Trabajos de Egiptología

Isfet
EGIPTOLOGÍA E HISTORIA

Centros de Estudios Africanos
Universidad de La Laguna

ISSN 1695-4750
9 771695 475008

12 2021
Trabajos de Egiptología

Trabajos de Egiptología
Papers on Ancient Egypt

número 12
2021

The Dual Solar (Solstitial) and Cardinal Orientation in Planning the Middle Kingdom Funerary Complexes in Qubbet el-Hawa

Juan Antonio MARTÍNEZ HERMOSO, Antonio T. MOZAS CALVACHE,
José Luís PÉREZ GARCÍA

The Qubbet el-Hawa necropolis, located on the west bank of the Nile, was the burial site chosen by the elite of Elephantine, from the Old Kingdom to the Middle Kingdom, and became one of the most important provincial cemeteries in the country. The hill affects the course of the River Nile and determines the disposition of the hypogea distributed between its two slopes (southeast and northeast). Therefore, the topography (and the river) determined the alignments of most of the tombs. During the Middle Kingdom, although only six large funerary complexes were built, there was a very significant change in the architecture of the necropolis in terms of the design of the burial chapels (which were planned as if they were a funerary temple), as well as the accuracy of the construction methods. In addition, they stand out because they were planned (and built) with a strongly symbolic double orientation, which is the subject of this study. The astronomical alignments of these funerary complexes, normally associated with royal temples and burials, appear to have been appropriated by the governors of Elephantine, lower-level officials, which has implications for our understanding of both Egyptian governance and Egyptian astronomy; undoubtedly, the architects had to possess knowledge of astronomy. The result is that these funerary complexes represent a clear example of “cultured” architecture carried out in a provincial cemetery. This article examines in detail the alignments of four of these funeral complexes: QH36, QH32, QH31 and QH33, building on the work of Belmonte and his collaborators in Qubbet el-Hawa, who are primarily responsible for increasing our data of Egyptian astronomical alignments.

La doble orientación cardinal y solar (solsticial) en la planificación de los complejos funerarios del Reino Medio en Qubbet el-Hawa
La necrópolis de Qubbet el-Hawa, situada en la orilla occidental del Nilo, fue el lugar de enterramiento elegido por la élite elefantina, desde el Reino Antiguo hasta el Reino Medio, convirtiéndose en uno de los cementerios provinciales más importantes del país. La colina condiciona el curso del río Nilo y determina la disposición de los hipogeos que se distribuyen entre sus dos vertientes (sureste y noreste), adaptándose a su topografía. Por tanto, la topografía (y el Nilo) determinaron las alineaciones de la mayoría de las tumbas. Durante el Reino Medio, aunque solo se construyeron seis grandes complejos funerarios, se produjo un cambio muy significativo en la arquitectura de la necrópolis tanto en el diseño de las capillas funerarias (planificadas como si fueran un templo funerario) como la exactitud de los métodos constructivos; además, destacan porque fueron planificados (y construidos) con una doble orientación cargada de fuerte carácter simbólico, que es el objeto de este estudio. Los alineamientos astronómicos de estos complejos funerarios, normalmente asociados con templos y tumbas reales, parecen haber sido apropiados por los gobernadores de Elefantina, funcionarios de nivel inferior, lo que nos dice algo interesante sobre el gobierno egipcio y la astronomía egipcia. Sin duda, sus arquitectos debían manejar los conocimientos que los antiguos egipcios tenían de astronomía. El resultado es que estos complejos funerarios representan un claro ejemplo de arquitectura “culta” realizada en un cementerio provincial. En este artículo se examinan en detalle las alineaciones de cuatro de estos complejos funerarios: QH36, QH32, QH31 y QH33, extendiendo en Qubbet el-Hawa el trabajo de Belmonte y sus colaboradores, los principales responsables de ampliar los datos de las alineaciones astronómicas egipcias.

Keywords: Ancient Egyptian architecture, Archaeoastronomy, Azimuth, Rock cut tomb, Solstice, True north.
Palabras clave: Arquitectura egipcia antigua, arqueoastronomía, acimut, hipogeo, norte verdadero, solsticio.

TdE 12 (2021) - Páginas: **113 - 137**
Recepción: 20/4/2021 - Admisión: 3/12/2021
Juan Antonio Martínez Hermoso — juanantoniomartinezhermoso@gmail.com
Grupo de investigación Proyecto Qubbet el-Hawa / Universidad de Jaén / Spain
Antonio T. Mozas Calvache — antmozas@ujaen.es
Departamento de Ingeniería Cartográfica, Geodésica y Fotogrametría / Universidad de Jaén / Spain
José Luís Pérez García — jlperez@ujaen.es
Departamento de Ingeniería Cartográfica, Geodésica y Fotogrametría / Universidad de Jaén / Spain
http://doi.org/10.25145/j.TdE.2021.12.06

In Ancient Egypt most of the population and settlements were (and still are) located along a long and narrow linear oasis in the middle of the desert, on the River Nile. The Nile valley runs from south to north, crossing Upper Egypt (a valley of about 1000 km in length with an average width of about 19 km) from the First Cataract (at the height of Aswan) to the plain of the great Delta, and Lower Egypt, where the Nile branches out into the Mediterranean Sea, which made it the main communication route for Egypt. In addition, the alluvial plain, with its important resources, defined a vital axis for the development of the country. Furthermore, the cyclical path of the Sun, moving east to west perpendicular to the Nile in a usually clear sky, was a cultural factor that defined a second important axis. In reality, both the Nile and the Sun established two mutually perpendicular axes that influenced Egyptian life and architecture, so that most of the ancient funerary and religious buildings were planned according to an axial structure organized at right angles to the Nile.[1]

In fact, in the necropolis of the Memphite region, the pyramidal complexes of the Old Kingdom and the Middle Kingdom were oriented according to the four cardinal points, following the north-south and east-west axes, with slight deviations of one or two degrees, which are especially precise in the case of the cemeteries of the Giza plateau.[2]

Indeed, all the royal funerary complexes, from Saqqara to el-Fayum, were built on the west bank of the Nile, so all their buildings (valley temple, ascending causeway, funerary temple and pyramid) were arranged successively, following the shortest path from the bank of the Nile to the pyramid,[3] which coincided with the path of the Sun, from sunrise to the equinoxes (times of the year where the duration of nights and days are equal).[4]

In addition, access to the royal underground chambers went from the north face of the pyramid, through a descending corridor that followed the north-south axis towards the centre of the base of the pyramid,[5] following an axis that coincided with the direction of the course of the Nile in this region. This route was important because, according to ancient Egyptian tradition, this arrangement would allow the deceased king to ascend directly from his tomb towards the stars surrounding the pole star (which are visible throughout the year) where he would achieve immortality.[6] Egyptian astronomers discovered that these stars never disappeared from the sky, concluding that whoever could ascend into the sky to become one of these "imperishable" or "immortal" stars would be guaranteed eternal life after death, as reflected in the Pyramid Texts.[7]

In ancient Egyptian architecture, the staking out of the north-south and east-west directions would have been familiar to ancient Egyptians. Most authors agree that at the time of the pyramids the ancient Egyptians used the boreal stars as a reference to establish true north.[8]

1 Roth 1993: 167–170.
2 Lull 2016: 287–302; González, Belmonte and Shaltout 2009: 290–291.
3 Molinero Polo 1998.
4 Wilkinson 2000: 20–21.
5 Edwards 1993.
6 Bolshakov 1997: 26–28.
7 Sethe 1908: 939–940.

If so, the first axis drawn would be the north-south, achieved by reference to some circumpolar stars, probably a set of seven stars in the constellation Ursa Major, which the ancient Egyptians called Meskhetyu.[9] On the other hand, a simple method used to align the east-west axis, taking into account the movement of the Sun throughout the day, would be to place a pole driven vertically into the ground and observe the movement of the projected shadow; calculating the bisector of the angle formed by the position of two shadows taken after sunrise and before sunset on any given day would fix the meridian line.[10] This double orientation was also used in the mastaba tombs built around the pyramidal complexes.

However, the fact that there are some specific areas in Upper Egypt in which the course of the river changes direction explains, for example, that the royal funerary complexes of the early dynastic period of Abydos (First and Second Dynasties), where the course of the Nile flows approximately to the northwest, were oriented perpendicular to the Nile, almost exactly along the northeast-southwest and northwest-southeast axes.[11] The fact that the Nile was (and still is) the country's main communication route, where movements always took place "upriver" (to the south) or "downstream" (to the north), is probably the reason that, in places far from the capital, the buildings were oriented topographically with respect to the course of the Nile, and although they present different variations with respect to true North (up to 45º), the ancient Egyptians probably considered them as being oriented according to the north-south axis.[12]

From the second half of the Old Kingdom, the provincial governors established large cemeteries near the capitals where they ruled. The cities were distributed, in a linear sense, throughout the entire Nile valley. However, as the valley approaches the Delta the number of cities doubles, with a city established on each bank of the river. In fact, the most important provincial cemeteries are found on both banks of the Nile. For example, during the Middle Kingdom, the Beni Hassan, el-Bersheh, Qau el-Kebir and Mo'alla cemeteries stand out on the eastern bank, and on the western bank the cemeteries of Meir, Assiut, Deir Rifeh, while on the southern border of the country is Qubbet el-Hawa.[13]

Although studies on the criteria for orienting the tombs of the provincial governors are almost non-existent, it can be assured that, in most cases, the most visible landmarks were selected to establish these cemeteries, and the local topography (including the Nile) determined the alignments of the tombs. For example, the Mo'alla necropolis is located on an isolated hill in the shape of a pyramid that provided an ideal location to build the tombs (those of Ankhtifi and Sobekhotep and others), since it was the highest landmark of the place.[14] In any case, the location of private cemeteries on a high level, outside of earthly life, responds symbolically to the concept of the West, understood as the threshold between this life and the Hereafter.

8 Lull 2016: 293–296.
9 Belmonte, Fekri and Serra 2009: 237–238.
10 Lull 2016: 290.
11 González, Belmonte and Shaltout 2009: 289–290.
12 Bolshakov 1997: 26–28.
13 Shedid1997: 119.

Figure 1. Panoramic view of the southeast slope of the Qubbet el-Hawa necropolis. Photograph: J.L. Martínez de Dios.

1 | The Qubbet el-Hawa Necropolis

The governors and high officials of the First Nome of Upper Egypt, during the Old Kingdom, First Intermediate Period and Middle Kingdom (mainly during the Sixth Dynasty (2305-2118^{+25})),[15] chose as their burial place a hill located on the west bank of the Nile, just over a kilometre north of the capital, Elephantine.[16] The silhouette of the hill is in the shape of a large natural mastaba, but seen from the east it recalls the shape of a pyramid, these being the two great funerary structures of the Old Kingdom, which undoubtedly reinforces its symbolic character. In the necropolis of Qubbet el-Hawa (fig. 1), more than seventy hypogea have been discovered so far, distributed among several superimposed terraces halfway up the hill (apart from earthly life), although the most important and monumental ones are found on the upper terrace, between 130 and 135 meters above sea level.[17]

The hill of Qubbet el-Hawa is the most prominent elevation in the vicinity of Elephantine. It rises about 180 metres above sea level (about 90 metres above the current level of the River Nile).[18] The elevated position of the necropolis, halfway up the hill, makes it possible to enjoy open views to the East from the hypogea, dominating the islands of the First Cataract and the eastern bank of the Nile. The southeast slope is very steep, more or less continuous from the top to the bank of the Nile. On the contrary, on the northeast side the slope is gentler in its upper part, although it presents a significant change at mid-altitude, from which the slope becomes quite steep again, finally ending in a plain next to the river bank (fig. 2). This variation in angle of the northeast slope of the hill formed a natural terrace that was used for the construction of the first hypogea of the necropolis[19] where over time, through the progressive carving of the façades and courtyards of the hypogea, several artificial terraces were configured.

14 Vandier 1950.

15 For all dates in this work, see Hornung, Krauss and Warbuton 2006. The superscript (+25) indicates that the proposed timeline may vary + 25 years.

16 Jiménez Serrano 2012.

17 Edel, Seyfried and Vieler 2008: xxv.

18 Storemyr 2007: 9–20.

19 Vieler 2011: 101.

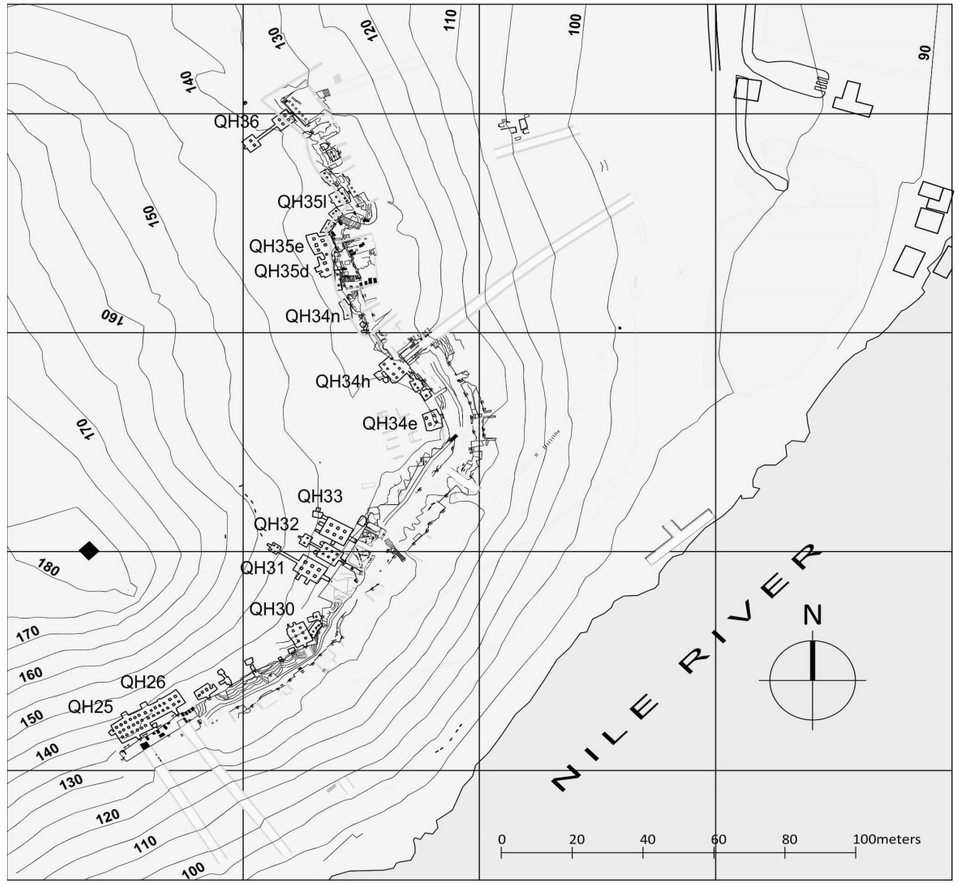

Figure 2. Cartography of the archaeological site of Qubbet el-Hawa. Author: J.A. Martínez Hermoso.

The first hypogea of the necropolis, among which are found some of the most important ones such as QH34n (Herkhuf)[20] and QH35d (Pepinakht Heqaib II),[21] were built on the northeast slope, presenting a wide range of orientations (more or less northeast). However, as free space became increasingly scarce, the hypogea were excavated further south. On this slope (south),

20 Edel, Seyfried and Vieler 2008: pls. 16.1 and 16.2.

21 Edel, Seyfried and Vieler 2008: pls. 17 and 18.

where the slope is much more uniform, the orientations of the hypogea, among which, for example, the double funerary complex QH25 (Mekhu) -QH26 (Sabni) stands out,[22] are generally close to the southeast and at the same time are perpendicular to the topography and to the Nile.[23]

To ascend to the terraces of the necropolis, large stairways were built[24] from a modest dock located on the bank of the Nile where the boats carrying the coffin of the deceased and his entourage could dock. Currently only three of them are fully visible (fig. 3). On the northeast slope of the hill the staircase of about 130 metres in length that serves to ascend directly to hypogeum QH34h (Khunes)[25] stands out, and on the southeast slope two parallel stairways are found, each about 70 metres long, that serve to ascend to the outer courtyards of the QH25 and QH26 hypogea, respectively.

There are at least four other large staircases, of which only their path can be gauged as currently only certain sections are uncovered. On the northeast slope there are two, one that probably ascends towards hypogeum QH35l (Sen-Mesi)[26] since the guideline of this stairway coincides exactly with the path towards this tomb (see figs. 2 and 3), although it cannot be ruled out that it served to ascend to a hypogeum that is on the second level; and the other that ascends directly towards the QH36 (Sarenput I) funerary complex.[27] On the southeast slope there are two others, one that seems to rise directly towards QH90 (Sobekhotep)[28] and another towards the area where QH35b is located.[29] However, in all probability there must be other buried staircases that served to ascend to the different terraces of the necropolis, although they are currently hidden under the sand.

The monumental stairways of the QH26 and QH34h funerary complexes mark the main alignments used by the builders to orient the hypogea (see fig. 3) during the Old Kingdom. On one hand, on the northeast slope the monumental staircase that leads to the QH34h hypogeum is oriented approximately to the northeast (at an azimuth of about 53º); and on the other, on the southeast slope, the staircase that ascends to the QH26 hypogeum is oriented very closely to the southeast (at an azimuth of about 143º), both alignments being practically orthogonal to each other.

The intermediate cardinal orientations are especially characteristic of Upper Egypt, since they fulfilled two requirements: having an astronomical (solar) orientation and, at the same time, being topographic (perpendicular to the Nile). Without going any further, in Elephantine there are two examples of temples oriented to the intermediate cardinal directions: the temple of Khnum (Eighteenth Dynasty), which was oriented towards the southeast (at an azimuth of 138.50º), and the cult centre of Heqaib (Eleventh to Eighteenth Dynasties) oriented to the northwest (at an azimuth of 318º), with exactly the same alignment but in the opposite direction.[30]

22 Edel, Seyfried and Vieler 2008: pls. 3.1, 3.2 and 3.3.
23 González, Belmonte and Shaltout 2009: 294, figs. 9.7 and 9.8.
24 Vieler 2011: 101.
25 Edel, Seyfried and Vieler 2008: pls. 11.1 and 11.2.
26 Edel, Seyfried and Vieler 2008: pl. 19.
27 Müller 1940: 15-51; Martínez Hermoso 2018.
28 Edel, Seyfried and Vieler 2008: pl. 23.2.
29 Edel, Seyfried and Vieler 2008: pl. 17.
30 Belmonte and Shaltout 2009: appendix II.

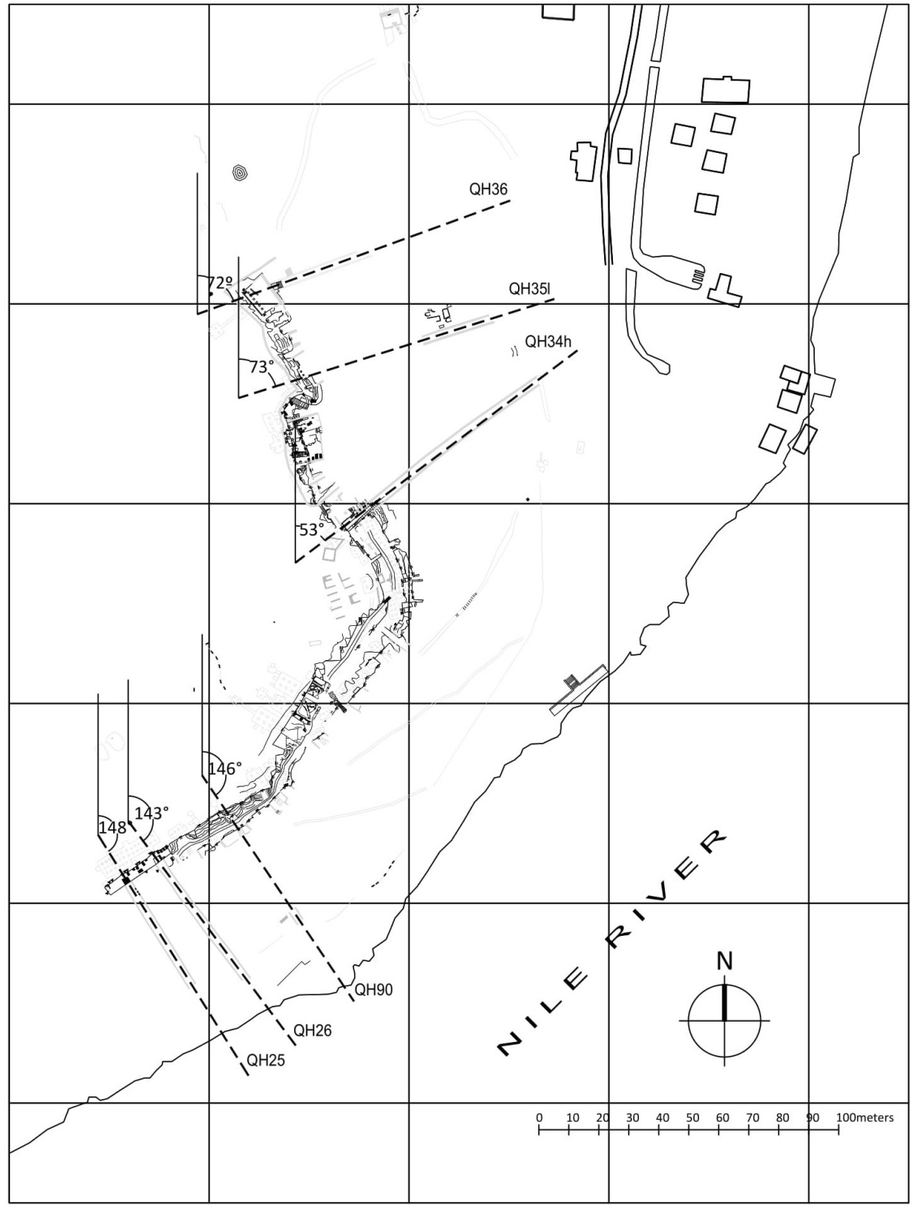

Figure 3. Orientation of the staircases of Qubbet el-Hawa. Author: J.A. Martínez Hermoso.

The staking-out of the axes of the tombs was probably carried out in a similar way to the "stretching the cord" (in which the staking-out of the main axes of the Egyptian temples was carried out).[31] Although the details of this ritual have been known since the Ptolemaic Period, there is evidence of its use (but not the details) from the First Dynasty.[32] For example, during the Old Kingdom the best representations of this ceremony are a partial relief showing Snefru and Seshat hammering poles,[33] and a large fragment of the Niuserran sun temple showing the king kneeling in front of a foundation shaft after performing the "rope stretch" twice, together with a goddess.[34]

In reality, buildings could be oriented according to two different methods: one nocturnal (with respect to the position of circumpolar or other stars) and another diurnal (with respect to the path of the Sun).[35] In the first case, a preliminary axis would be previously established (in the north-south direction) through astronomical observations[36] and later rotated at 45º (or 135º) in a clockwise direction, in a similar way to that of the temples that look to the east side of the horizon (the most frequent); or counter-clockwise, as with the temples that look to the west side of the horizon, in order to obtain the definitive axis of the temple, which in turn was almost perpendicular (or sometimes parallel) to the Nile.[37] In the second case, a preliminary axis would be established (now, in the east-west direction) through observation of the path of the Sun, to rotate it at 45º in a clockwise or anti-clockwise direction, depending on the cases.

Finally, the paradigmatic case of the QH35 hypogeum (Pepinakh-Heqaib I) stands out in Qubbet el-Hawa.[38] This hypogeum (one of the oldest in the necropolis), although located on the northeast slope in an exceptional way, was oriented almost exactly towards the east, where the Sun rises, structuring itself according to an east-west axis with its entrance looking approximately towards the point of the horizon (of the eastern desert plateau) where the solar sunrise occurs at the equinoxes.[39] It should also be noted that, in the hypogea of the Old Kingdom, access to the underground chamber was through a descending corridor or vertical shaft (although sometimes there was other access to secondary chambers) which followed the axis of the hypogeum from the entrance to the false door, to the burial chamber at the end of the corridor (or well);[40] although, in the particular case of the QH35 hypogeum, the corridor also follows the east-west axis and the main burial chamber faces north.[41]

31 Molinero Polo 2000; Belmonte, Shaltout and Fekri 2009; Monnier, Petit and Tardy 2016.
32 Rossi 2003: 148–153.
33 Fakhry 1961: 94 and figs. 84–95.
34 Borchardt and Schäfer 1900: 97 and pl. 5.
35 Lull 2016: 290.
36 Belmonte, Shaltout and Fekri 2009: 237–238.
37 Belmonte, Shaltout and Fekri 2009: 238–244.
38 Edel, Seyfried and Vieler 2008: pl. 14.
39 González, Belmonte and Shaltout 2009: 293.
40 Martínez Hermoso 2017b: 153–154.
41 Edel, Seyfried and Vieler2008: pl. 14.

2 | Objectives

The funerary complexes of the Twelfth Dynasty, QH36 (Sarenput I) and QH31 (Sarenput II) represent a qualitative leap in the architecture of Qubbet el-Hawa, both for their refined architectural design and for improvements in the construction techniques used.

In fact, the funerary chapels are structured along an axis of symmetry: from the entrance door, passing through a monumental hypostyle hall, a long and narrow corridor and a cult chamber, until reaching the sanctuary containing a statue of the owner of the tomb. Its hypostyle rooms are also notable for the precision of their shapes and dimensions, as well as for the perfection of the finishes of their walls and pillars.

However, these funerary complexes also stand out because they are the only ones in the necropolis whose main axes are clearly aligned with a double orientation. In fact, they were aligned with great precision, to very specific orientations (with a strong symbolic content), differently from those of the rest of the hypogea in the necropolis. In this article, we wish to demonstrate that in their initial planning their architects wanted to align the main axes of these funerary complexes to these "special" orientations. This would be possible if we take into account the knowledge that Egyptian astronomers had acquired through observing the sky (for example, of the changes in the apparent orbit of the Sun throughout the months of the year). It is known that astronomers were able to identify the most extreme positions of the Sun, in the northeast and southeast, from the sunrises at the summer and winter solstices, respectively.[42] If this were the case, QH36 and QH31 complexes would represent a clear example of "cultured" architecture built in a provincial cemetery.

3 | State of the Art

Astronomy played a prominent role in many aspects of Egyptian civilization, including architecture. This has been reflected in the orientation of Egyptian tombs and temples to certain astronomical (and closely related topographical) alignments, in accordance with religious beliefs and to reproduce the cosmic order on Earth.[43]

Fortunately, the field of Archaeoastronomy has gained more acceptance in recent years, not only due to the publication of complete and rigorous studies but also, and perhaps most importantly, because it has been progressed through Egyptologists who have been interested in the various aspects in which Astronomy was used in Ancient Egypt.

The astronomer who really started the modern study of Egyptian astronomical alignments was Gerald S. Hawkins.[44] All modern work began with him. He followed in Lockyer's much earlier footsteps and singlehandedly directed the research toward more accurate study of alignments.

The main discussions of Egyptian astronomical alignments have centred on the cardinality of the pyramids of the Old Kingdom and the intentional solstice alignments in the temples of the New Kingdom. The first modern comment to contrast these two different alignment approaches was probably made by the astronomer Edwin Charles Krupp. His study[45] compares the cardinality of the Niuserre Sun Temple at Abu Ghurab, of the Old Kingdom, with the orientation of the winter solstice sunrise of various New Kingdom sun chapels.

In relation to the subject of this article, the very recent studies of Giulio Magli and Juan Antonio Belmonte are of note.

42 Lull 2016: 169–172.
43 Lull 2016: 13–17; Shaltout and Belmonte 2009: 13–16.
44 Hawkins 1973,1974: 157–167. *Beyond Stonehenge* was published first, although it is an informal source.
45 Krupp 1988: 473–499.

Magli's work focuses on the pivotal role played by astronomyin Egyptian royal architecture.[46] This study offers an in-depth analysis of the influence of astronomy on the planning of the royal tombs of the Abydos necropolis (Early Dynastic Period), of the pyramidal complexes of the Memphite region (Old and Middle Kingdom), and the Theban temples of the New Kingdom.

We highlight the recent studies carried out by the Hispanic-Egyptian Mission for Ancient Egyptian Archaeoastronomy, in collaboration with the Supreme Council of Egyptian Antiquities. This mission, led by the astrophysicist Juan Antonio Belmonte and the astronomer and Egyptologist Mosalam Shaltout, has focused on the interpretive aspects of the stellar phenomena of Egyptian culture.[47] The results of the study show that the Egyptian temples, in addition to being able to be oriented topographically (especially with respect to the Nile), could also be oriented toward astronomical objectives, defining seven representative groupsthat can be summarized in three basic patterns (cardinal, solar and stellar). In addition, they provide a statistical study with the archaeoastronomical data of practically all of the Egyptian temples built overthree thousand years,[48] which we have used to identify temples that were built with similar orientations to those of the funerary complexes QH36 and QH31, the object of this study.

As we can see, all of the previous studies focus on the relationship between astronomy and religious architecture, and royal funerary architecture. However, for the private cemeteries of Upper Egypt we have only found a brief preliminary report (single page) that compares the necropolises of Qubbet el-Hawa and Beni Hassan.[49] Regarding Qubbet el-Hawa, this report states that, in general, the tombs of the necropolis are oriented according to the topography (including the Nile), distinguishing two groups of orientations at 90º from each other (depending on the slope on which they are found, northeast and southeast). The authors of the report add that a certain tendency is observed in the oldest tombs located on the northeast slope to face the sunrise on the summer solstice.

	Date (1825 BC)	Ortho Azimuth		
		Elev 0º	**Elev –0.83º**	**Elev –6º**
Winter Solstice		116.41º	115.99º	113.58º
Spring Equinox	05 January	90.28º	89.91º	87.60º
Summer Solstice	09 July	63.63º	63.19º	60.42º
Autumn Equinox	08 October	90.05º	89.68º	87.34º

Table 1. Azimuths of the winter and summer solstices at the Qubbet el-Hawa necropolis, calculated for 1825 BC. Source: NASA solar ephemeris, 2020.

46 Magli 2013.

47 Belmonte and Shaltout 2009.

48 Belmonte and Shaltout 2009: appendix II.

49 González, Belmonte and Shaltout 2009: 292–293.

4 | Methodology

For the astronomical results at Qubbet el-Hawa, there is a broader context. This article is directly related to the work of Belmonte and his collaborators on tombs andis, in turn, an extension of their previous study on the alignments of the temples. In addition, this new work is based on new and more robust field measurements.

Since 2008 the Qubbet el-Hawa project, the result of collaboration between the Ministry of Antiquities (Arab Republic of Egypt) and the University of Jaén (Spain), has been presented as a multidisciplinary action-carrying out the excavation, documentation, and study of various hypogea, especially those dated to the Middle Kingdom.[50] Within the context of the work carried out by the project's team, led by Alejandro Jiménez Serrano, the topographic works on the Qubbet el-Hawa hill which have been carried out in two phases are important.

During the 2008-2009 campaigns, the topographer Juan Manuel Anguita Ordóñez carried out a plan of the archaeological site of Qubbet el-Hawa,[51] which has helped us to interpret the general placing of the tombs in the necropolis. Since the 2017 season, the surveyors José Luis Pérez García and Antonio Mozas Calvache have been updating the cartography, work that represents a quantitative and qualitative leap within the field of cartographic representation and three-dimensional modeling.[52] This has allowed us to learnthe orientations of the funerary complexes of the Twelfth Dynasty, (the object of this study) with precision.

Regarding data collection methods or precision, the orientation of the tombs has been obtained by means of precise topographic methods. Thus, the definition of the axis of each tomb is based on different significant points of the same that define its main axes. These points are observed with a topographic total station by means of the radiation method, making these measurements from points of a precision topographic network. This network was previously observed using Global Navigation Satellite System (GNSS) techniques, which is why they are referred to a global reference system WGS84 in UTM spindle 36 North projection. From the coordinates of the points that define the elements of interest of the tombs, the alignments of the axes are determined by obtaining the azimuths of each alignment. These azimuths, initially referring to a cartographic projection, are corrected for the convergence of meridians for each case, obtaining the definitive azimuths (angle from the geographic north) of each axis. The estimated precision of each point radiated from the surveying station is greater than 50", so this method makes it easier to obtain the angles with a precision much higher than that required forthis study.

On the orientations that compare "summer solstice" and "winter solstice", the information on the azimuths of the winter and summer solstices calculated in the central area of the necropolis for 1825 BC, according to different solar elevations, is presented in table 1. We can estimate that the sunrise/sunset occurs with -0.83º elevation due to the solar diameter and the effects of atmospheric refraction.

Finally, on the discussion of what may be a "close enough" alignment, one can compare the temples facing the winter solstice built at Deir el-Bahari. Thus, the funerary temple of Mentuhotep II of the Eleventh Dynasty and the Mansion

50 Jiménez Serrano *et alii* 2018.

51 Jiménez Serrano *et alii* 2009: 44, pl. 1.

52 Mozas Calvache *et alii* 2020.

of Millions of Years of the queen-pharaoh Hatshepsut (Eighteenth Dynasty), located side by side, are not completely parallel to each other, asthey have an orientation of 118.25º and 115.50º respectively, so there is a difference of almost 3º. And even the memorial temple of Thutmose III, built later with an azimuth of 118.50º, is almost parallel to that of Mentuhotep II but diverges, even moreif possible, from that ofhisco-regent Hatshepsut.[53] In fact, later temples that follow the pattern of orientation towards the winter solstice, such as that of Millions of Years of Amenhotep III, present a variation of about 4º that, in part, could be explained by intrinsic errors in the determination of the orientation, or due to its inaccuracy.[54]

5 | Discussion and Results

In the Twelfth Dynasty, during a short interval of about one hundred years, at least from the reign of Senwosret I (1920-1875^{+6}) to that of Amenemhat III (1818-1773), the hill of Qubbet el-Hawa was once again used as a burial site by the Elephantine elite.[55] A dozen hypogea have been discovered so far from this period, all built on the main terrace of the necropolis. Six of these, belonging to the governors of Elephantine, are notable due to their size and architecture.

The first and oldest, QH35l (built at a time of transition between the Old Kingdom and the Middle Kingdom) and QH36 (Sarenput I),[56] were built on the northeast slope of the necropolis (fig. 4), probably seeking proximity to the funerary complex where the deified governor Pepy-Nakht Heqaib II (QH35d) was buried, considered by the governors of this dynasty as their divine ancestor.[57] Its location in the extreme north is explained by the lack of available space on this slope, which during this period would be an important determining factor since most of the hypogea were excavated during the Old Kingdom.[58]

However, most of the governors' funerary complexes were excavated on the southeastern side of the necropolis. On this slope we find an important burial area composed of three large complexes of governors catalogued as QH31 (Sarenput II),[59] QH32[60] and QH33[61] (fig. 5). This complex, contrary to the northeast slope, was visible from the capital of the province, Elephantine.[62] The QH30 funerary complex, also owned by a governor,[63] was built a little further south but outside the QH31-QH33 funerary complex, probably

53 Belmonte *et alii* 2019.
54 Belmonte *et alii* 2019: fig.1.
55 Edel 1984; Martínez Hermoso, 2017b.
56 Martínez Hermoso 2017b: 159–160.
57 Habachi 1956.
58 Martínez Hermoso 2017a.
59 Müller 1940: 62–88; Martínez Hermoso *et alii* 2015; Martínez Hermoso 2017b; Martínez Hermoso 2019b.
60 Müller 1940: 54–61.
61 Jiménez Serrano *et alii* 2014; Jiménez Serrano *et alii* 2018.
62 Martínez Hermoso *et alii* 2018; Martínez Hermoso 2019a.
63 Müller 1940: 89–95.

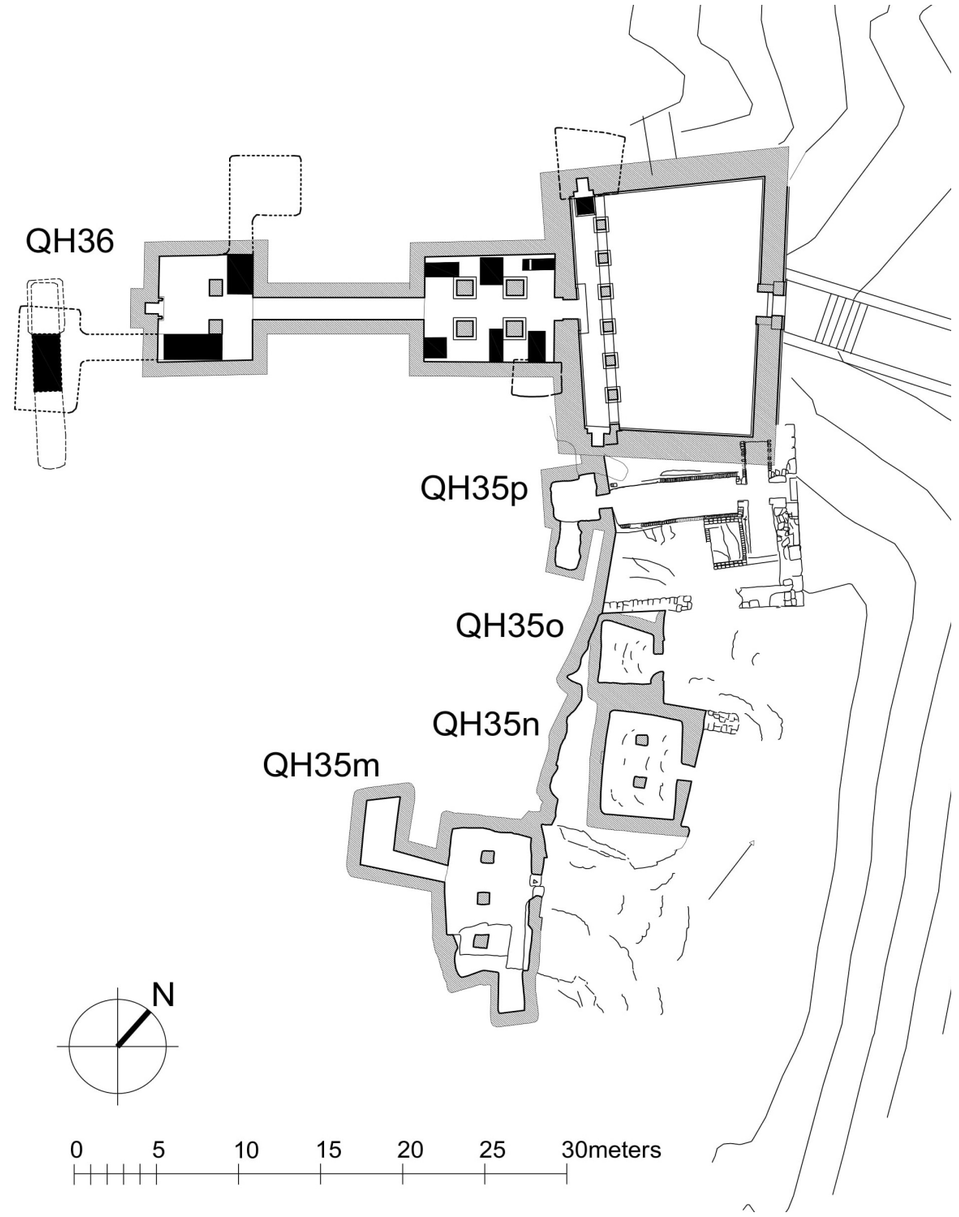

Figure 4. Funerary complex QH36 and other nearby hypogea located at the northern extreme of the Qubbet el-Hawa necropolis. Author: J.A. Martínez Hermoso.

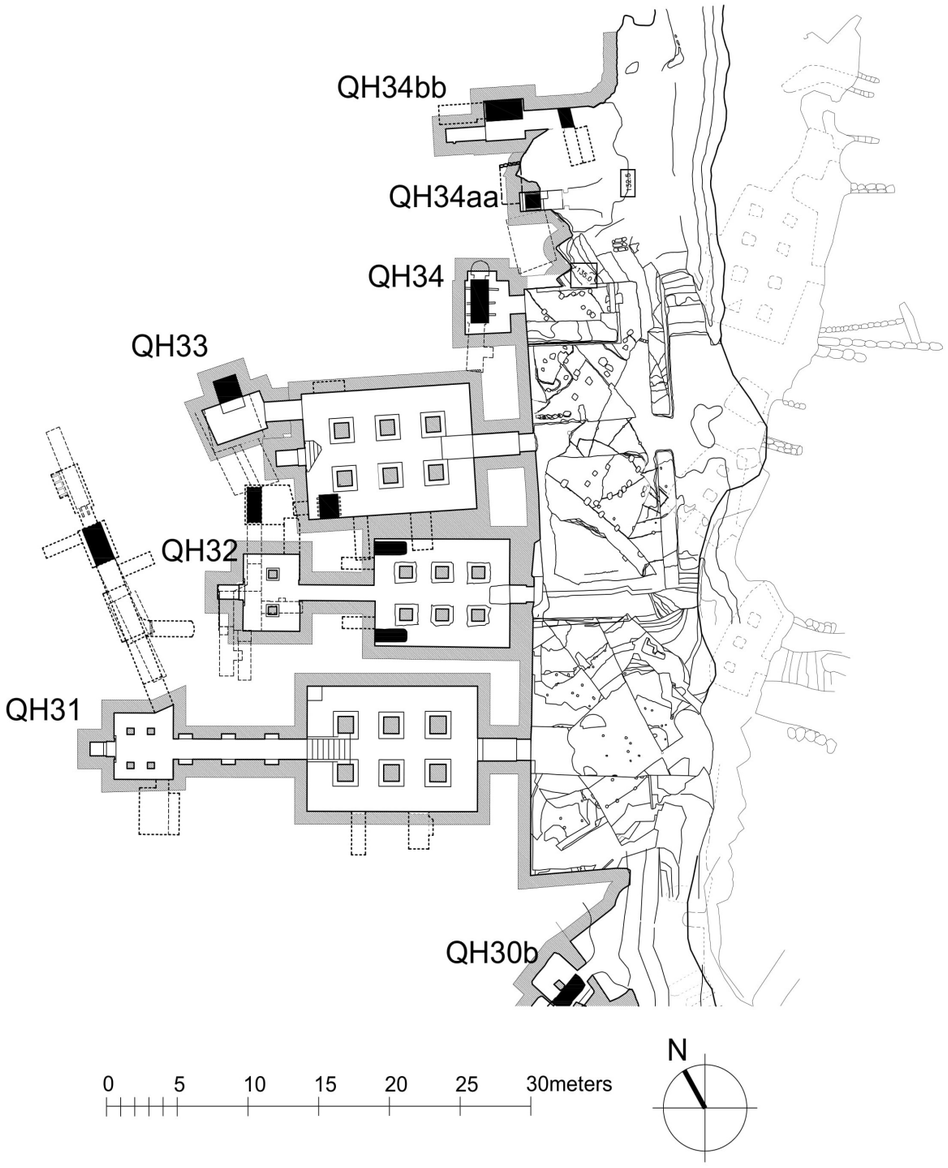

Figure 5. Funeral complexes QH31, QH32 and QH33 and other nearby hypogeal, located on the southeast slope of the necropolis. Author: J.A. Martínez Hermoso.

because it was already under construction when its owner took office (the enlargement of the hypogeum is clearly visible today, as during the second phase the polishing was never carried out). In fact, an older proximal hypogeum was invaded during its construction, further demonstrating the lack of free space on the main terrace during this period.[64]

One of the reasons for changing the location of the funerary complexes of this period was probably to improve the lighting of the different spaces inside the hypogea that were placed deeper and deeper into the hill`s interior.[65] In fact, while the sun does not shine on the façades of the hypogea facing northeast in winter (as is the case of QH36, whose chapel has a depth of about 25 metres), and during the rest of the year only shines until noon (which does not favour the illumination of their interior), the façades of the hypogea oriented to the southeast (as is the case with QH31, QH32 and QH33) receive the sun's rays throughout the year, so their interiors are much better.[66] Among all of them, the chapel of QH31 is significant; as one advances towards its interior, the ceilings are reduced in height and the floors are raised, which allows gradation of the intensity of light, from the entrance to the sanctuary, located about 30 metres deep.[67]

5.1 | Northeast and Summer Solstice

In this section, we will focus on analysis and discussion of the astronomical alignments of the QH36 funerary complex, located on the northeast slope of the necropolis.

In the vicinity of the QH36 funerary complex, the final section of a monumental staircase that leads directly to the entrance of its outer courtyard can be seen. It is striking that this stairway was not oriented according to the main axis of the funerary complex as was usual in the necropolis, since normally the stairs were oriented based on straight guidelines which aligned with the central axis of the hypogea they served.[68]

However, this does not occur in the case of QH36, where the axes of the hypogeum and staircase are not coincident.

There are other examples, such as the solar temples of Abu Ghurab, located north of Abusir (Fifth Dynasty), in which although the temples were oriented towards the four cardinal points, the ceremonial road that connected them with their respective temples of the valley was oriented approximately to the intermediate northwest-southeast cardinal direction, probably so that the route would be the shortest possible.[69] More specifically, although Krupp did not discuss the orientation of the ceremonial path of the solar temple of Niuserre, he suggested that it is oriented intercardinally. However, an examination of the plan of the temple indicates that it is much closer to the dawn of the summer solstice, which probably reflects the kind of dual orientation that the authors of this study find at Qubbet el-Hawa.

In fact, in the case of the QH36 funerary complex, while the main axis of the hypogeum is oriented close to the northeast (at an azimuth of 52.87º), almost coinciding with the orientation of the staircase (and the hypogeum) of QH34h (53º) of the Old Kingdom (see fig. 3),

64 Müller 1940: 89.
65 Martínez Hermoso 2017b: 200–204.
66 Vieler 2011.
67 Martínez Hermoso 2017b: 200–204
68 Martínez Hermoso 2017b: 126–127.
69 Lull 2016: 322–324.

the upper part of the landing of the staircase of QH36 (which is currently visible) is almost parallel to the staircase that ascends to the hypogeum QH35l. This dates from the beginning of the Twelfth Dynasty and was oriented to an azimuth of 72.28º (fig. 6), built orthogonally to both the contour lines of the mountain and the sunrise on the summer solstice.

At Elephantine, the small stepped pyramid built by Huni at the end of the Third Dynasty (or by Snefru, at the beginning of the Fourth) to the northwest of the island had also been aligned with exactly the same orientation (73º)[70] to the sunrise at summer solstice.[71] This also coincides with the average time of year of the Nile's floodwaters.[72] This had an important symbolic meaning with connotations of fertility and rebirth, which explains why some of the builders of the necropolis in Elephantine followed the trend of orienting the axes of the hypogea towards the summer solstice.

This is similar to a circular structure created several millennia earlier (approximately 6000 BC) at Nabta Playa, about 100 km west of Abu Simbel (in the Nubian desert), which is composed of slabs of sandstone arranged vertically, with four pairs of "doors" in facing pairs, some oriented in the north-south direction and others aligned according to an axis oriented at 65-70º azimuth, towards the approximate position of sunrise on the summer solstice.[73]

Therefore, it can be concluded that the QH36 funerary complex was consciously planned with a double orientation, counting on two main axes that were aligned according to two different orientations: the first, approximately towards northeast (the main axis of the hypogeum, from the entrance to the sanctuary), and the second oriented to the summer solstice (which serves as the axis for the staircase that connects the outer courtyard of the complex with the jetty that was located on the bank of the Nile).

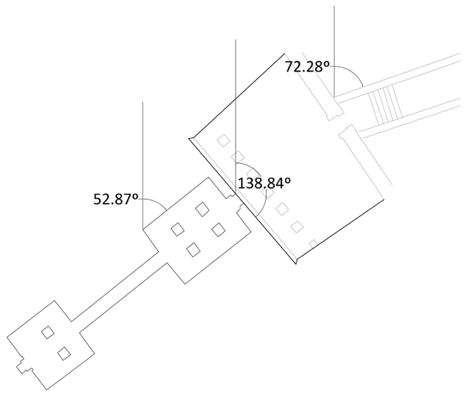

Figure 6. Double stellar (chapel) and solar (staircase) orientation of the QH36 funerary complex. The main axis of the chapel forms an angle of 85.97º with the plane of the façade. Author: J.A. Martínez Hermoso.

The explanation for having used the apparently most important orientation (solstice /flood) for the staircase instead of the tomb is probably because the builders adjusted the axis of the complex towards the northeast, conditioned by the topography of this particular site within the necropolis, while the stairway was aligned towards the summer solstice as this orientation was closest to that of the shortest path to the existing jetty on the bank of the Nile (as well as to take advantage of the natural slope of the land and avoid construction complications).

70 González García *et alii* 2009: 331–335, fig. 11.5.
71 González García *et alii* 2009: 292–294.
72 Belmonte 2003.
73 Malville *et alii* 2007.

5.2 | Winter Solstice and True North

In this section, we will analyse and discuss the astronomical alignments of the QH31, QH32 and QH33 funerary complexes located on the southeastern slope of the necropolis.

The QH31, QH32 and QH33 funerary complexes (see fig. 5) stand out because the orientation of the hypogea shows a very significant turn with respect to that of the rest of the hypogea located on the southeast slope of the hill.[74] In principle, this is because the façades seem to follow the orientation of the strata that naturally change with the location, as in the rest of the necropolis.

More specifically, the main axis of the QH31 and QH32 funerary complexes is also perpendicular to the course of the Nile but, at the same time, has an orientation at an azimuth of 122.57º (at 32.57º south, from the East) (fig. 7) and from 123.79º (to 33.79º south, from the east), respectively. A preceding example is the unfinished tomb currently attributed to Amenemhat I, to the west of the hill of Qurna, which was aligned precisely in that direction.[75]

The QH33 funerary complex (built later) (see fig. 5), presents a subtle twist with respect to the alignments of the previous ones (QH32 and QH31), despite sharing the same façade plan with them.[76] Indeed, its main axis is oriented at 115.24º azimuth (25.28º south, from the East) (see fig. 7). The deviation of the QH33 axis was probably the result of using a different stakeout method, likely seeking to obtain greater precision in the orientation chosen for the chapel. However, it cannot be ruled out that this was due to a staking (or execution) error. In fact, we observe that the main axis of the chapel and the façade plane (which theoretically should be orthogonal to each other) have a deviation of 4.03º in the case of QH36, 0.91º in the case of QH31, 0.23º in the case of QH32 and 3.02º in the case of QH33, being in the QH31 chapel where the best 90º is achieved (see figs. 6 and 7). This does not mean that QH31 and QH32 are the most adjusted to a certain orientation; rather, that during the execution of the work the builders were able to maintain with greater precision the orthogonality between the façade and the axis of the chapel.

In any case, the observed deviation can be considered within the usual margin of error since, for example, royal funerary constructions also present similar deviations with respect to the east orientation.[77]

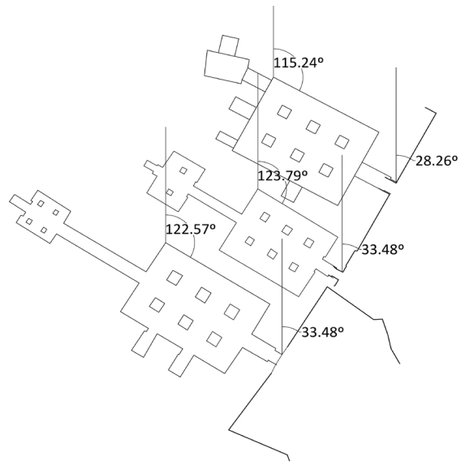

Figure 7. Orientation of the chapels of the funerary complexes QH31, QH32 and QH33. The main axis of the chapel forms an angle of 89.09º (in the case of QH31), 90.23º (in the case of QH32) and 86.98º (in the case of QH33) with the plane of the façade. Author: J.A. Martínez Hermoso.

74 Martínez Hermoso 2019a.
75 Belmonte and Shaltout 2009: appendix II.
76 Martínez Hermoso 2019a.
77 Belmonte and Shaltout 2009: appendix II.

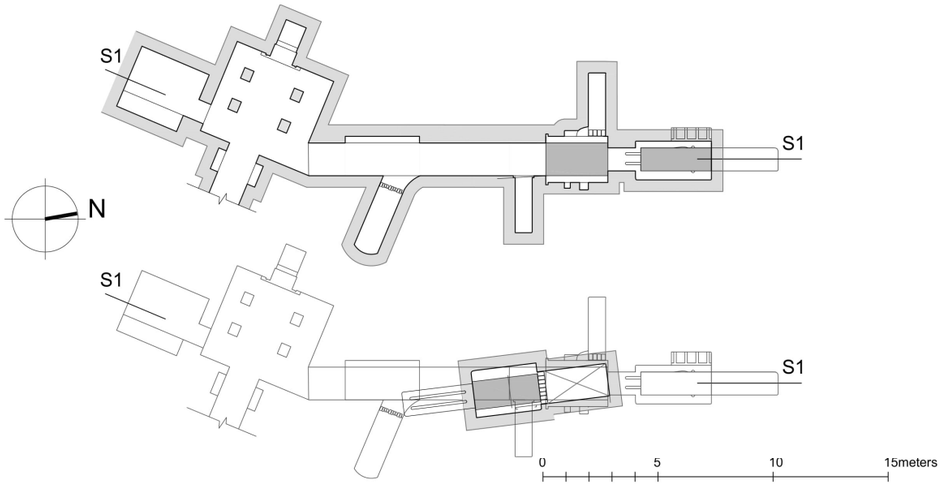

Figure 8a. Substructure of QH31. Upstairs upper level; below, lower level. Author: J.A. Martínez Hermoso.

From the Middle Kingdom, there are some prominent examples in the Theban region[78] such as the funerary temple of Mentuhotep II (in Deir el-Bahari)[79] and the original temple of Amun (Karnak),[80] as well as the small temple of Mentuhotep III on the hill of Thoth near Thebes,[81] which had been aligned precisely in that direction and, simultaneously, was perpendicular to the Nile.[82] In Elephantine, there is another example: the temple of Satet,[83] erected by Hatshepsut (Eighteenth Dynasty), also had its main axis aligned at 118.25º azimuth,[84] and the temples previously erected by Mentuhotep III and Senwosret I on the same site (Eleventh and Twelfth Dynasties, respectively) possibly also had this orientation.[85]

During the Twelfth Dynasty, we also find some private tombs oriented to the southeast in other necropolises; for example, the TT60 hypogeum in Qurna (West Thebes)[86] or even the funerary complexes of Wahka I, Ibu and Wahka II in Qaw el-Kebir, even though these are on the east bank of the Nile.[87] However, in the case of Qubbet el-Hawa the selection of

78 Lull 2016: 324–327.
79 Winlock 1942.
80 Barguet 1953: 145–155, pl. 1.
81 Bisson de la Roque 1937: 6–13, pl. II; Winlock 1943: 270.
82 Belmonte and Shaltout 2009: appendix II.
83 Kaiser 1988: 152–157.
84 Lull 2016: 328–329.
85 Belmonte *et alii* 2009: 230.
86 Davies and Gardiner 1920: pl. 1.
87 Steckeweh 1936: pl. vii.

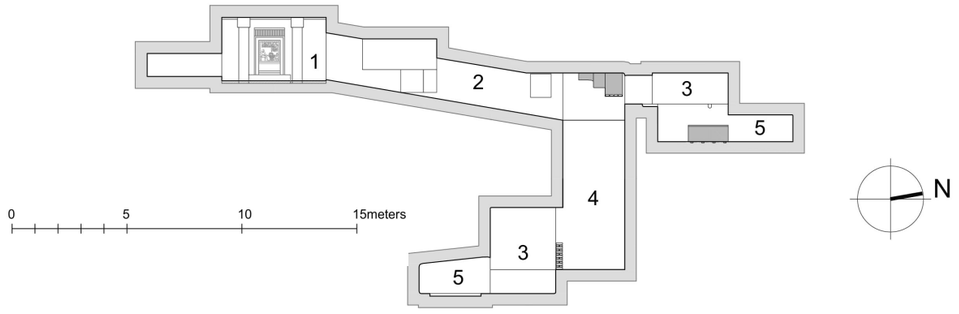

Figure 8b. Substructure of QH31. Sections: (1) cult chamber, (2) descending corridor, (3) burial chambers, (4) burial shaft and (5) burial niches. Author: J.A. Martínez Hermoso.

the site was probably due, among other reasons, to the fact that at this site it was possible to comply with the topographic limitations and at the same time provide the hypogea with a very determined orientation that would have an important symbolic meaning for its owners. The site of Qubbet el-Hawa, at the First Cataract (in particular, that of these hypogea), is the first site south of Thebes where the Nile flows in such a way that the solstice line connecting the solar rising at the winter solstice (on the shortest day of the year) with its sunset in summer (on the longest day of the year) is perpendicular to the river.[88]

Perhaps the governors of Elephantine during the Twelfth Dynasty wanted to transfer the same sacred scheme of Thebes to the necropolis, establishing the orientation of its hypogea according to the most extreme positions of the sun in the southeast, at the dawn of the winter solstice (from inside the hypogea towards the outer door). In fact, the winter solstice azimuth is compatible with the mean value of the azimuths of QH31, QH32 and QH33 (118º +/- 3º), this being the tomb that would best represent funerary complex QH33.

5.2.1 | Underground Areas

In this subsection we will focus on the analysis and discussion of the "special" orientation of the underground areas of the QH31 funerary complex.

An important difference with respect to the substructure of the previous funerary complexes (in which the underground system of corridors, shafts and burial chambers was arranged parallel and orthogonal to the direction of the main axis of each hypogeum) is that with the construction of the funerary complex of QH31 (and later, with that of QH33), the orientation of the underground system was not excavated according to the main axis of the chapel but was aligned with the north-south direction (see fig. 5), an arrangement that coincides, for example, with that adopted in all of the tombs excavated around the pyramid of Senwosret II, in el-Lahun.[89]

Schematically, the substructure of QH31[90] is composed of a long descending corridor (13.50 metres long) with a 26.83º slope (part of the cult chamber), a large rectangular section shaft (6.50 metres deep) and two burial chambers (fig. 8a–b).

88 González García *et alii* 2009: 268.
89 Petrie 1920: pl. xxiii.
90 Martínez Hermoso 2017b: 317–388.

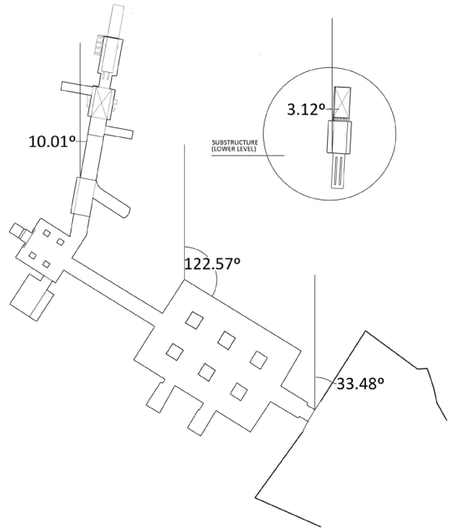

Figure 9. Double stellar (substructure) and solar (chapel) orientation of the QH31 funerary complex. Author: J.A. Martínez Hermoso.

The entire system is organized along a straight axis, oriented slightly towards the north (at an azimuth of 10.01º) (fig. 9). However, the burial niche of the main burial chamber (located on the lower level of the shaft) is oriented at an azimuth of 3.12º. It is very likely that this change of direction was implemented in order to obtain a more exact orientation towards the north.

Therefore, the QH31 funerary complex has two axes: the first for the chapel (oriented towards the sunrise on the winter solstice) and the second for the substructure (oriented along the north-south axis). In all probability, the adoption of this second axis was a planned decision with the purpose of orienting the entrance to the tomb of the owner of the funerary complex according to the north-south axis, following the Old Kingdom tradition of orienting the entrances to royal tombs in this direction (towards the "imperishable" circumpolar stars, visible throughout the year), and also adopted for private tombs.[91]

One way to easily transfer the desired orientation (towards the north) to the underground areas would probably be to stake out the north-south axis with respect to the axis of the hypogeum (previously oriented to the sunrise of the winter solstice) through the use of squares made of wood (in the shape of a right triangle in which the hypotenuse had the desired inclination), similarly to the process followed in staking out the slope of the faces of a pyramid.[92]

Funeral complex	Slope hill	Staircase	Façade	Chapel axis	Burial chamber axis
QH36	northeast	72.28º	138.84º	52.87º	
QH32	southeast		33.48º	123.71º	
QH31	southeast		33.48º	122.57º	3.12º
QH33	southeast		28.26º	115.24º	

Table 2. Orientations of the funeral complexes QH36, QH32, QH31 and QH33, arranged chronologically (the orientations of the burial chambers of the QH36, QH32 and QH33 complexes do not appear in the table as these are currently in different phases of archaeological excavation).

91 Bolshakov 1997: 26–27.

92 Arnold 1991: 46, fig. 2.24; Rossi 2003: 193, fig. 90.

Conclusions

In the necropolis of Qubbet el-Hawa, the funerary complexes of the governors of Elephantine of the Twelfth Dynasty stand out, in addition to their refined design and careful execution, because they were planned and built with a double orientation which was imbued with strong symbolism (see table 2). On one hand, they had an axis that was aligned according to the orientation towards one of the four cardinal points or, where appropriate, according to one of the intermediate cardinal orientations. On the other, they had a second axis that was aligned towards one of the extreme positions of the Sun, at the dawn of the summer solstice or the winter solstice (fig. 10).

On the northeast slope of the necropolis, the QH36 funerary complex was planned with the main axis towards the northeast, which was the main orientation of the hypogea of the Old Kingdom (for example, on this same slope the QH34h funerary complex and, on the southeast slope, the double funerary complex QH25-QH26 where, in this case, the alignment of the longitudinal axis was rotated 90º towards the East). Exceptionally, the orientation of the QH36 hypogeum does not coincide with that of the staircase (which was the usual situation in the necropolis) but was instead oriented to the rising of the Sun at the summer solstice, the position of the Sun that coincided with the beginning of the "flood" season, this being the only case of a funerary complex consciously planned with the "public area" articulated by two main axes: one for the ascending staircase (towards the sunrise in the summer solstice) and the other for the hypogeum (towards the intermediate cardinal northeast direction).

On the southeastern slope of the necropolis, the orientation of the funerary complexes QH31, QH32 and QH33 show a significant shift with respect to the layout of the rest of the hypogea on this slope, so the main axes of the hypogea are perpendicular to the topography and to the Nile but are also oriented towards the rising of the Sun in the winter solstice, the shortest day of the year after which the duration of the days increases. One of the criteria when choosing the location of these complexes was probably to meet these two conditions.

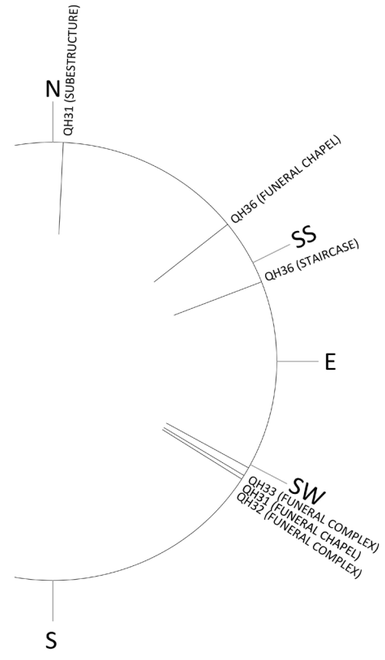

Figure 10. Orientation diagram of funerary complexes QH31, QH32, QH33 and QH36 of the Twelfth Dynasty. Author: J.A. Martínez Hermoso.

In addition, with the construction of QH31 the design of the main substructure changes with respect to the previous ones since the system of corridors, wells and sepulchral chambers, instead of being oriented according to the main axis of the hypogeum, was aligned according to the north-south axis. Despite the difficult working conditions in the underground areas (due to the lack of ventilation and natural lighting), the builders were able to progressively correct the orientation until it was adjusted to this axis in the main burial chamber (located in the deepest part of the hill).

In fact, the QH31 funerary complex (and, later, the QH33 complex) was planned with two clear main axes: the first, on which the funerary chapel is structured (the "public" area), was oriented towards the sunrise in the winter solstice (making a clear reference to the regeneration of the life of the deceased in the Hereafter), while the second, on which the substructure rests (the "intimate and inaccessible zone"), was oriented towards the north, which can be related to the ancient Egyptian belief that the deceased would ascend directly to one of the northern stars in order to achieve immortality.

Finally, it should be noted that the alignments with which the funerary complexes under study were oriented are also present in some of the most important religious buildings in Elephantine, indicating that they were also important in the city in which the governors of the First Nome of Upper Egypt lived.

To conclude, we would like to indicate that our final hypothesis has not attempted to define the general planning method used by the ancient Egyptians, since our conclusions have a limited scope as only several large funerary complexes of a given necropolis have been studied. Nevertheless, this study has given us a new point of view regarding future studies of other complexes of governors in private cemeteries, and/or a much broader study which would include the most important private funeral complexes in the rest of the country and would likely lead us to even more important conclusions.

Furthermore, we wish to highlight that astronomical alignments, normally associated with royal temples and burials, appear to have been appropriated by lower-level officials: provincial governors Sarenput I (QH36) and Sarenput II (QH31). The QH36 funerary complex (first half of the Twelfth Dynasty) has a double orientation, intercardinal (NE) and solar (SS, following the trend of many ancient Qubbet el-Hawa tombs). QH31 is the most modern funerary complex (second half of the Twelfth Dynasty) and has a double cardinal (N) and solar (SW, characteristic of the Theban temples of the Middle Kingdom) alignment. This is evidenced in this study, which expands on the work of González, Belmonte and Shaltout in Qubbet el-Hawa, and gives us interesting clues about the relationship between Egyptian governance and Egyptian astronomy.

Acknowledgements

The authors express their gratitude to Dr Juan Antonio Belmonte, recognised astrophysicist, for his valuable observations on the preliminary version of this work. We also thanks the Department of Economy and Competitiveness (MINECO) for the financial support of the Excellence Project HAR2016-75533-P with the name "Excavación, estudio histórico y conservación de las tumbas del Reino Medio de la necrópolis de Qubbet el-Hawa (Asuan, Egipto)".

Bibliographical references

Arnold, D.
1991 *Building in Egypt. Pharaonic Stone Masonry*. New York.

Barguet, P.
1953 "La structure du temple Ipet-Sout d'Amon à Karnak, du Moyen Empire à Aménophis II", *BIFAO* 52: 145–155.

Belmonte, J.A.
2003 "Some Open Questions on the Egyptian Calendar: an Astronomer's View", *TdE* 2: 7–56.

Belmonte, J.A.;Molinero Polo, M.Á.; Miranda, N.
2009 "Unveiling Seshat: New Insights into the Stretching of the Cord Ceremony", in: J.A. Belmonte and M. Shaltout (eds.): *In Search of Cosmic Order*. Selected Essays *on Egyptian Archaeoastronomy*, Cairo: 195–212.

Belmonte, J.A; Shaltout, M.
2006 "On the Orientation of Ancient Egyptian Temples (2): New Experiments at the Oases of the Western Desert", *Journal for the History of Astronomy* 37: 173–192.
2009 "Estableciendo la *m3't* en el Egipto antiguo. La orientación de los templos", *TdE* 5 / 1: 63–76.

Belmonte, J.A.; Shaltout, M. (Eds.)
2009 *In Search of Cosmic Order. Selected Essays on Egyptian Archaeoastronomy*. Cairo.

Belmonte, J.A.; Shaltout, M.; Fekri, M.
2008 "On the Orientation of Ancient Egyptian Temples (4): Epilogue in Serabit el Khadem and Overview", *Journal for the History of Astronomy* 39: 181–211.
2009 "Astronomy, Landscape and Symbolism: a Study of the Orientation of Ancient Egyptian Temples", in: J.A. Belmonte and M. Shaltout (eds.): *In Search of Cosmic Order. Selected Essays on Egyptian Archaeoastronomy*, Cairo: 213–284.

Belmonte, J.A.; Fekri, M.; Serra, M.
2019 "¿Atrapando el solsticio?... orientación de los templos de Deir el-Bahari", *TdE* 10: 11–26.

Bisson De La Roque, F.
1937 "Töd (1934 a 1936)", *BIFAO* 17: 6–33.

Bolshakov, A.O.
1997 *Man and his Double in Egyptian Ideology of the Old Kingdom* (*ÄAT* 37). Wiesbaden.

Borchardt, L.; Schäfer, H.
1900 "Vorläufiger Bericht über die Ausgrabungen bei Abusir im Winter 1899/1900", *ZÄS* 38: 94–100.

Davies, N.G.; Gardiner, A.H.
1920 *The Tomb of Antefoker, Vizir of Sesostris I and of his Wife Senet*. London.

Edel, E.
1984 "Qubbet el-Hawa", *LÄ* 5: 54–68.

Edel, E.; Seyfried, K.J.; Vieler, G.
2008 *Die Felsgräbernekropole der Qubbet el-Hawa bei Assuan. I. Abteilung. Architekture, Darstellungen, Texte, archäologischer Befund und Funde*. München.

Edwards, I.E.S.
1993 *The Pyramids of Egypt*. London.

Fakhry, A.
1961 *The Monuments of Sneferu at Dahshur*. Cairo.

González García, C.; Belmonte, J.A.; Shaltout, M.
2009 "The Orientation of Royal Tombs in Ancient Egypt", in: J.A. Belmonte and M. Shaltout (eds.): *In Search of Cosmic Order. Selected Essays on Egyptian Archaeoastronomy*, Cairo: 285–304.

Habachi, L.
1956 "Hekaib. The Deified Governor of Elephantine", *Archaeology* 9/1: 8–14.

Hawkins, G.
1973 *Beyond Stonehenge*. New York.
1974 "Astronomical Alignments in Britain, Egypt, and Peru", *Philosophical Transactions of the Royal Society of London*. Series A: Mathematical and Physical Sciences 276 (1257): 157–167.

Hournung, E.; Krauss, R.; Warbuton, D.A.
2006 *Ancient Egyptian Chronology*. Boston.

Jiménez Serrano, A.
2012 "Los nobles de la VI Dinastía enterrados en Qubbet el-Hawa", in: A. Agud, A. Cantera, A. Falero, R. El Hour, M.A. Manzano, R. Muñoz and E. Yildiz (eds.): *Séptimo Centenario de los Estudios Orientales en Salamanca* (*Estudios Filológicos* 337), Salamanca: 29–37.

Jiménez Serrano, A.; Martínez De Dios, J.L.; Valenti Costales, M.; Vivas Fernández, F.; De La Torre Robles, Y.; Anguita Ordóñez, J.m.
2009 "Proyecto Qubbet el-Hawa: Las tumbas nº 33, 34 y 34h. Segunda campaña (2009)", *BAEDE* 19: 41–75.

Jiménez Serrano, A.; Alemán Aguilera, I.; Ayora Cañada, M.J.; Botella López, M.; Domínguez Vidal, A.; Piquette, K.E.; Rodríguez Ariza, O.; Sáez Pérez, M.P.; Martínez De Dios, J.L.; Alba Gómez, J.M.; De La Torre Robles, Y.; Martínez Hermoso, F.; Martínez Hermoso, J.A.; López-Obregón Silvestre, T.; Calero García, C.
2014 "Proyecto Qubbet el-Hawa: Las tumbas 33, 34aa y QH34bb. Sexta campaña (2014)", *BAEDE* 23: 7–48.

Jiménez Serrano, A.; Alba Gómez, J.M.; Martínez De Dios, J.L.; De La Torre Robles, Y.; García González, L.; Barba Colmenero, V.; Caño Dortéz, A.; Espejo, A.M.; Bardonova, M.; López Grande, M.J.; Díaz Blanco, A.; Correas Amador, M.; Pérez Navazo, D.; Domínguez Vidal, A.; Ayora Cañada, M.J.; Eschenbrenner, G.; Botella López, M.; Alemán Aguilera, I.; Rubio Salvador, A.; Guimarey Duarte, R.; Rodríguez Ariza, O.; Montes Moya, E.; Martínez Hermoso, J.A.; Pérez García, J.L.; Mozas Calvache, A.; López-Obregón Silvestre, T.; Tapia Ruano-Juan, S.; Hernández Sánchez, R.; Molinero Reyes, J.F.; Krutzsch, M.; Hakin Karrar, A.

2018 "Proyecto Qubbet el-Hawa: primeros resultados de los trabajos llevados a cabo en las tumbas QH32, QH33, QH34bb, QH35n, QH35p y QH36 durante la décima campaña (2018)", *BAEDE* 26: 13–110.

Krupp, E.c.

1988 "Light in the Temples," in: C.L.N. Ruggles (ed.): *Records in Stone: Papers in memory of Alexander Thom*, Cambridge, 473–499.

Lull, J.

2016[3] *La Astronomía en el Antiguo Egipto*. Valencia.

Magli, G.

2013 *Architecture, Astronomy and Sacred Landscape in Ancient Egypt*. Cambridge.

Malville, J.M.; Schild, R.; Wendorf, F.; Brenmer, R.

2008 "Astronomy of Nabta Playa", in: J. Holbrook, R. Medupe and J. Urama (eds.): *African Cultural Astronomy: Current Archaeoastronomy and Ethnoastronomy Research in Africa*, New York: 131–143.

Martínez Hermoso, J.A.

2017a "Arquitectura funeraria durante el Reino Medio en Qubbet el-Hawa. El complejo funerario de Sarenput II", in: L. Bernal, A. Pérez Largacha and I. Vivas Sáinz (eds.): *V Congreso Ibérico de Egiptología* (*Colección Estudios* 157), Cuenca: 613–627.

2017b *Representación Gráfica y Diseño de la tumba de Sarenput II (QH31). Arquitectura funeraria de la necrópolis de Qubbet el-Hawa*. Doctoral Dissertation. Universidad de Córdoba. http://hdl.handle.net/10396/14783.

2018 "Reconstrucción virtual del exterior del complejo funerario de Sarenput I (QH36)", *Arqueología de la Arquitectura* 15: e071.https://doi.org/10.3989/arq.arqt.2018.006.

2019a "Reconstrucción Virtual de la secuencia de construcción de los patios exteriores de los hipogeos QH31, QH32, QH33 y QH34", *EGA Expresión Gráfica Arquitectónica* 24 (37): 108–119. https://doi.org/10.4995/ega.2019.7809.

2019b "Elementos arquitectónicos de la capilla funeraria de Sarenput II (QH31) en Qubbet el-Hawa. Caracterización geoquímica", *TdE* 10: 227–240.

Martínez Hermoso, J.A.; Martínez Hermoso, F; Montes Tubío, F.; Jiménez Serrano, A.

2015 "Geometry and Proportions in the Funeral Chapel of Sarenput II", *Nexus Network Journal. Architecture and Mathematics*17: 287–309.

Martínez Hermoso, J.A.; Mellado García, I.; Martínezde Dios, J.L.; Martínez Hermoso, F.; Espejo Jiménez, A.M.; Jiménez Serrano, A.

2018 "The Construction of the Funerary Set QH31 (Sarenput II)-QH33. Part I: The Exterior of the Funerary Complexes", *The Journal of Ancient Egyptian Architecture* 3: 25–44.

Molinero Polo, M.Á.

1998 *Realeza y concepción del universo en los textos de las pirámides*. Doctoral Dissertation, Universidad Complutense de Madrid. https://eprints.ucm.es/2515/.

2000 "Templo y Cosmos", in: M.Á. Molinero Polo and D. Sola (eds.): *Arte y sociedad del Egipto antiguo,* Madrid: 69–94.

Monnier, F.; Petit, J.P.; Tardy, Chr.

2016 "The Use of the 'Ceremonial' Cubit Rod as a Measuring Tool. An Explanation", *The Journal of Ancient Egyptian Architecture* 1: 1–9.

Mozas Calvache, A.T.; Pérez García, J.L.; Gómez López, J.M.; Martínez De Dios, J.L.; Jiménez Serrano, A.

2020 "3D Models of the QH31, QH32 and QH33 Tombs in Qubbet el-Hawa (Aswan, Egypt)", *The International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences* XLIII-B2-2020: 1427–1434, https://doi.org/10.5194/isprs-archives-XLIII-B2-2020-1427-2020

Müller, H.w.

1940 *Die Felsengräber der Fürsten von Elephantine aus der Zeit des Mittleren Reiches*. Glückstadt, Hamburg, New York.

Petrie, W.M.F.

1920 *Lahun I. The Treasure*. London.

Rossi, C.

2003 *Architecture and Mathematics in Ancient Egypt*. New York.

Roth, L.M.

2012 *Entender la arquitectura, sus elementos, historia y significado*. Barcelona.

Shaltout, M.; Belmonte, J.A.

2005 "On the Orientation of Ancient Egyptian Temples (1): Upper Egypt and Lower Nubia", *Journal for the History of Astronomy* 36: 273–298.

2009 "Introduction: under Ancient Egyptian Skies. In: The Orientation of Royal Tombs in Ancient Egypt", in: J.A. Belmonte and M. Shaltout (eds.): *In Search of Cosmic Order. Selected Essays on Egyptian Archaeoastronomy*, Cairo: 11–26.

Shaltout, M.; Belmonte, J.A.; Fekri, M.

2007 "On the Orientation of Ancient Egyptian Temples (3): Key Points at Lower Egypt and Siwa, Parts I and II", *Journal for the History of Astronomy* 38: 141–160 and 413–442.

Sethe, K.

1908 *Die Altaegyptischen Pyramidentexte nach den Papierabdrucken und Photographien des Berliner Museums*. Leipzig.

Shedid, A.G.

1997 "Moradas para la eternidad: las tumbas de los nomarcas y funcionarios", in: *Egipto. El mundo de los faraones*, Colonia: 119–131.

Steckweh, H.

1936 *Die Fürstengräber von Qaw*. Leipzig.

Storemyr, P.

2007 "Outline of the Geography and Environmental History of the West Bank at Aswan", in: E. Bloxam, T. Heldal and P. Storemyr (eds.): *Quarry Scapes Report. Characterisation of Complex Quarry Landscapes: an Example from the West Bank Quarries, Aswan* (*Geological Survey of Norway*, *Work Package* 4, *Deliverable* 4), Trondheim: 9–20.

Vandier, J.

1950 *Mo'alla: La tombe d'Ankhtifi et la tombe de Sébekhotep* (*BdÉ* 18). Le Caire.

Vieler, G.

2011 "Die Qubbet el-Hawa bei Assuan: Entdeckung und Architektur einer elitären Nekropole an Ägyptens Südgrenze / The Qubbet el-Hawa near Assuan. Discovery and architecture of an élite necropolis on Egypt´s Southern Border", in: L.D. Morenz, M. Höveler-Müller and A. El Hawary (eds.): *Zwischen den Welten. Grabfunde von Ägyptens Südgrenze/ Between Worlds. Finds from tombs on Egypt´s southern border*, Rahden: 97–121.

Wilkinson, R.H.

2000 *The Complete Temples of Ancient Egypt*. London.

Winlock, H.E.

1942 *Excavations at Deir el-Bahri 1911-1913*. New York.

1943 "The Eleventh Egyptian Dynasty", *JNES* II: 270.

Trabajos de Egiptología
Papers on Ancient Egypt

Número 12
2021

Trabajos de Egiptología está producida por
Isfet. Egiptología e Historia
con la colaboración del **Centro de Estudios Africanos de la Universidad de La Laguna**

C/ Blanco 1, 2º
38400 Puerto de la Cruz
Tenerife-Islas Canarias
España

Diseño de arte y maquetación
Amparo Errandonea
aeamparo@gmail.com

Imprime: Gráfica Los Majuelos

Depósito Legal: TF 935-2015
ISSN: 1695-4750

Índice | Contents