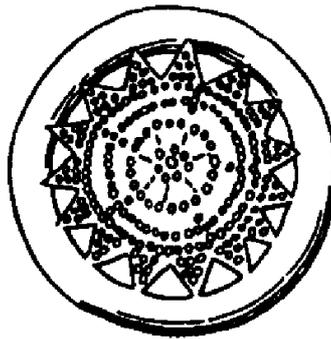


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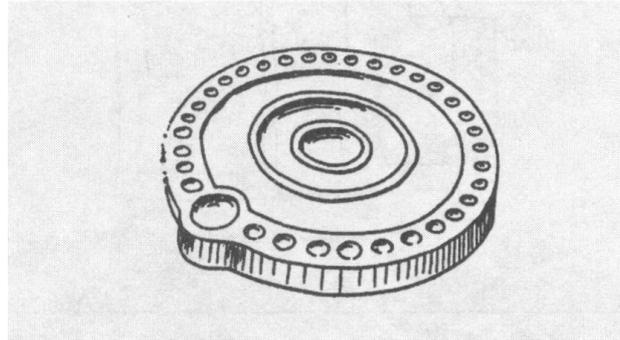


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# **ASTRONOMICAL CONCEPTS IN THE AENEOLITH AND BRONZE AGE EUROPE**



## **The calendaric relationship between the Minoan peak sanctuary on Juktas and the palace at Knossos**

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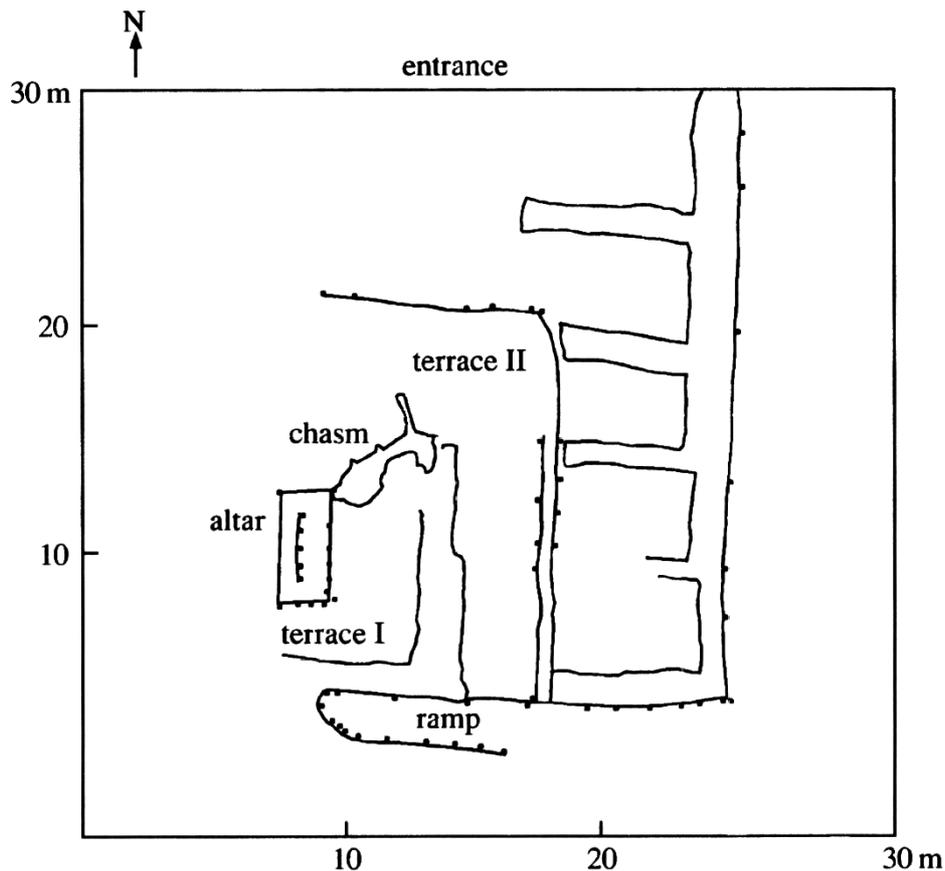
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The peak sanctuary on Juktas is different from the other Minoan peak sanctuaries with respect to the monumentality of the architecture, the richness of the finds and the presence of an altar (the one reported at the peak sanctuary on Gonies is doubtful). Another difference is the survival of a tradition, which associates Juktas with a specific Minoan god, the one later referred to as Zeus. The deep chasm beside the altar was said to be his grave (Fig. 1). Because of the monumentality and the rich finds, a special relationship has been proposed between the sanctuary and the largest Minoan palace, the one at Knossos ca 13 km to the northeast (Karetsou, 1981. P. 145)<sup>1</sup>.

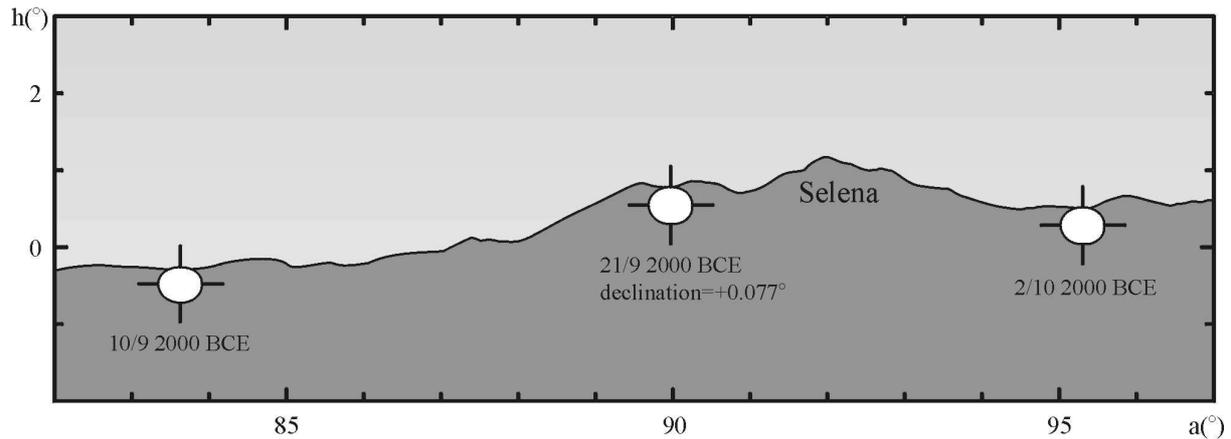
<sup>1</sup>We would like to thank Dr. Alexandra Karetsou for permission to make an archaeoastronomical study of the site on Juktas. We used the SOKKIA SET 4C theodolite and the orientation of the co-ordinate system.



**Fig. 1.** The Minoan peak sanctuary on Juktas. The dots are our theodolite measurements.

The presently accepted explanation for the monumental character of the site and for its precise location on the mountain is the tradition as the burial place of Zeus, who is considered to have been an annually dying god (*Postlethwaite, 1999*). The altar and the chasm are regarded as the religious focus, the chasm being the grave. However, if we are to fully understand the purpose, location and palatial connection of Juktas, we must also take into account the calendaric function, which we propose for the palace as well. This is a function shared also with at least one other peak sanctuary, that on Petsophas, and it implies systematic observations of the celestial bodies from an early date. We have argued elsewhere that one of the reasons why the Minoans established sites on high places was for the sake of such observations (*Henriksson, Blomberg, 1996; 1997-1998*).

The calendar function on Juktas is clear from the orientation of the sanctuary to sunrise at the *autumn* equinox, which additional evidence shows to have been the focus, as at both Knossos and on Petsophas – rather than the spring equinox, although the orientations are almost the same. This, we have argued, was because the Minoan year began in connection with the autumn equinox (*Henriksson, Blomberg, 1996. P. 113*). On the morning of the equinoxes the sun rises opposite the sanctuary on Juktas in a saddle formed by two peaks, and 11 days later it rises where two mountains intersect. There is no corresponding, well-marked position to the north where the sun rises 11 days before.

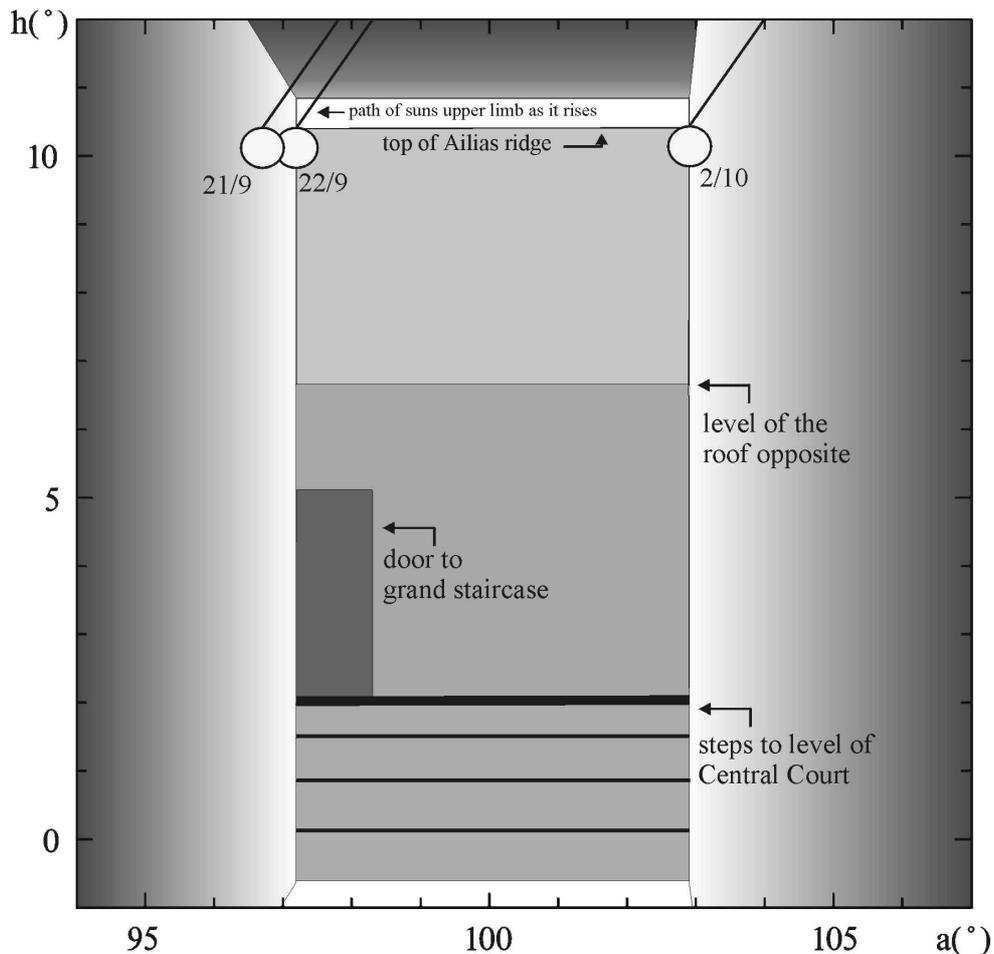


**Fig. 2.** Sunrise at the autumn equinox 2000 BCE and 11 days before and after, as observed from the altar at the peak sanctuary on the 811 m high Mt. Juktas.

the autumn equinox (Fig. 2). The 11<sup>th</sup> day after the autumn equinox has the special value of predicting the phase of the moon at the following autumn equinox, since the phase of the moon will be the same on both days. Knowing the phase of the moon in advance of the new year may well have been ritually important as there are indications that the moon had a prominent place in Minoan religion.

Orienting a structure to one major celestial event behind a clear natural foresight is not so difficult to achieve. However the precise relationship on Juktas to two significant celestial events both of which have clear natural foresights can only be the result of a diligent search for such a place. The same care was taken in the case of the sanctuary on Petsophas where both sunrise at the summer solstice and sunset at the equinoxes were clearly marked by natural foresights (*Henriksson, Blomberg, 1997-1998. P. 150*). On both Juktas and Petsophas the orientations had an important calendaric function.

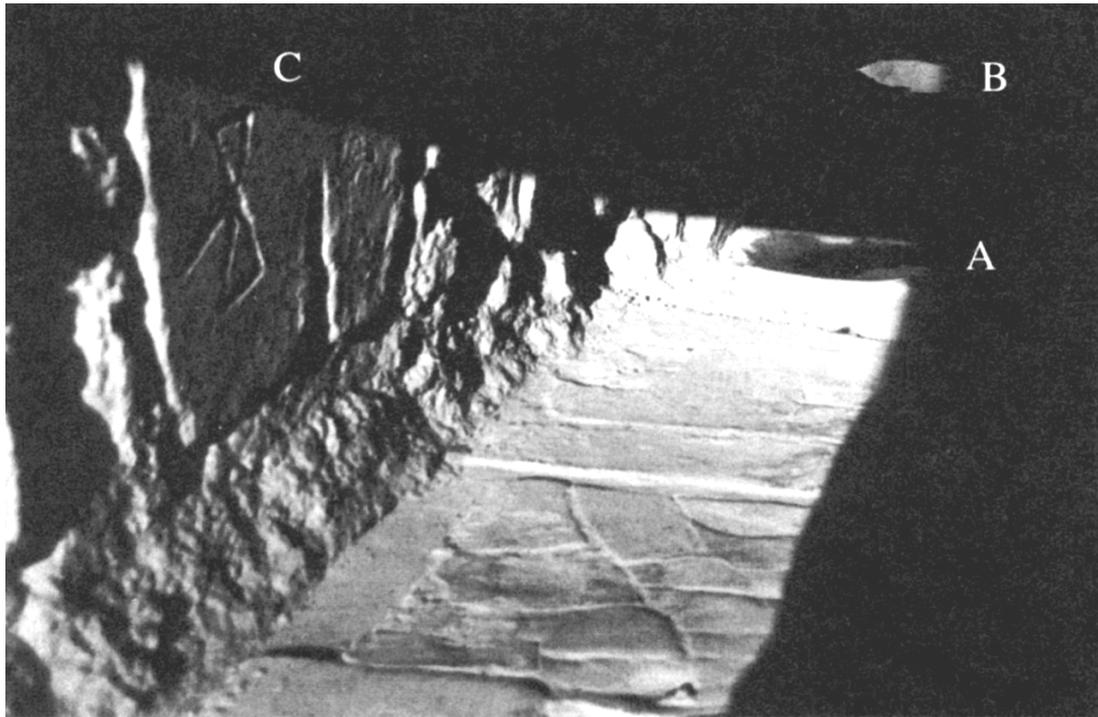
The relationships of the peak sanctuary on Juktas to sunrise at the autumn equinox and on the 11<sup>th</sup> day afterwards would have made it easy to regulate by intercalation a lunisolar calendar which began in connection with the autumn equinox, as explained below. The relationships, significantly, are similar to those arranged in the Central Palace Sanctuary of the palace at Knossos which is situated in the West Wing with doors opening to the east. The orientation of the south wall of the Sanctuary is 10.4° south of due east because of a high ridge in that direction and this allowed the sun at the equinoxes to reach deepest into the important cult area. The Sanctuary lies on the site of an earlier "palace" with the same orientation (*Catling, 1973-1974. P. 34; Shaw, 1977. P. 48*). The doorway was constructed so that the rays of the sun at the moment of sunrise on the equinoxes struck a stone bowl built into the floor and cast a reflection in the darkest part of the sanctuary. A shadow was also cast on the southern wall of the sanctuary, touching the upper corner of a large incised double axe. Eleven days after the autumn equinox the rays of the sun reached the bowl for the last time until the next equinox (Figs. 3; 4).



**Fig. 3.** Scale-correct computer drawing of the position of the sun at sunrise on the day before the autumn equinox (21/9), the autumn equinox (22/9) and 11 days after the equinox (2/10). Positions are for 1943 BCE. The width and height of the door correspond respectively to 4 and 8 Minoan feet.

It is not possible to go into all the archaeological features, which support our reconstruction of what we consider to have been a calendar device in the palace at Knossos; these will be presented in a separate publication. However there is no evidence against the reconstruction and there are several factors which speak for it. The most important points are that the stone bowl had been built into the area generally acknowledged to be the Central Palace Sanctuary and the orientation of the palace  $10.4^{\circ}$  south of due east is explained by the delay of sunrise due to the high ridge opposite.

The orientation of the ramp on Juktas underscores the calendaric relationship with Knossos. The autumn equinox and the 11<sup>th</sup> day afterwards are indicated in a very similar manner as in the palace. The ramp is from the early period of the site but seems not to have functioned as the entrance, as that was on the north side. On the morning of the equinoxes a shadow would have been cast by the southeast edge of the upper terrace wall, meeting a niche in the western wall of the ramp. Eleven days after the autumn equi-

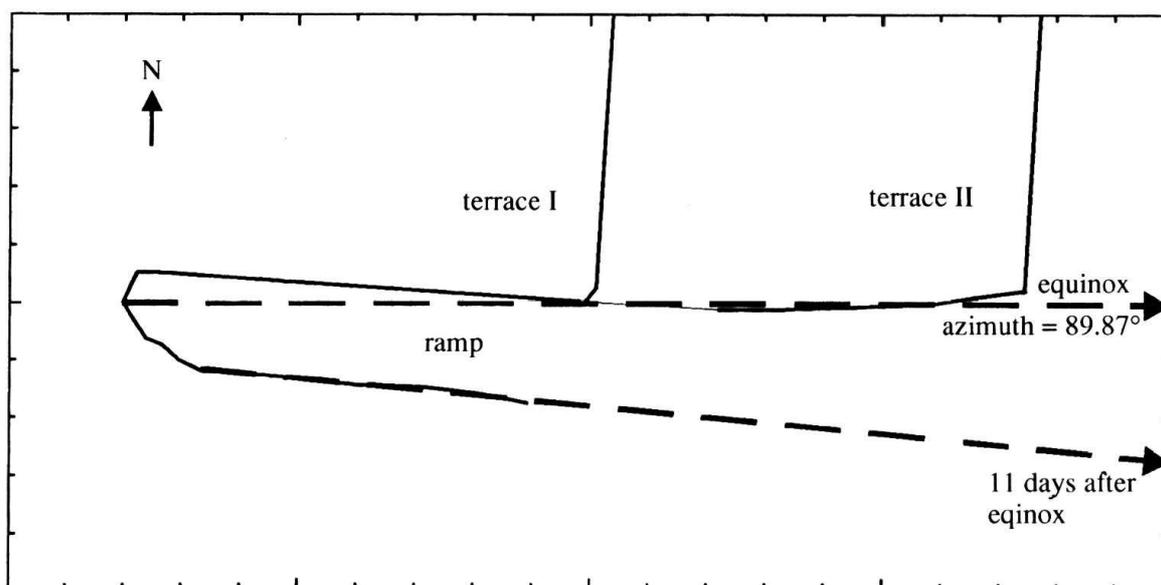


**Fig. 4.** The first rays of the sun on the equinox strike a shallow bowl (A) built into the floor of the darkest part of the Central Palace Sanctuary at Knossos. A reflection (B) is cast on the western wall and the shadow on the southern wall touches the tip of the incised double axe (C).

nox, sunrise occurs in line with the southern wall and the ramp is completely illuminated for the last time until the next equinox (Fig. 5).

Shadows and reflections, as at Juktas and Knossos, show the appearance of the sun instantaneously and in a clear and dramatic fashion. This is not the case for spectators watching for the sun at a considerable distance from where it will appear. In Mesopotamia in the same period, shadows at sunrise were used to identify specific days of the calendar. It is a simple and exact method (*Brack-Bernsen, Hunger, 1999. P. 281-284*). Another reason for using shadows and reflections was the danger to eyesight of looking directly at the sun, a danger known to ancient astronomers.

The 11-day difference in the length of the solar and lunar years was well known in contemporary Mesopotamia and Egypt and it can be used in rules-of-thumb for knowing when to intercalate months (*Parker, 1974. P. 52*). Such a rule of thumb can be assumed for Petsophas where there is an orientation to the heliacal rising of Arcturus which occurred one moon month before the autumn equinox: when the new crescent moon was observed in the 11-day period following the heliacal rising of Arcturus, it was time to intercalate a month. The use of heliacal risings of stars as aids in intercalating calendars is well-known from an early date in both Mesopotamia and Egypt (*Hunger, Pingree, 1999. P. 75; Parker, 1974. P. 52*). In a similar manner, the appearance at Juktas and



**Fig. 5.** The ramp along the southern border of the peak sanctuary on Juktas. The dotted lines are to the sun at sunrise on the autumn equinox and 11 days afterwards.

Knossos of the new moon in the 11-day interval following the autumn signaled the time for intercalation.

The observation of the two sunrises behind their natural foresights on Juktas is possible from a fairly large area at the northern part of the mountain due to the distance of ca 35 km to the foresights in the east. The presence of the chasm adjacent to the highest point within the area would naturally have indicated it as the place for the altar and the observations.

The similar methods for indicating the autumn equinox and the 11<sup>th</sup> day following it at both Knossos and Juktas support the proposal of a deliberate, calendaric connection between the two places. They also call to mind another tradition which not only connects Zeus with the mountain but also with both the Minoan king at Knossos and the eight-year lunisolar calendar (*Plato*, 1926. P. 624, B; *Homer*, 1919. P. 178-180). According to this tradition King Minos of Knossos met with Zeus every ninth year, i.e., at the end of an eight-year cycle, the shortest period of solar years in which there is an even number of lunar months. According to Plato, Minos was guided in making laws by Zeus through an oracle which was situated within walking distance of Knossos at a place where there was a temple and a cave dedicated to the god. The 13 km to Juktas from Knossos would not have been an unusual distance to go by foot in ancient times. We have interpreted this tradition as referring to the calendar-keeping responsibility of the Minoan king and also to a eight-year term of kingship which began anew every ninth year, perhaps depending on the outcome of the meeting with Zeus (*Blomberg, Henriksson*, 1996).

In the First Palace period (ca 2000-1600 BCE), Juktas was an unpretentious place, like the other peak sanctuaries (*Karetsou*, 1981. P. 145). In our opinion it also was used for astronomical observations. The architectural aggrandizement of the site at the same time that the palace underwent a similar transformation, at the beginning of the Second Palace period (ca 1600-1450 BCE), suggests that Juktas was appropriated by the rulers at Knossos who appreciated both the religious and the practical value of astronomical knowledge for legitimizing their claim to power. The dedication to Zeus and designation of the chasm as both his grave and oracle may have occurred at this time.

The most important reason for being able to maintain an accurate lunisolar calendar was the religious one of knowing the right times for the celebrations to the gods. The fundamental basis for good relations between humans and the divine world was the honoring of the gods in the proper ways. Paramount among these were the annually recurring monthly and seasonal festivals to the deities. It was therefore essential that the calendar be correct, with the months occurring in their proper seasons. By the beginning of the Middle Minoan Period a correct lunisolar calendar could have been maintained by applying simple rules of thumb, as shown by the evidence from three Minoan sites. Thus celebrations to the gods at the proper times were assured as long as the rules were followed. The responsibility for this surely rested as a religious duty with a person of high status, who was then accountable in the event of signs of divine displeasure. The tradition of the meeting between Minos and Zeus in which the eight-year cycle is referred to indicates that the responsibility for the regulation of the calendar belonged to the king at Knossos.

Observations for the sake of the calendar both at Knossos and on Juktas may have centered on ritual observation of the autumn equinox and the new year, which probably began on the evening of the appearance of the new crescent moon following the autumn equinox. The beginning of a new eight-year cycle may have been celebrated by the king's visit to the sanctuary on Juktas to account for himself to Zeus through the oracle. At that time, depending on the outcome of the encounter, the god through his oracle may have confirmed the king in his rule for another eight-year period, or had it taken from him. An ancient tradition of similar type survived into the historical period at Sparta, the area of Greece which had been in close contact with Minoan Crete from a very early period.

We think it likely that the astronomical observations on Juktas were conducted by priests, who were also responsible for the instruction of future priests for the same task. The amount of learning material found at the site for this purpose, in contrast to that found at other sites, is too small for larger groups (*Blomberg P.*, this volume). We can therefore distinguish a further difference between the sanctuary on Juktas and the other peaks. Instruction in astronomical knowledge on Juktas was likely to have exclusively for the religious purpose of keeping a ritual calendar and not, as at other sites, also for secular purposes such as navigation (*Blomberg, Henriksson*, 1999).

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