Mediterranean Archaeology and Archaeometry, Special Issue, Vol. 6, No 3, pp. 181-184

New media applications and their potential for the advancement of public perceptions of archaeoastronomy and for the testing of archaeoastronomical hypotheses

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Received: 13/4/2006
Accepted: 17/8/2006

Abstract

This paper looks at the use of astronomical programmes and the development of new media modelling techniques as a means to better understand archaeoastronomy. The paper also suggests that these new methods and technologies are a means of furthering the public perceptions of archaeoastronomy and the important role that 'astronomy' played in the history and development of human culture. This discussion is rooted in a computer simulation of Stonehenge and its land and skyscape. The integration of the astronomy software allows viewing horizon astronomical alignments in relation to digitally recreated Neolithic/Early Bronze Age (EBA) monumental architecture. This work shows how modern virtual modelling techniques can be a tool for testing archaeoastronomical hypotheses, as well as a demonstrative tool for teaching and promoting archaeoastronomy in mainstream media

Keywords: *3D, Computer Simulation, Virtual Environment, Phenomenology, Stonehenge, Celestia.*

Introduction

This SEAC2006 conference paper was presented largely through using video streams generated by new media technologies. As a conference publication the pictures in this paper are drawn from the conference video streams which can all be seen by the reader at **www.stonehenge3d.co.uk.** The advancement of new media technologies has taken us to the point where we can recreate virtual models of prehistoric monuments within their skyscape. The ability of computer programmes and simulations to rewind and repeat or adjust time sequences, as well as record and display the results in an inherently comprehensible way, have opened up access to mainstream popular media techniques as tools for testing archaeoastronomical theory and for bringing it to a wider audience.

Archaeoastronomy has frequently been restricted to using archaeological site plan diagrams and then superimposing upon them proposed astronomical alignments. Fig. 1 is an example of such a procedure, in this case showing the main double alignment shown by North (1996) for the main axis of sarsen Stonehenge when viewing from the heelstone. While it is an attempt to help the reader and assist interpretation, it needs to be accompanied by an elevation view to show

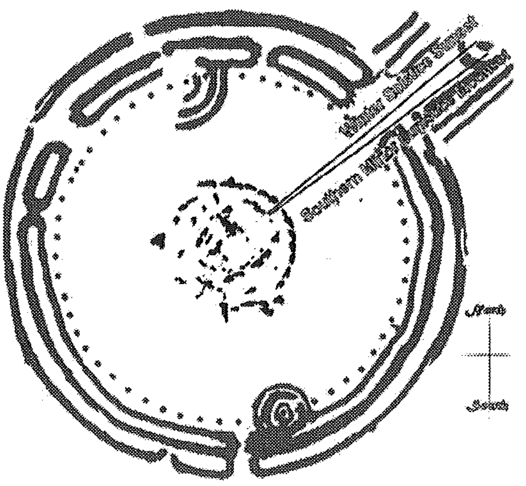


Fig. 1: *Main axis of sarsen Stonehenge when viewing from the heelstone*

the different altitudes of the two alignments. The point is that when tied to this 2-D 'paper' representation it is very difficult for any one image to impart the necessary information routinely handled by archaeoastronomy. This paper proposes that this 2-D plan viewing of monument alignments is now outdated by the new media technologies. We are now able to make three dimensional real time reconstructions possible in a way that could hitherto only be dreamed of. It is possible for the viewer to position themselves anywhere within the model and 'play with time' to test, research and display astronomical properties of any created structure or earthwork. Essentially, this allows us to look at the monuments from the same physical perspectives as the people responsible for building them and to appreciate them the way they were intended to be seen. The astronomy coded into the Neolithic/EBA monumental architecture of the British Isles is key in understanding the culture of their builders. We can check the power of the new technologies by demonstrating how they can discriminate between two current theories of prehistoric monument building cultures – that they were 'Sun worshipping farmers' or 'Lunar-solar pastoralists'.

Sun worshipping farmers or lunar- solar herders?

The main archaeological model of European prehistory contrasts a culturally and materially limited Mesolithic forager lifestyle with fixed settlements of socially complex Neolithic farmers. This argument has the social complexity, and the building of monuments like Stonehenge and Avebury henges, as a consequence or by-product of farming surpluses (Sims 2006). According to this view only farmers had the time and resources to develop complex societies able to build monuments. The second model suggests that Mesolithic hunting cultures prolonged their relatively mobile hunting-centred lifestyles and respect for lunar phased rituals into the Neolithic, even though they had switched to a largely pastoralist system of subsistence. Following the work of Sims (2006) sarsen Stonehenge is seen in this model as having been built to buttress a collapsing lunar cosmology by displacing lunar cycles and phases onto to a solar timescale.

At the University of East London our research team are using new media technologies to recreate the monuments of late Neolithic and Early Bronze Age Stonehenge and Avebury to create what will hopefully be an immersive phenomenological experience through 3-D virtual architecture and the 'celestial mechanics' integrated within it as was intended by the builders. By mechanics, I mean the 'astronomy' built into the monuments and the effect they have on the theories we construct to interpret the meaning of the architecture.

The 3-D simulation model was built using site plan diagrams to ensure accuracy and consistency with the known archaeology of sarsen Stonehenge.

Traditional astronomy programmes, such as 'SkyMap Pro' (Fig. 3-4) and 'Red Shift', are frequently used in archaeoastronomy and indeed have been used in this project to check the data generated by our own models. These programmes allow the sky to be seen from any location on earth, obviously essential for visualising horizon astronomy. However, they only allow clumsily superimposing the architecture onto static maps as an overlay, as shown in Fig. 4. While this allows an elevation view instead of plan view as shown in Fig. 1, it does not allow a simultaneous test-

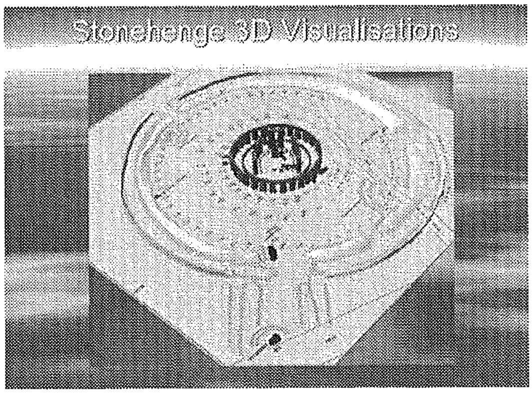


Fig. 2: *A 3-D simulation model built using site plan diagrams to ensure accuracy and consistency with the known archaeology of sarsen Stonehenge.*

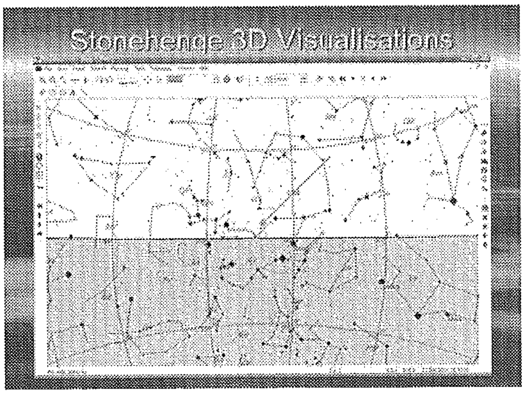


Fig. 3: *(left) Sky seen at Stonehenge with 'SkyMap Pro'*

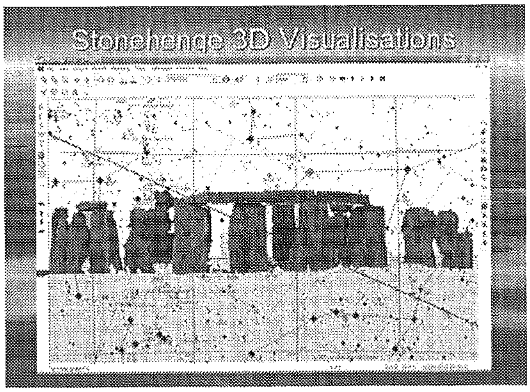


Fig. 4: *(right) Stonehenge 3D visualisation with 'SkyMap Pro'*

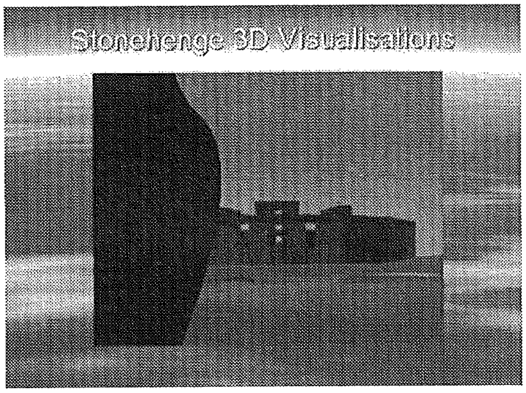
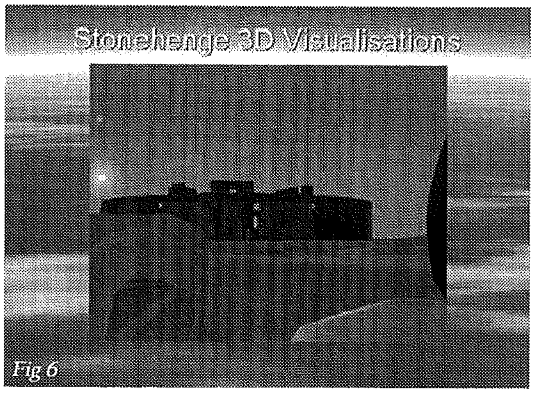


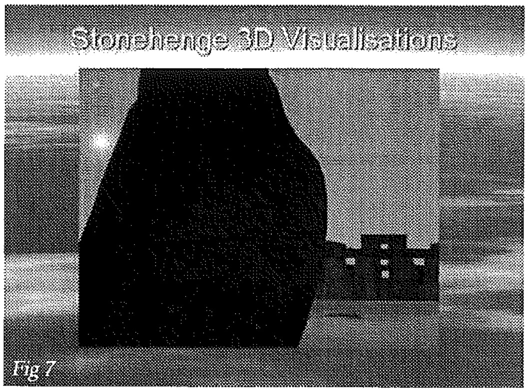
Fig. 5: *Recreated model as a snapshot and viewed from (Neolithic) head height.*

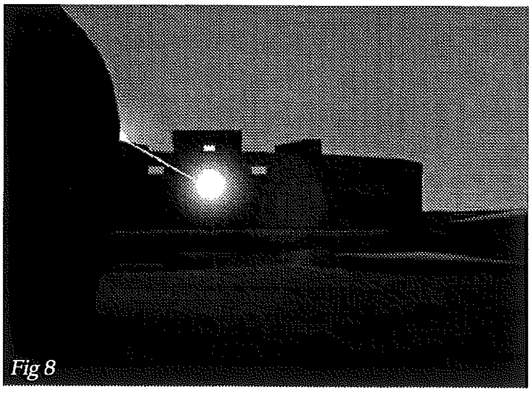
ing of alternative hypotheses within the same model. However a programme like Celestia is a free 'open source' program for virtual travelling across the sky and through space in three dimensions, from planet to planet if so wished. We can utilise this facility by building the programme into the landscape archaeology of Stonehenge using industry standard formats (a large community of users doing so exists at www.celestiamotherlode.net, file extensions being '.3ds'and '.cmod'). What was originally intended for games-programmers can then be used to recreate the architecture and horizon astronomy of a prehistoric monument.

The recreated model shown as a snapshot in Fig. 5 and viewed from (Neolithic) head height, allows us to see Stonehenge as the builders intended. This kind of ability had until recently been the limit of the technological benefits of new media technology on archaeoastronomy. Now however, rather than just building more realistic models we can integrate them into a real time working landscape and skyscape and use this to test archaeoastronomical hypotheses. The Stonehenge model seen here has been subject to such treatment and the results can easily be recorded and displayed as the snapshot examples in Figs 6-8 show.

According to our model the alignments visible at Stonehenge support the use of the monument as an obscuration device which, along its main axis, conflates winter solstice sunset with a superior southern minor standstill moonset. Looking from the Heel Stone the open monument paradoxically creates the illusion of a seeming nearly solid wall of stone framing two windows to the sky beyond. The alignment on







Figs 6, 7, 8: *The Stonehenge model. The ambient light has been increased in these images to show the dark moon. They show the moon above the sun with both setting into the centre of the stone circle. The moon viewed from the left and the sun from the right of the heelstone.*

winter solstice sunset can be in the lower window and on the southern minor standstill moonsets in the upper window. This hypothesis, first posited by John North (1996), is replicated and independently confirmed by our model. We checked the integrity of the model by independent checks made in SkyMap Pro. Having lunar alignments in late Neolithic/EBA monuments is supportive of the lunar-solar model postulated by the hunter-pastoralist scenario but is not predicted or accounted for by the sun-worshipping Neolithic farmer model. This is a one example of how the prehistoric tendency to embed 'astronomy' into monuments can be both tested and displayed with new media technologies. As an open resource in teaching and research, it is also a powerful tool in disseminating the growing knowledge base of archaeoastronomy.

Source Materials

Celestia and Celestia support, www.shatters.net/celestia

Celestia models, textures and support, www.celestiamotherlode.net

RedShift, www.redshift.de

SkyMap Pro, www.skymap.com

Stonehenge3D visualisations, www.stonehenge3d.co.uk

References

North, J. D. (1996) *Stonehenge: Neolithic man and the cosmos*, London, HarperCollins.

Sims, L. D. (2006) Solarisation of the Moon: Manipulated Knowledge at Stonehenge. *Cambridge Archaeological Journal.* Vol. 16:1 (in press).

Mediterranean Archaeology and Archaeometry, Special Issue, Vol. 6, No 3, pp. 185-192

Orientations of the Minoan palace at Phaistos in Crete

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Received: 15/04/2006
Accepted: 25/10/2006

Abstract

The primary orientation of the Phaistos palace, like that of the great majority of Minoan buildings and graves, is to the east within the limits of sunrise. There were two main building phases: near the end of the Middle Minoan IA period, ca 1900 BC (the Old Palace) and in the Middle Minoan IIIA period, ca 1750 BC (the New Palace). The two phases are unique in showing a difference in orientation of the west façade of the central court from the earlier to the later building. Surprisingly, we cannot detect a systematic change in the alignment of other parts of the New Palace. Its walls seem largely to have the same orientation as the visible walls of the Old Palace.

Our study concentrates on three orientations of the palace: 1) The western side of the earlier central court is aligned to the westernmost peak of Psiloriti, the ancient Mt Ida; 2) The east-west orientation of the Old Palace is close to sunrise at the equinoxes; 3) The western side of the later central court is oriented to the highest peak in the south, behind which the bright star Canopus rose and set near the equinoxes when that side was re-oriented. We conclude that the new appearance of the star is the probable reason for the change in orientation when the New Palace was built. We conclude, further, that this re-orientation at Phaistos provides information concerning the formative period of Minoan astronomy.

Keywords: *Archaeoastronomy, Aegean Bronze Age, Crete, Canopus, Minoan palaces, Phaistos.*

Introduction

This study is part of the Uppsala University archaeoastronomical project, which includes seventeen major Minoan sites (Fig. 1). The results from Phaistos are in good agreement with those we have so far from the other sites (see our articles in the references).

The excavation of Phaistos has been in progress since the beginning of the last century, conducted first by the Italian Archaeological Mission and later by the Italian Archaeological School of Athens (La Rosa and D'Agata 1985; La Rosa 1992). The palace is located in central Crete near the southern coast c. 85 m above sea level, overlooking the Mesara plain to the east, the most fertile area of Crete. It is generally considered to be one of the most important centres of Minoan culture. The site was inhabited from Late Neolithic times (c. 4000-3300 BC) until about 200 BC. This is significant for our archaeoastronomical study as intentional orientations to celestial bodies necessitate the habitation of a place for many centuries in order for the relationships between a building and these bodies to become familiar and receive a role in a culture. This is especially so in the case of stars, the positions of which change with respect to the earth at a very slow rate, 1° per 71.7 years.

There were two main construction phases: the Old Palace was built at the end of Middle Minoan IA, c. 1900 BC, and the New Palace was built in Middle Minoan IIIA, c. 1750 BC (Levi 1964; Kanta 1998). Both palaces had to be renovated to a greater or lesser degree from time to time as a result of the many earthquakes to which the island is subjected. There is a manifest, albeit small, difference in the orientation of the west side of the central court of the earlier and later phases, a suggestive feature for an archaeoastronomical study of the building as it is nearly equal to the rate of the precession of the equinoxes in 150 years (2.1°), the interval between the construction of the two palaces (Fig. 2). However, in the present case, the change is eastwards whereas the motion of precession is westwards. Nevertheless, as we have found several instances of Minoan orientations to the bright star Arcturus, we decided to keep orientation towards a star in mind.

To the north, the twin peaks of Mt Ida (h. c. 2450 m.), dominate the central court of the palace (Fig. 3). Just below the easternmost peak lies the cave of Kamares, which was an important Minoan cult place from earlier times. Its large entrance is visible from the central court.

The palace was built close to the edge of a steep slope, and the southeastern corner either eroded away or collapsed in a natural catastrophe; this may have been the result of one of the frequent earthquakes. When the New Palace was constructed, the site was not shifted further to the west, where a safer foundation could have been built. The western, or main, façade of the building was, in fact, moved several metres to the east. This suggests that the site was chosen and retained for compelling reasons.

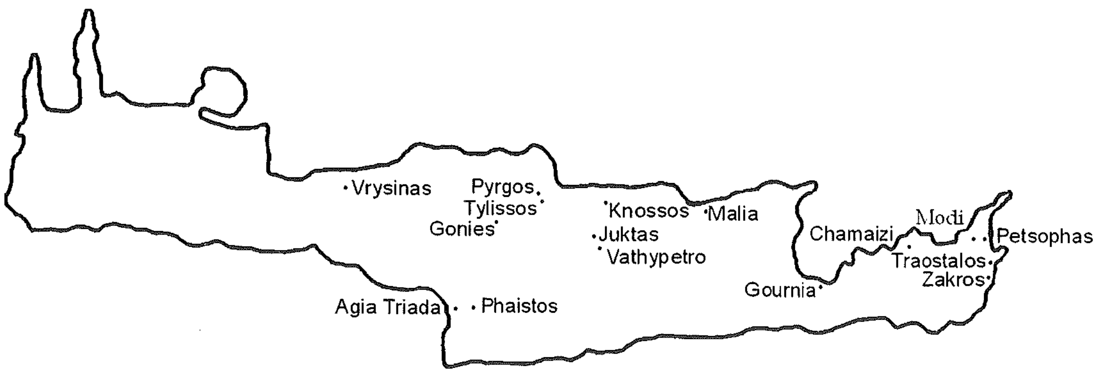


Fig.1: Location of the sites in the Uppsala Archaeoastronomical Project.

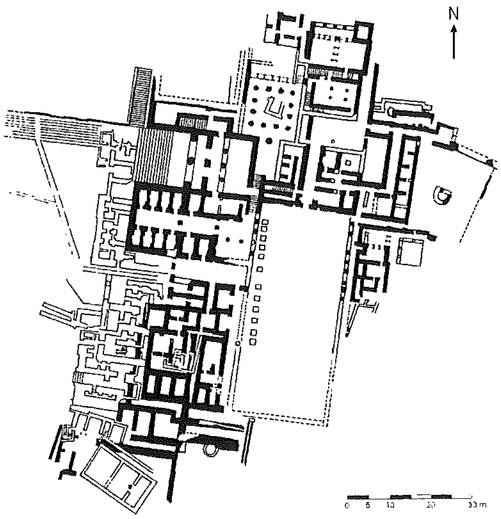


Fig.2: Plan of the palace at Phaistos. From Myers, Myers & Cadogan (1992: 236), with permission

Orientation to Mt Ida

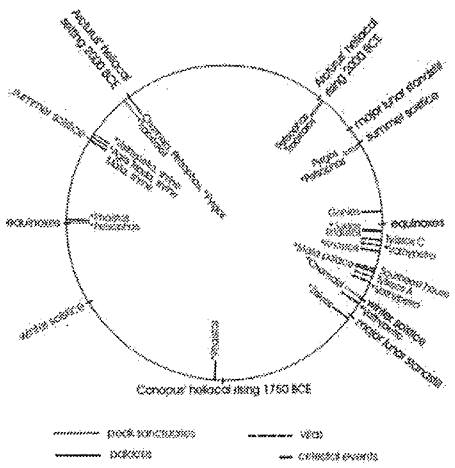
The north-south alignment of the earlier western side of the central court to the westernmost peak of Mt Ida is striking (Fig. 3). We have concluded, however, for the following reasons that this is fortuitous: 1) The Kamares cave is located just below the easternmost peak and its entrance is clearly visible from the central court, 2) Neither peak seems higher than the other from the central court, 3) The later change in alignment was not to any more prominent feature of the mountain, but is somewhat to the east of the centre of the dip between the two peaks, 4) Several Minoan sites are dominated by a dramatic natural feature, many of which exist in the mountainous island, but there seems to have been no tradition of aligning walls of any building to such a feature. Mt Juktas, for example, is an important sanctuary and impressive landmark south of the palace at Knossos, but no part of the building is closely oriented to it. It is relevant to point out that, according to our studies, the Minoans strove for exactness in their orientations (see our articles in the references). Our studies have also shown that the main orientation of the great majority of both buildings and graves was to the east within the limits of sunrise (Blomberg and Henriksson 2003b; 2001b). Shaw (1977) has written a general discussion of the orientation of the Minoan palaces.

Fig.3: Psiloritis, the ancient Mt Ida, as seen from the central court of the palace at Phaistos

Orientations to celestial events

Our research provides strong evidence that the Minoans seem to have placed greater importance on relating their buildings to celestial bodies rather than to natural features of the landscape. They did this by closely aligning specific parts of their buildings to major celestial events. The significance of any particular celestial event varies from culture to culture, and in Minoan Crete we have found sunrise at the solstices and equinoxes, the horizon risings and settings of bright stars, and the eastern southern major standstill of the moon to have been the focus for orientations (Fig. 4). The Minoans were only rarely interested in sunsets, whereas these seem to have been important to the Mycenaeans (Blomberg and Henriksson 2003b, 2001b). The orientation to sunset at the equinoxes from Petsophas is due, we think, to the difficulties of observing sunrise from that place, the horizon being the sea and often obscured by atmospheric conditions. This would have caused sunrise to have been unobservable on the morning of the equinoxes in some years. Sunset at the equinoxes occurred directly behind the conical peak of Mt. Modi and was more reliably observable. We seem to have a parallel case at Phaistos (see below). We have argued that the Minoan year began on the evening of the first new crescent moon following the autumn equinox, and this effort to determine as exactly as possible when that event occurred is therefore understandable (Blomberg and Henriksson esp. 2003b and 2002; Henriksson and Blomberg 1997-1998, 1996).

The orientation to a single major celestial event is in itself good indication that the orientation is intentional and not the result of chance. The presence of more than one orientation at the same site to such an event offers assurance that the orientations were deliberate (Blomberg and Henriksson 2001a). It would have been very difficult to find sites where several orientations could have been arranged, especially in a mountainous landscape such as Crete. Remarkably, we have found the presence of more than one orientation with respect to at least five of the Minoan sites we have investigated: Petsophas, Chamaizi, Pyrgos, Vathypetro and now Phaistos (Henriksson and Blomberg 1996, 2005; Blomberg and Henriksson 2003a, 2005).



Monuments in the Uppsala project. An asterisk indicates a foresight.

***Fig.4:** Orientations of the Minoan sites in the Uppsala archaeoastronomical project.*

Orientation to sunrise

The azimuth of the sun at sunrise and sunset at the equinoxes are the only celestial events that do not change appreciably as the result of precession. The horizon opposite many Minoan sites, however, varies due to the mountainous terrain, causing the orientation to sunrise to be to an azimuth more or less south of due east. At Phaistos, although there is a high mountain in the east opposite the palace, it is at such a distance (c. 65 km) that the azimuth of sunrise is shifted southwards by only a few fractions of a degree, being 90.3° (Fig. 5). In figure 5 we have also shown the sun at azimuth 91.5°, when sunrise would have been at right angles to the western façade of the Old Palace's central court. It is probable that sunrise at the equinoxes was more reliably observable at that azimuth from Phaistos, as the sun would have risen above the layer of fog that frequently obscures the distant horizon in the valley. We have a similar case at Petsophas, as we noted above. Pinpointing the day of sunrise at the autumn equinox was crucial in determining the beginning of the Minoan year, and any difficulty would have been a serious problem. Of course a manmade foresight could have been arranged to mark the point of sunrise on the horizon, but the Minoans seem to have preferred to anchor their buildings cosmically by establishing tangible connections between them and major celestial events by means of natural foresights. We think this is the reason why they placed the small building on Petsophas such that the sun set at the equinoxes directly behind the conically shaped Mt. Modi, thus clearly pinpointing the evening of the equinoxes, as well as of the preceding day (Henriksson and Blomberg 1996, Fig. 2). We shall see below that they did something similar at Phaistos.

The change in the orientation of the west façade of the central court would not have improved the observation of sunrise at the equinoxes and therefore would not have helped in determining the beginning of the Minoan new year. As the azimuth of sunrise does not change perceptibly due to precession and the older orientation was adequate to compensate for the low visibility at the horizon, there would have

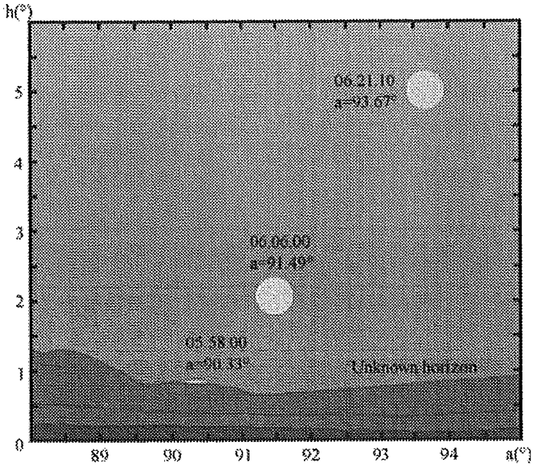


Fig.5: *Sunrise from the palace at Phaistos on the autumn equinox, 22 September 1900 BC. The time is local mean solar time (refraction for t = + 10°C). The positions of the sun at 06.06.00 and 06.21.10 correspond to the azimuths perpendicular to the two different orientations of the western façade of the central court.*

been no reason at all related to sunrise for changing the orientation of the west façade of the central court. Therefore we can conclude that the change in orientation would not have been made for the sake of sunrise.

As a result of the palace's poor state of preservation we could not discover any arrangements to dramatize the moment of sunrise through reflections or shadows, as we have found at Knossos (Henriksson and Blomberg 2005; Blomberg and Henriksson 2002). It seems possible, in any case, that such arrangements need not have been disturbed irreparably by the small change in orientation of the west side of the central court. This could also account for the fact that the orientation of many parts of the earlier building was not changed. (Fig. 2).

What we do find at Phaistos is the fact that the sun sets on the day of the equinoxes directly behind one of the peaks of Ephendi Christou (distance c. 600 m, h. above central court c. 60 m). The date of the autumn equinox could have been easily determined by observation from the central pillar of the monumental staircase at the main entrance to the New Palace (Fig. 6). We do not know where the main entrance to the Old Palace was located. The atmospheric conditions in Crete at this time of the year are not likely to have obscured this event very often. On any occasions when it may have, the position of the sun at sunset relative to the peak on the days before the autumn equinox would have indicated when the equinox occurred. As we noted above, the same method seems to have been used for determining the autumn equinox at Petsophas.

Orientation to a star

Once a re-orientation of the western façade of the central court for the sake of sunrise can be excluded as being most unlikely, the horizon rising or setting of a bright star remains the most appealing reason for the change. Several important Minoan buildings were oriented to such a star, and at least four sites in the northern half of the island were oriented to the horizon rising or setting of the bright star Arcturus (Fig. 4). Also, the constellation that we argue represented the double axe, the Minoans most important symbol, was composed of several bright stars, including Sirius, and it dominated the eastern sky at the equinox in the Middle Minoan period (Fig. 7). Thus in the three cases - Knossos, Petsophas and Phaistos - bright stars had a special relationship to the autumn equinox (Blomberg and Henriksson 1996; Henriksson and Blomberg 2005).

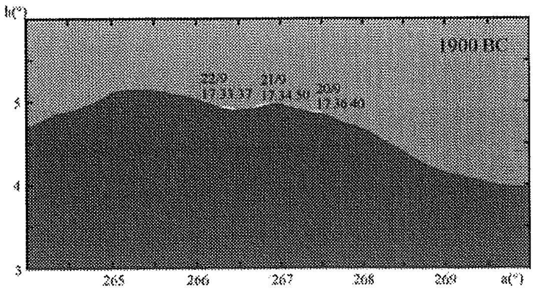


Fig.6: *Sunset at the autumn equinox behind Ephendi Christou from the central pillar of the entrance staircase to the New Palace. The dates are given in the Gregorian calendar and the times are local mean solar time at Phaistos (refraction for t = + 10° C).*

Canopus, the second brightest of all stars after Sirius, is an attractive target for the new orientation at Phaistos. It would have become visible for the first time from southern Crete somewhat before 3000 BC from high up on the slopes of Mt Ida. It would never have been observed in the northern half of the island in the Bronze Age except from a mountain peak, perhaps giving it a special meaning for the Phaistos area. The appearance of this new star must have been of the greatest significance, given the importance of the celestial bodies for the Minoans. In our opinion, such stars represented a Minoan divinity (Henriksson and Blomberg 1996, 113). It is clear that the Minoans were strongly motivated to orient important buildings to them, and the new appearance of a very bright star, one brighter than Arcturus, could have meant either the appearance of a new divinity or a new manifestation of an already existing divinity. There are many representations on Minoan seals and rings showing what are interpreted to be divinities and objects that were constellations hovering in the sky (Fig. 8; Kyriakidis 2005).

Following its first appearance in the Phaistos area, from the slopes of Mt Ida at some time around 3000 BC, Canopus rose higher in the sky at a very slow rate. By c. 2800 BC it would have been visible briefly just above sea level from the southern coast. By c. 2080 BC it would have been visible, again briefly - a few minutes only, from the hill Ephendi

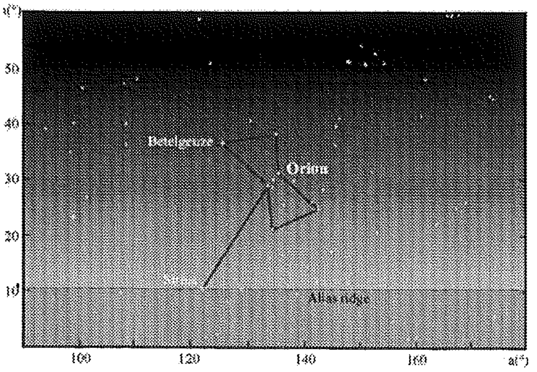


Fig.7: *The Minoan constellation of the double axe dominated the southeastern sky at the autumn equinox in the Middle Bronze Age, here opposite the palace at Knossos.*

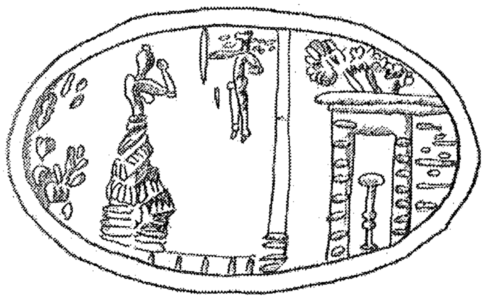


Fig.8: *Gold ring from Knossos with a hovering figure (after Evans 1921, 160, Fig. 115).*

Christou west of the palace (Fig. 9A). Unfortunately this hilltop has not been excavated, but there still remains an impressive stone floor. No original edges or corners remain, however, by which an orientation could be made. Not long ago small clay figurines of the type recovered from the Minoan peak sanctuaries were found below the hilltop (Watrous et al. 1993, 255), which leads us to believe that this site also was a peak sanctuary, places which we have argued were used to study the motions of the celestial bodies (Henriksson and Blomberg 1996; 1997-1998). By the time there was a palace, Canopus would have risen and set behind the mountain in the south, where it would have been above the horizon for twenty minutes in the Old Palace period and for twenty-nine minutes in the New Palace period (Fig. 9B). It is to the highest peak of this mountain that the new west side of the central court is oriented. Moreover, the heliacal rising of the star was three days before the autumn equinox following its long period of invisibility during the summer months. It would have been an excellent harbinger of the autumn equinox. The star would not have been visible from the central court during the life of the palace, but the Minoans would have known, of course, that it rose heliacally behind the mountain just before the autumn equinox.

We propose that when the Old Palace was built c. 1900 BC, the presence of Canopus and it relationship to the palace was known, but there had not been time enough for the Minoans to have accommodated it in their worldview. During the 150 years

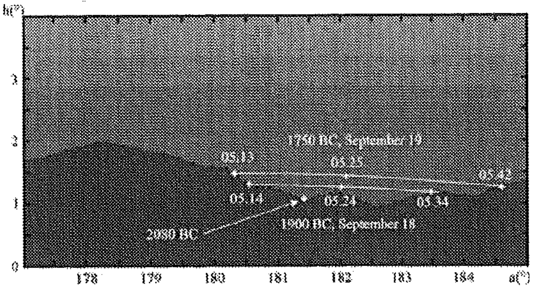


Fig.9A: *The first appearance of Canopus from Ephendi Christou occurred in 2080 BC. The star would have been visible for only a few minutes.*

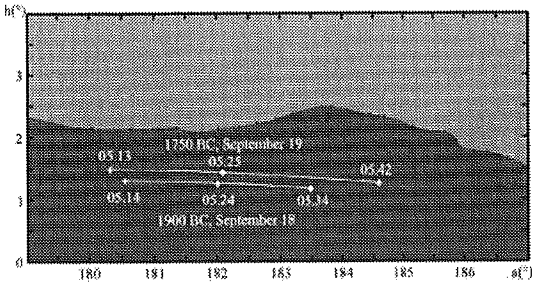


Fig.9B: *In the Old and New Palace periods, the heliacal rising of Canopus would have occurred behind the mountain south of the palace. The star would have been visible for less than a half hour.*

between the construction of the two buildings, the star had climbed ever higher in the sky and remained visible for longer periods of time. By the time the New Palace was built c. 1750, we can assume that its increasing prominence in the southern sky would have had a growing impact on the people of Phaistos, given the importance that the Minoans attached to such celestial phenomena.

The New Palace period marked the beginning of the high point of Minoan Culture. It therefore seems credible that, at such a time, when the accumulated knowledge concerning the celestial bodies was being systematized and their use in keeping the ritual calendar was established, Canopus would have had an important place in the cosmic view of the Minoans. In such a context the new orientation of the palace to Canopus seems a natural step.

Conclusion

In our pilot archaeoastronomical study of seventeen representative Minoan buildings – the four major palaces, seven peak sanctuaries and six villas, we have found good evidence of systematic orientations to major celestial events (Fig. 4). We have completed our study of eleven buildings and these show a total of eighteen such orientations. There are three additional orientations that we consider to be Mycenaean, and two sites (Malia and Vathypetro) have what we consider to be significant orientations to the same event, but it is a major cultural rather than celestial event, the beginning of the agricultural year (Blomberg and Henriksson 2005). Five sites have more than one orientation, and the peak sanctuary on Petsophas, with four, has the most. Thirteen of the eighteen orientations have a surviving natural or man-made foresight. Another remarkable fact about these orientations is that no Minoan building seems to have an orientation to sunset at the solstices and the only orientation to sunset at the equinoxes, other than the one here presented at Phaistos, occurs at Petsophas (Henriksson & Blomberg 1996, 1997-8). These two exceptions may be due to the difficulty of observing sunrise at the autumn equinox, which was used to determine the beginning of the Minoan year. These statistics all come from Middle Minoan buildings, but this may be an accident of history. As buildings were destroyed time and again by earthquakes, evidence for the earlier periods may no longer exist.

Our study of the palace at Phaistos provides us with a fuller understanding of Minoan interest in the bright stars. The orientation of a major building to such a star and to the prominent natural foresight for its known, but unseen, position is further strong indication of the importance of these bodies for the Minoans. This orientation gives us also some indication that the formative period for Minoan astronomy was in the time of the Old Palaces, c. 1900-1750 BC, as that palace at Phaistos was not oriented to Canopus whereas the New Palace was.

References

Blomberg, M. and Henriksson, G. (2001a) Archaeoastronomy: new trends in the field, with methods and results from studies in Minoan Crete. In Liritzis.I (ed.), *Journal of Radioanalytical and Nuclear Chemistry*, vol. 247, 609-619.

Blomberg, M. and Henriksson, G. (2001b) Differences in Minoan and Mycenaean orientations in Crete. In: *Astronomy, cosmology and landscape*, Proceedings of the SEAC 98 meeting, Dublin, Ireland, September 1998, C. Ruggles, F. Prendergast, and T. Ray (eds.), Bognor Regis, 72-91.

Blomberg, M. and Henriksson, G. (2002) The calendaric relationship between the Minoan peak sanctuary on Juktas and the palace at Knossos. In: *Proceedings of the conference "Astronomy of ancient civilizations" of the European Society for Astronomy in Culture (SEAC) and National Astronomical Meeting (JENAM)*, Moscow, May 23-27, 2000, T. M. Potyomkina and V. N. Obridko (eds.), Moscow, 81-92.

Blomberg, M. and Henriksson, G. (2003a) The Minoan peak sanctuary on Pyrgos and its context. In: *Calendars, symbols, and orientations: legacies of astronomy in culture*, Proceedings of the 9th meeting of the European Society for Astronomy in Culture (SEAC), 27-30 August 2001 (Uppsala Astronomical Observatory Report no. 59), M. Blomberg, P. E. Blomberg and G. Henriksson (eds.), Uppsala University Press, Uppsala, 127-134.

Blomberg, M. and Henriksson, G. (2003b) Literary and archaeoastronomical evidence for the origins of the Hellenic calendar in the Aegean Bronze Age. In: *Ad astra per astera et per ludum: European archaeoastronomy and the arientation of aonuments in the Mediterranean Basin* (Papers from Session I.13, held at the European Association of Archaeologists eighth annual meeting in Thessaloniki 2002), A.-A. Maravelia (ed.), *British Archaeological Reports International Series*, vol. 1154, 53-70.

Blomberg, M. and Henriksson, G. (2005) Orientations of the Late Bronze Age villa complex at Vathyptro in Crete. *Mediterranean Archaeology and Archaeometry*, vol. 5, 51-61.

Evans, A. (1921) *The palace of Minos*, vol. 1. Macmillan and Co., Limited, London.

Henriksson, G. and Blomberg, M. (1996) Evidence for Minoan astronomical observations from the peak sanctuaries on Petsophas and Traostalos. *Opuscula Atheniensia* 21, 1996, 99-114.

Henriksson, G. and Blomberg, M. (1997-1998) Petsophas and the summer solstice. *Opuscula Atheniensia*, vols 22-23, 147-151.

Henriksson, G. and Blomberg, M. (2005) Elements of Greek astronomy and religion in Minoan Crete. In: *Current studies in archaeoastronomy. Conversations across time and space.* (Selected papers from the fifth Oxford international conference at Santa Fe, 1996), J. W. Fountain and R. M. Sinclair (eds.), Carolina Academic Press, Durham North Carolina, 371-392.

Kanta, A. (1998) *Phaistos, Hagia Triadha, Gortyn*. Adam editions, Athens.

Kyriakidis, E. (2005) Unidentified floating objects on Minoan seals. *American Journal of Archaeology*, vol. 109, 137-154.

La Rosa, V. (1992) Phaistos. In: J. W. Myers, E. E. Myers and G. Cadogan (eds.) *The aerial atlas of Ancient Crete*, Thames and Hudson, London, 232-243.

La Rosa, V. and D'Agata, A. L. (1985) Phaistos. In: *Ancient Crete: A hundred years of Italian archaeology (1884-1984)*, De Luca Editore, Rome, 75-107.

Levi, D. (1964) *The recent excavations at Phaistos* (Studies in Mediterranean Archaeology 11), Lund.

Myers, J. W., Myers, E. E. and Cadogan, G. (1992) *The aerial atlas of ancient Crete*, Thames and Hudson, London.

Shaw, J. W. (1977) The orientation of the Minoan palaces. In: *Antichità cretesi: studi in onore di Doro Levi* 1, Catania, 47-59.

Watrous, L.V. et al. (1993) A survey of the western Mesara plain in Crete: preliminary report of the 1984, 1986, and 1987 field seasons. *Hesperia*, vol. 62, 191-248.