became obvious through a climate change study which found a match between these details and the hydrological profiles around the two terminal megalakes in the Atlas Basin during the green Sahara time.¹ This insight provides a key to decipher many obscure words in the current English translations. It also helps pinpoint the scattered environmental descriptions in the Pyramid Texts into a coherent portrait. This paper examines the relevant original hieroglyphs in the Pyramid Texts against their corresponding transliterations and English translations. The newly identified geographical traits in the Pyramid Texts fit together to form a more complete picture of the Akhet environment. The evidence for the lineage of the Pyramid Texts to the Atlas Basin is clear and overwhelming. This is important not only for the origin of Egyptian civilization but also for the start and expansion of the desert Sahara.

Keywords: Akhet, Atlantis, Atlas Basin, desertification, Field of Reeds, green Sahara, Pyramid Texts, Sun Disk, water cycle

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Introduction

The Pyramid Texts (PT) are the earliest known ancient Egyptian religious writings about the afterlife and the oldest representatives of Egyptian literature.² They were engraved onto the subterranean chamber walls of pyramids at Saqqara in Lower Egypt. The Texts laid the foundation and core structure for the Egyptian religion, which later evolved and had far-reaching inspirations.

The hieroglyph Akhet (𓆎 or 𓆏, *ꜥḫt*, meaning “place of becoming effective”) is generally translated as “horizon” which blanks its original true identification. The Pyramid Texts portray the Akhet as the gate between the Duat and the Sky, a focal point of the ancient Egyptian religion. It is the place where the deceased becomes akh with the Sun. His akh will rise from the Akhet with the gods to the Sky (PT217:3-4). The afterlife includes a journey through the Field of Reeds to join the gods, specifically the Ennead from Heliopolis and their associates, exclusive of gods from other cults. Then, the deceased experiences a perpetual rebirth everyday with the Sun at the Akhet. The Pyramid Texts describe a process of afterlife in a specific and vivid environment with great details – although scattered in various spells – of positions, shapes, depths, colors, temperatures, connections, flows, inundation events, and vegetation transitions of the water bodies as well as the human activities of religion, irrigation, farming, and ferry around the Akhet. These geographical and hydrological details are very consistent and systematic. They do not seem like pure fiction but rather seem to be from a real environment foreign to Egypt. Then, the question is: where and when does this environment correspond to?

Based on water cycle stability and paleoclimate data, I reconstructed the desertification process of the green Sahara.³ The breach point of the green Sahara is the Atlas Basin, which is in the rain shadow area of the Atlas Mountain range in today's East Algeria and South Tunisia (see insert of Figure 1). About 5700 years ago, the water cycle in this standalone catchment collapsed. The water surface areas of the two terminal megalakes shrank rapidly, and the precipitation decreased sharply. Due to the low evaporation, the strong rain shadow effect of the Atlas Mountain range became fully active. Desert formed immediately in the Atlas Basin and gradually expanded to the south

and east, spreading like wildfire powered by the westerlies and trade winds. This chain reaction also includes synchronous desertification and aridification in West Asia and the Mediterranean region. The Sahara expansion forced people in North Africa into the Nile Valley. The population shift gave birth to the Pharaonic Egyptian civilization shortly after the end of the green Sahara.

The understanding of the hydrology and water cycle stability in the Atlas Basin led to the identification of a site, which resembles Plato's Atlantis at the outlet of the canal connecting the two terminal megalakes in the basin.⁴ Shortly afterward, I came across the English translation of the Pyramid Texts. The descriptions of the Akhet and its surrounding water bodies in the Pyramid Texts match perfectly with the physical environment around the terminal megalakes of the Atlas Basin before the end of the green Sahara.¹ Then, I started to learn hieroglyphs and study the original Pyramid Texts. Again, the paleo-environmental knowledge helps identify the exact meanings of many hieroglyphic words, which leads to improved interpretations and provides much richer matching details.

This paper will pinpoint the details of the Akhet scene scattered in the Pyramid Texts and compare with the Atlas Basin environment during the green Sahara time. Wherever needed, the original hieroglyphs and their transliterations are presented with discussions on the revised English translations. The primary quotes in this paper are from Allen's *The Ancient Egyptian Pyramid Texts* (2nd ed).² The revisions are parenthesized as **bold face** following the underlined words to be modified. The six volumes of Allen's *A New Concordance of the Pyramid Texts* provide a comprehensive collection of the original Pyramid Texts and the corresponding transliterations.⁵ In this concordance, the same spells from different pyramids (often with variations) are listed side-by-side for comparison. This collection is a tremendous resource for studying the Pyramid Texts and examining the corresponding transliterations and English translations. Allen's books include Texts found in the pyramids of Unis, Teti, Pepi I, Merenre, Pepi II, and Neith, spanning from ca.2353 to 2152 BCE. The quotes in this paper are tagged with the same spell and verse numbers adopted by Allen.⁵

Figure 1 shows the layout of the two terminal megalakes of the Atlas Basin. Water from the western lake flowed to the eastern lake, which further discharged to the Mediterranean Sea if there was a surplus. The water surface areas correspond to 24 meters above sea level. The Pyramid Texts depict a vibrant and rich aquatic ecosystem around the Akhet. Lakes, canals, and farmlands were connected to the

Akhet. Different epithets were given to each water body to reflect its specific characteristics and functions. In Figure 1, the water bodies are matched with the epithets identified from the Pyramid Texts by analyzing the related recitations and contexts in the entire Pyramid Texts. The following sections will give comparisons and explanations for each of them.

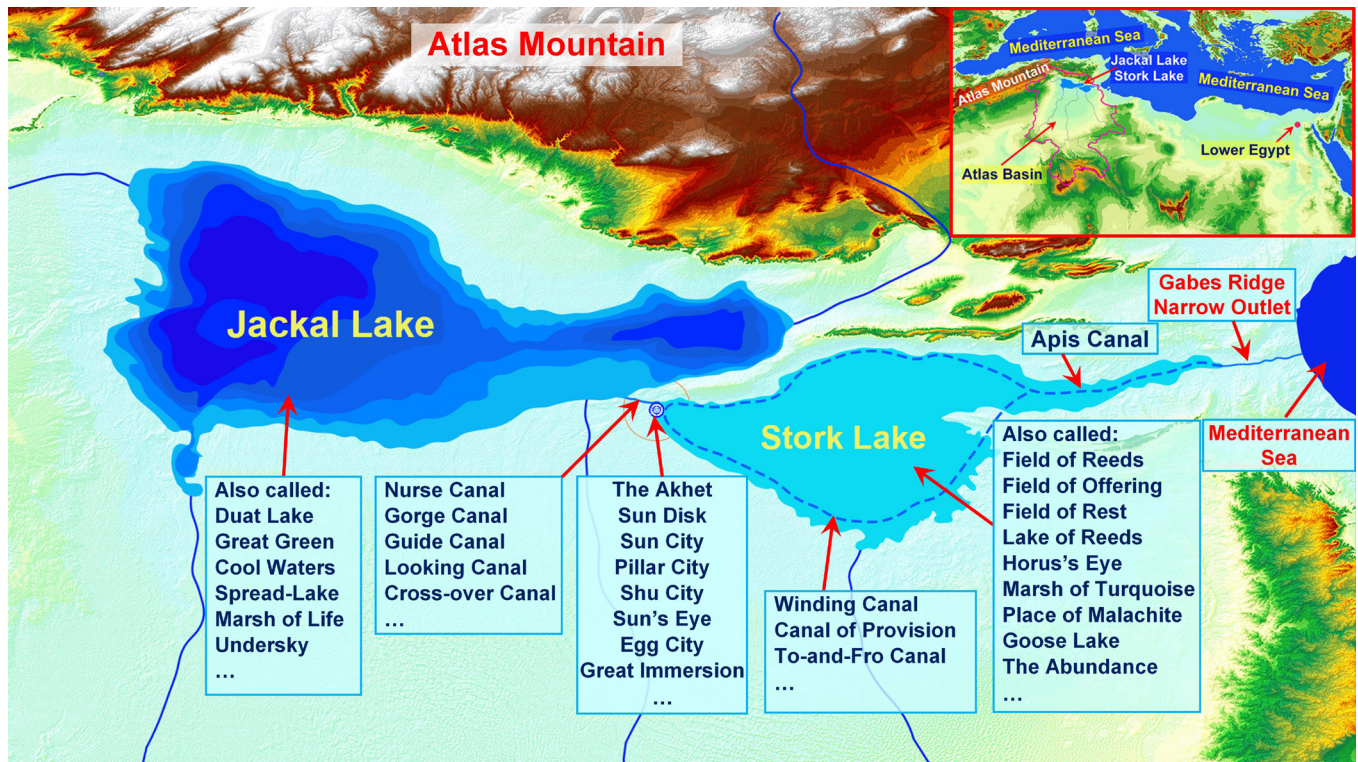


Figure 1 Characteristic names found in the Pyramid Texts matched to the water bodies in the Atlas Basin during the green Sahara time.

The Akhet profile and function

The Akhet was a water city

Akhification is a process of joining the Sun and Horus at the Akhet (Horakhty) and becoming akh (PT664C). The deceased receives his abundant provisions from the Field of Reeds (PT437:43), becomes clean with the cool water from Jackal Lake (PT222:32), and is given a new birth at the Akhet (PT264:5-9), which is the gateway of this afterlife process. In the Pyramid Texts (PT), many characteristic details about the Akhet are provided in the descriptions of the akhification process. For examples, the Akhet has gate (PT220:1, 246:12), wall (PT683:4), palace (PT357:8), dual shrines (PT579:5), throne (673:5), pillars (PT324:16, 515:5), ruler and elites (PT254:4, 273/274:46 and 50), green fields (PT317:5), lakes (PT222:32), canals (PT767:20), and shores (PT317:6). It is connected to the Cool Waters (Duat Lake) (PT246:12) and the Field of Reeds (PT265:5-9). One can reach the Akhet by boat (PT263:3-4) and row around it (PT407:4-5). The Akhet is the place where the gods are born, and the Ennead are the principal gods (PT246:13) including Atum, Shu, Tefnut, Geb, Nut, Osiris, Isis, Seth, and Nephthys plus Horus. The Akhet hieroglyph has an “island” determinative, . All these attributes portray a water city surrounded by canals and lakes, like Venice, Italy – the City of Canals. It was also a sovereign state or a kingdom. The Papyrus of Ani clearly says that

the Akhet is a city: “He (Ani) cometh into his city. What then is this [city]? It is the Akhet of his father Atum.”⁶

The afterlife described in the Pyramid Texts is a recurring process with the solar cycle. The deceased emerges with the Sun from the Akhet, which is on the eastern side of the Sky, every morning after going through the underworld (Duat Lake) (PT473:9-10):

I emerge on the eastern side of the sky where the gods are born, and I am born as Horus, as He of the Akhet.



Based on PT697:3-5, the Akhet is located on the east side of the Duat Lake, which is the underside of the Sky (Nut). “The eastern side of the sky” or “that eastern side of the sky” (*gs pfiꜣbti n pt*) is a synonym of the Akhet by comparing PT264:5-7 and PT266:5-7. The deceased can also be ferried to the Akhet from the Field of Rest through the Winding Canal to join the Sun. The Akhet is located on the west side of the Field of Rest (or Field of Reeds) as described in PT613:17-19:

So, Hedjedj, ferryman of the Winding Canal, come to me [and] fetch me the ferryboat, that I may cross in it to the Field of Rest, [put] myself on the west side of the Field of Rest behind the two great gods, and hear what they say to me.

From the contexts, we know that the “two great gods” are Shu and Tefnut who reside in the Akhet. The Akhet is the gate (or stairway)

for the deceased to rise to the Sky (PT610:29). The trip from the Duat Lake to the Akhet is a short distance ferry (PT263:3-4):

The sky's two reedfloats are placed for me, that I might cross on them to the Akhet, where the Sun (Sun Disk) is: the sky's two reedfloats are placed for me, that I might cross on them to where Horus of the Akhet is, to where the Sun (Sun Disk) is.



The Pyramid Texts always use  (*d3*, ferry across) for the ferrying between the Duat Lake and the Akhet, implying their close vicinity with each other. In this recitation, the “Sun” () could be replaced with the “Sun Disk” (*itn*). Explanations will be given later.

PT673:1-8 report about the honors the king receives in the Akhet. The scene includes the dual shrines, the bronze chair in front of the shrine as Geb's throne, being welcomed by the Dual Ennead who come to the king in obeisance, and obtaining the kingship over the people of the Sun City:

Oh, my father! It is your time for going. Go off as a god and you will be conveyed as one of the Cool Waters. Your envoys go, your hurriers run, going forth to the sky and saying to the Sun that you have stood up in the Akhet's dual shrines upon the void (in the mighty Shu City). You sit on your father Geb's throne in the fore of the shrine, on the chair of metal at which the gods marvel, and the Dual Ennead come to you bowing and you govern humanity (the Sun-Folk).

The replacements “in the mighty Shu City” and “the Sun-Folk” will be explained in the next section, where we will also know that the Shu City and the Sun City are the same place of the Sun Disk. PT407:4-5 clearly state that one can row his boat around the Akhet:









The crew who row the Sun, they are the ones who will row me; and the crew who conduct (revolve) the Sun around the Akhet, they are the ones who will conduct (revolve) me around the Akhet.



According to Budge,  (*pšr*) means “revolve” or “make a circuit.”⁷ This indicates that there is a circular canal surrounding the city. Furthermore, PT767:20 clearly says that “this Circular Canal” ( *mr-šnw-nw*) is located “on the lips of the Winding Canal.”




The Eroded Ring Island

PT366:7-12 contain rich details about the layout of the Akhet (and the Sun Disk):

Your sisters Isis and Nephthys come to you, making you sound – very black in your identity of the Great Black Wall, very green in your identity of the Great Green. Look, you have become great and round, as the Great Round (Ring Island). Look, you have become encircled and round, as the circuit (Circular Canal) that surrounds the External Isles. Look, you have become round and big, as he who surrounds the Big Waters That Perish (Great Eroded Island).

The “Great Black Wall” is likely to be the wall surrounding the citadel in the Akhet. The Great Green (Duat Lake) is connected to the waterways of the Akhet. “The Great Round”  (*šn-wr*, great ring) has an “island” determinative, . Therefore, it should be translated as “the Great Ring Island.” The “circuit” ( or , *dbn*) has a Sun Disk determinative, . It must be the Circular Canal mentioned earlier. The Circular Canal surrounds “the External Isles” (, *h3-nbwt*). “The Big Waters That Perish” is not an accurate translation for  (*3-sk*).  (*sk*) means “wipe” or “sweep.” With a

“water” determinative () it becomes obvious that *sk* means “erode.” Due to the “island” determinative for “the Great-Erode,” *3-sk* should be translated as “the Great Eroded Island.” Comparing the last two verses of the above quote and PT718:22-23 below, “the Great Eroded Island” and “the External Isles” must refer to the same place. “The External Isles” must be a result of long-time water erosion of “the Great Ring Island.” Corroboration can also be found in the inscription on the Thutmose I's Victory Stela, where “the Isles of the Great Ring Island” (, *iww šn-wr*) are mentioned.⁸

 (*šnt šn-wr*) appears in the Victory Hymn of Thutmose III. Breasted translates it as “the circuit of the Great Circle.”⁹ Since *šnt* has an “island” determinative () and *šn-wr* has a “canal” determinative () it can be better translated as “the Ring Island of the Great Circular Canal.” This “Great Circular Canal” clearly originated from the “Circular Canal” described in the Pyramid Texts, which “surrounds the External Isles.” However, *šn-wr* has generally been mistaken as “ocean” in most Egyptological studies and dictionaries.^{10, 11} As shown above, when *šn-wr* has an “island” determinative it represents the “Great Circular Island” or “Great Ring Island.”

The above PT366 spell is found in pyramids of several pharaohs including Pepi I, Teti, Merenre, and Pepi II. Coherent messages are also contained in other spells such as PT454, 593, and 718. All of them clearly describe that the Circular Canal (the circuit) encircles the External Isles:

Osiris Pepi, you have become great and round, as the circuit (Circular Canal) that goes around the External Isles. (PT454:3)

Your sister Isis has taken hold of you, having found you very black in your identity of the Great Black Wall. You have encircled everything inside your arms in your identity of the circuit (Circular Canal) that goes around the External Isles, having become big in your identity of the Big Waters That Perish (Great Eroded Island). (PT593:11-14)

Ho, Osiris Neith! You are the great god, elder (great) and round as he who (the Circular Canal that) surrounds the External Isles. (PT718:22-23)

The circular island city encircled by a man-made circular canal is a unique geometrical feature. Nothing like this has been found in Egypt. However, this special feature strikingly resembles the surface profile at the outlet of the canal connecting the two megalakes in the Atlas Basin during the green Sahara time (as shown in Figure 1). In the close-ups shown in Figure 2, (a) is the surface image from Google Earth, (b) is the ground profile for the same area based on the Global Digital Elevation Model (GDEM).⁴ A central round island and a crescent-shaped external island are clearly visible. They are very likely to be the remains of a ring island and a central island after long-time erosion due to the surrounding water flow from the western lake to the eastern lake. Figure 2 (c) shows the likely water flow around the central island and the eroded ring isles right before the end of the green Sahara. After the start of desertification about 5700 years ago, the water flow stopped, but wind erosion and sand accumulation continued to make changes to the surface profile until reaching the status we see today.

Based on the Pyramid Texts description, it is reasonable to imagine that the original ring island was a more complete structure surrounded by the Circular Canal. Due to water erosion over several thousand years, the canal gradually widened the openings of the ring island and eroded it into several isles. Therefore, “the Great Ring Island” and

“the External Isles” correspond to different stages of the long-time erosion. The estimated outside diameter of this ring-island structure is about 3700 meters, the same size described by Plato for Atlantis.⁴

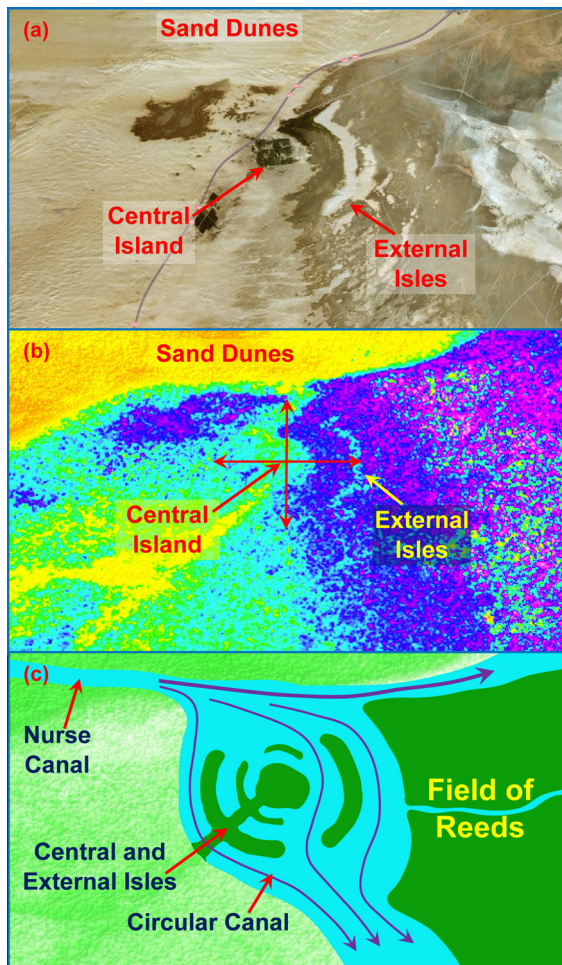


Figure 2 Identified site in Atlas Basin matches all the Akhet details: (a) current surface image from Google Earth; (b) ground profile based on GDEM; (c) likely water flow during the late green Sahara time.

The Akhet concept in the Pyramids

Khufu's pyramid – the largest Pyramids on the Giza plateau – is the Akhet of Khufu (𓆎𓅓𓏏𓏏, *shu hufu*). In most of the pyramids built from the end of the Fourth Dynasty to the end of the Sixth Dynasty, the subterranean chambers have a uniform plan. As shown in Figure 3, the antechamber (Akhet chamber) is situated to the east of the burial or sarcophagus chamber (Duat chamber). Allen found functional similarities between the layout of the chambers and the arrangement of the spells on their walls, being consistent for all pyramids during this era.¹²

The Akhet serves as the stairway for the deceased to join and continue the solar cycle between the Duat and the Sky (PT619:7). The spells for joining the gods the first time were inscribed on the south-west walls of the Akhet chamber. PT254 vividly describes this exciting beginning of the afterlife by entering and rowing through the Field of Reeds to the Akhet. The king pleads to the lord of the Akhet to make a place for him (PT254:4). The Apis Canal is dammed at the outlet so that his boat can be rowed into the Field of Reeds where he is welcomed by the beautiful West (PT254:21-25):

Look, she is coming, the beautiful West, to meet you, to meet you with her beautiful tresses, and she is saying: “Welcome, you to whom I gave birth, with rising horn, eye-painted pillar, bull of the sky: your form is distinguished; pass in peace, for I have joined you” – so says the beautiful West about Unis.

The king receives his purification, rejuvenation, and provisions from the Field of Reeds (or Field of Offerings), which is located on the east of the Akhet. Probably for this reason, the east wall and gable of the Akhet chambers of the pyramids are covered with spells for offering, nourishment, and cleansing (PT406:3-6). Also, the spells against the inimical beings are always found on the east wall of the Akhet chamber. This may reflect the dangers on his journey to the afterlife, especially before reaching the sacred land.

The exact function of the isolated Serdab chamber of the pyramids is not clear to Egyptologists, especially about the tripartite structure. The spells in this area are all related to offerings such as foods, drinks, clothing, eyepaint, censuring, and anointing. Obviously, this is the connection to the Field of Reeds, the source of the provisions for the afterlife. Later we can see that the tripartite structure of the Serdab may represent three canals leading to the Field of Reeds.

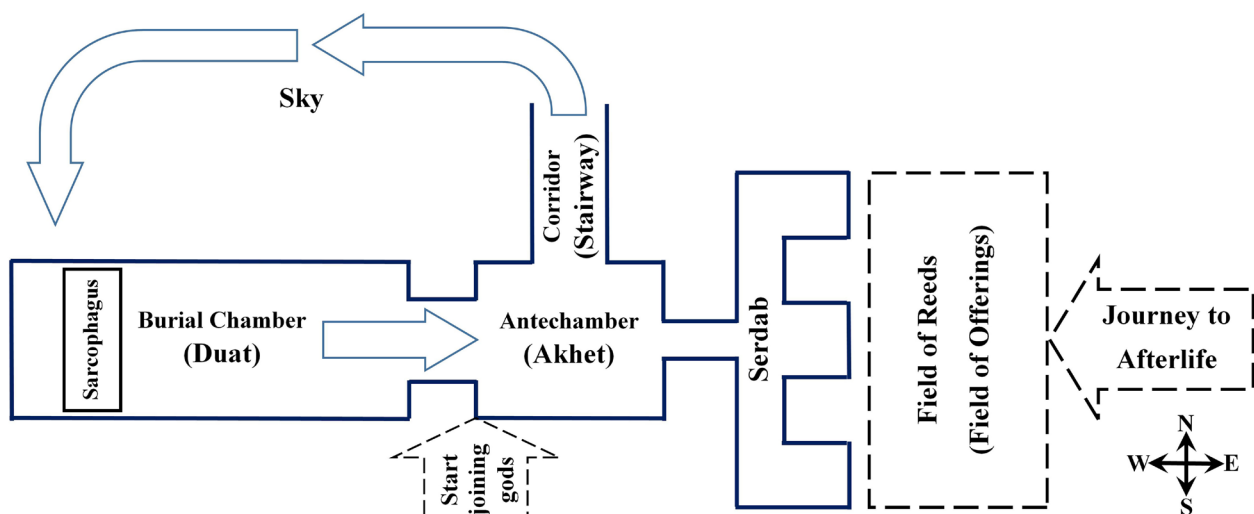


Figure 3 The Akhet concept manifested in the Pyramids.

His mother the sky bears him alive every day like the Sun: he appears with him in the east and goes to rest with him in the west; his mother Nut is not void of him every day.

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Humanity (The Sun-Folk) will cry out to you once the Imperishable Stars have raised you aloft. (PT214:11)

Humanity (The Sun-Folk) have witnessed me. (PT262:28)

Greetings, Great Flood, cupbearer of the gods and leader of humanity (the Sun-Folk)! (PT344 (348):1)

The Mooring-Post cares for you, humanity (the Sun-Folk) calls out to you. (PT463:3)



Ho, Pepi! You are at the fore of the houses of the great ones in Heliopolis...you have grabbed (control of) humanity (the Sun-Folk). (PT535:22...24)






I lift my arm toward humanity (the Sun-Folk), and the gods come to me bowing. (PT509:18-19)



I have come for you as Horus's messenger, for he has installed you, father Osiris Nemtiemzaf Merenre, on Sun Atum's throne, that you may lead humanity (the Sun-Folk). (PT606:8-10)

I grasp by the hand him who is over humanity (the Sun-Folk) [...], he whom the Dual Ennead blesses [...] the sunlight (Sun City). (PT766:7-8)

[Your grasp is taken by the sunlight (at the Sun City)] and humanity (the Sun-Folk) are given to you. (PT716:6)

In the Pyramid Texts, almost all hieroglyphic words with the determinative  have a meaning related to the Sun City (Sun Disk). The PT409:1 translation by Allen is "I am the bull of light." Here  (*psdt*) is interpreted as "light," while its true meaning is "the Ennead of the Sun City" or simply "the Ennead." Same errors can be found in the translations of PT293:6, 383:3, 501A:1, which will be shown later with other corrections.

PT254:8 from Unis's pyramid is  (*sr hnt pr psdt h' wr*). Allen's translation for this verse is: "The pelican will prophesy, the Sunshine-bird will come forth, the Great One will stand up." The corresponding verse from Teti's pyramid has some variations for the same hieroglyphic words: . Here, there is a "town" sign, , following "marsh" (, *hnt*) and a  determinative for *psdt* (Ennead). Therefore, these two versions can corroborate for a better translation: "The Marsh Town will announce, the Ennead will come forth, the Great One will stand up." This "Marsh Town" could be a place in the Field of Reeds close to the Sun City, or it could be the Sun City itself.

In the Pyramid Texts, another frequent word with  determinative is  (*psd*). Allen translates it as "shine," which is probably not far from the true meaning. Examining all its uses, we can find that this word is always related to the Sun Disk and has a meaning of "be reborn" or "renew," e.g.:

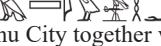
When I set in the west, those of the Duat follow me; when I shine anew (am reborn) in the east, he who parted the two contestants comes to me in obeisance. (PT257:9-10)




I shine (am reborn) in the east like the Sun and proceed into the west like the Beetle. (PT467:7-8)

Should you delay fetching it (the ferryboat)...the Sun will not shine forth (be reborn) from the Akhet. (PT613:20...23)

The Shu City

Shu is the god who supports the Sky. He and Tefnut are called the great gods of the Sun City (PT670:41). In the Papyrus of Ani, Shu is

called "the chief of the Akhet."⁶ In several recitations of the Pyramid Texts, it is obvious that Shu also represents the place he rules on, namely the Sun Disk. Therefore, the Sun Disk was also called "the Shu City." PT261:5 from Unis's pyramid says: "I traverse Shu (the Shu City), travel the horizon." The corresponding verse of the same spell from Pepi I's pyramid draws an equivalence between the Shu City and the Sun City: "[I traverse] Shu (the Shu City), travel the sunlight (Sun City)." PT259:9 from Teti's pyramid says: "He is off to the sky, he is off to the sky, from the Shu City together with the Sun Disk."  (*m šw hn' itn*) can be translated as "from the Shu City together with the Sun Disk." *hn'* means "together with." This makes it clear that the Shu City and the Sun Disk are the same place.


In PT509:5, "Shu's walls" clearly means "the walls of the Shu City": "I travel across the fierce lake, one who topples Shu's walls (the walls of the Shu City)." Similarly in PT222:32, "Shu's lakes" means "the lakes of the Shu City" which is together with the Akhet: "You become clean in the Akhet and release your cleaning in Shu's Lakes (the lakes of the Shu City)." In PT*767:9,  (*šw*) cannot be translated to "void" but means "the Shu City": "So raise yourself and sit on the void (Shu City)." Same for PT673:4: "You have stood up in the Akhet's dual shrines upon the void (in the mighty Shu City)." Allen translates  as "upon the void" (*hr šw n ht*).² Here,  (*nht*) should be together as one word meaning "mighty." Therefore, the correct translation of "*hr šw nht*" is "in the mighty Shu City." PT511:5 is a similar expression: "I stand up on Shu (the Shu City)."


About Shu's location, PT484:12 says: "Shu is in the earth's limit under his feet." The Egyptian creation mythology views the earth as surrounded by waters, including the oceans. Shu is Atlas in Greek mythology. The Atlas Mountain is personified as Shu supporting the sky at the limit of the earth with the Atlantic Ocean on its west.

The Pillar City

There were two pillars at the center of the Sun City (or Sun Disk). PT515:5-6 provide interesting information about these two pillars:

I am one who is at the two obelisks (restored pillars) of the Sun (Sun Disk) that belong to the earth, I am one who is at the two dazzling ones (restored whites) of the Sun (Sun Disk) that belong to the sky.

 (*nwy*, brought back) is used after the "two obelisks" and "two dazzling ones." This means that the two pillars were rebuilt or refurbished after long-time weathering, even possible damage due to flooding, which will be discussed later. The restored pillars were probably polished smooth and gave a bright look under the sun.

The hieroglyph for Heliopolis is  (*iw nw*), literally the Pillar City. Heliopolis is mentioned many times in the Pyramid Texts, and it obviously represents the Sun City (Sun Disk). The meanings of following statements would fit perfectly if "Heliopolis" is replaced with "the Sun City" or "the Sun Disk":

You sit on your metal chair and judge them, at the fore of the Big Ennead in Heliopolis. (PT424:8-9)

They have put you, Osiris Pepi, at the fore of the Dual Shrines of the bas of Heliopolis. (PT532:24)

Shu and Tefnut are the ones who guide you when you emerge from Heliopolis. (PT690:20)

You are given the Field of Reeds [by] the two great gods who row you: Shu and Tefnut, the two great gods in Heliopolis. (PT670:40-41)

Paths-Parter parting a path for me, Shu lifting me, the bas of Heliopolis laying down a stairway for me to join with the above. (PT505:5-6)

I sit with my back to the swept area (open side) in Heliopolis; I am taken to the sky. (PT316:2-3)

As explained earlier, the “swept area” is the “open side” on the east of the Akhet. The last quote indicates that the king was sitting in Heliopolis (the Sun Disk) with his back toward the east (the Field of Reeds) and his face to the west (the Sky). In the above verses, “metal chair (throne),” “Dual Shrines,” and “Big Ennead (including Shu and Tefnut)” are all associated with the Sun City (or Sun Disk), which serves as a stairway to the Sky.

Although the hieroglyphic name for Heliopolis means “the Pillar City,” the Greek name “Heliopolis” indeed means “the Sun City,” agreeing with the new insight of this paper which pins the Pillar City and the Sun City together at the same place – the Sun Disk. Did the city Heliopolis in Lower Egypt inherit the same name of the Sun City in the Atlas Basin? We know that it is a common practice for colonists to carry the city names of their homelands to the new frontiers to name the new cities they build. This seems to be the case for Heliopolis and some other cities in Lower Egypt. The religious practices depicted in the Pyramid Texts are all about the afterlife dominated by the solar cycle. The facilitators of the process are the gods from Heliopolis. The gods from other cults such as Amun and Ptah are rarely mentioned in the Pyramid Texts, and no deeds of these gods are given. In such a colonial scenario, the oldest Pyramid Texts ought to contain the purest information about the original environment in the Atlas Basin. Naturally, the original information would be subsequently dispersed and mixed with evermore spells added in the development of the Book of the Dead. This indeed is the trend we observe.

The Sun's Eye

In the Pyramid Texts, the Sun City is symbolized as “Sun's Eye” (𓂏𓂐, *irt r*) or “God's Eye” (𓂏𓂐, *irt ntr*). This is obviously due to its unique eye-pupil shape:

A meal for me, you in the Sun's Eye! A meal for me, you with access to the boat, you in the God's-Eye! (PT207:1-2)

I am a bull with sunlight (of the Sun City) in the middle of his eyes (its eye). (PT319:1)

The sky has fortified the sunlight (Sun City) for me. So, I ascend to the sky as the Sun's Eye, and stand at the eastern eye of Horus by means of which (wherein) the gods' case is heard. (PT523:1-4)

Note that there are two eyes mentioned in the last quote, “the Sun's Eye” and “the eastern eye of Horus.” In PT684:30-32, the Sun Disk is metaphorized as young girl's pupil and is clearly identified as on the bends of the Winding Canal:

I remain more than you beneath the sky's belly, as the young girl's helmsman (pupil) on the bends of the Winding Canal. When I go up to the sky, I use it – this mouth – for you, that the Sun might become perfect every day.

𓂏𓂐 (*sh3t*) has nothing to do with “helmsman” but clearly means “pupil” of an eye.¹⁰ What a beautiful and poetic metaphor for the Sun City! The Winding Canal is like a mouth (see later discussions). Its bends correspond to the western corner of the mouth. The Sun's Eye (like the young girl's pupil) is located right at this corner (see Figure 1).

The Sun's Eye has a similar function as the Sun for afterlife. The king is embodied in the Sun's Eye who ascends to the Sky every

morning and sets into the underworld every evening. During the night, he is conceived as the Sun's Eye in Nut's womb for a rebirth (PT402:4, Teti pyramid): “I am the eye of the Sun that spends the night conceived and is born every day.” This personification is similar as the Egg metaphor below. In the same verse from Pepi II's pyramid, “the eye of the Sun” was replaced with “the eye of Horus.” This may indicate that the Sun's Eye and Horus's Eye are exchangeable as an epithet for the Sun Disk.

In the Pyramid Texts, Osiris is frequently called the Foremost of Westerners whose throne is at the Sun Disk (PT422:12-24). Now we know why Osiris's hieroglyphic name 𓂏𓂐 (*wsir*) has a possessive eye symbol (𓂏) in it. Literally, it is a title meaning the “Throne of the Eye” or “King of the Eye.” The Eye is obviously the Sun's Eye or the Sun Disk. Therefore, the name Osiris means “the King of Sun's Eye” or “the King of the Sun Disk.”

The Egg

PT317:3 gives a clear description about the location of the Sun City with respect to the Sky (Nut): “I came from the thigh and tail of the great goddess in the sunlight (at the Sun City).” The Sun City (Sun Disk) is right at the thigh and tail, the birth outlet, of the great goddess (the Heavenly Cow). Nut (the Sky) spreads herself over the Duat with her head in the west where the Sun sets every evening, and the Akhet on her east side where the Sun rises every morning. The Akhet is the birthplace for the Sun and the gods, and Nut gives birth from the west as stated in PT609:1: “My mother Nut has given birth to me from the west.”

PT517:3-4 point to the Sun City as “that island” (𓂏𓂐, *iw pw*) located in between Nut's thighs: “I am one righteous before that island of land I have swum to and arrived at, which is between Nut's thighs.” “That island of land” (𓂏𓂐, *iw pw n t3*) clearly indicates that the Sun City was an island but connected (or belong) to the land. With the cosmological knowledge people had achieved, the Sun Disk would be naturally viewed as an egg laid by the great goddess Nut. When the Egg is broken (as the Ring Island being eroded into the External Isles looked like), a new life starts (PT516:3): “I am your potter on earth, the breaker of the complete egg, to whom Nut has given birth.” PT669:20-21...28-29 provide more details about the conception and birth processes through the Egg:

“Look, he is tied together; look, he has developed. So, with what can we break his egg?” said the gods...

Look, I have developed. Look, I am tied together. Look, my egg has been broken for me. So, with what can I be made to fly?

PT408:1-5 describe the joyful moment of birth through the Egg:

You night's brood, come, give me birth. You two who conceive by day, extend yourselves and give birth to me, who am in the egg (Egg City). And I, when you have given me birth; and I, when you have reared me – my mind will be expanded (with joy) at the fore of the Duat.

Here, “the egg” (𓂏𓂐, *swht*) has a “town” determinative, 𓂏, which makes it clear that “the egg” is actually “the Egg City,” the Sun Disk, “at the fore of the Duat (Lake).” This detail survived in the later development of the Book of the Dead (e.g., in the Papyrus of Nebseni):⁶

O thou who art in thine egg (Egg City), who showest from thy Disk (Sun Disk), who risest on thy horizon (Akhet), and dost shine with golden beams in the height of heaven, like onto whom there is none among the gods, who sailest above the Pillars of Shu.

This short quote ties the Egg City, the Sun Disk, the Akhet, and the Pillars of Shu together at the same location. The Papyrus of Ani tells that one can “go round about the egg.”⁶ This agrees with the Great Ring Island being surrounded by the Circular Canal as discussed earlier. Budge also noted that “the egg is the Sun (Disk).”⁶ The hieroglyphic name for Isis, 𓆎 (ꜥst), has an “egg” sign. Therefore, like Osiris, Isis is also a title, literally the “Queen of the Egg.” Since the Egg is the Sun Disk, the name Isis means “the Queen of the Sun Disk,” a perfect match to the title of her husband Osiris.

The Duat Lake

The Duat portrayed in the Pyramid Texts is a realm in the west for the dead, the underworld the Sun and gods go every night. It is represented by the Duat Lake (𓆎 𓆎 𓆎 𓆎, *št dwꜥti*) (PT697:3), which is under Nut’s belly (PT437:30). The deceased rows through the Duat as a star with Osiris during the night and emerges in the eastern side of the Sky in the morning, renewed and rejuvenated (PT466:1-4). The following discussions will show that the Duat Lake, Great Green, Jackal Lake, Spread-Lake, Cool Waters, etc. are all corresponding to the same western megalake in the Atlas Basin.

The Great Green

The Great Green (𓆎 𓆎 𓆎, *wꜥd-wr*) frequently appears in Egyptian religious texts and literature. Egyptologists often take “the Great Green” as the Mediterranean Sea or the Red Sea. However, both seas give a deep blue color, which does not fit this name. Of the two megalakes in the Atlas Basin, the eastern lake was very flat and shallow with a water depth in most of its area less than 6 meters, which gave a turquoise color. The western lake was much bigger and deeper with a water depth in its central area about 70 meters. It gave a green to blue color. Therefore, the Great Green was a nickname used for the Duat Lake in contrast to the turquoise color of the eastern lake.

Besides the watercolor, the Great Green has several other characteristics which the Mediterranean Sea (or Red Sea) does not have. The Great Green was a lake (PT665D:40), whose freshwater flowed into the Field of Reeds for irrigation and ferrying. This function is also reflected by its later mentioning in the Great Hymn to the Aten:¹³

All distant lands, you make them live, for you set a Nile (the Apis Canal) in the sky that it may descend for them and make waves upon the mountains like the sea (Great Green) to irrigate the fields in their towns.

Unlike the sea, the Great Green could surge (PT406:4), possibly due to flash flooding from the surrounding mountains. It is the residing place of Osiris and Horus (PT576:12-13) and hence called the Duat Lake. The Jackal identity is honored in the Great Green (PT665A:35-36), and Jackal Lake is another epithet for the Duat Lake. It was under Nut’s underside (PT610:31) on the west of the Akhet. The Papyrus No. IX in the British Museum also confirms “the Akhet on the eastern side of the Great Green.”¹⁴

PT610:29-35 describe the king being welcomed and honored in the Sun City (Heliopolis) after passing through the Great Green (Duat Lake):

The sky’s gate to the Akhet is opened for you, the mind of the gods is welcoming at meeting you as a star that crosses the Great Green that is under Nut’s underside, in this privilege of yours that comes from the mouth of the Sun, while you sit on that metal chair of yours as the great one in Heliopolis. You lead the akhs and content the Imperishable Stars, with your abundance from the grassland (field) in which the gods have abundance and on which the akhs feed.

As discussed earlier, Heliopolis (the Pillar City) is the Sun City (or Sun Disk). The “grassland” is the farmland in the Field of Reeds, which provides abundant offerings.

Jackal Lake

The summit of the Tell Atlas Mountain range north of the Atlas Basin is about 2300 meters high. Standing on this mountain range and looking south, one would have a clear view of the megalakes and the plain further south. Figure 4 is the view of the Great Green from the north. The shape of this lake resembles a jackal head facing to the east. This must be the namesake of Jackal Lake (𓆎 𓆎 𓆎, *št zꜥb*) and the origin of the jackal god Anubis. One of the functions of Jackal Lake is purification. PT268:7-9 describes the cleansing of the deceased by Horus in Jackal Lake (Duat Lake) and in the Circular Canal of the Akhet:

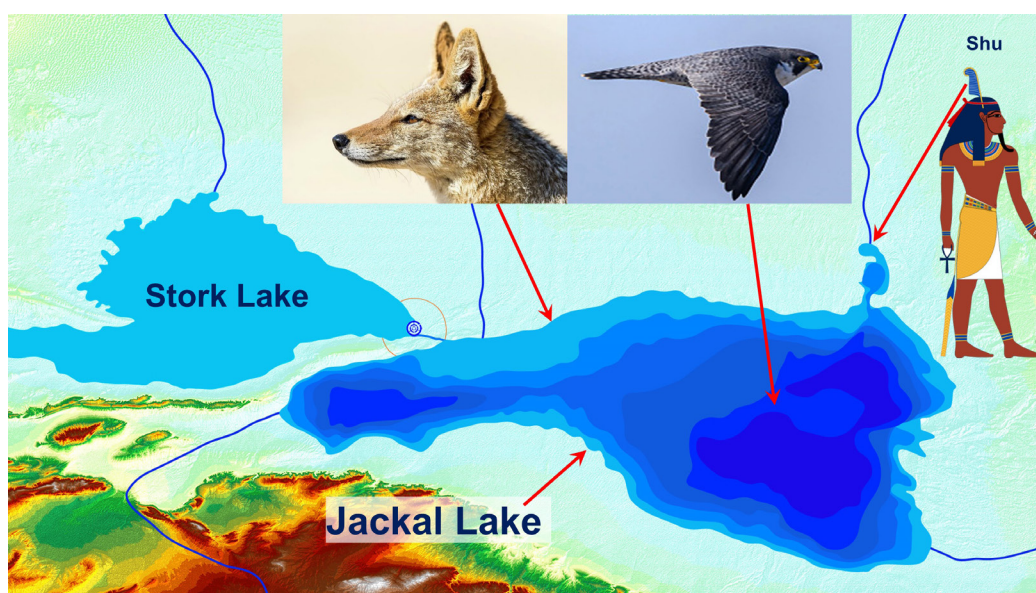


Figure 4 The western megalake in Atlas Basin resembles a jackal head as viewed from the north.

Citation: Hong-Quan Zhang. The Akhet environment depicted by the Pyramid Texts – A comparison to the Atlas Basin hydrology during the Green Sahara time. *Int J Hydro*. 2023;7(1):27–44. DOI: 10.15406/ijh.2023.07.00336

like small lake is connected to the bottom-left corner. Many scholars believe that the name Sobek (*s-bk*) is derived from a causative of the verb “to impregnate.”¹⁶ The origin of this name might also be related to the peculiar shape of the lake’s eastern half (viewed from the south as shown in Figure 5). In the same spell, PT317:9-10 provide more support: “I appear as Sobek, Neith’s son. I eat with my mouth, I urinate and copulate with my penis.”

Spread-Lake and Cool Waters

Spread Lake (𓂏𓂏𓂏𓂏, *pdw-št*) and the Cool Waters (𓂏𓂏𓂏𓂏, *kbhw*) are also epithets for the Duat Lake in the Pyramid Texts. PT553:8-9 say: “He takes to himself your arm – Sokar, foremost of Spread-Lake having cleaned you – to your throne in the Cool Waters.” Sokar is a god of the underworld, the lord of Spread-Lake (PT300:3). The western megalake spreads out from east to west, but the name Spread-Lake is most likely related to the spreading of Nut (the Sky) over this lake.

In the Pyramid Texts, the Sky and the Duat (Undersky) are interconnected through Nu, the primeval waters. PT536:1-4 says:

You have your water, you have your inundation (abundance), you have your outflow that came from Osiris. The sky’s door is opened to you, Nut’s door is pulled open to you. The sky’s door is opened to you, the Cool Waters’ door is pulled open to you.

Here “inundation” (𓂏𓂏𓂏, *bʿh*) is better translated as “abundance,” which often represents the Field of Reeds. In the Pyramid Texts, water is generally viewed as a blessing. The Undersky (primeval water Nu) existed even before the Sky and Earth came into being (PT769:1-4). After the Sky and Earth were separated by Shu, the lakes and other water bodies on land became the Underskies. Both the Sky and Undersky are linked to Nu. Therefore, when “the Undersky” is mentioned in the Pyramid Texts, it refers to Jackal Lake (Duat Lake). When “the two Underskies” is mentioned, it refers to the western Jackal Lake and the eastern Stork Lake (PT273/274:42, 548:11).

PT325:3-4 describe the flow of the cool water from Jackal Lake to the Field of Reeds:

The sky’s doorway is opened, the Cool Waters’ door is pulled open, for Horus of the Akhet at daybreak, that he might emerge into the Field of Reeds and become clean in the Field of Reeds.

This is one of the most frequently recited spells in the Pyramid Texts. When the water from the deeper western lake flowed into the shallow eastern lake, people would be impressed with the refreshing purity and coolness of the current. This must be the reason why Jackal Lake got the nickname Cool Waters that reflects the depth difference between the two lakes. In PT515:10, the Duat Lake is also called the Marsh of Life (𓂏𓂏𓂏𓂏, *šht ʿnh*) which is the Sun’s resting-place in the Cool Waters. The Great Lake (𓂏𓂏, *št-wr*) is also an epithet used for Jackal Lake (PT466:9, 666:1-2).

The Nurse Canal

According to the Pyramid Texts, both the Nurse Canal (𓂏𓂏𓂏, *mr mnʿ*) (PT473:43-44) and the lips of Stork Lake (PT473:14-15) are the “drinking places” for the akhs. This means that the Nurse Canal is connected to the lips of Stork Lake, i.e., the lips of the Winding Canal, which surrounds the Field of Reeds (see further discussions in the next section). PT265:5-9 describe the process of filling water to the Winding Canal and the Fields of Reeds by opening the Nurse Canal so that the king might be ferried to the Akhet for a rebirth with the gods:

The Nurse Canal is opened up, the Winding Canal becomes inundated, the Fields of Reeds is filled, so that I might be truly ferried to that eastern side of the sky, to the place where the gods are born, and I am born there in my birth with them as Horus, as him of the Akhet.

This is one of the most frequently recited spells in the Pyramid Texts. In many other similar spells, “the Nurse Canal is opened up” is replaced with “the sky’s door is opened” or “the Cool Waters’ door is pulled open.” Therefore, the Nurse Canal is a waterway connecting the upstream Jackal Lake (Duat Lake) to the Akhet and further to the Winding Canal downstream. Why was it called the Nurse Canal? First, this canal was the “drinking place” for the living and provided cool water for irrigation of the farmlands in the Field of Reeds. Secondly, this canal was the birth canal for the gods. The Sun Disk is located right at its outlet.

Comparing PT265:5 with the following verses, it is obvious that the Nurse Canal was also called the Cross-over Canal (𓂏𓂏𓂏, *nmʿ*), the Guide Canal (𓂏𓂏𓂏, *mʿʿ*) and the Gorge Canal (𓂏𓂏𓂏, *bʿn*):

Father Osiris Pepi’s Cross-over Canal is unplugged, the Winding Canal floods. (PT556:13)

The Guide Canal is opened, the Winding Canal floods. (PT504:8)

The Gorge-Canal is opened, the Field of Reeds floods and the Winding Canal fills with water. (PT507:2)

The name “Cross-over Canal” reflects the short length of the Nurse Canal connecting the Duat Lake to the Akhet. As shown in Figure 1, the length of the Nurse Canal is indeed very short, only about 10 km. It was called the Guide Canal probably due to its function to channel the afterlife from the Duat Lake to the Akhet where the stairway is set to the Sky. The name “Gorge Canal” was likely due to a very narrow section across a ridge. The two megalakes in the Atlas Basin were separated by a ridge now called the Draa el Djerid Ridge (see in Figure 5). The paleo-river linking these two lakes was located at the lower peak of the ridge. PT519:8 tells that the gate controlling the water flow was located at the lower peak: “Open, door of the Looking (Canal)! Pull open, door of the lower peak!” This was a very impressive hydraulic structure, which could regulate the water flow to smooth inundation, and provide water for irrigation and ferry. The Looking Canal (𓂏𓂏𓂏, *ptrt*) (PT510:23) is obviously another epithet for the Nurse Canal since this canal is behind the Sun’s Eye (the Sun Disk) as discussed earlier.

Row boats on calm waters

There are numerous operation details of different types of boats in the Pyramid Texts, including Dayboat (𓂏𓂏𓂏, *mʿndt*), Nightboat (𓂏𓂏𓂏, *mʿsktt*), Sun’s boat (𓂏𓂏, *wiʿ rʿ*), god’s boat (𓂏𓂏𓂏, *dpt-ntr*), ferryboat (𓂏𓂏𓂏, *mʿhnt*), etc. All the boat ideograms in these names have a “lake” or “canal” sign at the bottom. None of them shows the use of sail. This suggests that these boats were not used for transportation along the Nile River between north and south. The hieroglyph for the word “sail upstream” or “travel southward,” (𓂏𓂏𓂏, *hnti*), has a determinative of “sail ship,” (𓂏𓂏).¹⁰ The sail ship is equipped with mast and sail which help push the ship upstream to the south on the Nile under the north winds (trade winds). However, there is no such word for “sail south” (*hnti*) in the Pyramid Texts. The waterborne travels described in the Pyramid Texts are always between west and east.

Figure 6 shows a model of the Khufu Boat which was discovered in 1954 in a pit next to the Great Pyramid (the Akhet of Khufu) at Giza,

Egypt. Constructed around 2500 BCE, this vessel is about 43-meter long and 6-meter wide. The absences of mast and sail indicate that the boat was not intended for transportation on the Nile. Morabito, Brier and Greene conducted the first tank testing of a model of the Khufu Boat and had several interesting new findings.¹⁷ Their stability analysis reveals that the boat is suitable for carrying cargo and people in protected waters such as rivers and lakes but unfit for operations in

exposed waters such as the Mediterranean Sea. Based on the Pyramid Texts, this boat must be intended to be used for Khufu's afterlife ferrying between the Great Green (Duat Lake), the Akhet, and the Field of Reeds, where the waters were shallow and calm. This insight also proves that the Great Green was not the Mediterranean Sea but an inland megalake.



Figure 6 Model of the Khufu Boat showing no use of mast and sail.

The Field of Reeds

The Field of Reeds or Marsh of Reeds (𓆎𓅓𓏏𓏏, *shṯ iꜣrw*) is also known as the Elysian Field from the Greek pronunciation of *iꜣrw*.² Consistent with the previous quotations, PT512:10-11 also indicate that Jackal Lake (Duat Lake) and the Field of Reeds are connected:

You become clean from the Jackal Lake and washed from the Duat Lake. You are cleansed on top of your lotus in the Field of Reeds.

The Field of Reeds is a place for purification with the cool water from Jackal Lake. PT253:4-6 talk about the king becoming clean in the Field of Reeds and receiving his title from the Sun Disk (Sun City):

I have become clean in the Field of Reeds. My title is from the Sun (Sun Disk): Nut, receive my title; Shu, raise it up; Shu, raise it up.

The Field of Reeds is located downstream of the Cool Waters (Jackal Lake). When the water gate is pulled open at the Nurse Canal, water flows from Jackal Lake to the Field of Reeds for ferrying and irrigation as well as purification (PT479:5-6):

The sky's door is opened, the Cool Waters' door is pulled open, for Horus of Shezmet (Malachite), that he might go forth at daybreak, having (and) become clean in the Field of Reeds.

PT263:11-14 describe about the king's arriving at the Akhet for the first time across the Field of Reeds via the Winding Canal's north branch:

Greet his entrance into the north of the Field of Reeds. Let him cross on the Winding Canal. Let him be transported over to the eastern side of the Akhet, let him be transported over to the eastern side of the sky.

The Field of Reeds and its surrounding Winding Canal are located east of the Akhet. The descriptions of the water bodies around the Akhet in the Pyramid Texts perfectly match the layout shown in Figure 1.

Stork Lake

The Pyramid Texts frequently use parallel sentences to emphasize the same action by using different expressions of the subjective or objective, such as in PT473:47-48:

I sit at the fore of the great shrine and govern every akh with his mouth equipped. I sit on the lips of Stork Lake and govern every akh with his mouth equipped.

Through this parallelism, it is clear that "the great shrine" and the "lips of Stork Lake" are meant to be the same place, which is the Sun Disk. The same place is also referred to as "lips of the Winding Canal" (PT767:20) or "bends of the Winding Canal" (PT648:31).

Like Jackal Lake, this eastern lake was called Stork Lake (𓆎𓅓𓏏𓏏, *shṯ iꜣrw*) due to its bird shape. Later, we will show that the Winding Canal is a canal surrounding the Field of Reeds. The Egyptian bird deity Benu is associated with the Sun, recreation, and rebirth. It appears as a perched heron, 𓆎, in almost every illustration of the Field of Reeds in the Book of the Dead.¹⁸ As shown in Figure 7, the shape of the eastern megalake in the Atlas Basin does look like a stork. The Apis Canal connecting Stork Lake to the Mediterranean Sea resembles the long neck of the bird.



Figure 7 The eastern terminal megalake in the Atlas Basin resembles a stork.

Marsh of Turquoise

In the Pyramid Texts, the Field of Reeds is also called the Marsh of Turquoise (𓆎𓅓𓏏𓏏, *shṯ mfkst*), e.g. in PT473:37-38: “I sail around with you in the Field of Reeds and moor like you moor in the Field (Marsh) of Turquoise.” Here the hieroglyph for the second “Field” (𓆎𓅓, *shṯ*) should be translated as “Marsh” considering the presence of water surfaces. The name “Marsh of Turquoise” reflects the turquoise color of the shallow water of this area compared to the deep green color of the Great Green in the west. The shallow water depth is an ideal condition for the reeds to flourish, and thus this area was called the “Field of Reeds.” When the water was drained lower, the Field of Reeds was gradually converted to fertile farmland, which gave a deep green color during the growing season. The emerald farmland and the surrounding turquoise lakes would vividly show a picture of “malachite.” PT627B:19-20 describe such an environment: “I am now off to my place of malachite and my food is now in the Fields of Rest and the Lakes of Turquoise.” The Field of Rest (𓆎𓅓𓏏𓏏, *shṯ htp*) is a synonym of the Field of Reeds. The plurality of the “Fields” and “Lakes” indicates that the original shallow megalake was now drained and evolved into many farmlands separated by canals and shallow lakes.

PT609:6-9 tell about irrigation of the farmland:

The reed-plot fills, the Winding Canal floods, and the Nurse Canal unplugs for me, that I may cross on them (it) to the Akhet, to the place where the gods are born, and I am born there with them.

The “reed-plots” are the farmland excavated in the Field of Reeds after draining the water to a lower level. These new farmlands were highly productive due to the long-time sedimentation of organic matter. However, these new farmlands needed irrigation during the growing season when rainfall became insufficient. This was done by opening the Nurse Canal, and water would flood the Winding Canal, which would further direct water into the farmlands. At the same time, ferrying was made possible due to the higher water level in the canal.

The area of the eastern megalake shown in Figure 8 (a) corresponds to the water surface level of 24 meters above sea level (masl). The lakebed is very flat as shown by recent satellite measurements. If the water level is drained to 18 masl, only about 1/3 of the water surface area would be left.

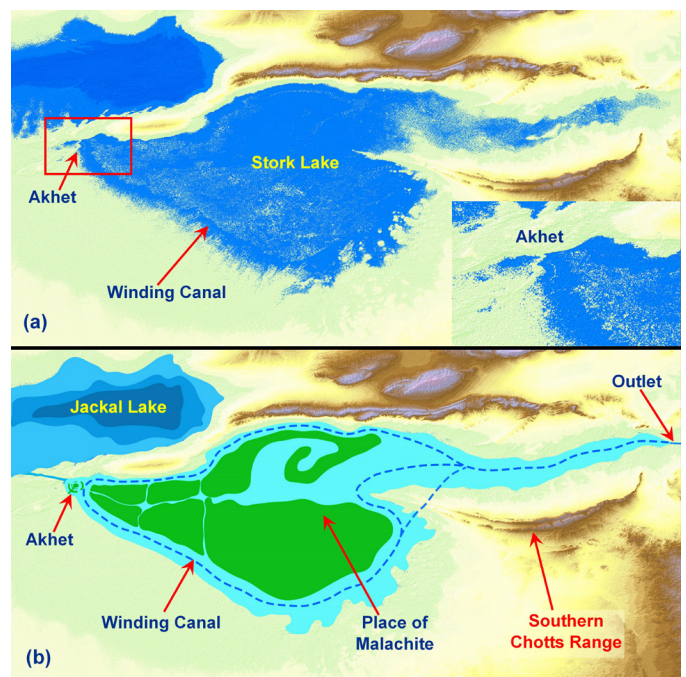


Figure 8 Stork Lake now and 6000 years ago: (a) the current profile showing the Winding Canal around Stork Lake; (b) the Place of Malachite before end of the green Sahara.

The Field of Reeds is a place for the king to get supplies and rejuvenation before joining the gods. It is also the source for the akhs to receive their provisions to sustain their eternal lives with the Sun. Therefore, it was also called the Field of Offerings (𓆎𓅓𓏏𓏏, *shṯ htp*). Another frequently used name for the Field of Reeds is Horus’s Eye.

Horus’s Eye

“Horus of Shezmet” is often cited in the Pyramid Texts for Horus’s identification. Here, “Shezmet” (𓆎𓅓 or 𓆎𓅓𓏏, *šzmt*) should be replaced with its literal English translation “the Malachite,” since it represents the combination of the emerald farmlands and the turquoise

shallow lakes/canals. Note the lake determinative (𓏏) and the island determinative (𓏑) are alternatively used for this hieroglyphic word. “The Malachite” or “the Place of Malachite” was the Field of Reeds during its transition from a shallow megalake to farmland. PT301:15-17 suggest that the Place of Malachite was related to Horus’s Eye:

I have come to you, Horus of Shezmet (the Malachite); I have come to you, eastern Horus. Look, I have gotten you your great eastern eye from the cavern.

Here, the “great eastern eye” of Horus is emphasized to differentiate from the Sun’s Eye (the Sun Disk) and to reflect its location on the east side of the Akhet. PT522:2 says: “I have fetched for you the eye of Horus that was tied together, the one in the Field of Rowing.” The Field of Rowing (𓏏𓏑𓏑𓏑, *shṭ hn*) is obviously the same place as the Field of Reeds. As shown in Figure 8 (b), the shape of the Field of Reeds indeed resembles a human eye with a long lateral canthus. Could this eastern megalake be the origin of Horus’s Eye? Based on the current lakebed profile, if this shallow lake was converted into farmlands by draining the water to the Mediterranean Sea, it would experience a gradual transformation. At a certain stage, the combination of farmlands and the surrounding canals and lakes would give a likely appearance shown in Figure 8 (b). In the Pyramid Texts, the color of Horus’s Eye is frequently described as green (PT162:1, PT186:1, PT404:3, PT605:1-2). It offers provision, cleansing, and censuring (PT800:1-4):

Osiris Neith, accept Horus’s eye: provide yourself with it. Horus has censed himself with his eye. Ho, Neith! Cense yourself with Horus’s eye, cleanse yourself with Horus’s eye.

The Horus’s Eye also provides water (PT62:1-2), endurance (PT667B:34), content (PT83:2-3), healing (PT140:1) among many other benefits. All these characteristics align with the functions of the paradisiac Field of Reeds.

Horus’s Eye is related to the legendary story about the fight between Horus and Seth, in which Horus lost his left (eastern) eye, which was later recovered and made a landfall on the east side of the Sky (PT359:2-3...7-9):

Horus’s eye jumped and made landfall on the other side (that side) of the Winding Canal so that it might save itself from Seth...

You gods cross on Thoth’s wing to the other side (that side) of the Winding Canal, to the eastern side of the sky, in order to contend against Seth over that eye of Horus.

“The other side” (𓏏𓏑, *pf gs*) here should be interpreted as “that side” since this specific location is intentionally emphasized. From the context, “that side of the Winding Canal” clearly means to be “the eastern side of the Sky,” which is equivalent to the Akhet as identified in previous discussions. Interestingly, the hieroglyph for “side” (𓏏) mimics the shape of the Winding Canal for the part close to the Akhet. Therefore, “that side of the Winding Canal” is the Akhet, where the contestants’ case is heard.

The Winding Canal

As pointed out earlier, the Winding Canal is located downstream of the Nurse Canal. It goes around the Field of Reeds. When “the Nurse Canal is opened up, the Winding Canal is inundated, the Field of Reeds fills with water” (PT264:5-6). PT767:19-20 clearly tell that the Circular Canal is located on the lips of the Winding Canal:

So, raise yourself! Place your head on your shoulders and drink the waters of the inundation (abundance) that are in the Circular Canal on the lips of the Winding Canal.

This statement also indicates that the shape of the Winding Canal is like a mouth having two lips. Such a unique shape resembles the layout of the eastern megalake in the Atlas Basin as shown in Figure 1.

The “Winding Canal” hieroglyph is 𓏏𓏑𓏑𓏑 (*mr-n-ḥz*). If the hieroglyphs are read from right to left, the “ḥz” symbol 𓏑 becomes 𓏏, which resembles the shape of the Winding Canal, or the Field of Reeds shown in Figure 8 (b). The curved “canal” determinative (𓏑) appears in several spells for the Winding Canal. It was intentionally carved in such a way to stress that the canal was not a regular linear canal but a curved one. In PT555:14 from Merenre’s pyramid, the “canal” determinative is 𓏑. These depictions are consistent with the elliptic mouth-like shape of the Winding Canal.

PT539:13 mentions the “great To-and-Fro Canal” and its mouth shape. Obviously, this is another epithet for the Winding Canal, which has two branches – the north route and the south route. PT555:9-14 tell that the Winding Canal has a “north side” and a “south side.” PT613:3 analogizes these two routes as the two lips of the Winding Canal. According to PT263:11-14 (presented earlier), one could ferry from the east to the Akhet via the north branch. One could also “sail around the Field of Reeds” (PT473:13) through this looped canal.

Figure 8 (a) shows the current profile of the eastern megalake in the Atlas Basin with the areas below 24 meters above sea level painted blue. The areas along the shoreline clearly show a lower profile, indicating an ancient man-made canal around this lake. Since the water depth of this lake was very shallow, a canal must be excavated off the shoreline to enable ferry and irrigation. Later, the outlet to the Mediterranean Sea could have been dug deeper to drain the water from the Field of Reeds to form farmland. From the ground profile, a short-cut canal was likely excavated across the western end of the Southern Chotts Range to significantly reduce ferrying distance as shown in Fig. 8 (b). On the south side of the lake, the ground slope is very gentle. Short radial canals could have been dug to gain access to the loop canal from the towns on shore. In several Pyramid Texts spells, the “ḥz” symbol for the Winding Canal was even carved with short radial lines on the lower side, 𓏑, e.g. in PT359:22, possibly to illustrate the canal extensions.

PT522:5 from Pepi I’s pyramid says: “Fetch for me that Khnum-made boat that is in the Winding Canal.” However, in the same spell verse from Merenre and Pepi II’s pyramids, the “Winding Canal” was replaced with “the Canal of Provision” (𓏏𓏑𓏑𓏑, *mr pw n ḥtm*). This confirms that the Winding Canal served as the highway for transporting the offerings from the Field of Reeds (or the Field of Offerings) to the Akhet. As discussed earlier, the Serdab tripartite structure attached to the chambers under the pyramids is likely to symbolize the three canals connecting the Akhet with the Field of Reeds, the northern and southern branches of the Winding Canal plus a middle one leading to the central areas of the field, as shown in Figure 8 (b).

The Apis Canal

As described in the spell PT254, when the king starts his afterlife, he first passes the Apis Canal before reaching the Field of Reeds or the Winding Canal (PT254:13-14): “The rope has been guided (pulled), the Beaten Path crossed, and the ball struck (gong beaten) at the mouth of the Apis’s Canal.” The revisions in this quote are suggested by Shmakov.¹⁹ As shown in Figure 7, the shape of the strait from the Gabes Ridge to the Field of Reeds looks like an Apis bull horn. 𓏏𓏑 (*hp*) frequently appears in the Pyramid Texts. Allen translates it as “inundation”.² However, this word has a “canal” determinative. Very likely, it refers to the same “Apis’s Canal” in PT254:14. Apis is the

most important and highly regarded bull deity of ancient Egypt. His original name in Egyptian is Hapi or Hep (*hp*). Apis is the Greek name. Therefore, we should call $\text{𓆎} \text{𓆏}$ the Apis Canal. This is evident in the following verses from the Pyramid Texts:

This Unis has come, an imperishable akh, as the one who is to be worshiped, who is over the inundation (Apis Canal): let the akhs in the water worship him. (PT217:13-14)

The Sunshine's (Ennead's) Servant falls in the inundation (Apis Canal). (PT293:6, 383:3)

The [...] falls in the inundation inside the sunshine (Apis Canal as the Ennead's stream) (PT501A:1)

Those who see the inundation (Apis Canal) when it surges shake. (PT581:9)

I am the high inundation (Great Apis Canal). (PT*706:31)

My life is more than the year's, the food extended to me is more than the inundation (My life is according to the regnal year, my offerings are from the Apis Canal). (PT347:5)

This is Horus, who has emerged from the Inundation (Apis Canal); this is the longhorned bull who has emerged from the walled compound (place in the Circular Wall). (PT683:3)

The hieroglyph for “walled compound” is $\text{𓆎} \text{𓆏} \text{𓆐}$ (*inbt*, walled place). It has a specific “circular wall” determinative, 𓆑 . Therefore, it should be translated as “the place in the Circular Wall.” This circular place certainly refers to the Sun City (or the Sun Disk), where Shu (Atlas) is honored as the chief god. The Circular Wall must be the wall around the Great Ring Island, “the wall of the Shu City,” which was once topped by the “fierce lake” as told in PT509:5.

Just as Sokar being the lord of Spread-Lake (the Great Green) (PT300:3), the bull deity Apis is associated with the Blackland as told in PT674:11-12: “You stand at the fore of those of Blackland as the Apis, you stand at the fore of Spread-Lake as Sokar.” Here, the Blackland is obviously the Field of Reeds. When Stork Lake was converted to farmland by draining the water to the Mediterranean Sea, the color of the fresh lakebed soil was black due to the long-time accumulation of organic matter.

Inundation, farming, and aridification

The Great Immersion

There was only one narrow canal across the Gabes Ridge to release water from the terminal megalakes of the Atlas Basin to the Mediterranean Sea. If heavy flooding occurred in the basin, the water level of the lake would surge, and the farmland would be inundated due to the narrow outlet. In case of a landslide (e.g., caused by an earthquake) at the narrow outlet, the water flow would be blocked, and the towns around the lakes would be submerged. “The Great Immersion” $\text{𓆎} \text{𓆏} \text{𓆐}$ (*mht-wrt*) appears many times in the Pyramid Texts, and it clearly refers to a place. PT254:43 says: “I judge between the two contestants in the Great Immersion.” According to the Pyramid Texts, the judgement is conducted within the Sun Disk's shore (PT252:5), in front of the Dual Shrine (PT412:33) and observed by the Big Ennead (PT610:14). Therefore, “the Great Immersion” must be an epithet of the Akhet or the Sun City. The following Pyramid Texts verses provide more confirmations. If we replace “the Great Immersion” with “the Sun City,” the meaning of these verses will remain consistent with the descriptions about the Sun City:

May you let me eat of grain, and I will become thereby like Osiris on the Great Immersion. (PT493:3-4)

I collect (grain from) them like the one at the fore of his Dual Ennead, who lives on the Great Immersion. (PT496:12-13)

They row Horus in Horus's emergence from the Great Immersion. (PT510:8)

Figure 9 shows one of vignettes in the Plate VIII of the Papyrus of Ani. The legend of this vignette is: “The Great Immersion, the Sun's Eye ($\text{𓆎} \text{𓆏} \text{𓆐}$, *mht-wrt irt r'*).” In the correspondent text, we are told: “The Great Immersion is the great Celestial (or Primeval) Water, but others say that the Great Immersion is the image of Sun's Eye at dawn at his birth daily.” The Pyramid Texts have made it clear that the Sun's Eye is the Sun Disk or the Sun City. In this illustration, the Sun Disk supported by the two horns of the Heavenly Cow looks very similar as the Sun City surrounded by the two branches of the Circular Canal after it splits from the Nurse Canal and connects to the Winding Canal.



Figure 9 The Great Immersion, the Sun's Eye.

In the verse PT510:8 from Merenre's pyramid, the hieroglyph for the Great Immersion is $\text{𓆎} \text{𓆏} \text{𓆐}$, where the “water” determinative, 𓆑 , is replaced with a “surging lake” determinative, 𓆒 . This indicates that the Great Immersion originated from “the surge of the Great Green” (PT406:4), also described as “the Great Lake's wrath” (PT262:22).

PT317:1...4-5 further draw equivalence between “the Great Immersion” and “the Akhet”:

I have come here in advance (to the fore) of the flood's immersion...



I have come to my canals in the flood-shore in the Great Immersion, to the place of rest with green fields in the Akhet.

Why was the Sun City (or the Akhet) called “the Great Immersion”? Very likely this epithet originated from a catastrophic high flood which immersed the Akhet. It was also called “the flood's immersion.” This high flood was clearly “the Great Flood” ($\text{𓆎} \text{𓆏} \text{𓆐}$, *zgh-wr*) that emerged from the great goddess (Nut) (PT311:12). Nut spreads over the Great Green on the west of the Akhet. PT249:7-8 indicate that “the Great Flood” occurred during a night:

I am the one to whom belongs the linen that the uraei guard during the night of the Great Flood that comes from the great goddess.

PT513:12-14 identify “the Great Flood” with the life in the Duat Lake:

You shall become the akh in the Duat and live in that pleasant life in which the lord of the Akhet lives, the Great Flood in Nut.

Therefore, “the Great Immersion” was the result of “the Great Flood” that came from the Great Green (Jackal Lake). The hydrological profile of the Atlas Basin provided an ideal condition for such a surge to occur. Earlier we discussed about the Sun City  (i_{shw}). This hieroglyphic name may also be related to  (i_{shi}), meaning “be inundated.”

Marsh drained for farming

In the Pyramid Texts, we can clearly observe a transformation of the Field of Reeds from lake to marsh and then to farmland. This process was certainly a development over a long time by draining water out of the area, a knowledge learnt in dealing with flash flooding. The Field of Reeds was called Stork Lake and the Lake of Reeds in several Pyramid Text spells indicating that this area was originally a lake. PT323, PT526, and PT564 are clearly the variants from the same text, which depicts a picture of becoming clean in the Lake of Reeds and rising to the sky:




Someone becomes clean in the Lake of Reeds. The Sun becomes clean in the Lake of Reeds: I myself become clean in the Lake of Reeds. Shu becomes clean in the Lake of Reeds: I myself become clean in the Lake of Reeds. Shu, Shu, lift me to the sky! Nut, give your arms toward me! (PT564:1-7)

With the lowering of the lake water level, more lake area became shallow enough for the reeds to flourish. More areas were also exposed, and the black sediment became ready for crop cultivation with very high productivity. PT254:41-42 and 461:10-12 talk about such a reclamation to produce the supplies for the king:


...excavating a plot for me in the Field of Reeds; and establishing my farmland in the field of the Field of Offerings.

You set course (row) to the Field of Reeds, (where you) farm barley, reap emmer, and make your yearly supplies from them like Horus, Atum's son.

PT480:4-5 provide more details about the transformation of the Field of Reeds into farmlands: “Atum has gotten the towns for me, he has collected the cultivations for me, he has joined the grasslands (farmlands) for me.” Naturally, the Fields of Reeds first appeared as isolated isles when the water in the Lake of Reeds was drained. The plurality of “Fields of Reeds” (in PT264:6, 265:6, 268:14) reflects this environment. With further drainage, the isolated isles became connected to each other to form larger farmlands. The water surface was divided into many smaller lakes. PT627B:19-20 (quoted earlier) vividly portray the area as the Place of Malachite

 (ist nt šzmt) and the water bodies as the Lakes of Turquoise  (šiw jkštiw). PT650:5 mentions about the “eastern cultivations”  (spšwt jbštt), which must be the farmlands in the Field of Reeds east of the Akhet.


The Abundance

In the Pyramid Texts, flood  (šgb) is often taken as a blessing and therefore can be translated as “abundance,” e.g.:

My booth is plaited of reeds; my flood (šgb) (abundance) is in the Field of Offerings. (PT210:14)

May you fetch for me Isis's milk, Nephthys's flood (šgb) (abundance). (PT406:3)



Abundance (šgb) is for my evening meal...I live on your abundance (šgb). (PT662A:8...11)

 (b^h), is another word often translated by Allen as inundation.² Examining its uses, almost all of them can be translated as “abundance,” e.g.:

I have allowed them to eat from their cups and drink from their inundation (b^h) (abundance). (PT254:36)

Ho, Pepi! Your water is the inundation (b^h) (abundance); your cool water is the great inundation (b^h) (abundance) that comes from you. (PT460:1)

One of the most frequently recited verses in the Pyramid Texts is (PT536:1, PT413:1, PT424:17, PT436:1): “You have your water, you have your inundation (b^h) (abundance).”

When  (b^h) is used as a verb, it means “richly provide” or “richly supply,” e.g. in PT483:21: “You are inundated (b^h) (richly provided) in the green field in which Geb's offspring have been inundated (b^h) (richly provided).” In some cases,  (b^h) is a synonym of the Field of Reeds, e.g.:




Greetings, you at the fore of the inundation (b^h) (Field of Reeds), who guard nourishment. (PT493:1)

Ho, Osiris Pepi Neferkare! Horus does not imbibe from you, in your identity of the inundation (b^h) (Field of Reeds). (PT658A:28)

Irrigation



The water gate at the narrow gorge of the Nurse Canal controlled the water flow from Jackal Lake to Stork Lake. This was a very advanced hydraulic development at the time. PT264:5-9 describe the process of releasing water into the Winding Canal and the Field of Reeds so that one can be ferried to the Akhet:

The Nurse Lake (Canal) is opened up, the Winding Canal is inundated, the Fields of Reeds fills with water, and my ferrying is ferried on them to that eastern side of the sky, to the place where the gods give me birth, and I am fully reborn there, new and rejuvenated.

In PT264:5,  (šī mn^c) from Teti's pyramid can be translated as “the Nurse Lake.” However, the same word from Pepi I's pyramid is  (mr mn^c) meaning “the Nurse Canal.” PT266:5 is a similar verse which uses “the Nurse Canal.” The Teti version might be a typo or imply that Jackal Lake might be called the Nurse Lake. When the Nurse Canal is opened up, water pours out from Jackal Lake, and the Winding Canal is inundated  (i_{shi}).

At the later stage of the farmland development in the Field of Reeds, the isolated Lakes of Turquoise became less and smaller, and the water level in the Winding Canal became lower. The water outlet of the Field of Reeds had to be blocked to raise the water level in the canal so that boats could ferry on it (PT254:9-10):

The earth is completely dammed up (The canal is earth-dammed up), for the mountain ranges on either side of the river have been joined and the two banks have been united.

 (tš-dni dnit) literally means “the dam is earth-dammed.” A “blocked canal” determinative, , is used for both the noun and verb “dam.” Therefore, the translation should be “the canal is earth-dammed up”. From the contexts of the same spell, we know that the canal refers to the narrow outlet of the Apis Canal. There are mountain ranges on the south and north sides of this canal as shown in Figure 7.

Controlling the water flow from Jackal Lake to Stork Lake and further into the Mediterranean Sea could serve two main purposes. The first one was flood mitigation, a lesson learnt from the unique hydrological profile of the basin and the past deluges. The initial objective of draining the Field of Reeds was probably to reduce the risk of flash flooding and lake surging. This led to the agricultural development of the fertile lakebed, the Field of Reeds. Then, the second function of the water flow control came into play – irrigation of the farmlands. Based on the seasonal water needs of the farmlands in the Field of Reeds, the Nurse Canal could be opened up for irrigation as described in the following Pyramid Texts verses:

The marshes (fields) become content, the irrigation canals flood. (PT457:1)

The Quail-canal (irrigation-canal) is unplugged, the Quail-canal (irrigation-reservoir) fills with water. So, the Field of Reeds floods and the Field of Rest fills with water. (PT519:15-16)

𓆎𓅓𓏏𓏏 (pꜣꜥ) should be translated as “the irrigation canal” and 𓆎𓅓𓏏𓏏𓏏 as “the irrigation reservoir” based on Faulkner.¹⁰ PT516:1 mentions about the “Field of Irrigation” or “Irrigable Field” (𓆎𓅓𓏏𓏏𓏏, *sht pꜣꜥ*). From the similar start of the following spell (PT517:1), clearly this “Irrigable Field” is the Field of Reeds. It has an irregular elliptic determinative, 𓆎, giving a shape of the farmland inside the Winding Canal.

Water cycle collapse

The above-discussed details from the Pyramid Texts systematically agree with the hydrological profiles of the Atlas Basin during the green Sahara time. The water cycle stability over this basin also provides a scientific insight into the environmental changes. The Atlas Mountain range has a strong rain shadow effect, which creates desert in its southeastern leeward area if not compensated.²⁰ The water surface area of the two terminal megalakes together was about 30,000 km² 6000 years ago, roughly the size of Belgium. This giant water surface area plus the surrounding arable land could generate water vapor more than enough to eliminate the rain shadow effect of the Atlas Mountain and maintain the green Sahara.

The Atlas Basin is a standalone catchment and has its own water cycle dictated by the non-linear relationship between precipitation and evaporation. When precipitation is higher than evaporation, there is a runoff surplus flowing out to the Mediterranean Sea, and the ecosystem is healthy. However, if precipitation decreases below evaporation, the basin will become drier. The lower local relative humidity further reduces precipitation. The water cycle enters a self-propelled destabilizing process, and the basin quickly moves to a desert condition. Because of its leading position for the westerlies and trade winds, the Atlas Basin desertification would inflict a breach to the green Sahara and cause deterioration of all downwind areas including North Africa, West Asia, and the Mediterranean region.²⁰

When the Lake of Reeds was converted into farmland by draining water to the Mediterranean Sea, the water surface area was significantly reduced. This would trigger a collapse of the water cycle over the Atlas Basin. Then, the water cycle collapse would lead to a rapid desertification in the basin. The green Sahara period and the abrupt desertification in the Atlas Basin are clearly shown by the dust flux changes obtained from the marine cores extracted at four locations close to northwest Africa coast from 19°N to 27°N.^{21,22} These data are extremely important due to their close locations right downwind of the Atlas Basin under the trade winds. The environmental transitions in the Atlas Basin are directly reflected by the dust flux variations

observed in these downwind areas. Zouari also finds that runoffs recommenced around 11 thousand years ago in the Atlas Basin.²³ This can be seen from the establishment of a continuous lacustrine phase with an optimum around 8.5-8.0 thousand years ago. Climate data and archaeological evidence from North Africa, West Asia and the Mediterranean area are consistent with such a process.²⁰

Aridification in Pyramid Texts

In the Pyramid Texts, there is no chronological information on the environmental changes, but indeed signals of aridification are mentioned. PT504:6-7 tell about thornbush spreading around the Field of Reeds, and thornbush is a typical vegetation in dry land: “Thornbush, remove yourself from my path, that I may attain the southern part of the Field of Reeds.” PT555:9-14 indicate that the drought was more severe on the south side than north side of the Field of Reeds:

Tie the lashings, land my ferryboats, for a son of Atum who is hungry and thirsty, thirsty and hungry, on this southern side of the Winding Canal. Thoth in the limit of your bush's shade, put me on your wingtip in yonder northern side of the Winding Canal.

When the water cycle over the Atlas Basin was broken, the desert must have first developed in the middle of the plain and expanded to the lake area in the north. Therefore, the south side of the Field of Reeds was first affected before the dry-up on the north side.

PT273-274 are the only spells mentioning cannibalism in the Pyramid Texts. Scholars suggest that they may reflect an ancient custom. For a well-developed civilization, cannibalism occurs only during the time of extreme famine. However, there is no evidence that cannibalism was practiced in Egypt until the First Intermediate Period when extreme drought caused devastating famines corresponding to the 4.2 ka event.²⁴ Therefore, the devastations that inspired the cannibal spells in the Pyramid Texts were probably related to the abrupt desertification in the Atlas Basin around 5700 years ago.²⁰

Conclusion

The Pyramid Texts contain a great amount of specific and vivid details of the environment around the Akhet. Through this comparative study, these scattered details have been pinpointed together as a coherent picture, which perfectly matches the hydrological profiles of the two terminal megalakes in the Atlas Basin before the end of the green Sahara. The Akhet was a water city including two parts – the circular archipelago and the shore shoulder separated by the Circular Canal. The circular archipelago was called the Sun Disk as a metaphor for the sun. It consists of a central island and external ring-shape isles, with an outer diameter of about 3700 meters – the diameter of Atlantis as told by Plato. Due to several thousand years of water flow, the ring-shape isles were severely eroded into isolated External Isles. The Sun Disk was called the Shu City since Shu (Atlas) was “the chief god of the Akhet.” The circular island city looked like “the young girl’s pupil”, and it was called the Sun’s Eye (or God’s Eye). Due to its round shape and its location at Nut’s thighs as the birthplace of the gods, the Sun Disk was also called the Egg. The epithets Sun’s Eye and Egg explain that Osiris (𓂋𓏏𓏏) and Isis (𓂋𓏏) are literally titles of “the King of the Eye” and “the Queen of the Egg.” Other epithets for the Sun Disk include the Sun City, the Pillar City, and the Great Immersion.

The western megalake was bigger, deeper and gave a green to blue color. Therefore, it was named the Great Green. Viewed from north, its shape resembles a jackal head, and hence it got the epithet Jackal

Lake. Through the short Nurse Canal, the Cool Waters flowed from Jackal Lake to the Circular Canal around the Sun City and then to the eastern megalake, which was called Stork Lake due to its bird shape. The Stork Lake was very shallow and flat and gave a turquoise color, which led to the epithet March of Turquoise. When water was drained from this lake to the Mediterranean Sea, it experienced a transformation from lake to marsh and then to farmland. The wide flourishing reeds gave this megalake its most famous name – the Field of Reeds or the Elysian Field, the paradise for afterlife in both Egyptian and Greek traditional beliefs. With the farmland development in this area, the combination of the emerald crop fields and the turquoise water areas was viewed as “the Place of Malachite.” When the water surfaces gradually disappeared from this area, water had to be released from Jackal Lake to irrigate the fields during growing seasons through the Winding Canal around the Field of Reeds. This lakebed Blackland was highly productive and provided abundant supplies for the king. However, the conversion of the Field of Reeds to farmland eventually triggered the water cycle collapse in the Atlas Basin. Desertification started abruptly from this basin. This inflicted a breach to the green Sahara and caused an unprecedented exodus, suddenly from the Atlas Basin and then gradually from west to the Nile Valley, giving birth to the Egyptian civilization.

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Conflicts of interest

The author declares no conflict of interest.

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