

## Solar Orientations of Bronze Age Shrines in Gournia, Crete

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**Abstract.** The measurements of orientations at Gournia are part of the Uppsala University project to investigate the nature of Minoan astronomy. The town is typical of Minoan settlements and therefore was chosen for the selection of representative buildings from different kinds of Minoan sites. We use classical archaeoastronomical methods and our own computer programs for calculation of the positions of the sun, moon and stars in the Aegean Bronze Age. We discovered that Gournia is the fourth Minoan site with shrines that are oriented to sunrise at lunar month intervals with respect to the equinoxes. There is also a Mycenaean shrine in the town and we compared its orientation to Mycenaean buildings of the same type in Crete.

### 1. Introduction

Our project consists of 23 buildings at 16 Minoan sites, and our goal is to gain insight into Minoan astronomy by studying the orientations of the buildings to the sun, moon and bright stars. Our work is the first of its kind with respect to Minoan buildings other than graves. The potential of such research in Greece was demonstrated in the 1930s by William Dinsmoor (1939).

We have so far evaluated our measurements from 18 buildings at 14 sites and have found that each building was oriented or in some other distinctive way related to either sunrise and sunset at the solstices and equinoxes, moonrise at the major standstill, the heliacal risings and settings of bright stars, or to sunrise at lunar month intervals calculated from the equinoxes (publications listed in Blomberg & Henriksson 2007). Some sites, which we have measured from well-preserved archaeological remains, have multiple orientations to these events. We have found archaeological and archaeoastronomical evidence from several sites that the Minoan calendar was lunisolar and began in connection with the autumn equinox, making this the most important celestial event of the Minoan calendar (Blomberg & Henriksson 2002). As there are no Minoan written records to help us in interpretations, we have concentrated on understanding the utilitarian functions of orientations to the sun, moon and bright stars; e.g., to keep an accurate calendar and to determine the times of the year for crucial economic activities such as planting, harvesting and sailing. It is probable that there were connections to the social, ceremonial and religious life of the society as well, and we may have some insight into a religious function in the results we present here.

## 2. Methods, Calculations

In the absence of relevant writing and iconography, archaeoastronomical methods are the best approach in discovering the astronomical accomplishments of a society. Our methods are described in Blomberg & Henriksson (2001a).

## 3. Results

We are fortunate in having a cult place preserved from each of the three main periods of Gournia's history, the northern shrine from the early Middle Bronze Age town, the southern shrine from the so-called neopalatial town, and the Mycenaean shrine from the period of the reoccupation (Figure 1). We have measured their orientations and found that the two Minoan shrines, although built in different areas and at different eras, were closely aligned to sunrise at the same date, one lunar month interval from the equinoxes. This is the fourth site with orientations of important Minoan buildings to lunar month intervals with respect to the equinoxes.

The interior arrangement of the northern shrine is irregular, and we cannot be certain of exactly where the viewing position of sunrise occurred. There is no natural or remaining manmade foresight. These factors are important when the eastern horizon is only about 300 metres distant. The azimuth of the north wall is  $78.9^\circ \pm 1.0^\circ$  and gives us a good approximation of the axis of symmetry of the main room. One moon month before the autumn equinox and after the spring equinox, the azimuth of the upper limb of the sun was  $80.8^\circ$  (Figure 2). If we take into consideration the inner arrangement of the shrine and the uncertain true ancient horizon, it is reasonable to hypothesize that this shrine was oriented to sunrise one lunar month before the autumn equinox and after the spring equinox.

The southern shrine is located just before the southern entrance of the palace. The orientation of the southern outer wall is  $78.3^\circ \pm 0.6^\circ$ . As in the much earlier northern shrine, we do not know for sure from where sunrise was observed. The eastern ridge from here is also about 300 metres distant, and there is no natural or remaining manmade foresight. The azimuth of the upper limb of the sun at sunrise at one moon month before the autumn and after the spring equinoxes was  $79.3^\circ$  (Figure 3). Here again it is reasonable to hypothesize that the shrine was oriented to sunrise one moon month before the autumn and after the spring equinoxes.

The orientation of the Mycenaean shrine was to sunset at the equinoxes. A collection of typical Mycenaean cult objects was found in the northeastern corner. The room was placed on the highest part of the site with approach through a curving path such that sunset on the evening of the equinoxes illuminated the corner in which the cult objects were assembled. There is a manmade foresight formed by the southern doorjamb where it intersects the western horizon (Figure 4). On the evening of the autumn equinox, the sun will reach the corner for the last time of that year. The azimuth of the upper limb of the sun at sunset was  $265.3^\circ$ .

#### 4. Discussion

Gournia was inhabited for nearly all of the Aegean Bronze Age, from 2500 to 1200 BCE, and was rebuilt several times due to earthquakes or other catastrophes. The street layout was irregular and houses were rebuilt one upon another as time went on (Hawes et al 1908). In about 1450 BCE, in the period of reoccupation; following a period of destruction and abandonment of almost all Minoan sites, there is evidence that the Mycenaean were in control at nearly all of these places including Gournia (Driessen & Macdonald 1997). Despite the more than 250-year interval between the constructions of the two Minoan shrines, built in separate parts of the town, these places had the same orientation to sunrise one lunar month before the autumn and after the spring equinox. We have found the same orientations to sunrise at lunar month intervals with respect to the equinoxes at the palace at Malia, the manor house at Vathypetro and the peak sanctuary on Modi. The orientation to sunrise one lunar month after the autumn equinox and before the spring equinox at Vathypetro was the major orientation of the ceremonial room, which also had foresights marking sunrise at the equinoxes and the winter solstice. (Blomberg & Henriksson 2005a, 2005b).

These orientations of five important buildings at four sites on sunrises and sunsets other than on the equinoxes and solstices, in addition to those sites oriented to the equinoxes and solstices, provide insight into how the Minoans used the months of their calendar. It seems that a specific site had a role in commemorating a specific month of the Minoan year. The orientations gave the earliest possible day for the beginning of each lunar month, which could be determined in the following way. Since the year began at the new crescent moon following the autumn equinox, the following months would began at the new crescent moon following the earliest possible beginning of the month marked at each site (see Table 4.).

Site	Month
Petsophas, Phaistos, Knossos, Juktas, Vathypetro	first (autumn equinox)
Malia, Vathypetro (one moon month from equinoxes)	second
Modi	third
Chamaizi, Vathypetro	fourth (winter solstice)
Modi	fifth
Malia, Vathypetro	sixth
Petsophas, Phaistos, Knossos, Juktas, Vathypetro	seventh (spring equinox)
Gournia	eighth
Gonies, Petsophas, Pyrgos	tenth (summer solstice)
Gournia	twelfth

The marking of the first day on which a month could begin probably had symbolic significance in the Minoan festival calendar, as we may infer from the Mycenaean practice. Clay tablets in Mycenaean Greek, each beginning with the name of a month, have been found together in the palace at Knossos (Ventris & Chadwick 1973, Fp tablets). They record offerings to certain divinities in each month. A number of these divinities have the same names which we recognize later among the Archaic and Classical Greeks: Hera, Athena, Poseidon and others. We see on the tablets that the divinities were to be honored at specific times of the year, and therefore the determination of the months had an



Figure 1. Plan of Gournia. (Aerial Atlas of Ancient Crete 1992, with permission).

important sacral function in the Mycenaean religion. The orientations at four Minoan sites to specific months in addition to those months determined by the equinoxes and the solstices at other sites may point to such a ritual calendar among the Minoans and even for its origin there.

This may give us a rare insight into Minoan religion and cosmology – the association of their divinities with time. The Minoan study of celestial events and the keeping of time may have been central to their cosmology and was taken up by the Mycenaean, who then passed it on to the Greeks.

The orientation of the Mycenaean shrine to sunset at the equinoxes can be compared to those of three other Mycenaean shrines in Crete; they are all oriented exclusively to the equinoxes and solstices in the west whereas mainland shrines do not have orientations to these events (Blomberg & Henriksson 2001b; 2005b). It seems likely that the Mycenaean in Crete were influenced by the Minoans in orienting their buildings to the celestial bodies, but not the Mycenaean on the mainland.

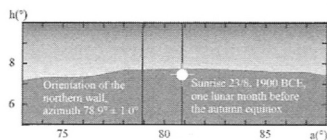


Figure 2. Orientation of the northern shrine.

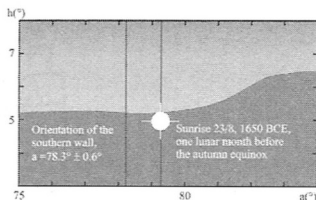


Figure 3. Orientation of the southern shrine.

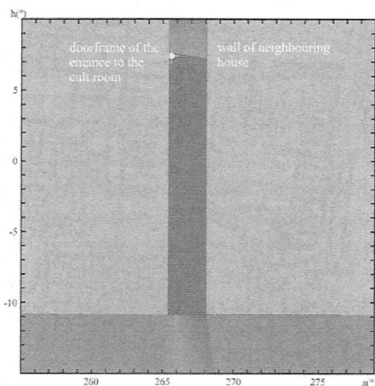


Figure 4. Orientation of the Mycenaean shrine.

## 5. Conclusion

The orientations of the Minoan and Mycenaean shrines in Gournia are in full agreement with our findings of the 18 buildings that we have so far studied in Crete: they are to sunrise or sunset at major calendar points including sunrise at lunar month intervals with respect to the equinoxes. We may thus conclude that the Minoans had good knowledge of the motions of the sun, moon and stars from the Early Bronze Age.

We may also make a conclusion about the influence of the Minoans on the Mycenaean and Greece cultures. Their practice to offer gifts to the gods in specific months may well have had its derivation from Minoan religion.

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