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# Satellite-Aided Analysis of the Position of the Sun Temples and the Dynastic History of the Vth Egyptian Dynasty

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## Article

# Satellite-Aided Analysis of the Position of the Sun Temples and the Dynastic History of the Vth Egyptian Dynasty

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**Abstract:** The Sun Temples of the Vth dynasty are the most elusive Egyptian monuments of the Old Kingdom. Textual sources seem to refer to a different temple for each different pharaoh of the dynasty, but only two have been discovered at Abu Gurab, a few hundred meters north of the dynastic necropolis of Abusir. Previously, the author has proposed a cognitive–topographical framework that strongly supports the idea, originally formulated by Stadelmann, that only these two already known temples actually existed, while the others—with the possible exception of the last one—mentioned in the sources refer to renovations carried out by subsequent pharaohs on existing monuments. This paper aims to give a complete reassessment of this question using satellite imagery. Together with recently disclosed archaeological excavations at Abu Gurab, which have direct relevance for the history of the Sun Temples, the analysis provided here adds new, surprising aspects to the dynastic scenario, bringing in the meantime, further support to the above-mentioned framework. A proposal for the location of the last temple is also highlighted in the same analysis.

**Keywords:** Google-Earth aided archaeology; Egyptian Sun Temples; Abusir pyramid field

## 1. Introduction

The IVth Egyptian dynasty—that of the builders of the Giza pyramid—came to an end in the first half of the 25th century BC with Shepsekaf, the son of the owner of the third Giza complex, Menkaura. Shepsekaf built his tomb in the form of a huge monument nicknamed Mastabat Faraun; his reign represents a sort of breakthrough in the tradition of the “solar” successors of Khufu who added the suffix -Ra to their names (Djedefra, Khafra, and Menkaura). The successor to Shepsekaf, and founder of the Vth dynasty, is King Userkaf, who initiated a process of return to the solar tradition which would become dominant with Sahura, the founder of the royal necropolis of the dynasty at Abusir [1,2].

Userkaf’s building project included two monuments. First of all, the king’s pyramid, located in Saqqara, and secondly, another, quite original building, usually called Sun Temple, located in a previously unbuilt area, that of Abu Gurab. The Pyramid of Userkaf was conceived as a relatively unambitious project but was placed close to the north-east corner of the step pyramid complex of Djoser in Saqqara as a sign of closeness to a very ancient tradition. An unobstructed line of sight connects the pyramid with Khufu’s at Giza, crossing over the Sun Temple [3]. If a similar connecting line is traced between the summit of Djoser’s pyramid and the apex of Khafra’s, it turns out that the two lines are almost parallel (deviation being less than 2°). The length of these lines is about 14.5 km, and therefore, they allow for direct inter-visibility, an experience that can still be enjoyed today (on very clear days). The likely reason, then, for Userkaf’s placing his pyramid exactly where it is is the idea of replicating, at Saqqara, the sacred space of the two main Giza pyramids. This ambitious project—completed at the end of the Vth dynasty by Unas, whose pyramid in Saqqara aligns in a similar way with the third pyramid of the Giza complex—tells us that topographical, dynastic relationships were of fundamental importance for Vth dynasty planners (Figure 1).



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**Figure 1.** Saqqara. A picture taken from the south of Unas pyramid (foreground) showing the Step Pyramid in the middle and the pyramid of Userkaf in the background (photograph by the author).

The Sun Temple of Userkaf was called the Stronghold of Ra and is located at Abu Gurab, a plateau to the north of Saqqara. The layout is somewhat similar to that of a pyramid complex: a “valley” temple close to the cultivation, a causeway, and an upper temple. The latter underwent several stages of construction, as it was re-elaborated by at least two of Userkaf’s successors, Neferirkara and Niuserra (we shall come back on this point). Initially, there was only a rectangular enclosure with a central mound. To this structure, Neferirkara added an obelisk, which stood on a huge pedestal. Later, Niuserra added an inner enclosure wall and chambers of limestone [4,5]. The upper temple is very well-orientated to the cardinal points, as are all the pyramids and temples of the IVth dynasty [6,7].

Documents dating to the end of the Vth<sup>V</sup> dynasty mention other temples, making up a total of five, one for each of the pharaohs: Sahura, Neferirkara, Neferefra, Niuserra, and Menkahour. These are listed in Table 1, where also the hitherto obscure pharaoh Shesepkara is listed (this pharaoh will be discussed at length in what follows). However, only one of these five monuments, that of Niuserra, is archaeologically known. It is located north of Userkaf’s Sun Temple. The temple was called Delight of Ra and once again consisted of a valley temple (almost lost), an upper temple, and a causeway linking the two. The main focus of the upper temple was a non-monolithic obelisk placed on a huge pedestal. A winding ramp still today ascends to the obelisk’s base, accessed from a chamber within the pedestal, which contained reliefs relating to the three Egyptian seasons. In spite of its age of almost 4500 years, the temple is still an imposing monument; its courtyard still contains a masterpiece of Egyptian sculpture, a huge, four-sided alabaster offering an altar (Figure 2).

**Table 1.** List of The Sun Temples of the Vth dynasty.

King Name	Temple Name	Site	Site Proposed in the Present Paper
Userkaf	The Stronghold of Ra	Abu Gurab	
Sahura	The Field of Ra	Unknown	Renewal of Userkaf's
Neferirkara	The Place of the Ra Pleasure	Unknown	Renewal of Userkaf's
Neferefra	The Offering Table of Ra	Unknown	Renewal of Userkaf's
Shesepkara	The Heart of Ra is satisfied (unsure)	Abu Gurab	
Niuserra	The Delight of Ra	Abu Gurab, rebuilt/renewal of Shesepkara	
Menkahour	The Horizon of Ra	Unknown	Abu Gurab

List of The Sun Temples of the Vth dynasty

**Figure 2.** Niuserra Sun Temple (photograph by the author).

Why were the Sun Temples built? They are an isolated episode in the history of Egyptian architecture, and of course, they are understandable only in relationship with the strong solar connection of the pharaohs who ordered their construction. We know from almost contemporary texts (the so-called Abusir Papyri) that rituals and sacrifices of oxen were made there on a daily basis, and their placement on the west bank of the Nile (the same as the pyramids) led to the identification of the king with the Sun God Ra “before birth and after death” [1]. In spite of the fact that the fine details of these meanings elude us, there is no possible doubt that the Sun Temples can be understood only if also the main temple of the Sun is taken into account. This temple was located in Heliopolis, on the opposite bank of the Nile [8]. Almost nothing remains of it, and the city of modern

Cairo has grown in between Heliopolis and the Nile, making inter-visibility impossible. It is, therefore, mandatory to use satellite imagery if we want to understand the ancient topography of the area.

## 2. Materials and Methods

Non-invasive analyses in search of traces of eventually buried monuments at Abu Gurab have proved inconclusive so far (see, e.g., [9,10]). Actually, the present author has verified on site in several zones of the Abu Gurab–Saqqara South ridge that non-invasive analyses are likely doomed to be ineffective due to the inhomogeneous accumulation of desert sand mixed with pottery fragments and garbage in artificial dunes, which—sadly—were created in the course of the last 150 years or so of excavations of the main monuments nearby.

In order to clarify the question of the “missing” temples and their meaning, the approach of the present paper is, therefore, different. We study here spatial relationships between Vth dynasty monument, with simple tools of Google Earth Pro (GEP) satellite imagery. For archaeology, GEP is already the instrument of choice for many—technically simple but fruitful—remote sensing investigations [11]. As a matter of fact, GEP has been recently used in a variety of archaeological scenarios: for instance, we recently carried out a complete satellite survey of the imperial tombs of Japan [12], and it has been used in Egypt to study activities that threaten archaeological sites [13]. These applications in archaeology add to the impressively growing number of scientific applications of GEP and the Google Earth Engine (GEE) in several different fields. There are specific reasons for using GEP instead of GEE in the research context of the present paper. In fact, we need to measure alignments, and therefore azimuths of lines connecting different monuments, with the best possible accuracy. These measures depend crucially on the accuracy of geographical north, which, in GEP, is referred to by the ruler instrument of the program. The author had, in the past, several occasions to verify on the field (thus, with direct measures) the impressive precision of the program’s compass in the areas object of the present study. On the other end, importing satellite images in processing programs (e.g., in AutoCAD) may introduce additional errors [14,15]. We shall also need to control the inter-visibility between selected sites, and the GEP ruler can also be used for this aim since it allows us to calculate the height of the visible horizon along any chosen direction. In fact, the function “show elevation profile” returns a “section” of the altitudes from which the closest maximal height with the corresponding distance can be extracted (Figure 3). The value in degrees of the horizon height, as seen from an observer, is then given by trigonometry.

To ensure an easy reproducibility of the results, an appendix is added (Appendix A), giving the coordinates of all the sites of interest in the present paper.

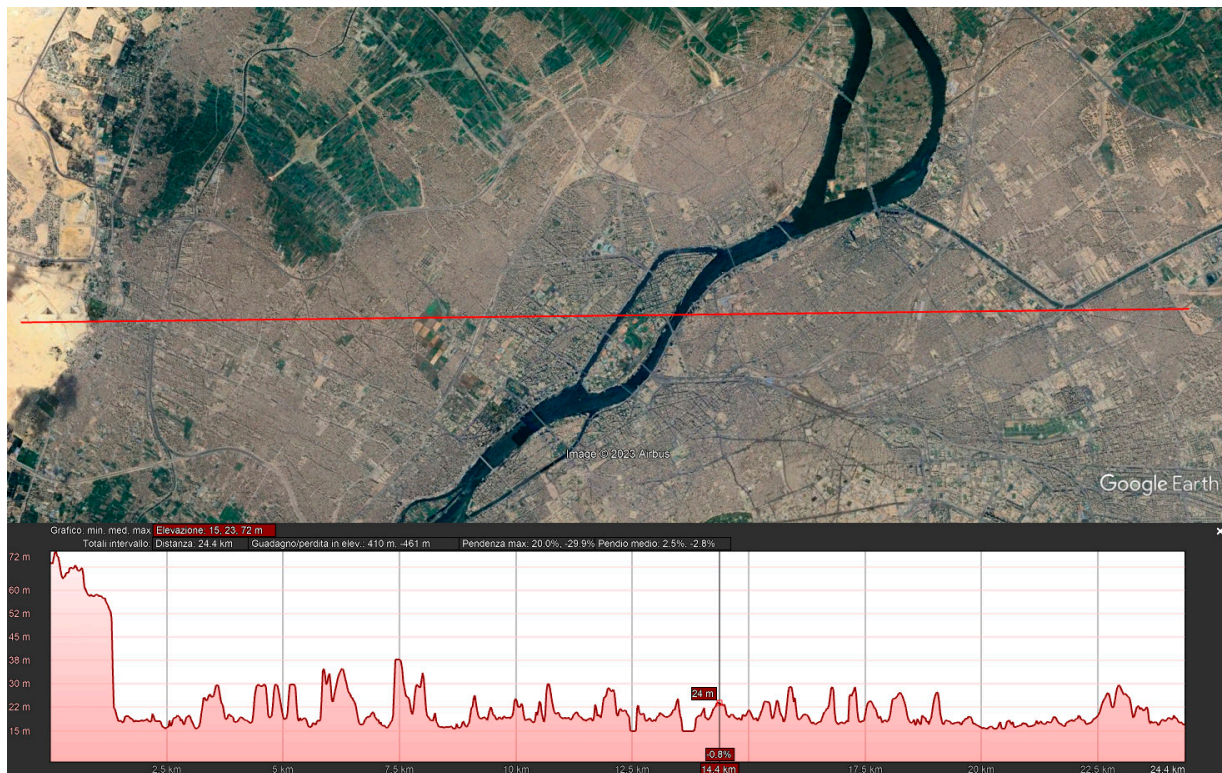
Regarding resolution, the images that have been used cover the areas with a resolution that GEP does not provide directly, but it is possible to obtain it from the producer standards. It can be seen that the Google Earth coverage of the Nile Valley is very good, with resolutions usually of 30 cm. Thus, non-negligible errors are possible mostly because of difficulties in precisely individuating the corners or the centers of the monuments. Overall, we can (very prudentially) estimate a maximal uncertainty of  $\pm 1^\circ$ , a value which is by far sufficient for our purposes.

Finally, an important comment is in order about the very definition of alignment and the method used to recognize it. In fact, fringe publications are plenty of “laylines” that should allegedly and exoterically connect sacred places on Earth. Nothing could be more *distant* than this from the Egyptian idea of alignment as well as, of course, from the contents of the present paper: all the connecting lines discussed in this paper are indeed inter-visibility lines; that is, the extreme points were inter-visible in ancient times (today pollution and buildings obstruct the view, another reason for which the use of satellite imagery is fundamental). The Egyptians designed these lines to pass on explicit messages of power and religion. However, some of these lines crisscross the Nile valley and are up to 25 km in length. Therefore, we need a method to take the earth’s curvature into

account. This can be done by using the so-called horizon formula (a simple consequence of Pythagoras' theorem). A handy version of this formula gives the maximal distance  $d$  in kilometers at which an object of height  $h$  can be seen as

$$d = \sqrt{13h}$$

where  $h$  is expressed in meters. It follows, for instance, that a person 2 m tall has a visible horizon slightly greater than 5 km. However, if the object sighted has a non-negligible height, then the two heights have to be added together. Consequently, to make two points as distant as—say—20 km inter-visible, it was sufficient to use sun-reflecting signals or night fires located on two provisional wood structures, each one 10 m high, and only during the planning phases of the monuments. It goes without saying that this was an easy problem to solve for the builders of stone monuments as high as the Khufu Pyramid (around 146 m tall). Immediately afterward, once the objects being constructed reached a sufficient height, they became clearly and definitively visible along the same lines.

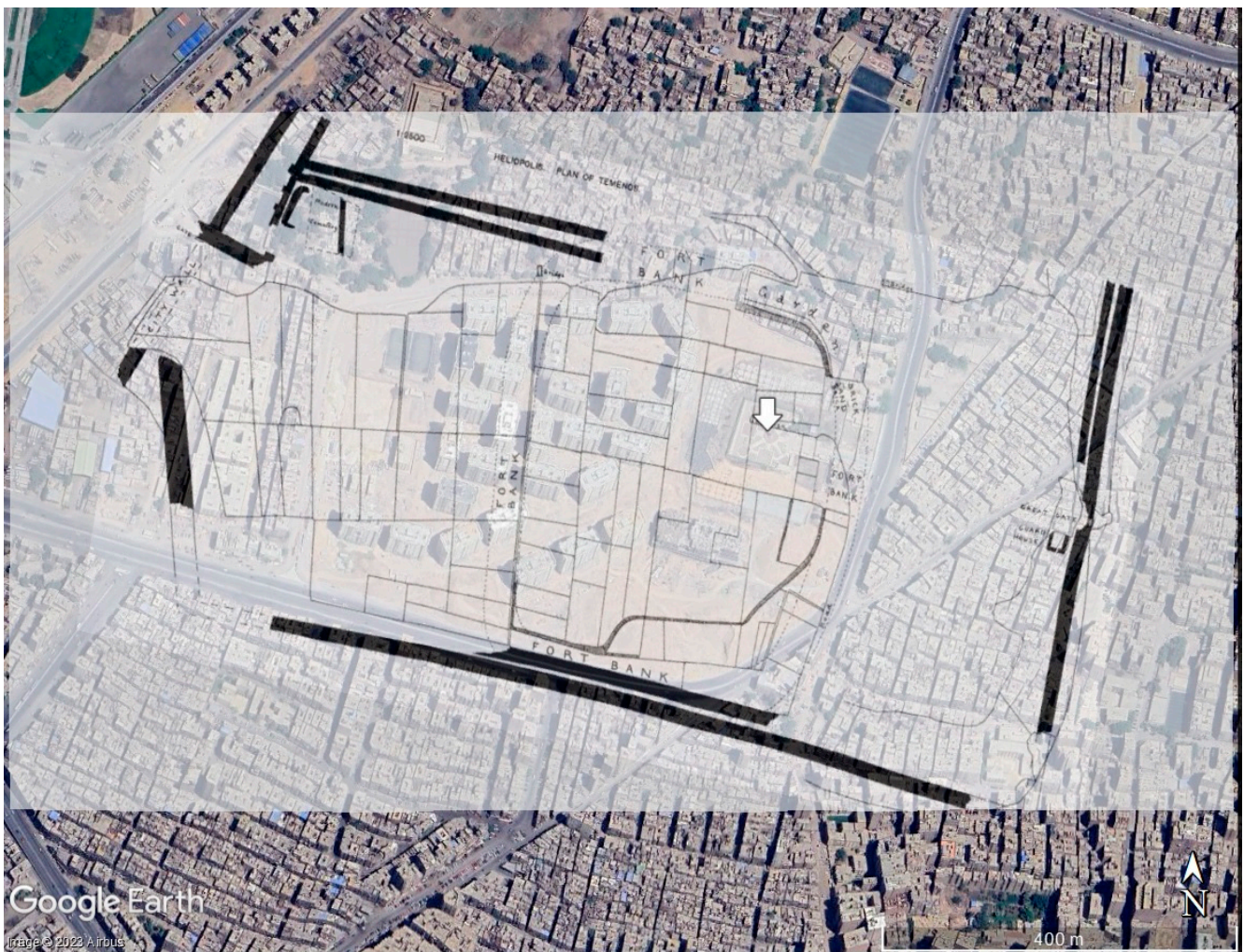


**Figure 3.** One example of the techniques used in the present paper is the alignment of the south-east corners of the Giza pyramids towards Heliopolis, with the corresponding elevation profile (Image courtesy Google Earth (<https://earth.google.com/web/>)).

### 3. Results

#### 3.1. Topographical Alignments at Abusir and Abu Gurab

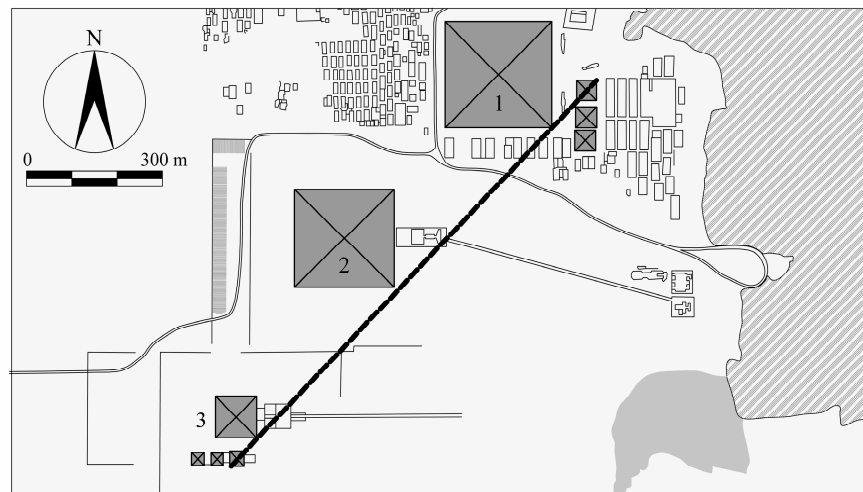
As mentioned, the main cult center of the Sun was the temple of Heliopolis, located on the east bank of the Nile, whose ruins lie under the modern buildings of Cairo in a district known as Mataria. Today, at Heliopolis, only one obelisk remains standing. The obelisk refers to a new sanctuary established by the Middle Kingdom pharaoh Sesostris I around 1968 BC, many centuries after the Vth dynasty. However, the Egyptologist Petrie [16] was fortunate enough to sketch a map of the area when the remains of the temenos walls were visible, and we can overlay his map on Google Earth to obtain a good estimate of the location of the entire complex and its entrances (Figure 4). The main (western) entrance will be taken as a reference point in our maps here.



**Figure 4.** The map of the precinct of the temple of Heliopolis drawn by Petrie overlaid on a Google Earth image of the same area of modern Cairo. The positions of the western and eastern entrances and the huge dimensions of the complex are apparent. The arrow denotes the position of the Middle Kingdom obelisk.

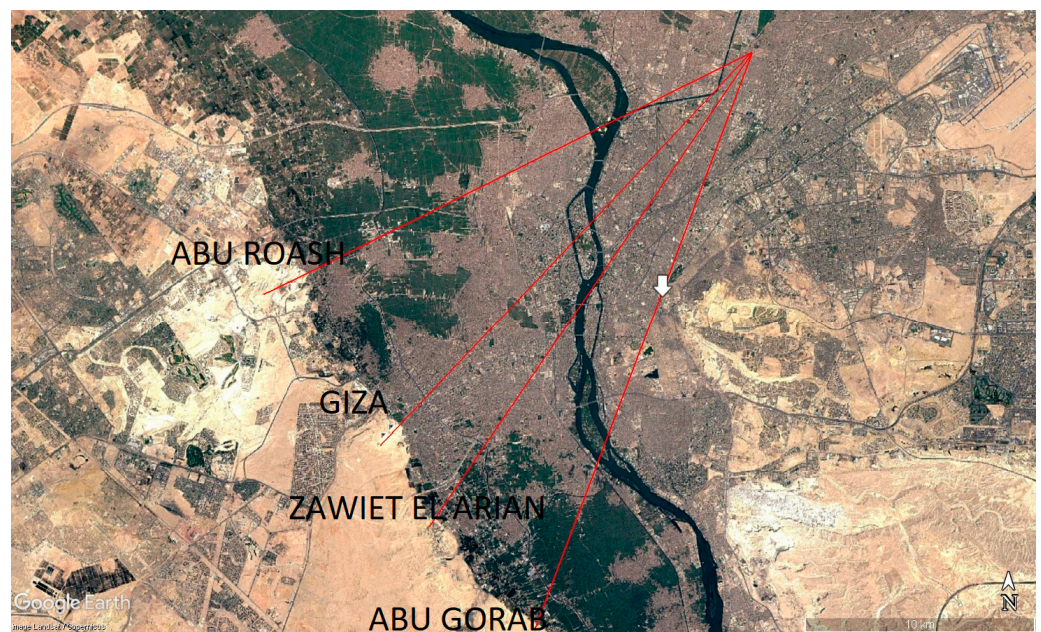
The direct descendants of the kings from the Sun God were symbolically asserted as a geographic provenience from Heliopolis, as stated in the pyramid texts. These texts were written in the internal chambers of the pyramids starting from the end of the Vth dynasty and collect a series of spells and formulae that the deceased Pharaoh had to pronounce to access the afterworld. One of these spells asserts ([17], PT 307), “My father is an Onite, and I myself am an Onite, born in On when Ra was ruler” (On stands for Heliopolis in the Faulkner translation). Therefore, symbolic provenience from Heliopolis was considered of fundamental importance; actually, in the case of the IVth dynasty kings, it can be seen on the ground, at Giza, in a spectacular way [18,19].

Indeed, an alignment oriented south-west/north-east runs along the diagonal of Menkaura’s first queen’s pyramid, touches the south-east corner of Menkaura’s pyramid, follows the diagonal of his funerary temple, passes the south-east corner of the second pyramid court, cuts the diagonal of the fore-temple, touches the south-east corner of Khufu’s Pyramid and very nearly cuts the diagonal of his first queen’s pyramid before projecting all the way across the Nile towards Heliopolis (Figure 5). The land between Giza and Heliopolis is occupied by the Nile valley, so an unobstructed line of sight connected the two places in ancient times (actually up to the 19th century, as testified by some beautiful photographs of the epoch).



**Figure 5.** The Giza Necropolis with the main axis connecting the pyramids of Khufu (1), Khafra (2) and Menkaura (3) highlighted (thickness of the line is exaggerated for clarity).

The idea that the sun temples also should have had a topographical relationship with Heliopolis was explored by several authors [19–21]. These studies were based on inter-visibility and pointed out that looking from Heliopolis towards the west bank of the Nile and gazing progressively to the south, an unobstructed line of sight runs to the IVth dynasty pyramid sites of Abu Roash, Giza, and Zawiet el Arian (allowing, in particular, the sighting in alignment at setting/rising of relevant stars of the Egyptian firmament [7,22]). When the view moves further south, the visibility is blocked by the rocky outcrop located at the north-west extreme of the plateau called Moqattam formation (this outcrop is today occupied by the medieval Cairo citadel) (Figure 6, Table 2). Abu Gurab, the site of the Sun Templetemples, marks the last visible point of the pyramid fields, those of Abusir, Saqqara, and Dahshur being invisible from Heliopolis.



**Figure 6.** Visibility lines between the western entrance to the Heliopolis precinct area and (from North to South) Abu Roash, Giza, Zawiet el Arian, and Abu Gurab. The outcrop of the Cairo citadel is denoted by an arrow.



**Table 2.** Azimuths and lengths of visibility lines to Heliopolis.

Place Name	Azimuth to Heliopolis	Length
Abu Roash (center of pyramid)	63.5°	24.2 km
Giza (axis)	44°	24 km
Zawiet el Arian (center of pyramid's pit)	34.5°	25.5 km
Abu Gurab (center of Userkaf temple)	21°	27 km

These topographical relationships were re-examined by Verner and Bruno [23], who correctly noticed that from the area of the Middle Kingdom obelisk in Heliopolis, only the Niuserra Temple is visible, Userkaf's being actually covered by the citadel's westernmost outcrop. They ventured to say that, as a consequence, there must be another reason for the placing of this temple. What they failed to notice, however, is that the temple in Heliopolis was enclosed in a large temenos wall. This vast sacred area contained, as was customary in Egypt, subsequent additions made by different Pharaohs over millennia. The obelisk is the unique remaining feature but refers to a brand new sanctuary founded by the Middle Kingdom pharaoh Sesostris I around 1968 BC, thus many centuries later than the Vth dynasty. There are doubts even about the precise location of this new temple with respect to the obelisk [24], but in any case, the obelisk cannot be used a priori to identify an area that stretches from east to west some 800 m (this area contained the ancestral temple which was perhaps in the form of a sacred mound). As a matter of fact, moving from the obelisk to the west for 300 m, the temple becomes visible, and in particular, it was visible from the western entrance, which was probably the main one [24] and whose importance is testified by several later embellishments including one of Ramesses III. From the position of the western entrance, the citadel outcrop acted as a sort of collimator for the view of any person who was looking south before entering, attracting the gaze of the Userkaf temple.

The interest of the Vth dynasty kings in topographical alignments to Heliopolis is fully confirmed by their necropolis at Abusir, some hundreds of meters south of Abu Gurab (Figure 7). The necropolis was inaugurated by Sahura, whose pyramid is the first going from north to south. Then we find Neferirkara, which sits in the background to the south-west, and Neferefra, further south-west. These pyramids align on a row that starts with Sahura and proceeds to the desert; if prolonged to the north-east, the axis "points" to Heliopolis but "hits" on the citadel, and therefore, it is not a visibility line [2]. Elsewhere, I have called this curious scenario "symbolic invisibility" [21] because, in spite of the fact that the pyramid's row is located behind the citadel's outcrop, anyone on the opposite bank of the Nile would have been aware of the existence of the Abusir necropolis signaled by the visible Userkaf temple (Figure 8). As a consequence, I proposed that the builders of these pyramids did not need to build a new temple but only made renovations to the existing ones, as already put forward by Stadelmann [24].

When observing the Abusir plateau, the tomb of Niuserra, the second successor of Neferefra, breaks the regularity of the sacred landscape. There was, in fact, no space between Abu Gurab and Sahura (see next section), and it was impossible to go as far in the desert as the positioning of a fourth pyramid along the south-west diagonal would have required. However, the dynastic and the solar lineage of the king had to be shown, and therefore, Niuserra apparently necessitated the construction of two monuments. First of all, the pyramid, placed on the east side of an existing one, that of the king's father Neferirkara, is a quite unique example of intrusive design in a pyramid field. In this way, however, they inaugurated a new dynastic axis. This second Abu Sir axis is a line (first discovered by Lehner [18] but later apparently forgotten up to the present author's study [8]) oriented at ~42° which connects the south-east corner of Niuserra pyramid with the same corner of the pyramids of Neferefra and Neferirkara; on this axis the corner of the Mastaba of Ptahshepses, a very important personage who became a son-in-law of Niuserra, was also placed. Together with the pyramid, the king built (but see next section) a sun

temple located north of Userkaf's one and, therefore, in full view of Heliopolis. In this way, both constraints were satisfied. Proof of this is that—amazing as it may seem—the Niuserra architects even managed to institute yet another Abusir axis [21]. This axis is a line oriented  $\sim 45^\circ$  north of west, which follows the diagonal of the Niuserra pyramid. It then proceeds to the south-west corner of Userkaf's temple and intersects the basis of the obelisk in the Niuserra Sun Temple (Figure 8). This topographical alignment is similar to that connecting the Pyramids of Khufu and Djedefra; there can be no doubt that it was deliberately designed, and it can still be perceived very clearly today if one stands on the obelisk terrace of the Sun Temple and looks towards Abusir. Its function is unmistakable: to establish a “dynastic” link between the funerary complex of the king and his Sun Temple and, by extension, to Heliopolis [19,25].

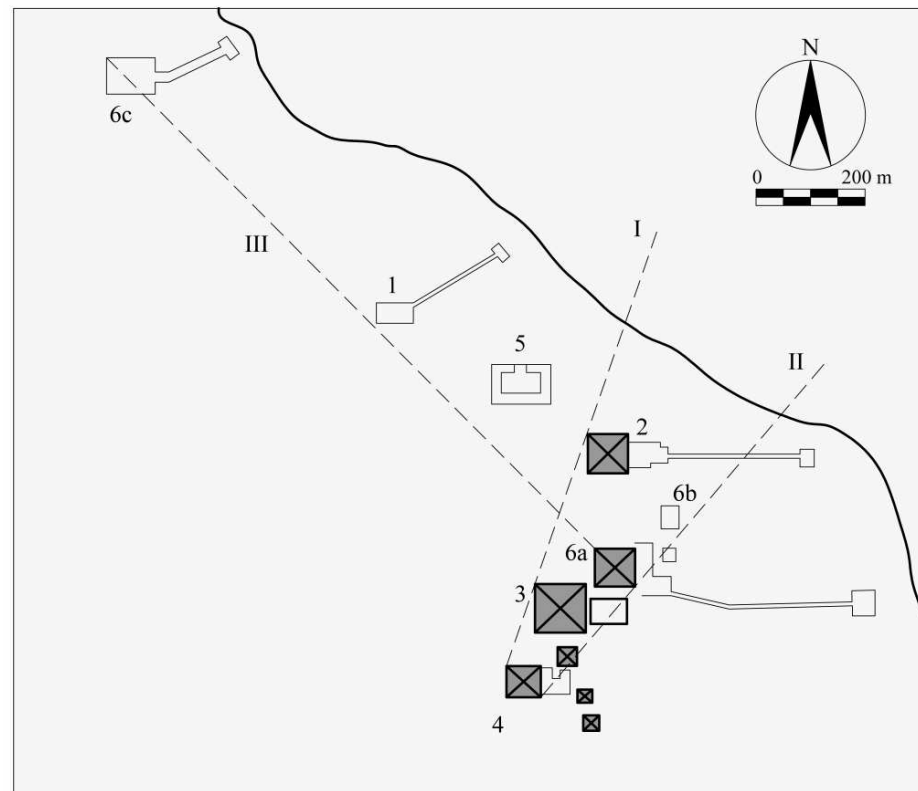


**Figure 7.** The Abusir pyramid's field seen from the platform of the Niuserra temple in Abu Gurab (Photograph by the author).

### 3.2. *The Unexpected Role of King Shesepkara*

It has long been known that, within the chronology of the Vth dynasty, a king called Shesepkara must also be placed and perhaps his role considered within the problem of the Sun Temples. However, he was known only on the basis of a few seals bringing his name and from the Saqqara table kings list. Consequently, he was usually considered an ephemeral king placed between Neferirkara and Neferefra, making him the fourth ruler of the dynasty. The situation started to change when Verner [26,27] convincingly demonstrated that this pharaoh (who, anyway, probably ruled for a very short period) was the successor of Neferefra, ruling before Niuserra. I fully adopt this chronology here, and the king is listed consequently in Table 1.

The pyramid of the king was probably only planned on the ground due to the short reign. An unfinished pyramid at this stage was found between the Sun Temple of Userkaf and the Pyramid of Sahure, and it likely is that of Shesepkara [26]. According to the measures of the leveled base, the finished pyramid would have been very similar to that of Neferirkara. The reason for such a placement of the pyramid is, with all probabilities, the following. As the successor of Neferefra, the king's “correct” place would have been in Abusir, but very far in the desert, in order to align to the pre-existing axis running on the north-west corners of the existing three pyramids. This was judged impossible, but the pyramid had to remain “just invisible” from Heliopolis, and this led to actual choice.



**Figure 8.** Map of the Abu Gurab—Abu Sir area (numbering of the monuments in chronological order). 1—Userkaf Sun Temple, 2/3/4 Pyramids of Sahura, Neferirkara, Neferefra, 5—possible site of the pyramid of Shesepkara 6a Pyramid of Niuserra 6b Mastaba of Ptahasespes 6b Niuserra Sun Temple; The Abu Sir main axis (I) the Niuserra “dynastic” axis (II) and the Niuserra-Sun Temples axis (III) are highlighted.


Of course, the existence of this Pharaoh among those of the Vth dynasty posed a problem if he planned a solar temple as well. It is indeed likely that the Sun Temple, when considered a necessary and new construction, was also considered a complementary building to the pyramid, and therefore, its planning was not delayed with respect to that of the royal tomb. In this respect, it has been proposed—but based only on the tentative reconstruction of a single clay seal—that Shesepkara built (or, better, started to build) a sun temple named *the Heart of Ra is satisfied* [28]. However, this hypothesis has been considered unsuitable by specialists due to the difficulties in a clear interpretation of this single text [27].

The situation has now completely changed due to recent excavations carried out at the Niuserra Sun Temple. These results have been made available by the official bulletin of the Ministry of Antiquities [29]. The mission working at the site found the remains of a building lying under the Niuserra Temple, which was therefore built over it. Scant remains of this previous building are visible, but enough to think that it is indeed one of the missing Sun Temples. However, it is certainly not one among those of Sahura, Neferirkara, and Neferefra because, in the foundations, fragments of clay seals have been found, bringing the name of Shesepkara. These seals, of course, act as a terminus post quem for the building, which is, with all probabilities, the Sun Temple of this last pharaoh. According to our discussion here, the reason for its building is pretty clear: the king was in need of a personal connection to Heliopolis, which was missing due to the location of his pyramid out of the Abusir diagonal. In other words, with the discovery of what likely is the Shesepkara temple, we now know that the reasoning we made for the Niuserra building project was correct but must be shifted back to one pharaoh. As far as Niuserra is concerned, he only needed to rejuvenate the existing temple because his architects managed to trace it to the connecting line we mentioned before.

#### 4. Discussion

All in all, after this complete re-evaluation of the topographical situation at Abu Gurab, we can clarify the building projects of the Vth dynasty as follows.

- (1) Userkaf builds his temple in the very last visibility point from Heliopolis' western entrance.
- (2) Sahura founds the necropolis at Abusir. Userkaf temple signals its existence; he has no need to build a new sun temple, which, therefore, does not exist.
- (3) The very same holds for Neferirkara and Neferefra. They align symbolically to Heliopolis, their pyramids, and have no need for a new sun temple, which, therefore, does not exist as well.
- (4) Shesepkara cannot build his pyramid to the south-west of the third in Abusir, as it would have been too far in the desert. He then starts building to the north of Sahura but breaks the Heliopolis rule, so he needs a new sun temple at Abu Gurab.
- (5) The situation on the ground for Niuserra was really worse: impossible to add a pyramid to the row and no space to the north. His architects managed a clever, albeit intrusive, solution: a new dynastic line and a new connecting line with an existing temple, which was, therefore, renovated without the need for a new one.

The above-described results look as a definitive picture of the way sacred topography governed the Vth dynasty monuments and strongly point to the non-existence of the Sun Temples of Sahura, Neferirkara, and Neferefra, as well as showing the existence of an unexpected one, that of Shesepkara. The situation remains open only for Niuserra's successor, Menkahour, as he was probably interred in a pyramid in Saqqara. As a consequence, he might have been in need of a Heliopolis connection with a new temple. The name of this temple, the Akhet of Ra, evokes the beautiful hierophany connected with the name of the Khufu pyramid (the Akhet of Khufu), which occurs every year at the summer solstice [18,30–32]. A hierophany, or "manifestation of the sacred," is any event in which the sacred reveals itself: it can be simply a procession in which the statue of a God is shown, but it can be connected with an astronomical alignment, and therefore occur only in fixed dates of the year. In the Giza case, a gigantic image of the hieroglyph  -Akhet is recreated by the Sun setting between the two main pyramids. Akhet was a symbolic horizon composed of two "mountains" with the Sun rising or setting in between, the place where the king united with the Sun God. This name for a temple is unusual, and we may suppose that it directly alludes to an Akhet hierophany visible from it. Following this idea—at a purely speculative level—I would like to propose that this unique missing temple might really be in a position that is almost natural and already hinted at by many Egyptologists: the zone between the Userkaf and the Shesepkara/Niuserra temples in Abu Ghorab [33].

To see this, we should first recall that the Egyptian calendar was 365 days long. As a consequence, it wandered along the tropical year at a rate of almost 1 day every four years, and the same, of course, holds for *Wepet Renspet*, New Year's Eve. The exact date of the start of the calendar is still a subject of debate, but what is certain is that it was at the summer solstice around the middle of the 28 century BC. It follows that the New Year's Day coincided with the spring equinox around 2400–2390 BC. The exact dates of accession of the Pharaohs are still a subject of debate as well, but Menkahour's reign should be placed some tens of years later (for instance, ref. [34] gives 2373–2366 BC). Therefore, New Year's Day should have occurred some 6–8 days before the Spring equinox during his reign. The second ingredient to be taken into account is the fact that the pyramid of the king is very likely the so-called Headless pyramid, located in Saqqara close to the complex of Teti I (built by the second pharaoh of the VIth Dynasty, reigning about one century later). The temple of Teti I, in turn, is the unique pyramid temple of the Old Kingdom, which is not oriented to the cardinal points; it has been shown [31] to be orientated to the single topographical feature of the otherwise almost flat eastern horizon of Saqqara, the entrance of a dried river (Wadi Hof) on the opposite bank of the Nile. This natural feature recalls the sign Akhet when the sun rises in between it, which, as recalled above, is the main

hierophany occurring in Giza (a very similar choice will be made, many years later, by the architect planning Amarna, the capital of the “heretic” pharaoh Akhenaten). However, the dates at rising do not appear to be significant during Teti’s reign, but the dates of setting in the opposite direction are, since one of the two is around 1 March, close to the date of Wepet Renpet. Finally, an interest in the sun rising at Wepet Renpet has already been suggested to explain the slightly skewed orientation of the altar of the temple of Niuserra with respect to the main building [31].

Combining these observations, we are led to consider the possibility that the Sun was seen to rise in Wadi Hof from Menkahour temple on New Year’s Day, forming at the horizon the very name of the king’s Sun Temple, the Akhet of Ra. Perhaps this was the inspiration for the anomalous (subsequent) orientation of the Teti complex, which, as we have seen, is close to the pyramid attributed to Menkahour. For all this to be true, the azimuth from the presumed position of the temple to Wadi Hof should correspond to the azimuth of the Sun some 6–8 days the before Spring equinox, and an area on the west bank of the Nile can be individuated satisfying this requirement. This area turns out to fit well with the one mentioned above, between Userkaf and the Shesepkara-Niuserra temple (for example, the azimuth of Wadi Hof from the point between the two temples is around 95°, corresponding to the Sun rising around 12–13 March).

To conclude, the scenario that arises from the present paper leads us to interpret the enigmatic buildings called Sun Temples in a coherent way. Their main function was to act as “signposts” marking from the west bank of the Nile—the place of the royal Necropolis—the close connection of the Pharaohs of the Vth dynasty with the Sun God “residing” in Heliopolis on the east bank. Only the Pharaohs whose pyramid was not symbolically connected with Heliopolis needed a new temple: Userkaf, Shesepkara, and Menkahour, and therefore, we suggested that only three temples were constructed. Future excavations may be of help in confirming (or disproving) this interpretation and, in particular, might confirm or disprove the proposed location of the third temple with respect to the Wadi Hof.

In any case, I would like to stress that the results of the present paper show once again that there is no exoteric knowledge, and there are no hidden secrets in ancient Egyptian sacred topography. It is exactly the opposite: the kings wanted to make glaringly visible their connections with chosen predecessors and/or the Sun God. Their architects worked so well that we can manage, using simple but powerful remote sensing tools, to still see these connections today in spite of pollution and the growth of modern Cairo.

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## Appendix A

**Table A1.** Coordinates location of the monuments and places discussed in the paper.

Site	Coordinates
Pyramid of Djedefra (Abu Roash)	30°01'56" N 31°04'29" E
Pyramid of Khufu (Giza)	29°58'45" N 31°08'03" E
Pyramid of Zawiet el Arian	29°56'24" N 31°9'5.6" E
Niuserra Sun Temple (Abu Gurab)	29°54'14" N 31°11'37" E
Userkaf Sun Temple (Abu Gurab)	29°54'00" N 31°11'56" E
Pyramid of Sahura (Abusir)	29°53'51" N 31°12'12" E
Heliopolis (West entrance)	30°07'46" N 31°18'07" E
Wadi Hof	29°53'27" N 31°20'19" E
Coordinates location of the monuments and places discussed in the paper	

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