MINOAN ORIENTATIONS IN CONTEXT*

It was a common practice in Mesopotamia and Egypt from as early as the third millennium BCE to establish relationships with the cosmos by orienting important structures to major celestial events, e.g. sunrise and sunset at the equinoxes and solstices and the heliacal risings and settings of bright stars. The Uppsala University archaeoastronomical project has studied the orientations of major Minoan structures in order to understand the nature and purpose of Minoan practice in this respect. In brief, our results indicate that the Minoans conducted systematic astronomical observations from at least the Early Minoan Period, that they used the knowledge acquired in this way to keep a lunisolar calendar and to navigate, and that their knowledge survived to exert an important influence on Greek astronomy. The evidence indicates a local development in Crete in response to the particular interests of the Minoans, rather than to influence from the Mesopotamian and Egyptian cultures. Eight articles have been published so far and three more are in press.¹

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Using a digital theodolite, we measured the orientations of eighteen buildings: four palaces (Knossos, Mallia, Phaistos, Zakros), five villas (Aya Triada, Gournia, the Southeast House at Knossos, Tylissos, Vathypetro), seven peak sanctuaries (Gonies, Juktas, Modi, Petsophas, Pyrgos, Traostalos, Vrysina), the bâtiment oblique at Mallia, and building H at Ayia Triada. We chose buildings or areas of buildings that are generally assumed to have been cult centers – the west wings of the palaces, the peak sanctuaries etc., as the heavenly bodies can be assumed to have had divine status of some sort. We have not yet completed our evaluation of all sites, so the results presented here are still preliminary.

In this paper we report the results of our recently completed investigation of the small Middle Minoan building on Pyrgos (684 m.), near Tylissos. We then proceed to a wider consideration of Minoan orientations and a comparison of them to orientations of similar Mycenaean monuments.

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Pyrgos (Maleviziou)

After measuring the positions of the stones of the peak sanctuary on Pyrgos with the theodolite, we used orthogonal regression estimation to calculate the orientations of the walls. We found that of the long wall BCE to be 59.3° ± 0.4° (fig. 1). This is very close to the calculated azimuth of sunrise at the summer solstice in the Middle Bronze Age in Crete, which was 59.2° (fig. 2). The horizon in the direction of the summer solstice from Pyrgos is the open sea, and the altitude at which the sun will become visible is very sensitive to variations in atmospheric refraction and extinction. Sunrise at the summer solstice in the Middle Bronze Age could have been observed as far north as 59.2°, but never further north. Thus the orientation of the major axis of the building on Pyrgos would have served well to show where the sun would rise at the summer solstice at the time when the small structure was built. In addition, to someone standing in the near vicinity of the building on Pyrgos, the most prominent peak opposite the site to the northwest, Kako Kefali, would have been a useful foresight for the heliacal setting of the bright star Arcturus at the beginning of the Middle Minoan Period, when the structure was most probably built (fig. 3). When Arcturus descends further down, it is no longer visible due to atmosphere extinction.²

These orientations at Pyrgos gain greater significance when they are compared to those that we found earlier at Petsophas and Traostalos, peak sanctuaries on the east coast of Crete.³ The long wall CDE of the building on Petsophas was oriented, as at Pyrgos, to sunrise at the summer solstice (fig. 4), and it was arranged so that the highest peak, Kali Limni, on the island of Karpathos opposite served as a foresight (fig. 5). The two oblique walls AB and AA' were oriented to the heliacal rising and setting of Arcturus in the same period.

² The parameters for calculating the visibility have been based on the results of A. Bemporad, “Zur Theorie der Extinktion des Lichtes in der Erdatmosphäre”, *Mitteilungen Grossh. Sternwarte zu Heidelberg* 4, 1904, 1-78; H. Siedentopf, “Neue Messungen der visuellen Kontrastschwelle”, *Astronomische Nachrichten* 271, 1941, 193-203; A. Ljunghall, “The intensity of twilight and its connection with the density of the atmosphere”, *Meddelanden fran Lunds astronomiska observatorium*, ser. 2, vol. 13, no. 125, 1949; J. F. Schmidt, “Über die Dämmerung”, *Astronomische Nachrichten* 63, 1865, article no. 1495. B. We have used Schmidt's visibility calibration for Athens of ca 1850, as they were made before modern air pollution.

³ For the publications of these two sites see articles 6) and 7) in note 1 above.
At Traostalos there are also two oblique walls designated AB and AA' that were oriented to the heliacal rising and setting of Arcturus in the Middle Minoan Period (fig. 6). The orientation to the heliacal setting of Arcturus had as foresight the isolated conical peak of Modi (fig. 7). Thus we have a third instance of orientation to Arcturus in the Minoan period—the other two being at Pyrgos and Petsophas—and a second instance of a mountain peak being used as foresight for the heliacal setting of the same star.

The orientations and relationships of the generally identified cult areas at the sites in our study are shown in figure 8. Relationships are not orientations of walls to celestial events, but are observations of such events that can only occur in the near vicinity of the buildings. As can be seen, there is a heavy concentration of what we call major celestial events: sunrise at the summer solstice (at Petsophas, Pyrgos), sunrise or sunset at the equinoxes (at Juktas, Knossos, Petsophas, Phaistos), moonrise at the southern major standstill (Zakros), and the heliacal rising and/or setting of Arcturus (Petsophas, Pyrgos, Traostalos). The heliacal rising and setting of Arcturus at Petsophas and its setting at Pyrgos are in addition to the orientation to sunrise at those sites, which may indicate that regulation of the calendar was a special interest at these two places.

It must be kept in mind that the orientations are influenced by the mountainous landscape and the azimuths are therefore in many cases shifted as a result. Those site names preceded by an asterisk in figure 8 have a natural foresight which focused attention on the place where the celestial event would take place, so we may be confident that these orientations or relationships were intentional. The only exceptions to orientations within the limits of sunrise or moonrise are the small shrines at Mallia and Ayia Triada, which were oriented to sunset at the summer solstice. These two deviations and the later dates of the buildings, LM II and LM IIIA2 respectively, suggested to us that they were built under Mycenaean influence, and this led us to make a preliminary comparison of Minoan and

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4 For the calendric significance of the palace at Knossos and the sanctuaries on Juktas and Petsophas see articles 3), 6) and 11) in note 1 above.


6 These two sites are presented in greater detail in article 2), note 1 above.
Mycenaean orientations with respect to comparable types of structures. It seems to us that any differences or similarities here could shed light on the great difficulty in distinguishing the Mycenaean and the Minoan in Crete after LM IB.\(^7\)

We compared the orientations of the Mycenaean cult buildings given by Hélène Whittaker in her recent book, but included also the bâtiment oblique at Mallia because of its date and the megara of the mainland palaces, although they are not discussed by Whittaker.\(^8\) We added the latter to increase the comparability of the two samples, as cultic activities probably took place in them as they did in the Minoan palaces. We also added the LM III sanctuaries on Crete, which Whittaker considers to represent Minoan cult continuity and not radical innovations introduced by the Mycenaean. The orientation pattern formed by these buildings, however, is radically different from those of Minoan cult places (fig. 9). The insistence on orientations to major celestial events or to the east no longer exists, and this is as true in Crete as it is in the mainland. Indeed 17 of the 22 cultic rooms from LM II and III are oriented outside the limits for sunrise and moonrise, whereas this was the case for only one of the Minoan buildings, Traostalos, once we excluded the two small shrines from Mallia and Ayia Triada because of their date (cf. fig. 8). The orientations to the heliacal settings at Petsophas and Pyrgos are in addition to the orientations at those sites to sunrise at the summer solstice. There was an enormous change in the orientations of cult centres in Crete after LM IB, and it seems probable that this change is to be connected to Mycenaean influence. Another indication of radical change is the fact that none of the LM II and III cult centres were built on sites of earlier cult places, which suggests deliberate avoidance.

If we compare the orientations of graves with passage entrances in Crete and the mainland, we find a similar insistence on eastern orientations in Crete, but not on all in the mainland. Eighty-seven per cent of the tombs

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\(^8\) H. Whittaker, *Mycenaean cult buildings: a study of their architecture and function in the context of the Aegean and the eastern Mediterranean* (Monographs from the Norwegian Institute at Athens, 1), Bergen 1997.
in Crete are oriented within the limits of sun and moonrise, which encompass only about 20% of the circle (fig. 10). Especially noteworthy is the fact that 40% of the orientations are within ±10° of due east. There is, however, a small group of tombs with orientations in the southwest quadrant to which we will return. The orientations of graves in the mainland give an entirely different pattern. Only 11% lie within the limits for sun and moonrise. There is, instead, a preference for the southwest quadrant, which contains 56% of the orientations (fig. 11).9

We can assume that the great majority of graves in the mainland are those of Mycenaeans, but what about the graves in Crete? Most of the passage tombs in Crete are, in fact, from LM III, the period generally considered to have been under Mycenaean domination. But the graves can’t all be those of Mycenaeans. In fact the only ones that have been identified as Mycenaean are the few so-called warrior graves at Knossos.10 These do indeed have the southwestern orientation most typical of the mainland – they are among the group referred to above. Others in this group are 15 of the graves at Mavro Spelio at Knossos. The interesting fact about the graves from Mavro Spelio is that most were built in the Middle Minoan period and that the only figures of goddesses with upraised arms found in graves in Crete come from them. These figures are central to Whittaker’s identification of cult buildings in LM III.11 Should we not consider the possibility that these may be the graves of a group of Mycenaeans living at Knossos already in the Middle Minoan Period, and that they continued to be used for the burial of Mycenaeans afterwards?

In any case, we cannot deny the fact that the Mycenaean presence in Crete in the LM III period seems to have had very little effect on the island custom of orienting graves to the east within the limits of sun and moon rise. We do not find the radical change in orientations of graves that we find in the case of cult buildings. One explanation, suggested by the graves in the mainland, is that the Mycenaeans did not consider the orientations

9 For lists of the graves included in figures 10 and 11 and their publications see article 2), note 1 above. The orientations of the graves at Prosmyna in the mainland and at Armenoi in Crete were given in the publications; the remainder were determined by us from published plans.
10 M. S. F. Hood and P. DeJong, Late Minoan Warrior-Graves from Ayios Ioannis and the New Hospital Site at Knossos, BSA 47 (1952), 243-277.
11 Supra note 8, 42-43.
of graves to be very important. We may on the same grounds even conclude that they did not consider the orientations of cult buildings to be important. We are left with the question as to why they seem in Crete to have followed the Minoan custom of burial, accepting eastern orientations for their graves, but did not do so for their cult buildings.

There is a clear exception to the eastern orientation for graves in Late Minoan Crete, and this is in the case of the warrior graves, which we may assume to have been the graves of important Mycenaeans. Could it be that in the case of prominent leaders and important places, such as those for cult use, it was felt necessary by the Mycenaeans to make clear statements as to their differences from their Minoan subjects?

Whatever the explanation, we hope that this brief comparison of Mycenaean and Minoan orientations has shown the value of such studies.
Fig. 1. Plan of the building on Pyrgos (Maleviziou). The natural rock to the southeast may have served as the rear wall.

Fig. 2. Sunrise at the summer solstice on 23 June 2000 BCE. 04.34 local mean solar time, from the peak sanctuary on Pyrgos. The altitude at which the sun becomes visible is very sensitive to variations in atmospheric refraction and extinction. The computed horizon altitude is $-0.39^\circ$ from a mountain with altitude of 684 m. above sea level. The computed azimuth for sunrise at this altitude is $59.2^\circ$. The refraction is valid for $T=+17^\circ$C and barometric pressure 760 mm HG. The orientation of the inside of the northern wall of the sanctuary is $59.3\pm0.4^\circ$, determined by orthogonal regression of 11 measurements on preserved stones of the wall.
Fig. 3. Heliacal settings of Arcturus above Kako Kefali as observed from Pyrgos during the Early and Middle Bronze Ages. The corresponding dates and local mean solar times are from right to left 12 October 1900 BCE at 18:02, 11 October 2000 BCE at 18:03, 11 October 2100 BCE at 18:04 and 10 October 2200 BCE at 18:06. The minor axis of the building coincided with the heliacal setting about 2300 BCE.

Fig. 4. Orientations of the walls on Petsophas.
**Fig. 5.** Sunrise at the summer solstice 23 June 2000 BCE (sun on the left) and 21 June 2000 CE (sun on the right) behind Kali Limni, the highest peak on Karpathos.

**Fig. 6.** Plan of the building on Traostalos. The wall AA' is formed partly by the natural rock, which has been smoothed for the purpose.
Fig. 7. Heliacal setting of Arcturus above Modi as observed from Traostalos 13 October 1731 BCE, 18:00 local mean solar time.

Fig. 8. Orientations of the Minoan structures included in the Uppsala project.
Fig. 9. Orientations of Mycenaean cult buildings and cult buildings in LM III Crete.
Fig. 10. 323 passage graves from 15 sites in Crete. Thicker lines signify more than one grave with the same orientation.

Fig. 11. 372 passage graves from 25 sites on the Greek mainland. Thicker lines signify more than one grave with the same orientation.