Publ. Astron. Obs. Belgrade No. 85 (2008), 87 - 94 *Contributed paper*

KOKINO CALENDAR

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Abstract. In 2001, in the northeast part of Macedonia, a site of impressive dimensions and with remarkable contents was discovered. Archaeological excavations in the following years have shown that the site represents a huge mountain sanctuary with enormous amount of artefact dated in XIX century B.C. In unison, performed archaeo-astronomical analysis exposed the fact that this site encompasses all characteristics of an ancient observatory built 3900 years ago as a result of which the site was called Megalithic Observatory Kokino. As any similar observatory, Megalithic Observatory Kokino was used for development of a calendar, by utilization of which, life in the community of ancient farmers was organized. By the end of 2006 and at the beginning of 2007, specially crafted stone markers for measurement of lunar month were discovered. This fact revealed that people of that time living in the area of Central Balkan Peninsula were familiar with the 19 years lunar cycle, according to which they prepared lunar calendar, today known as Kokino Calendar.

In the course of 2007, additional evidences found verified that on the territory of the ancient observatory there is a specially crafted observation post and four stone markers used for observation of the Full Moon rise on the east horizon in the night of its total eclipse. These stone markers marked the cycles of eclipses in periods of 54 years and 34 days.

1. INTRODUCTION

Combined historical and archaeological data lead to the conclusion that at the end of the third and at the beginning of the second millennia B.C. population on the Balkan Peninsula abandoned the nomad style of life and started with agriculture and stockbreeding. Provision of satisfactory amounts of food was in direct link with the knowledge of the plants' biological rhythm and organization of agricultural works during the year. Very quickly, people noticed the connection between the periodical movements of Sun and the rhythm of the vegetative cycles. At the same time, periods in the Moon phases helped them develop time measurement systems. There we trace the beginnings of construction of special places for continuous observation and marking of the places of rise on the east horizon as well as movements of Sun and Moon on the sky all over Europe and in the world. Today these places are known as ancient observatories or sanctuaries depending of their purpose and main activities organized there. Development of a calendar was one of the main tasks, but at the same time represents the extraordinary achievement of the ancient sky observers' creativity.

Figure 1: See the text.

2. KOKINO CALENDAR

Archaeo-astronomical analysis of the archaeological site located near the village Kokino in the northeast Macedonian confirmed that this site has all characteristics of an ancient observatory today known as Megalithic Observatory Kokino. (Cenev 2006). Existence of stone markers on the horizon validates the fact that ancient observers were familiar with apparently Sun movement during the year, as well as apparently movement of the Full Moon in 19 years time cycle, which immediately impose the dilemma of the type of the calendar that was developed in this ancient observatory. Was the calendar of a solar, lunar or combined -lunar and solar type?

The dilemma was solved at the end of 2006 and at the beginning of 2007 when the existence of stone markers for measurement of the lunar month length of 29 and 30 days was confirmed (Cenev 2007). 5^{th} of December 2006 was a day when the Full Moon had its maximum winter declination in a 19 years cycle and its rise was seen exactly through the opening of the stone marker discovered in the previous years (Fig. 2). In the same stone block (Fig. 1) there is clearly noticeable same in shape stone marker, which was found to be used for marking the rise of the Full Moon exactly one lunar month later or on 3^{rd} of January 2007 (Fig. 3). Rise of the Full Moon

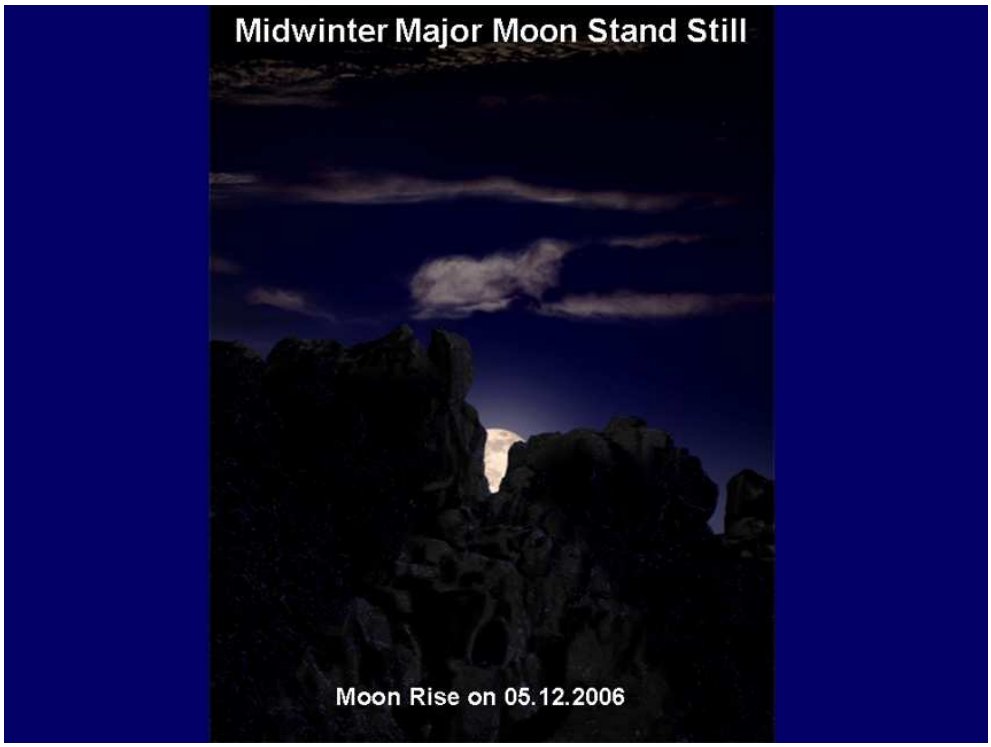

Figure 2: See the text.

seen through this marker on the above-mentioned date clearly indicates that ancient astronomers were familiar not just with the 19 years lunar cycle of the Full Moon rise but they knew and measured the length of the lunar month in the winter period, which is 29 days. Existence of two similar markers in the same stone block with posts for the purposes of observing Full Moon rise in the maximum summer declination shows that ancient people also knew and measured the length of the lunar month with 30 days.

By this, it becomes evident that on the Megalithic Observatory Kokino people developed lunar calendar with cycle of 19 years where they included certain number of lunar months with 29 days of length and a certain number of lunar months with 30 days of length. Analysis findings are that 19 years cycle encompasses of 12 lunar years with 12 lunar months so called ordinary years and 7 lunar years with 13 lunar months that are leap years. Ethno-astronomical data obtained during the 25 years of research among Macedonian people (Cenev 2004) supported the analysis of the lunar calendar. According to them even nowadays people that live in Macedonian villages claim that in one calendar year there are two seasons: winter and summer. The reason for this is the fact that in the past winter months were very bad so they were shorter, while the summer months were good and they have more days.

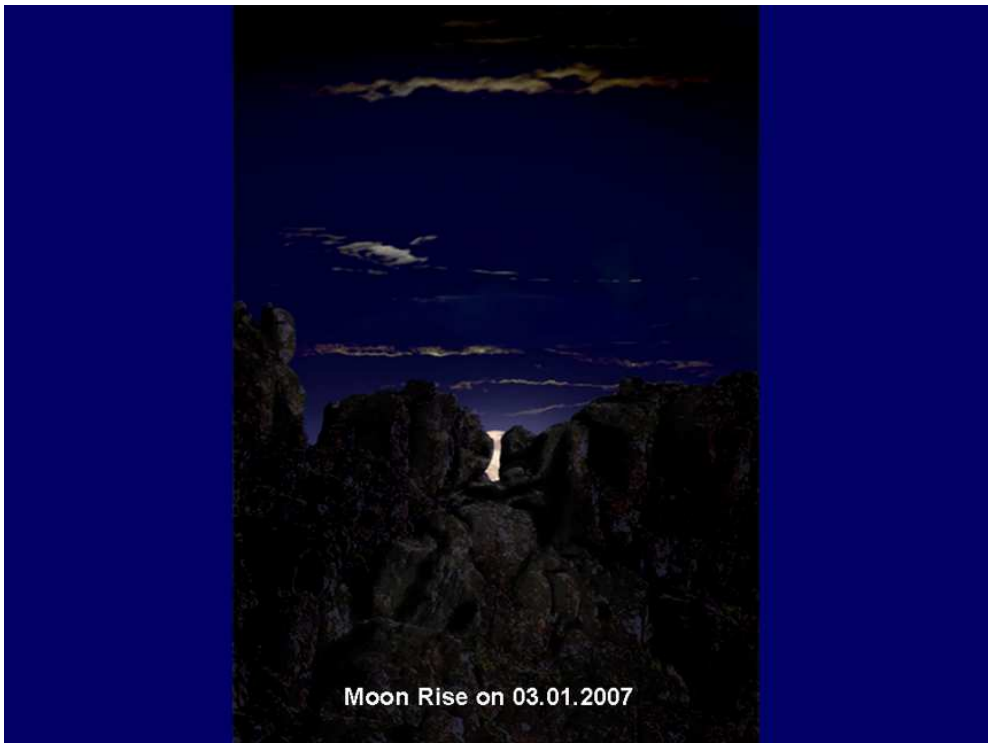

Figure 3: See the text.

In line with the data recorded in the collective memory of the people it can be concluded that ordinary years in Kokino calendar were with 6 winter months of 29 days and 6 summer months with 30 days. Leap years were with 13 lunar months because one summer month with 30 days was added. In 19 years cycle leap years followed a special pattern, which can be determined by simple counting of the number of full moons in the course of one calendar year. In Kokino calendar, based on the number of the full moons in the years of that historical period in every 2, 5, 8, 10, 13, 16 and 18 one lunar month with 30 days was added. By that (Table 1), we have 19 years cycle lunar calendar, which can be called Kokino Calendar.

This lunar calendar is similar to the well known Metonic cycle, but in the table we can see that Kokino's lunar calendar has a better compliance with the tropical year, which makes it in better agreement with the change of seasons and events in the nature. In line with the above mentioned, The Kokino lunar calendar had great potential for good organization of the agricultural and farmers' woks performed within the agricultural communities at that time, but also could provide organization of a ritual and spiritual life of the community on a qualitative manner. Only by starting a fire on the top of the mountain, people that lived in the circle of around 30 km were informed about the day of carrying out some agricultural works or performance of some rituals related to the religious life of the community.

Table 1: KOKINO CALENDAR METONIC CYCLES

Year in the Kokino Calendar	Number of the Lunar months	Number of days	Number of days in a tropical year	Difference in days with the tropical year	Number of days in the Metonov Cycles	Difference in days with the tropical year
1	12	354	365	-11	354	-11
2	13	384	365	+8	354	-22
3	12	354	365	-3	384	-3
4	12	354	366	-15	354	-15
5	13	384	365	+4	354	-26
6	12	354	365	-7	384	-7
7	12	354	365	-18	354	-18
8	13	384	366	0	354	-30
9	12	354	365	-11	384	-11
10	13	384	365	+8	354	-22
11	12	354	365	-3	384	-3
12	12	354	366	-15	354	-15
13	13	384	365	+4	354	-26
14	12	354	365	-7	384	-7
15	12	354	365	-18	354	-18
16	13	384	366	0	354	-30
17	12	354	365	-11	384	-11
18	13	384	365	+8	354	-22
19	12	354	365	-3	383	-4

By means of that, this ancient observatory had the possibility to organize qualitatively the life of people in a wider central region of the Balkan Peninsula.

Defining the type of the calendar developed on Kokino, the role and purpose of the stone markers used for marking the positions of the Sunrise on the east horizon become clear. Consistent with all well-known experts of the history of religion (Eliade 2005) in time when Megalithic Observatory Kokino was built, in all ancient civilizations, the Sun was considered as very important divinity managing life cycle of the plants. Its movement over the horizon was monitored very carefully even we can say with fear. If the Sun in summer continued to move towards the north after the day of solstice, people believed that the heat would increase so much that it would burn down the entire world. However, if in winter the Sun continued to move towards the south after the day of solstice, people believed that the cold would frieze the entire world. Rise of the Sun seen through the marker used for marking the days of vernal and autumn equinox, actually meant change of the winter and summer in the years of the Kokino Calendar.

Based on presented data it can be concluded that in Kokino Calendar the New Year started on the day of winter solstice. This claim could be verified with events

linked with the beginning of the 19 years calendar cycle. In the first year of the calendar cycle, in twenty-four hours we have the longest night without Moon (phase of the New Moon) and the shortest day in the year. This coincidence, by all means, had great impact over the religious life of the ancient agricultural community and on that day, various rituals and ceremonies were performed. It can be said that beside the fear people felt, this day had the greatest potential of faith of people for the new birth and renewal of the power of the Sun and the Moon. Perhaps, that is why it is believed the greatest Gods-saviours such as Mithra and Jesus Christ were born on the day of winter solstice.

3. CYCLES OF ECLIPSES

The fact that people on Kokino monitored the movements of the Moon in a very careful manner in long time periods imposes the question whether these ancient sky observers were familiar with the cycles of Sun and Moon eclipses. In compliance with the existing literature, archaeo-astronomical analyses of the well know megalithic sites, such as for example Stonehenge in England (Hawkins 1963) are concentrated on linking the number and position of stone markers with the cycles of Sun and Moon eclipses. (Hawkins 1964, Colton and Martin 1967). Efforts are made in direction of presenting the stones' disposition in function of some kind megalithic computer that in the past served the purposes of predicting Sun and Moon eclipses.

Analysis of the Megalithic Observatory Kokino design showed that for each special type of activity, ancient people constructed special observation post and special stone markers on the east horizon seen only from that post. They followed the same principle for the purposes of monitoring the Sun and Moon eclipses.

Archaeo-astronomical analysis of the site showed that for the purposes of observing Moon eclipse there is a specially crafted post in a standing position. (Fig. 4). Ancient observers from this post very carefully monitored the rise and movement of the Full Moon. Conducted analysis provided evidences that only from this post four stone markers can be very easily seen on the east horizon (Fig. 5). Measurement of the stone markers' coordinates and calculation of the Full Moon rise coordinates showed that these four stone markers were used to mark positions of the Full Moon rise on the horizon in the night of total Moon eclipse. Each of these markers was crafted after period of 54 years and 34 days (Table 2). General Astronomy provides us with information that the well known Saros cycle of eclipse has a length of 18 years 11 days and 8 hours. Also we all know that the same schedule of eclipses in the same geographical region will repeat on every 54 years and 34 days or after three series of Saros. Concordance of the stone markers' coordinates with the coordinates of the Full Moon rise in the night of eclipse, directs to the fact that these ancient sky observers from Kokino were familiar with the moon eclipses' cycles and they monitored them continuously in a period of over 220 years.

On the basis of these data we could draw a conclusion that data on the eclipses' pattern we recorded with some kind alphabet of symbols, but whether such records will be found we will know from further archaeological excavations on the site. Moon eclipses, and especially Sun eclipses at those time but also nowadays are considered

Figure 4: See the text.

Table 2:

date	Eclipse Type	Saros	Moon		markers	
			A	h	A	h
1917 BC Jan 24	Total	3	70° 37′	11° 18′	70° 43′	10° 42′
1863 BC Feb 25	Total	3	78° 00′	10° 12′	78° 01′	09° 50′
1809 BC Mar 30	Total	3	88° 28′	04° 30′	88° 30′	03° 54′
1755 BC May 01	Total	3	104° 54′	02° 40′	104° 53′	02° 24′

as manifestations of the fight between the good and the evil or between the forces of the darkness and forces of the light. Without exception considerations found in all civilization periods and among all civilizations are that, an eclipse is a very bad sign predicting wars, diseases, and death. Therefore, people familiar with the eclipse

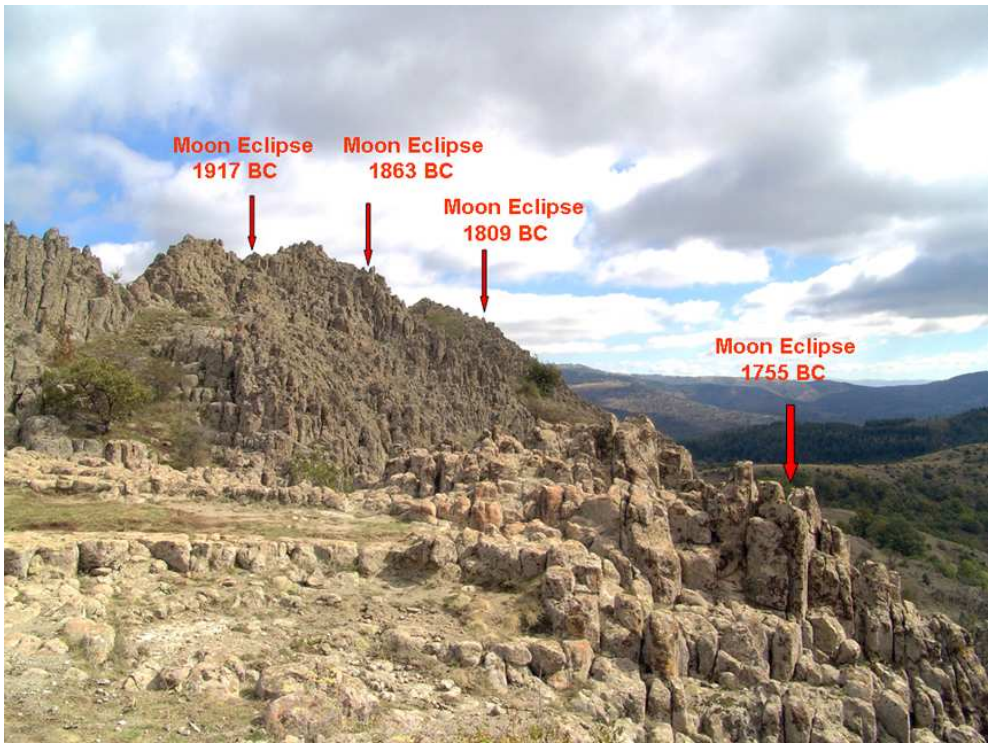

Figure 5: See the text.

pattern had a special status and power in the community. Salvation from the forces of darkness and evil was found in the performance of various religious rituals and magical ceremonies, which in broader geographical regions were organized and guided from the ancient priesthood-sky observers living in the area of the observatory. These findings of archaeo-astronomy contribute to the enlightenment of the life of people 4000 years ago who seem to have highly developed culture and organization of community.

References

Cenev, Gj.: 2004, "Sky over Macedonia", MKC Skopje, p. 105 -106.
Cenev, Gj.: 2006, "Megalithic Observatory Kokino", *Publ. Astron. Obs. Belgrade*, **80**, 313.
Cenev, Gj.: 2007, "Archaeo – astronomical sharacteristics of the Kokino archaeological site", Astrophysical Investigations Electronical Journal ofthe Institute of Astronomy Bulgarian Academy of Sciences Volume 9 p. 1-15.
Colton, R., Martin, R. L.: 1967, "Eclipse Cycles and Eclipses at Stonehenge", *Nature*, **213**, 476.
Eliade, M.: 2005, Histoire des croyanceset des idees religieuses" Taberncul Skopje, p. 90 – 91.
Hawkins, S. G.: 1963, "Stonehenge decodet", *Nature*, **200**, 306.
Hawkins, S. G.: 1964, "Stonehenge: A Neolithic Computer", *Nature*, **202**, 1258.