



# ARCHAEOASTRONOMY AND ARCHAEO-TOPOGRAPHY AS TOOLS IN THE SEARCH FOR A MISSING EGYPTIAN PYRAMID

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## ABSTRACT

Among the royal pyramids of the 6th Egyptian Dynasty, that of the second king, Userkare, is missing. This Pharaoh, however, ruled long enough – two to four years – to plan his pyramid on the ground and have the workers excavate the substructure. Userkare's unfinished tomb might therefore be buried in the sands of the Memphite necropolis, possibly with a copy of the Pyramid Texts carved on its walls. In the present paper, methods based on archaeo-topography and archaeoastronomy have been applied with the aim of finding the possible location of the building site of this monument.

## Introduction

Userkare was the second Pharaoh of the 6th Egyptian Dynasty, ruling between Teti and Pepi I; he may have been a usurper of the royal line (Kanawati, 2002). His existence is fully corroborated by several independent sources, including the South Saqqara Stone list (Baud & Dobrev, 1995).

Userkare's reign most probably lasted two to four years, around 2334 BC according to Baines & Málek (1984) chronology. The planning of a king's pyramid usually commenced immedi-

ately after accession, and therefore this lapse of time is sufficient to let us believe that at least the first stages of the construction of the funerary monument of Userkare were already underway at the time of his death. And yet Userkare's pyramid is missing from the known royal pyramids of the 6th Dynasty. There are two other missing royal pyramids of the same period, those of the 5th Dynasty kings, Shepsekare and Menkauhor. For these pyramids, however, we have at least likely candidates: a foundation trench at Abusir for the former, and an anonymous pyramid (Lepsius no. 29) in the Saqqara

central field for the latter. If we reject as unlikely the idea that the construction of Userkare's pyramid was never started, then there is a distinct possibility of finding its building site buried in the desert sand. Although we can rule out the possibility of finding the burial place undisturbed, unveiling the tomb might be helpful in solving historical problems connected with Userkare's accession and kingship. Further, it should be noted that, as soon as the plan of a pyramid was surveyed on the ground, the excavation of the funerary apartment could begin. A few years would definitely give sufficient time for the rock-carved substructure (which was very simple in the 6th Dynasty: a descending corridor leading to an antechamber/chamber system underground) to be completed. Interior chambers began to be inscribed with the Pyramid Texts with Unas, the last king of the 5th Dynasty, and all known royal pyramids of the 6th Dynasty have them on their walls (Lehner, 1999; Verner, 2002). Consequently, a hitherto unknown copy of the texts might well be located in the king's burial site.

The place to look for Userkare's pyramid is, of course, Saqqara, where all the known pyramids of the kings of the Old Kingdom from Unas onward are located. In particular, the pyramids of the two immediate successors of Userkare, Pepi I and Merenre, were built in an area of the Saqqara plateau located a couple of kilometers south of the central field, so that it is here that research should be concentrated. Recently, French archaeologists operating in this area have made brilliant discoveries: the progressive uncovering of the pyramids of the queens of Pepi I (Berger-El-Naggar, 2005; Berger-El-Naggar & Fraisse, 2008) with fragments of Pyramid Texts (<http://msaqqara.free.fr/index.htm>), and a new necropolis of 6th Dynasty dignitaries located in the so-called 'Tabbet al-Guesh area', to the north-west of the Pepi I complex (Dobrev, 2004; 2008).

Although the name of Userkare does not appear anywhere in these tombs, the presence of this necropolis is a strong hint that there may be a pyramid located nearby, and geo-radar surveys have revealed the presence of two adjacent, north-south oriented, squared structures underneath. It may be that they are the foundations of a pyramid and of its funerary temple (Dobrev, 2008). However, according to the

geo-radar results, the funerary temple would in this case be located north of the pyramid. The north side of a pyramid was usually left free to allow the symbolic connection of the entrance with the northern stars (Edwards, 1952). The only example of a temple located to the north of a pyramid is that of Djoser's Step pyramid, constructed some 300 years before Userkare, around 2630 BC. In this specific case, though, the symbolic connection of the complex with the northern stars is assured by a special structure, the serdab, a sealed room containing a statue of the Pharaoh. The eyes of the statue indeed look towards the stars of the Egyptian constellation of the bull's foreleg Meskhetiu (our Big Dipper) through two holes drilled in the masonry of the wall (Belmonte, Shaltout & Fekri, 2008). For these reasons, in the present author's view, the structure beneath Tabbet al-Guesh, rather than being a pyramid, may turn out to be a double-tomb, like the so-called 'Lepsius 25 complex' located in Abusir (probably dating to the end of the 5th Dynasty [Krejci, 2001]).

It is the purpose of the present work to propose a specific, different zone of Saqqara south as the possible location of Userkare's monument. In making this suggestion, I shall follow an argument – admittedly speculative – that is based on the results of a project, which attempted a complete analysis of the astronomical and topographical features of the 'sacred space' of the pyramid fields of the Old Kingdom.

### Topographical Patterns before Userkare

In recent years, several studies have been carried out with the aim of better understanding the topographical and astronomical patterns, which connect Dynastically-related monuments of the Memphite area. These patterns appear to have been inspired by a perception of the whole area as a sacred space in Eliade's (1978) sense, as will be made clear below.

The first of such patterns has been common knowledge at least since the 19th Century, but its importance has been stressed only relatively recently (Goedicke, 2001; Jeffreys, 1998; Lehner, 1985; Magli, 2009b). It is the presence at Giza of a 'main axis' directed to the spot where the Sun temple of Heliopolis once stood, on the opposite bank of the Nile. This axis runs across the south-east corners of the main pyramids, which therefore align along a north-east/south-

west axis 'proceeding' into the desert. Although Heliopolis is fairly distant (about 24 kilometers to the north-east), the pyramids are so high that earth's curvature did not hamper the view (today, pollution and buildings do). The Giza axis reflects the connection between religion and power during the 4th Dynasty, since Heliopolis was the main center of the Sun cult, and probably Khufu and his descendants claimed for themselves a direct lineage from the Sun God (Hawass, 1996; Stadelmann; 1991).

The Czech mission working at Abusir, the building site of the pyramids of the 'solar' kings of the 5th Dynasty, discovered that a similar axis also exists there, 8 km to the south of Giza. The Abusir axis connects the (north-west in this case) corners of the pyramids of three kings (Verner, 2002) and points to Heliopolis as well; the rocky outcrop of the Cairo citadel blocks the direct view to Heliopolis (Jeffreys, 1998; for a complete discussion see Magli, 2010b).

Finally, it has recently been shown (Magli 2010a) that a symbolic pattern – already hinted at by Lehner (1999) and Goedicke (2001) – was

in action also in the project of king Unas, the last king of the 5th Dynasty. Since this project is of direct relevance for the present paper, I shall now recall its main features.

The pyramid of Unas is located near the south-west corner of the precinct of Djoser's Step Pyramid, quite a distance from the Nile floodplain. Consequently, the builders had to construct a very long (more than 700 m) causeway connecting the complex with the valley temple. To do this, they had first to 'clear' the area near Djoser's south wall, which was already overcrowded with pre-existing mastabas and even some royal tombs of the first Dynasties. Some tombs were consequently filled with earth, and some mastabas completely dismantled.

Unas must have had a very important reason for choosing such an inauspicious building site, and such a reason clearly had nothing to do with practical purposes. The first clue comes from Lehner (1985; 1999) who noticed the existence of a 'Saqqara axis' (figure 1). The Saqqara axis is a line oriented roughly north-

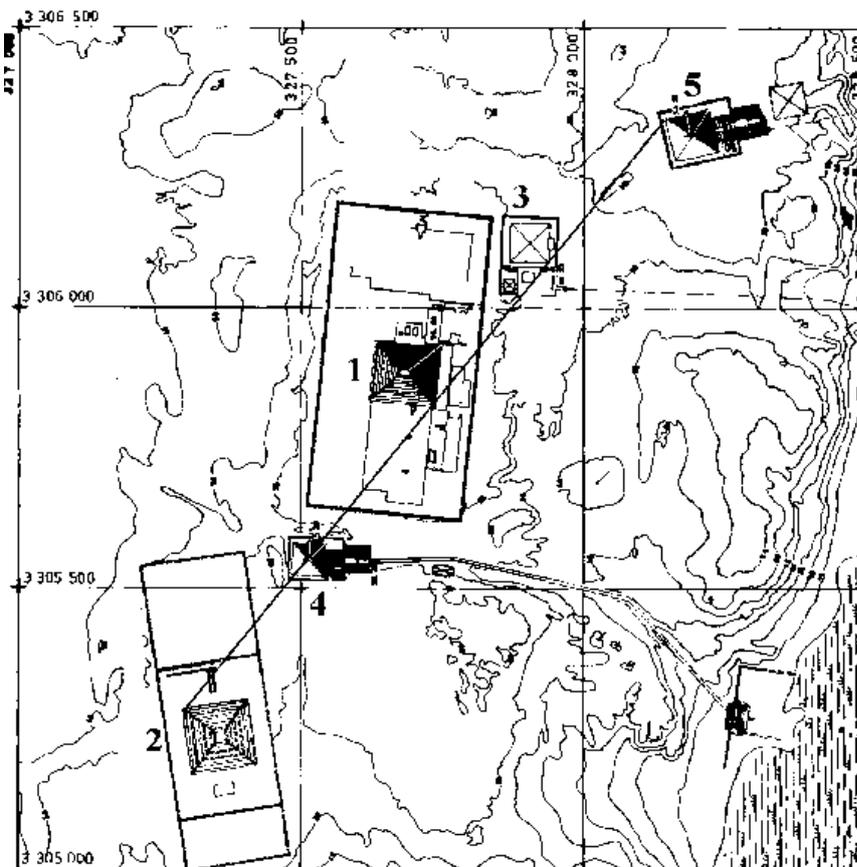


Figure 1. Topographical map of the Saqqara central field with cardinaly-oriented grid. The 'Saqqara axis' is highlighted (numbering of the monuments in chronological order). 1: Djoser Step Pyramid; 2: Unfinished pyramid of Sekhemkhet; 3: Pyramid of Userkaf; 4: Pyramid of Unas; 5: Pyramid of Teti. Diagram by the author.

east/south-west which connects the south-east corner of Userkaf's (first king of the 5th Dynasty) pyramid with the south-east corner of Djoser's pyramid and then crosses over Unas' north-east/south-west base diagonal, ending at the north-west corner of the (unfinished) 3th Dynasty pyramid of Sekhemkhet. It is difficult to ascertain the azimuth of this line accurately; bearings taken with a precision magnetic compass (accuracy around  $\frac{1}{2}^\circ$ ) give a value  $\sim 39^\circ$  east of north.

There can be no possible doubt (at least in the present author's view) that it was precisely the desire to align his pyramid to Djoser's and Userkaf's monuments that impelled Unas to his tour de force. Furthermore, although the side base of the monument (57.7 m) is the smallest among all the royal pyramids – implying considerable economy in its construction – the monument is also the one with the steepest slope (the slope was of course chosen with the help of rational fractions, and Unas' is  $\frac{3}{2}$ ). This implies that the pyramid rose to the respectable height of 43 m (Lehner, 1999). The likely reason for this choice is the following. The inspiring principle of the project, far from being 'hidden', was meant to be recognisable by anyone approaching the plateau. However, the wall of

the Step Pyramid complex obstructed the view of the lower courses of Unas' pyramid, which was, therefore, planned to be as high as possible (probably to increase visibility slightly, the alignment was designed along the diagonal of the base).

The problem then arises as to the meaning of such a huge effort. There can be little doubt about: after Unas' works, the placement of the three pyramids of the Saqqara central field resembles that of the three pyramids of Giza, aligned along a north-east/south-west axis, as mentioned before. At Saqqara, the axis does not point to Heliopolis, because its azimuth is similar to that of Giza, while the site is 15 km to the south-west (Heliopolis would have been invisible in any case, due to the Moqattam formation which blocks the view from all sites south of Abu Gorab). This similarity has therefore to be understood as an ideal relationship with the pre-existing Giza monuments.

The first to notice a Saqqara-Giza analogy was Goedicke (2001), who observed that an unobstructed line of sight connects the Userkaf pyramid with that of Khufu, crossing over the Userkaf's sun temple in Abu Gorab (figure 2). Today this temple has almost been erased, but at that time it was surmounted by a huge



Figure 2. A satellite image of the Memphite area. Lines connecting the Giza pyramids of Khufu (G1), Khafre (G2) and Menkaure (G3) respectively with the Userkaf (S1), Djoser (S2) and Unas (S3) pyramids in Saqqara are shown. Given the pre-existing (of course casual) G2-S2 line, the G1-S1 line may have inspired the choice of Userkaf's building sites; it actually crosses Userkaf's sun temple located in Abu Gorab (denoted by T). After more than one hundred years, Unas added his pyramid in accordance with the pre-existing topography (G3-S3 line). This image is shown here only as a visual aid to identify the 'Saqqara-Giza' analogy; the connection was indeed (and partially still is) clearly perceptible on the ground, because the length of the lines is about 14.5 kilometers and therefore they allow direct inter-visibility. See text for full details. Diagram by the author. Courtesy of Google Earth.

(non-monolithic) obelisk. If other sight-lines are traced between the summits of Djoser's and Unas' pyramids and the apexes of Khafre's and Menkaure's monuments respectively, the fact that Unas' project was conceived with the aim of recreating a sort of (rough) copy of the arrangement of the Giza pyramid field becomes clear. These lines are in fact about 14.5 km long (and therefore allow for direct visibility) and, though not parallel, their relative deviation is relatively small (about 2° if measured with a satellite map).

If prolonged north-west, the Saqqara axis touches the north-west corner of Teti's pyramid (Lehner, 1985). Teti was Unas' successor, and therefore the 'natural' position for his pyramid would rather have been to the south-west of Unas, in an area very far off in the desert and partly occupied by Sekhemkhet's complex. On the other hand, the outcrop of the Saqqara ridge north-west of Userkaf pyramid was free, as well as convenient from a practical viewpoint. Interestingly, however, it was decided to try to respect the 'Dynastic' perspective of the pre-existing axis, and probably for this reason it is the north-west corner of the pyramid which lies on the pre-existing line. Another 'mystery' of the Teti project is the fact that the pyramid complex is badly aligned with respect to the cardinal points; recently, however, it has been shown that this is probably due to a solar – as opposed to stellar (see below) – orientation of the complex (Belmonte *et al.*, 2008).

### Topographical Patterns after Userkare

At Teti's death and Userkare's accession, in the area of Saqqara south – extending from the central field down to the huge tomb of the 4th Dynasty king Shepsekaf, today called Mastaba el Faraun – there were no royal complexes present. An exception is the complex of the 5th Dynasty king Djedkare located on a favorable spur very close to the ridge of the plateau, 2.6 km south of Teti's. As mentioned, we do not know where Userkare's pyramid was planned; his successors Pepi I, Merenre and Pepi II all choose the area initiated by Djedkare for the building of their monuments.

In the planning of these pyramids – in addition to a probable, new 'diagonal axis', see below – a new kind of topographical pattern also emerges. In fact, the positions of the three mon-

uments appear to have been chosen according to 'meridian' axes. Such lines run from north to south, in the sense that each new monument has been constructed due south of an existing one in the Saqqara central field. Indeed, the three 6th Dynasty pyramids are located in such a way that (figure 3):

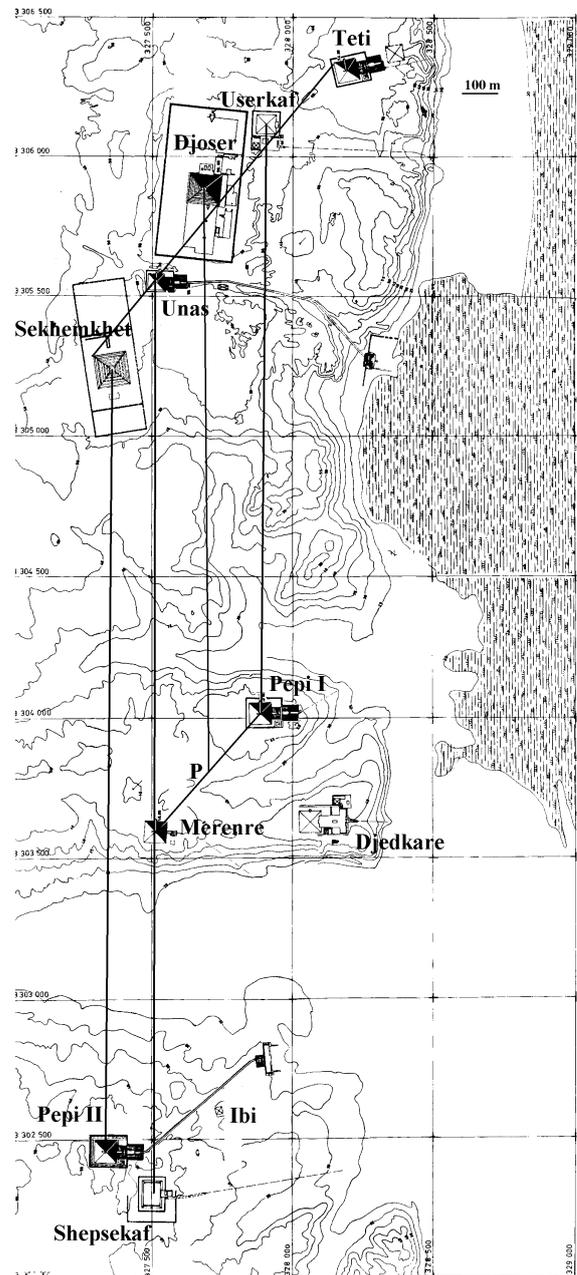


Figure 3. Topographical map of Saqqara with cardinal-oriented grid. The 'Saqqara axis' is highlighted and the meridian alignments connecting its monuments with those at Saqqara south are drawn: Pepi I-Userkaf; Merenre-Unas, Pepi II-Sekhemkhet. Finally, the 'diagonal' axis Pepi I-Merenre is also highlighted. The possible position of Userkare's pyramid on this axis, in meridian alignment with the Djoser pyramid, is denoted by P. Diagram by the author.

- the apex of Pepi I aligns with that of Userkaf;
- the apex of Merenre aligns with that of Unas. This alignment extends to the south to the pre-existing Shepsekaf Mastaba;
- the apex of Pepi II aligns with the apex of the last pyramid of the Saqqara axis, that of Sekhemkhet.

The accuracy of such alignments is quite good, especially for the first two as already noticed by Goyon (1977) (the third suffers from the approximation in locating the center of Sekhemkhet's pyramid). Bearings taken by the author on site with a precision magnetic compass (of course taking into account magnetic declination) give an accuracy within  $\frac{1}{2}^\circ$ ; the same holds if a topographical (1:5000) map of the site is used. Finally, as a double-blind control, the same lines can be traced on high definition satellite images such as those provided by the Google-Earth Program. Distortion effects due to 3D rendering, which are the major source of errors in this kind of analysis (Potere, 2008; Redzwan *et al.*, 2007), are not to be expected for the Saqqara plateau, so that the program gives quite reliable results; the accuracy of the alignments checked in this way again appears to be well within  $\frac{1}{2}^\circ$ . To ascertain if, in their planning of the Saqqara south monuments, the 6th Dynasty surveyors attained an even higher precision – comparable to that achieved for the sides of the pyramids of Khufu and Khafre at Giza, which is within  $10'$  (Dorner, 1981) – a new survey of the site with high-precision instruments would be needed.

The existence of 'meridian' alignments raises the issue of their interpretation. It should be observed that to plan such alignments the use of astronomical sightings was required, in order to find true north and then to collimate the position with that of the pre-existing monument. Determination of true north actually appears to be a key component of the architecture of the pyramids from Meidum onward (Belmonte, 2001; Spence, 2000; Magli & Belmonte, 2009). It was probably carried out with nocturnal observations aimed at the transit of 'imperishable' stars, *i.e.* either circumpolar or anyway sufficiently close to the North Pole to be visible each night of the year. Besides their practical function, these stars are repeatedly mentioned in the Pyramid Texts and play a key role in the 're-birth' process of the king (Krauss, 1997). Thus, we might conjecture that the 'meridian axes' at

Saqqara had a 'stellar' origin, as opposed to the Giza and Abusir axes which, being oriented towards Heliopolis, have a 'solar' character.

To proceed further, let us now look at the relative arrangements of the Pepi I and Merenre pyramids (figure 3). The Merenre project was located to the south-west of Pepi I, in such a way as to place the pyramid along the diagonal of the latter. As for the Saqqara central field, it is difficult to estimate precisely the bearing of this axis, which is about  $41^\circ$  east of north and as such is roughly parallel to the Saqqara axis. Taking into account the meridian alignments mentioned before, we see that there is a symmetrical connection between the Pepi I/Merenre complexes and the complexes placed at the two ends of the Unas project, namely Unas' and Userkaf's. This leads us to suspect that in the projects of the successors of Teti there was the intention of creating yet another 'diagonal' alignment of pyramids, this time conceived as a 'southerly replica' of that of the Saqqara main field. To check if such a hypothesis is correct, we have to study the location of the pyramid of the successor of Merenre, Pepi II.

The 'natural' position of his pyramid in accordance with the above-described idea would have been to the south-west of Merenre, along the Pepi I-Merenre diagonal alignment, with the apex in meridian alignment with the last pyramid of the Saqqara 'diagonal', that of Sekhemkhet. As already mentioned, this second requirement was met; it was, however, impossible to satisfy the first because the Pepi I-Merenre 'axis' ends in a *wadi* (dry riverbed) which runs west-east to the immediate south of Merenre's complex; building a pyramid there would have been inadvisable. The king's tomb was constructed to the immediate south of this area, near Shepsekaf's monument. With the choice of this position he could of course take advantage of the pre-existing, 4th Dynasty causeway (Barta, 2005). Yet the geology of the area is unfavorable, and the pyramid was probably subject to structural problems. This led to the construction of a mud-brick 'bandage wall', which seems to have retaining functions rather than artistic (Lehner, 1999). To avoid similar problems Shepsekaf's mastaba was built on an artificial terrace; actually, also this monument (constructed around 2500 BC) was probably located in such an inauspicious area for symbolic rather than practical reasons (Magli, 2010a). Pepi II could

well have chosen a more easterly position for his building site, possibly also along Shepsekaf's causeway (later, the small pyramid of Ibi was constructed in this way) or even a position to the north of the *wadi*. Since it is unlikely that the king wished to construct his pyramid there to assert how close his ideas or traditions were to the remote king Shepsekaf, the more likely reason for his choices seems really to be the intention of 'deviating' as little as possible from the pre-existing north-east/south-west arrangement.

At this point, if we accept the above scenario as being non-casual, then a curious chain of facts emerges. Indeed, Pepi I – allegedly the first king to put a pyramid in 'meridian alignment' with a pre-existing one – choose that of Userkaf, in spite of the fact that Djoser's pyramid was by far the most important and revered pyramid at Saqqara. An alignment with Djoser would have implied a building site some 200 meters west, without creating any serious logistical problems. After Pepi I, Merenre also rejected the position in meridian alignment with Djoser's pyramid, and aligned the apex of his pyramid with that of Unas. Finally, Pepi II avoided this location too, and moved further to the south-west, aligning the apex of his pyramid with that of Sekhemkhet.

Why? Clearly, there exists the possibility that the position in meridian alignment with the Step Pyramid was not available, insofar it was occupied by the unfinished project of Userkare.

I would therefore suggest that what remains of the Userkare tomb can be located approximately in the middle of the line connecting Pepi I and Merenre's diagonals, in the position denoted by (P) in figure 3.

## Conclusions

It is difficult to imagine that the meridian alignments of the three 6th Dynasty pyramids at Saqqara south with the corresponding pyramids of the central field are purely coincidental. As we have seen, it is highly probable that they were obtained as a result of nocturnal observations of the 'imperishable' stars, which in turn played a fundamental role in the 'rebirth' rituals described in Pyramid Texts. The 'sacred space' of the Saqqara necropolis was thus crisscrossed by invisible lines aimed at harmonising

the newly constructed monuments with the pre-existing landscape. This 'harmonisation' included the northern sky, with its symbolic content, but also what could be called the 'Dynastic' landscape, that is, exploiting Dynastic – blood, or ideal – relationships with previous rulers by means of topographical and visual references to their monuments.

Nevertheless, the proposal I am advancing regarding Userkare's tomb naturally remains highly speculative. Fortunately, it is relatively easy to test its validity on the ground, using non-intrusive methods such as radar-based techniques, and I certainly hope that this can be done in the near future. For the time being, I believe it is important to stress yet again that the results presented here do not hint at any kind of 'esoteric' knowledge concealed in the architecture of the ancient Egyptians. Quite the opposite, at least in the author's view, what we have here is an example of that sacred space Mircea Eliade was speaking about. Indeed Eliade once said that the symbolism contained in the ancients' sacred space is so "old and familiar" that it may be difficult for us to recognise it. The topographical relationships between the pyramids at Saqqara were perfectly visible, even familiar, we might say, to any pious person approaching the royal necropolises, the places where the cults of the dead Pharaohs were practiced.

As a matter of fact, many of the ideal lines which visually connect such sacred places can still be clearly perceived, after 4500 years, by anyone visiting the pyramid fields today (figure 4).

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Figure 4. A photograph taken from the area immediately south of the Unas pyramid, visible in the foreground. The 'Saqqara axis' connecting Unas' diagonal with the south-east corners of the Step (middle) and Userkaf (background) pyramids can still be clearly perceived, in spite of the bad state of Unas' and Userkaf's monuments. Photograph by the author.

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