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WAS THE PARTA NEOLITHIC SANCTUARY IN ROMANIA ASTRONOMICALLY ALIGNED?

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ABSTRACT

Since its discovery, the Neolithic sanctuary from Parta, Timis county, Romania has been the subject of many archeoastronomical and ethnoastronomical studies. While interesting, the sanctuary itself is no longer visible in situ, with a scaled replica, based on original materials, accessible inside the National Museum of Banat in Timisoara. Studies have focused on its solar alignment, lunar and stellar symbolism, eclipses, and horizon astronomy. The lack of actual azimuth readings of the original sanctuary make any astronomical alignment studies challenging if not impossible. The only evidence lies in the original experiment performed in situ during the autumnal equinox sunset on 23 September, 1982, and on maps showing the direction of the North. Regarding eclipses, the high ΔT uncertainty in Neolithic times makes any eclipse study questionable. In this paper we critically review prior work and introduce our own hypotheses regarding some interesting aspects of the sanctuary. We also identify possible horizon markers for the WSSR and equinoxes.

KEYWORDS: Parta, Neolithic, Romania, solar and lunar alignments, eclipses, constellations, horizon astronomy.

1. INTRODUCTION

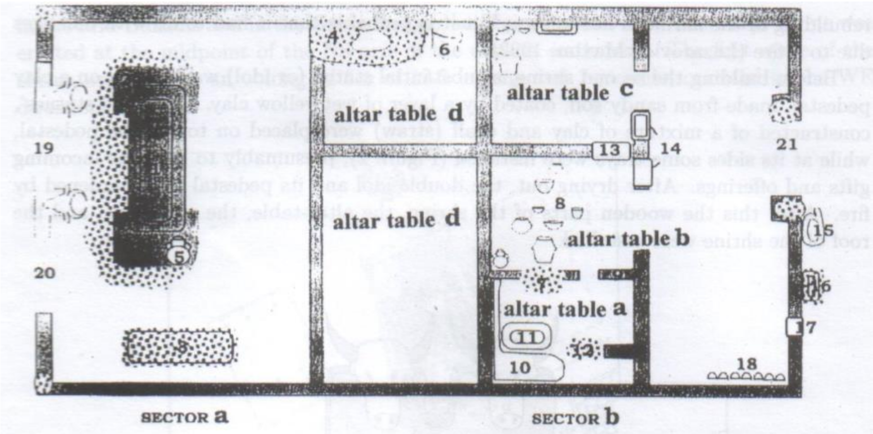
The purpose of this paper is to examine the proposition formulated by many researchers over the past 30 years that the Neolithic Sanctuary from Parta Romania was astronomically oriented. The site of the sanctuary was first excavated in 1931. Based on archaeological findings and carbon dating the site was determined to be part of Banat culture itself derived from the local evolution of the Starčevo-Criș over which elements of Vinča A are intermixed. According to Lazarovici (2006), the earliest carbon dating for the Parta settlement are from the Parta 7a layer (5600 CAL BCE) while the latest are from grain seeds found in the Parta 6a layer (4800 CAL BCE). Most settlements in the perimeter of Parta are placed at an elevation of 90-95 meters in floodable areas near the Timis River. The main settlement, tell 1, was placed on a former river meander which during floods could have been islanded. The architecture of the settlement cannot be generalized, Parta, presumably being a religious, economic, cultural, and socio-political center. Over time the settlement has been intensely occupied with seasonal character at times. Overall the definitions given to a medieval commercial center can be without doubt applied to Parta (Lazarovici, 2006).

In the center of the settlement there was a ceremonial building called Sanctuary 2 (Parta 6 layer, 5200-5000 CAL BCE). Over time the building was reconstructed and destroyed repeatedly. Evidence suggests an earlier Sanctuary 1 (Parta 7c layer, 5300 CAL BCE). This was also predated by another building with an unknown purpose. This older building had an N-S orientation of the longer axis whereas the two sanctuaries were E-W oriented based on their entrances and longer axes. The entire settlement was found burned in layer 6 a result that has been attributed to conflict. The function of Sanctuary 2 as a temple is motivated according to Lichter (2014) by: (1) the existence of clay boxes with incised decoration interpreted as cult or libation tables, (2) the existence of bull skulls and horns, and (3) raised applications of a stylized human face and a bull skull as well as a sickle-shaped clay application around a hole in the wall (Sun-Moon window).

Over the years many archaeoastronomical researches on Sanctuary 2 were conducted (Lazarovici et al., 2002; Szűcs-Csillik, 2013; Szűcs-Csillik, 2015; Lazarovici, 2009; Szűcs-Csillik, 2017). We summarize and analyze here their relevance from an astronomical and ethno-astronomical context. Our objective is not to dismiss them entirely but to raise new questions about the uncertainties regarding the accuracy of astronomical algorithms and actual orientation of the sanctuary which make any theory regarding its orientation rather probabilistic. Any solid archaeoastronomical study needs to consider both archaeological and astronomical uncertainties as well as (where possible) cultural evidence. Recent examples include the debate around the meaning of the animals depicted on pillars at Göbekli Tepe (Notroff et al., 2017). In case of the Parta sanctuary we cannot dismiss the fact that the building was excavated and reimagined based on several incomplete or uncertain components. While its importance in the Neolithic period is unquestionable uncertainties about its orientation, placement and existence of some of its components, as well as the accuracy of numerical algorithms make it hard to prove any archaeoastronomical study on the building itself.

Our analysis is based on the following data (also see Figure 1) from Lazarovici et al. (2002):

- GPS coordinates: 45˚37′ N, 21˚06′ E.
- Dimensions: 11.6m x 6m.
- Distance of the Sun-Moon window (on the west wall) from the north wall: 1.5m.
- *Presumed* height of the Sun-Moon window from the ground: 1.35m.
- Diameter of the Sun-Moon window: 0.35m.
- Distance of the interior window from the north wall: 2.25m.
- *Presumed* height of the interior window from the ground: 1m.
- Diameter of the interior window: 0.3m.
- Distance of the bull-female twin statue from the north wall: 3.05m.
- Distance of the bull-female twin statue from the east wall: 1m.
- Width of the bull-female twin statue: 0.5m (*approximation*)
- Distance of the interior wall from the east wall: 6.65m (*determined from the scaled model*).
- Thickness of walls: 0.3m (*approximation*)



Plan of the second shrine. 1: the double idol; 2: pedestal; 3: adobe trough; 4: portable fireplace; 5: amphora; 6: great cup; 7: taurian skulls; 8: vessel; 9: mounting for the taurian skull; 10: cassette; 11: 'man-faced vessel'; 12: mounting for the taurian skull; 13: taurian skulls; 14: mounting for the taurian skull; 15: hand-mill (mortar); 16: adobe cup; 17: Sun–Moon couple; 18: vertical loom; 19: window; 20: eastern entrance; 21: western entrance

Figure 1. Plan of Sanctuary 2 (from Lazarovici et al., 2002). East is left.

2. EXISTING HYPOTHESES

We have identified five main studies addressing the following problems: equinoctial alignment of the sanctuary (Lazarovici et al., 2002), eclipses (Szűcs-Csillik, 2013), Moon symbolism (Szűcs-Csillik, 2015), and stellar symbolism (Lazarovici, 2009), and alignments (Szűcs-Csillik, 2017).

2.1. Solar alignments

On September 23, 1982 Lazarovici performed an in situ experiment during excavations at Sanctuary 2 in which it was determined the path of the light through the Sun-Moon window on the *reconstructed* western wall. Assuming that the dividing wall had a similar window the light would have hit the back of the bull-female twin statue[1] approximately at the point where the amphora was found. To represent the window Lazarovici used a cardboard disk stuck on a wooden stick. Right before sunset he noticed the shadow (in the original setting it was the light) touching the division of the statue, the floor, the idol, the fireplace and the man-faced vessel. In Lazarovici et al. (2002) it is speculated on the light path at SSSS (Summer Solstice Sun Set) and WSSS (Winter Solstice Sun Set) as well. At SSSS the light would have hit the dividing wall and illuminated the southern wall where the vessel with corn was found. Correspondingly, at winter solstice, the light would have touched the hand-loom. In both cases the authors identify ritualistic symbols associated with the corresponding moments. Unfortunately, no exact measurements of the orientation of Sanctuary 2 exist, and only approximate indications of an E-W oriented long axis are given. For this reason we attempted to demonstrate the illumination effect on scaled models. Our own experiments on a scaled gypsum model and computed based simulations showed this to be true in both cases but only if the sanctuary is shifted to N-E (see Figure 2 and Section 2.1). If an exact E-W alignment is used the Sun does not touch the southern wall at SSSS as in Lazarovici's experiment. We will discuss the alignment problem later in this section.

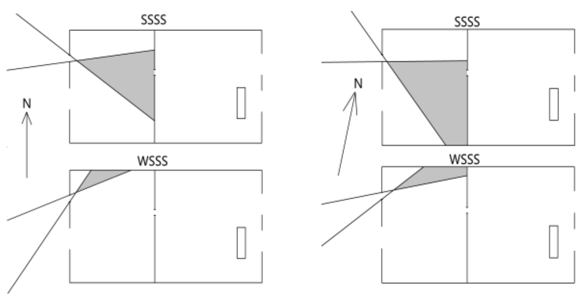


Figure 2. Simulation of sunlight (shaded area) entering in 5000 BCE inside the sanctuary at solstices (E-W aligned – left; shifted to N-E – right).

An interesting aspect is given by the orientation of the sanctuary and the path of the beam of light through the two windows. From the dimensions of the sanctuary and the placement of various elements we can determine that the beam of light is 8.82˚ deviated from the E-W axis. Other sources indicate a deviation of 9˚-10˚ (Szűcs-Csillik et al., 2017). Considering that many sources indicate an *exact* E-W orientation of the sanctuary (Szűcs-Csillik et al., 2013; Szűcs-Csillik et al., 2015) while others just mention an E-W orientation (Lazarovici et al., 2002;

[1] The female was interpreted as the Great Mother Goddess and the bull as the Bull God (Lazarovici et al., 1994).

Szűcs-Csillik et al., 2017) then the beam of light had an azimuth of 278.82˚ and an altitude of 7.18˚ at the moment the first beam of light would enter both windows (considering that light first touches the upper limb of the Sun-Moon window and the lower limb of the inner window). Szűcs-Csillik et al. (2017) give a value of 20˚ but that would place the inner window at only 1.94m from the Sun-Moon window making the west room too little compared to known plans. In our computations we used a distance of 4.95m plus 0.6m to account for the thickness of both walls. The last beam would enter from an altitude of 0.51˚ (about one solar diameter). It is clear that it points to a position of the Sun in the sky prior to the autumnal equinox and after the spring equinox. By using Stellarium 0.15 with DE431 algorithm for the year 5200 BCE we checked the date for the position of the Sun at the computed azimuth and inclination and found that the first light would enter about 30 days before the autumnal equinox and about 30 days after the spring equinox. Hence there is an apparent contradiction between the results of the 1982 experiments and the orientation of the path between the two windows which would have caused light to illuminate the idol about a month before the fall equinox and a month after the spring equinox. This gives approximately 8 months between the late summer and early spring illumination. Currently we have no means of knowing whether or not this orientation was intentional or not.

A major problem with the solar alignment hypothesis is represented by the actual orientation of the sanctuary. There are no known azimuth readings or any accurate maps and the sanctuary has been reconstructed at the National Museum of Banat with the original location buried after the excavations. Most maps given in papers have a North arrow roughly parallel with the N-S axis of the sanctuary. However, prof. Lazarovici provided for this article another map (see Figure 3) which gives a calculated offset of about 38-40˚ N-W (for the North arrow compared to the initial maps). Lazarovici mentioned in a discussion that he sometimes used a centesimal compass so the difference may be due to an error in plotting centesimal readings using a sexadecimal protractor. Sadly, the actual azimuths are missing and without additional information it is impossible to rely on it. Prof. Drasovean from the National Museum of Banat recalls the long axis of the sanctuary to be S-E oriented but does not remember any azimuth readings. The hard question in our case is: *why was the experiment on September 23, 1982 a success if the sanctuary as cited in most papers is E-W aligned but the light path is off by 8.82˚?* A possible answer is that the experiment was conducted on site with no outer walls and an approximately placed cardboard on a wooden stick as seen in Figure 4 (left). Another reason could be that an error was incorporated in the first reports stating the E-W *exact* orientation of the sanctuary when in fact this is not the case. Or maybe the term *exact* refers to the equinoctial alignment? In this case the sanctuary may be off by at most 16.18˚ to the N-E. Given the inclination of the beam through the two windows (7.18˚) the Sun would start to illuminate the idol at equinox sunset from an azimuth of 262.64˚. Further considering the azimuth offset of the light beam from the longitudinal axis of the sanctuary (8.82˚) this gives an orientation of the sanctuary of 253.82˚, or a total of 16.18˚ from the true north. In this case the Sun would illuminate the back of the idol at equinox through the two windows starting about one hour before sunset up until an altitude of 0.51˚, validating the experiment performed by Lazarovici. Interestingly, this N-E deviation would also validate Lazarovici's initial statement that during SSSS the southern wall is illuminated (Figure 2 – right image). Common sense dictates that the offset range is too large to go unnoticed, the experiment was probably erroneous, and that initial maps depict a realistic image: a slightly S-E orientation. If so, the idol would have been illuminated about 30 days before fall equinox.

Lazarovici has also showed a connection between the sanctuary and the Neolithic fertility and fecundity cult so perhaps the light entering through the two presumed windows at equinoxes had some sort of ritualistic role when hitting the twin idol's back. Interestingly, the female idol on the pedestal seems to be pregnant (see Figure 4, right side). We will discuss this aspect in greater detail in Section 2.4.

But how could have they marked the equinox date? Ruggles (1997) gives four possible methods: (1) finding the spatial midpoint between the rising/setting at two solstices, (2) finding the half-way point in time between two solstices, (3) finding the day on which the sunrise is exactly opposite of the sunset, and (4) finding the day when the length of time from sunrise to sunset is the same as from sunset to sunrise. Method (4) is inapplicable as we do not know of any exact time keeping methods in Neolithic. Method (3) is inapplicable to Parta as we have the Pades Mountains rising due east making the Sun visible to the south of true east on the equinox day. This also makes method (1) unreliable *except* if they watched the *sunset horizon* since it lacks any horizon markers. Method (2) as explained by Ruggles always gives a positive declination as the Earth does not have a constant speed around the Sun and the Sanctuary would have been N-E aligned.

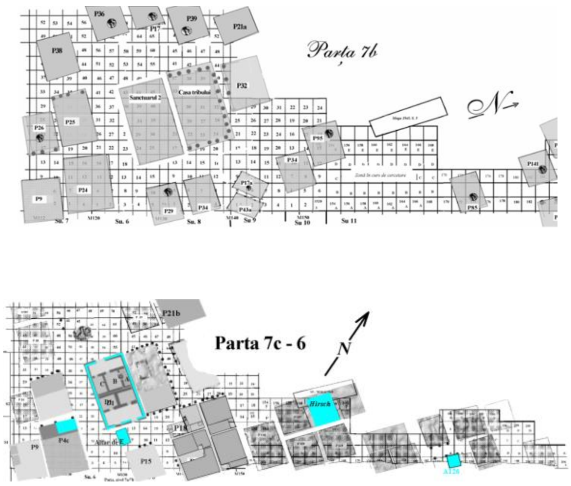


Figure 3. Orientation of Sanctuary 2 by Lazarovici (top: orientation from the 2006 book; bottom: map possibly wrongly showing north by reading the centesimal azimuth not the converted sexadecimal).

Figure 4. Left: partially reconstructed wall and the cardboard used to test the alignment hypothesis (half of the cardboard can be seen on top of a wooden staff in the upper part of the picture). Right: twin bull-female idol from Parta. There is a prominence on the belly of the female which would indicate her being pregnant.

2.2. *Eclipses*

While the subject of identifying eclipses in Neolithic times is known to be virtually impossible due to the ΔT problem this has not stopped researchers from associating ancient sites, including Parta, with the observation of eclipses. Simply put, the ΔT problem arises from the variable rotation rate of Earth which is unknown in the past and cannot be estimated for the future accurately. ΔT is the difference between the Uniform Terrestrial Time used to compute the positions of the planetary bodies and the Universal Time which is linked to the Earth rotation speed which varies (with a tendency of slowing down) over time due to many factors (e.g., ice ages, lunar gravity). ΔT can be approximated and correlated based on observed historical eclipses. Presently, the oldest identifiable eclipse has taken place on October 30, 1207 BCE (Humphreys, 2017). Numerical algorithms such as JPL DE (Jet Propulsion Laboratory Development Ephemeris) (Folkner et al., 2008) and VSOP (Variations Séculaires des Orbites Planétaires) (Bretagnon and Francou, 1988) as well as methods based on the Saros cycle can predict eclipses but their accuracy in determining *where* they would be visible from decreases drastically the further one goes in the past or future. If the oldest mentioned eclipse indeed took place at the indicated date then it means that the currently used expressions for ΔT can be extended up to 1200 BCE which is not enough for Neolithic times. Figure 5 shows the increase in ΔT uncertainty over years. Even if an eclipse took place around the time Sanctuary 2 was in use the uncertainty area is of about 70˚ in longitude meaning that the eclipse could have been visible also from either the East coast of Canada or China.

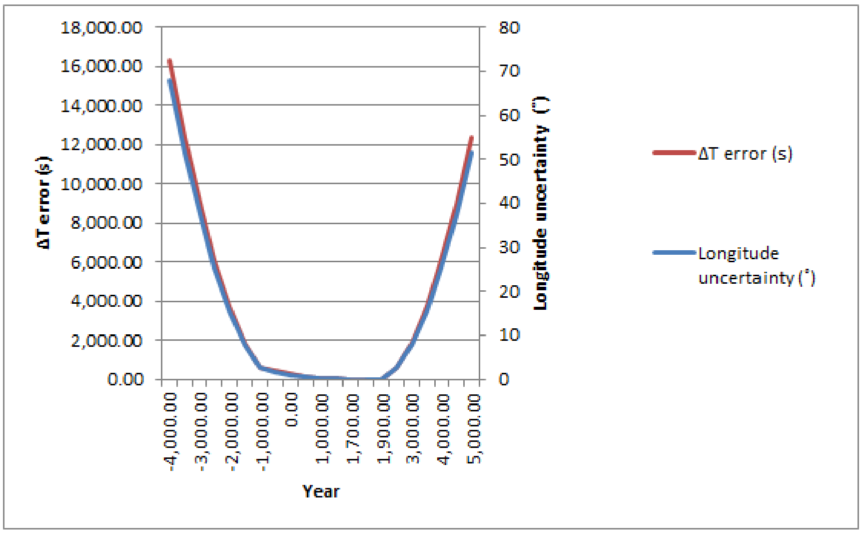


Figure 5. ΔT uncertainty as a function of time as derived from https://eclipse.gsfc.nasa.gov/SEhelp/deltaT.html.

Szűcs-Csillik et al., (2013) theorized that eclipses could have played a major role in the local society having a deep impact on the lives of the people of the era. The occurrence of an eclipse could have triggered wars or a migration of the people after the great fire that destroyed the settlement. A debatable account which has survived to this day is that of Herodotus in his work *The Histories* about an eclipse that stopped the war between Medians and Lydians. While their eclipse theory is interesting, Szűcs-Csillik et al. fall (as we also had initially) in the trap of actually trying to predict the date for a Neolithic eclipse. They identify using a custom made Matlab code based on Saros cycles, two solar and two lunar eclipses that might have been visible on 4974 BCE and 4563 BCE (solar), respectively on 4825 BCE and 4631 (lunar). Furthermore, in a different article Szűcs-Csillik et al., (2015) mention (based on Stellarium) a solar eclipse that presumably took place on September 18, 5401 BCE (Szűcs-Csillik et al. mention 5400 however Stellarium uses astronomical year numbering which includes year 0).

Assuming the eclipses had been visible from the sanctuary, we analyse the actual possibility of them being *observable* by the inhabitants and focus on the one in September 18, 5401 BCE and the one on April 30, 4593 BCE (Szűcs-Csillik et al. mention 4592 for the same reason as depicted above) which we could precisely identify ourselves using Stellarium 0.15 with DE431 algorithm installed. The 5401 BCE eclipse despite being too early for the Sanctuary 2 period covered approximately 6.7% (Szűcs-Csillik identify it as an annular eclipse using an older version of Stellarium 0.12 with the default VSOP87 algorithm) around noon making it impossible to be seen with the naked eye due to the intensity of the Sun. On the other hand, the one in 4593 presumably took place right before sunset starting with about 10% coverage at an altitude of 1˚ (roughly two solar diameters). While such eclipses are clearly visible (as seen in Figure 6 depicting the rising of a partially eclipsed Sun as seen with the naked eye) people must actually know where to look. It is not unconceivable that ancient man looked at the sun at sunset or sunrise and that they observed partial eclipses with at least 5% coverage as witnessed by today's eclipse hunters. The possible 4593 BCE eclipse taking place around the sunset was however after the period of Sanctuary 2. Furthermore, the ΔT uncertainty makes it rather improbable that the eclipse would have been visible from Parta.

An interesting fact we mention here with regard to Sanctuary 2 is the existence of a crescent Moon shaped ornament on the outer western wall window as depicted in Figure 7. This may hint of a possible eclipse observed at some point by the local inhabitants. This so called Sun-Moon window is traditionally interpreted as follows: the crescent shape object is the Moon and the window is the Sun (Lazarovici et al., 2002; Szűcs-Csillik et al., 2015). However, astronomers know that this is an impossible interpretation of a solar eclipse since it is the Sun who has a crescent during the event. Hence, if the solar eclipse representation theory is correct then the window would symbolize the Moon and the crescent the Sun. Following the same reasoning if the window depicts a lunar eclipse than the crescent represents the unshaded part of the Moon while the window represents the shadow of the Earth.

Figure 6. Solar eclipse on January 15, 2010 (courtesy of Cătălin Beldea).

Figure 7. The Sun-Moon window on the western wall at Parta (reconstruction from the original).

2.3. Lunar significance

According to researches the sanctuary holds significant lunar symbolism probably most obvious through its Sun-Moon window (as seen in Figure 7). Probably the most detailed work done on the subject is that of Szűcs-Csillik et al. (2015). We focus here on the symbolism alone and ignore any references to eclipses as we have discussed them previously. Under the Sun-Moon window there was a rimmed hand-mill and a cup in which remains of seeds were found. All these together form a complex picture depicting an agricultural culture and possible offerings to the Sun and Moon both symbols of fertility and procreation. In the ancient world the light of the Moon was regarded as favourable to vegetal grow and animal reproduction. According to Eliade (1976), the connection between the Moon, rain and plant life was realized before the discovery of agriculture.

An interesting interpretation given by Szűcs-Csillik about the pregnant female on the twin idol is that it is in fact a symbol for the Full Moon or a total lunar eclipse when the Moon looks reddish (Blood Moon). This can be further correlated with the light entering about a month before/after the fall/spring equinox and hitting the bull's back (if the sanctuary was indeed exactly E-W aligned) but without definitive proof on the actual orientation of the sanctuary this is mere speculation.

We cannot dismiss here the interpretation of the bull's horns as a crescent Moon (Drössler, 1986). Another lunar interpretation was given to the bulge between the horns of one of the bull heads guarding the eastern entrance (see Figure 8).

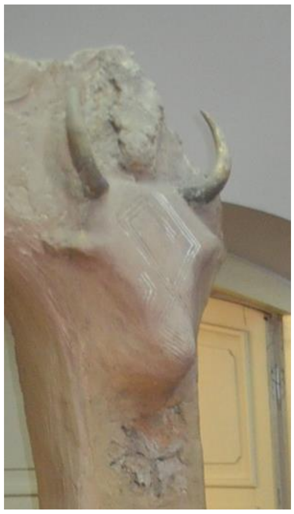


Figure 8. Bulge between the horns of the bull interpreted as the Moon. Another one on the second column is interpreted as the Sun.

2.4. Constellations

During the period of Sanctuary 2 the sun rose from the constellation of Gemini at spring equinox and set in the constellation of Sagittarius during the autumnal equinox. This means that at the autumnal equinox sunset the constellation of Taurus together with Gemini would have been visible on the eastern horizon. The twin idol faces east through a door marked by the columns with bulls on their head. Only the female is placed in front of the door, the bull shape figure facing the wall. Symbolically, this might indicate some sort of fertility ritual with the pregnant woman facing the rising Bull constellation full of sexual energy. The symbolism could have been increased by the light of the Sun at sunset through the two windows hitting the bull idol's back.

Recently, a paper was published by Szűcs-Csillik et al. (2017) were it is hypothesized that through the line of sight defined by the inner and Sun-Moon windows priests could see the night sky. Their theory is that someone standing near the pedestal could have looked through the two windows at the starry sky at an angle of 20˚. This is somewhat strange given that for that angle the distance between windows should have been of 1.94m whereas the dividing wall with the inner window is closer to the middle of the sanctuary. Figure 9 depicts the maximum angle of the line of sight. The angle is trivially computed from the dimensions of various sanctuary elements as tan(0.70/5.55)=7.18˚. From the northern corner of the twin idol a viewer looking through the two windows would have seen a region of about 2.3˚ of the western night sky. While Szűcs-Csillik uses a date of 5400 BCE which may be 200 years earlier than the date Sanctuary 2 was constructed they identify several stars which might have been visible at least partially through the two windows: Castor and Pollux (Gemini), Capella (Auriga), Regulus (Leo), Antares (Scorpio), Altair (Aquila). Interestingly they do no mention Mirphak (Perseus) which also has a similar declination. Our analysis using Stellarium for 5200 BCE showed that among them the best candidate is Pollux with the others being outside the window due to precession. This is not surprising as it is one of the two brightest stars in the constellation that in 5200 BCE rose heliacally at spring equinox. Szűcs-Csillik et al. also link the twin idol with the constellation itself.

In the same study, Szűcs-Csillik et al. also attribute the V shape and zig-zag symbols found on the wall of the sanctuary to constellations such as Cassiopeia or other less noticeable constellations such as Serpens and Ophiucus but this aspect deserves more investigation as except few cases (e.g., Taurus, Ursa Major) we have no records of these constellations being known as they are today.

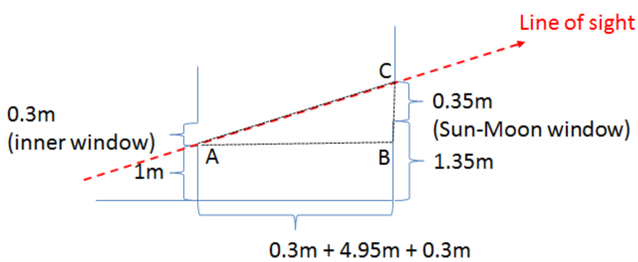


Figure 9. Maximum angle for the line of sight of a viewer placed inside the sanctuary. Conversely it is the maximum angle at which sunlight can enter through the two windows.

3. OUR DISCOVERIES

Parta is located on a plain with few horizon markers available. To the east there are the Pades Mountains at 94km and 87.34˚ azimuth (Pades peak, 1382m), to the S-W are the Semenic Mountains at 88km and 123.83˚ azimuth (Piatra Goznei peak, 1447m) and to the south are the Vršac Mountains at 59km and 159.10˚ azimuth. In 5200 BCE WSSR would have been visible from an azimuth of 125.20˚. Semenic is a plateau with an altitude of 0.5˚ between azimuths 122-126˚. Based on this data we went on the field to investigate the possible horizon alignments of visible from the site. On March 20, 2017 after three unsuccessful events due to bad weather we witnessed the sunrise from behind Pades Mountains. The alignment is almost perfect with the rising from the middle of the peak due to its elevation (Figure 10). In the same year we photographed after one unsuccessful attempt the WSSR from behind the highest peak in Semenic Mountains. The image was taken, due to bad weather, 10 days after the solstice on January 1, 2017 (Figure 11) when the Sun rises from behind the plateau and to the left side of the peak at an azimuth of 124˚. On the solstice day the Sun would have risen from behind the peak and in 5200 BCE from the right side of the peak. While the alignment is not perfect Piatra Goznei (visible in Figure 11) is the most significant landmark on the plateau and could have been used as a marker for the *winter solstice period* (not date itself).

Figure 10. Sunrise at Spring equinox on March 20, 2017 from behind Pades Mountains.

Figure 11. Sunrise near the winter solstice on January 1, 2017 from behind Semenic Mountains.

4. DISCUSSION

Given the existing data it is impossible to determine the *exact* orientation of the sanctuary. However, we believe most maps to be fairly accurate and that the orientation was roughly E-W. This questions the accuracy of the 1982 fall equinox. Due to the offset of the light beam from the E-W axis of the sanctuary the twin idol would have been illuminated about a month before fall equinox. Despite uncertainties in the actual orientation, the geographical position however seems to indicate that the astronomy of the horizon may have played an important role. Simulated experiments on scaled models have shown that the handloom, is illuminated at winter solstice and that light touches the southern wall at summer solstice but only if the sanctuary is N-E oriented. We believe that the eclipse hypotheses regarding Parta are interesting but impossible to validate due to the ΔT problem. Finally, while a lot of lunar symbolism seems to be present the constellation alignments are hard to prove due to the sanctuary's long period of existence and the precession of equinoxes which may have *aligned* different stars in the sky with the two windows over time. Also, any association with present day constellations is purely speculative.

Concluding, while the sanctuary is a fantastic example of Neolithic craftsmanship uncertainties about its orientation (and even placement of some of its components) and numerical algorithms make it hard to prove any archaeoastronomical study on the building itself. Nevertheless, the sanctuary remains an interesting place full of (astronomical) symbolism in the Neolithic period.

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