

## Megalithic Observatory Kokino

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### Abstract

In 2001, on the foot path of a mountain pick, near the village Kokino, archeologist Jovica Stankovski, discovered archeological site from The Bronze Age. Site has stately dimension and is scaled on two levels. Several stone seats (thrones) are dominant on the site and they are pointing towards east horizon.

The high concentration of the movable archaeological material found on the upper platform probably indicates its use in a function which is so far remains unknown cult activities.

With precise measurement and detail archaeoastronomical analyze of the site preformed in the past three years by Gjore Cenev, physicist from Planetarim in Skopje, it was shown that the site has a characteristics of a sacred site, but also of a Megalithic Observatory.



Figure1.

In this observatory found markers point on summer and winter solstice and spring and autumn equinox. Also it can be seen that on both sides of the solstice markers, there are markers for establishing

Moon's positions. Markers are crafted on such a way that for example in days when special ritual were performed (harvest rituals for example) Sun was filling narrow space of the marker and special ray lighted the man sitting on only one of the thrones, which of course had special meaning. According to the positions of the markers that are used for Sun marking, especially in solstice days, it was calculated that this observatory dates from 1800 B.C.

### **Introduction**

Archeoastronomy is scientific field of recent interest. Studying myths and religious views of ancient cultures related to the sky, as well as recognizing their real knowledge related to the movements of the celestial objects, positioning of their places of raise and set over the horizon, making and usage of calendars are just part of the themes that are filed of interests of the archeo-astronomers. Thus they usually say that they are dealing more with anthropology of the astronomy to make difference with the existing history of the astronomy.

In 2001 archeologist Jovica Stankovski from the National Museum from Kumanovo-Republic of Macedonia, near the village Kokino discovered a huge site with terracotta from the Bronze Age (Stankovski J. 2002). According the dimensions and the type, this site differentiates from all archeological sites seen up till then. The site covers an area of 5000 sq m, scale like established on two platforms right beneath the mountaintop Taticev Kamen with an altitude of 1013 meters. At first sight stone seats called thrones crafted into the rock and positioned in north-south direction are dominant on this site (Figure 1). On that way person seating on one of the thrones is turned towards the east horizon that, among the archeologist, build an idea of existence of a possibility celestial objects to be observed on that way.

In 2002 physicist Gjore Cenev from the Planetarium at MKC in Skopje got involved in the researches of the site and he made the first more comprehensive archeo-astronomical analyze (Cenev Gj. 2002). On the site, central position was located for observation of the celestial objects as well as existence of seven markers made in vertical rocks used for marking of the positions of the raise of the Sun and the Moon.

### **Results and discussion**

According the analyzes of the geologist N. Đoređević (Đoređević N. 2003) the entire archeological site is placed on the top of neo-volcanic plate made of andenzite rocks. The inhabitants from that period used natural disposition of the andenzite to fissure in vertical and horizontal direction and on a relatively easy way they could craft four thrones as well as stone markers.

Main idea of the archeo-astronomical analyze was to measure horizontal coordinates of the stone markers observed from the central position, and then using the formula for transit from equator coordination system to build a conclusion of the nature of the celestial object which raise was marked on the east horizon. For that purpose the following formula was used:

$$\sin\delta = \cos A \cos\varphi \cosh + \sin\varphi \sinh$$

where  $\delta$  is the declination of the celestial object,  $A$  is the azimuth,  $h$  is the height over the horizon, and  $\varphi$  is latitude of the site. This archeological site has the following geographical coordinates: latitude  $\varphi = 42^{\circ} 15' 47''$  and longitude  $\lambda = 21^{\circ} 57' 32''$ .

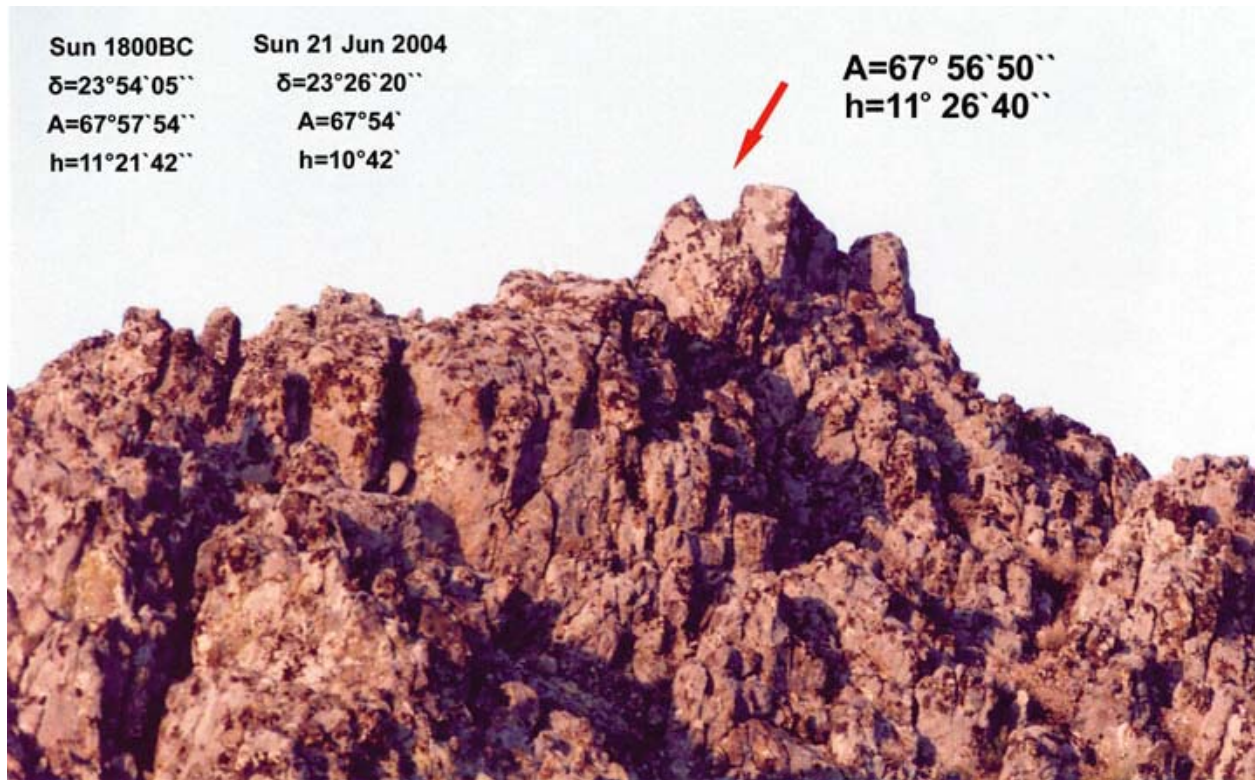


Figure2.

These measurements were performed with an assistance of the geodesist Chedomir Arsovski, and instrument used was Total station Lica 307 with laser, that enables us to receive results with great precision. (Cenev Gj. 2002). As an illustration of the measurements and analyze preformed we will present the following example of the marker used for marking the position of the Sun raise in the day of summer solstice. Measurements of the horizon coordinates of the marker has provided the following values:  $A = 67^{\circ}56'50''$  and height  $h = 11^{\circ}26'40''$  (Figure 2). Calculations have anticipated a mistake that is due to the refraction impact ( $\rho = 3,1'$ ). Using the given values we can calculate that the declination of the celestial objects which raise was marked with the stone marker had a declination of  $\delta = 23,9^{\circ}$ . This is the declination value of the Sun in a day of the summer solstice in 1800 B.C., meaning that the stone marker was crafted 3800 years ago and used for marking of the Sun raise on the horizon observed from the central position of the site.

Due to the procession impact current value of the Sun declination in the day of the summer solstice has different value (Figure 2), that means that nowadays Sun over the stone marker will raise lower and more on left than 3800 years ago. That can be nicely seen on the photo of the Sun raise over the stone marker taken on 21<sup>st</sup> of June 2003 or on the day of the summer solstice (Figure 3). Using the similar methods measurements and analyzes of the other markers were performed. It was concluded that observed from the site's central position 7 stone markers could be easily recognized. Three of them are marking the places of the Sun raise in the days of the summer solstice, winter solstice as well as in the days of vernal and autumn equinox. Four markers are marking places of the Moon raise over the horizon when the Moon has maximum and minimum values of the declination in the summer and in the winter period. These values are provided in the Table 1, where for comparison purposes values of the markers of the famous Stonehenge in Great Britain according to the measurements and calculations of G. Hokins are

also provided (Hawkins S.G. 1963), as well as theoretical values of the declination of the objects in 1800 B.C.

	STONEHENGE	KOKINO	2000 BC
Sun summer solstice	23,9 <sup>0</sup>	23,9 <sup>0</sup>	23,9 <sup>0</sup>
Sun winter solstice	-23,9 <sup>0</sup>	-23,9 <sup>0</sup>	-23,9 <sup>0</sup>
Moon winter major standstill	29,0 <sup>0</sup>	28,2 <sup>0</sup>	28,2 <sup>0</sup>
Moon winter minor standstill	18,7 <sup>0</sup>	20,4 <sup>0</sup>	17,9 <sup>0</sup>
Moon summer major standstill	-29,0 <sup>0</sup>	-30,2 <sup>0</sup>	-30,0 <sup>0</sup>
Moon summer minor standstill	-18,7 <sup>0</sup>	-18,6 <sup>0</sup>	-19,6 <sup>0</sup>

Figure3.

Several conclusions could be drawn from the performed measurements and analyzes. On the archeological site clearly we can recognize central position for observation of the celestial objects, as well as existence of seven stone markers used for marking of the places of the raise of the Sun and the Moon over the horizon observed from the central position that using the astronomical terms has the role of top center for observation of the movements of the celestial objects. All stone markers are providing information for the same time of crafting, and that is 1800 +/- 50 years B.C. In the astronomy it is very well know fact that places for the raise of the Moon repeats in a period of 18,6 years, and to understand that this is really a periodical event there should be observations of the raise of the Moon at least forty years. That leads us to the fact that before the stone markers were crafted in the ancient past, there were some people that dedicatedly on a daily bases observed the sky and movements of the Sun and the Moon. Establishing the stone markers they had a possibility to make also a calendar used for organization of the life in the community, i.e. in practice they could determine days for start and finish of the agricultural activities and activities related to the cattle breeding, as well as for determination of the days for performance of rituals.

In one archeo-astronomical analyze it is of crucial importance to have the same time of archeological findings and the time of stone markers crafting. At first on the site terracotta that was found had anticipated age of around 3400 years, but the most recent excavations from 2005 made by the archeologist Jovica Stankovski has shown that on the east side of the site there are some burrows with objects which age is anticipated to be around 3800-4000 years, that is in excellent agreements with the time of stone markers crafting according to the archeo-astronomical analyze.



Figure4.

Everything that was presented above leads us to the concluding that this archeological site beside the role of the mountain sanctuary 38 centuries ago also had a role of a prehistoric observatory. In accordance with the time and culture known for that period, this site was called Megalithic Observatory Kokino.

#### References

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