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Aspects of prehistoric astronomy in India

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Abstract. Some archeoastronomical aspects regarding the development of observational astronomy in India during prehistoric times are described. A plea is made for the preservation of megalithic monuments of possible astronomical significance.

Keywords : Constellations; Indus seals ; megaliths

1. Introduction

Astronomy is one of the oldest of sciences. Consciously or unconsciously the knowledge of the heavens, particularly the cyclic nature of certain celestial phenomena, helped the societies adapt to their environment and establish permanent settlements. Observing and recording positions of the Sun, Moon and Stars as objects of wonder and the furthur realisation that their movements are repetitive is a major step in the intellectual growth of ancient man. It is of interest to see how the pre-historic man in India did develop the sky sense, how he distinguished one day from the other and the passage of seasons. The study and interpretation of upper paleolithic art (and artifacts) is important in its possible influence in the astronomical concepts of later times. The animal depictions in caves and rock paintings of upper paleolithic (mesolithic) period, e.g. the bulls, bisons, rhinoceroses, tigers etc. may also represent the prototype of celestial images that later blossomed into zodiac and stellar constellations (Abhyankar 1993; Parpola 1973; Asfaque 1973; Bag 1985 etc.). Following Agrawal (1985), the middle paleolithic period refers to 37000 to 11000 BP, the upper paleolithic period refers to 11000 to 8000 BP and mesolithic period refers to less than 8000 BP.

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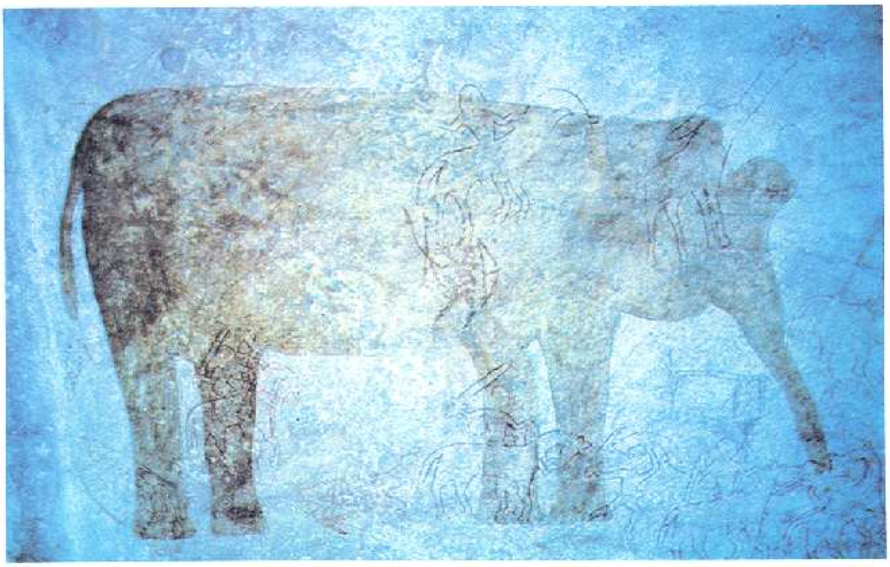

Figure 1. Prehistoric painting of an elephant from Adamgarh (Wakankar and Brooks 1976).

2. Constellations

Animal worship in India dates back to the paleolithic times as evidenced by the paintings in rock shelters and caves. Studies by V.S. Wakankar and others revealed that India has one of the richest collections of rock paintings belonging to the Paleolithic and Mesolithic periods.The main groups are located in Adamgarh, Mahadeo and Bhimbetka hills. The earliest paintings are huge and date back to upper paleolithic period (37000 to 11000 BP from ^{14}C dating) as characterised by Wakankar on the basis of style and technique (his period I). They were generally done in dark red and green. The earliest paintings are bisons, elephants, tigers, rhinos and boars (Figure 1). Generally they are large, some of them measure two to three meters in length. A few are wash paintings that are filled with geometric patterns, and no hunters are associated with them.

These are the same animals that appear in some Indus seals that have been interpreted as constellations representing the equinoxes and solstices. (e.g. Abhyankar 1993). These depictions of animals that ancient man worshipped (either out of fear or wonder) were later translated on to the sky as constellations to denote the groups of stars either to monitor the movements of the Sun and Moon (and possibly planets) or to estimate the passage of time during the night. Even in recent times the village (agricultural) communities denote the constellations with names of things they are familiar with, and not the ones that occur in (siddhantic) literature. In my village in Andhra, the Orion is called as 'prongs of a plough' (gorakoaiahlu or gorthi koaiahlu in Telugu) not by the traditionally

known name of Mrigsirsha, the Pleiades is called a 'hen with chicks' (pillalakodi), and not as Krittikas.

One of the paleolithic artifacts is the figurine of the mother goddess, the symbol of fertility, usually called Venus (in the west). One of the earliest measures of time is the lunar phase. The cycle of waxing, waning and the disappearance provided an obvious visual representation of the month. The similarity of the menstrual cycle to the lunar month provided a link of the biological clock to the celestial clock. In all primitive societies including India the mother goddess figure provided the link of fertility, menstrual periods and Moon and its phases. The faceless mother goddess (or Venus) bas-relief figurine at Laussel, France, belonging to the upper paleolithic period is a well known example. The figurine depicts a naked, faceless female holding in her right hand a bison horn inscribed with thirteen lines. The horn is thought to represent the crescent Moon and thus the incisions might have some astronomical significance (Marshack 1972). The number thirteen in astronomical context can be interpreted in several ways. It may refer to a lunar year of thirteen months or it might also refer to half a lunation period, i.e., from new Moon to full Moon or full Moon to new Moon. S.B.Roy in his book 'Pre-historic lunar astronomy' (1976) identifies Venus from Laussel as Vedic Aditi, the mother of Gods, which represents the star Pollux (punarvasu). Based on his interpretation of Rig vedic hymns and verses in 'Chandi', he not only finds similarity in the description of the figure with mother goddess Aditi but also estimates the period of this figure as about 19000 BC by assigning the autumnal equinox to occur near the star. He asserts that the mother goddess is associated with the Moon in almost every race and culture and her emblem is the crescent or half crescent Moon. 'The Laussel figure would seem to represent her perfectly'. Venus figurines have been found in Britain, France, Italy, Spain, Austria, Germany, Czechoslovakia,Ukrine and as far as Lake Baikal (Brown 1976). Roy (1976) even suggests that 'In other words, the pre-history of the distant ancestors of the Vedic seer goes back to the days of European cave art. ..... The hymn shows (i.e rig vedic 1.164) that the ancestors of the Vedic people once in the distant past - lived in Europe'. It is hard to imagine how in 19000 BC the ancient man could travel from Europe to India.

The discovery of a large number of rock shelters (may be a thousand or more) with pre-historic paintings and the habitational sites in M.P, U.P, etc suggests a parallel development of similar ideas in the paleolithic communities in India and Europe. A better documented paleolithic site is Bhimbetka and its surroundings. A large number of cave shelters were occupied here from the early paleolithic to Mesolithic times. The mother goddess figurines were also found in paleolithic sites. According to Agrawal (1985), 'Sharma claims a distinct upper paleolithic industry in Belan Gravel III (River Belan - Kaimur range, U.P). A ^{14}C date for shell from this gravel gives an age of 18000 BP. The reported discovery of a mother-goddess figurine from these levels lends it a European flavour'. [Even in recent times the figurines of mother goddess used in rituals, in India retain the same characteristics of exaggerated breasts, featureless face, and prominent display of the female genital etc. eg. the figure found at Keeseragutta (Indian Archaeology review 1983) similar to the paleolithic Venuses].

The figurine of the mother goddess represents the seminal connection between the menstrual cycle, fertility, and the observations of lunar phases (the count of days of lunar month). The notation of the incisions as seen on the horn of Laussel Venus or on some prehistoric bones might be calendric (although other interpretations might be possible).

One of the most publicized investigations into the possible astronomical notation content of the upper paleolithic artifacts is that of Marshack (1972) who has assembled what he considers positive evidence that pre-neolithic man utilized a notation system to record the cycle of the Moon's phases on a scratched bone that had been found at Ishango. This bone dated as 6000 BC was found at the head waters of the Nile (de Heinzelin 1962). The most interesting feature, however, was groups of scratches or notches arranged in three distinct columns which Heinzelin, the founder, has dismissed as simple decoration or some arithmetical game. On the other hand Marshack felt it as a system which could be read unambiguously to show the cycle of the Moon's phases and periods. He found several bones all over the world that showed similar notation to the Ishango bone. When tested against his lunar model they gave a reasonable fit and the notation appeared to be more like a record of the Moon's phases. The waxing period of 13 days, full Moon period of 3 days and wanning period of 11 days and invisible (around new Moon) period of 1-2 days form the basic model. In Marshack's notation, months vary from 27 to 33 days, the first and last quarters vary from 5 to 8 days and periods of full Moon and new Moon from 1 to 4 days, plus an allowance of ± 1 day for errors in observation (like cloud outs etc.). From this very flexible parameter the lunar model of Marshack can be made significant for any number or sequence of numbers between 1 and 16 and between 26 to 34.

At this point, it is appropriate to mention the use of more modern lunar calendar sticks from Nicobar Islands. These had been known long before Marshack began his investigation into the upper paleolithic material. These are notched sticks which take the form of white wood shaped to appear like a knife or scimitar with notches on the edge and on the flat. The months are recorded by cheveron marks; when all the space is used up, further months are engraved across earlier ones, resulting in a cross hatched pattern (Figure 2). Inscribed marks on these clearly denote the days of the waxing and waning Moon. The Nicobar lunar calendar sticks are engraved on soft white tropical wood cut to look like a dagger or knife. They look similar to the bone 'spatulas' or knives of unknown use found in the upper paleolithic period in Europe which often contain notations. The style of these Nicobarese notation recalls that of upper paleolithic, for the periods are differentiated both by count and by the angle of making. The notches are meant to go as 10-6, 10-4 = 30 showing the lunar phasing as from new (or the last sighting of the crescent) to quarter Moon as 10 days and quarter to full as 6 days, full to next quarter another 10 and from the quarter to the new Moon or the last sighting of the crescent before new Moon as 4 days. The notation is not precise.

The general thinking involved in this style of notation is so similar to that found in upper paleolithic period of Europe that it is uncertain whether we are dealing with

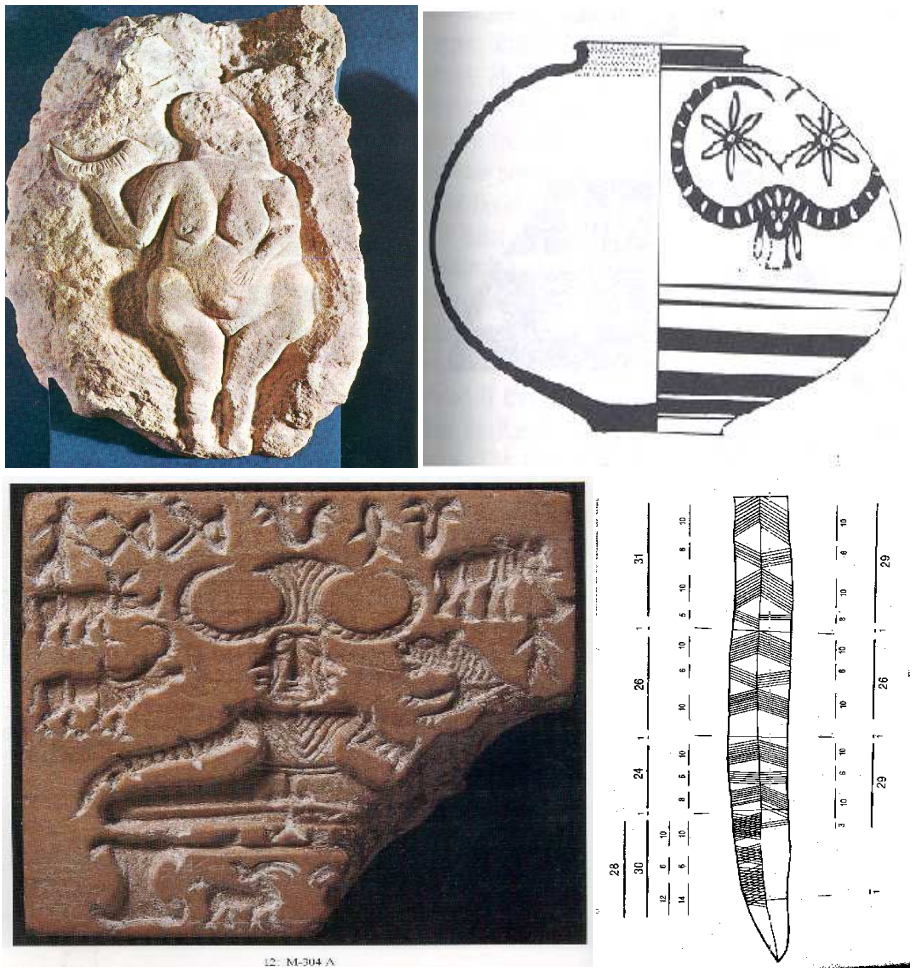

Figure 2. (top left) Venus of Laussel; (bottom left) Mohenjadaro seal 304: proto-Siva or Prajapathi Brahma (Joshi and Parpola); (top right) horned figure on a pot from Kot Dijin (Agrawal 1985); (bottom right) calendar stick from Nicobar Island (Marshack 1972).

the evolved remnant of an ancient notational tradition or merely a similar expression of cognitive capacity. Significantly the Nicobarese used a naming system for every day in the lunar month, with a name for each change of phase and they broke this down even further with a name for each phase period consisting of a number of days such as the period of waxing Moon, the disappearing Moon, the full Moon.

The inscribed notation in association with the mother goddess figures like the middle Magdalen baton, which could be menstrual cycle day count and the horn of Laussel Venus gives credence to Marshack's assertion that 'there seems little doubt that upper

paleolithic man had a fairly sophisticated knowledge of the 29 - 30 day movement of the Moon coupled with a profound knowledge of the seasons'. The antiquity of these notations might even go beyond 20000 BP and are present in several parts of the world. In Australia, the 28 incisions on the tooth of a diprotodon (now an extinct mammal) suggests nights of viewed Moon dates back to 19800±390 BP. The cup and groove tradition (another notation denoting lunar cycle) suggests that the lunar phase cycle representation might have been a very ancient activity. Recent cation dating suggests that in Australia the cup-and-groove tradition extends back beyond 30000 BP (Cairns 1993).

In India too such artifacts with calendric notations are found. Wakankar and Brooks (1976) report 'In 1973 S.A.Sali reported finding an engraved Ostrich egg shell in an open campsite, upper paleolithic layer near Patna. In 1974, Wakanker reported finding a bone engraved with cross hatching in an upper paleolithic layer and another in a mesolithic layer at Bhimbhetka, shelter III A - 28. Additional search for engravings on bone or soft rock may also show evidence of the use of calendrical devices, such as those now well authenticated by Alexander Marshack for earlier periods in France.' Markings similar to the incisions on the Laussel Venus horn with calendric notations are also present on pottery of later period. The pre-Harappan site of Kot Dijian excavations located 40 km east of Mohenjadaro (left bank of Indus) belonging to the period 2600 BC (based on ^{14}C dating - Agrawal 1985) showed a pot depicting a horned human(!) head. The horns are decorated with white paint. Apparently white paint is quite rare at Kot Diji (although common at Kalibangan period I) implying that it is a deliberate effort to denote some thing. Interestingly the horns show the paint marks corresponding to the lunar count - from new Moon to full Moon at the centre and back to new Moon. It contains 15 paint marks up to the middle of the forehead during which the size of the marks gets larger and another 15 (or 14) marks to the other end of the horn during which the size decreases as though they are denoting the phases of the Moon from new Moon to full Moon at the centre and back to new Moon to complete the cycle (note that even horn ends almost come together). A similar horned head gear is present on the famous Mohenjadaro seal (M-304) (Joshi and Parpola 1987) called 'proto-Siva' (by Wheeler) or 'Prajapathi Brahma' (by others - e.g. Abhyankar 1993, Roy 1976) with the same pattern as the Kot Diji pot. The markings on the horns are of the same number. If these are the notations of lunar month it suggests a continuation of the same tradition (A similar horned deity is seen on a pot in the neolithic site of Burzahom). If the figure on the seal represents later lord Siva, it is interesting to note that the horns get replaced by the lunar crescent in the imagery of Lord Siva, literally suggesting the connection.

This brings us to the Harappan and Indus civilizations. There have been several astronomical interpretations of the Indus seals by Parpola, Asfaque, Bag, Roy, Abhyankar etc. Although the general astronomical connotation is suggested each author interprets the motifs in different ways. In the M-304 seal referred above, the central figure is supposed to be Prajapathi Brahma, the lord of civil year, which starts at the autumnal equinox according to Abhyankar (1993). The animal motifs are to represent various zodiacal constellations at the time of equinoxes and solstices. The autumnal equinox is represented

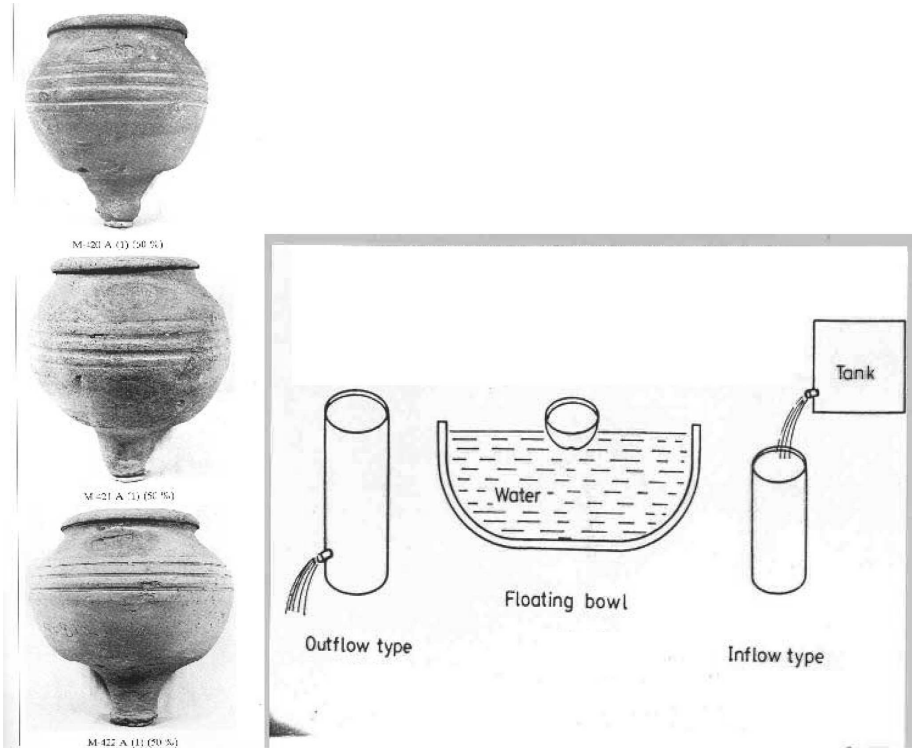

Figure 3. (right) Types of water clocks in vedic times (Ohashi 1993); (left) Pots from the excavations at Mohenjadaro (Joshi and Parpola 1987).

by the elephant (now represented by Scorpio), the vernal equinox is represented by the buffalo (now represented by Taurus), the summar solstice by the tiger (now represented by Leo) and the winter solstice by Rhino (or boar represented by star satabhisag -alpha PsA). Regarding the seal M-430 Abhyankar and Bag interpret in different ways. They both agree that it represents the celebration of new year (samvatsarasatra), but interpret the figures in the seal differently-the figure in between the branches of the tree is thought to be Agni by Abhyankar whereas Bag feels it is the Moon. The seven figures at the bottom of the seal are thought to be the alignment of five naked eye planets plus the Sun and the Moon on 7 Feb 3104 BC by Abyankar, whereas Bag thinks they represent Pleiades, the seven sisters. Thus the interpretations are subjective, moreover the ^{14}C dates for Mohenjadaro cluster around 2000 BC. If the epoch referred in the seal is the planetary alignment of 3104 BC the collective memory of this epoch is to be retained for over a millennium.

3. Earliest Instruments ?

The question of what sort of instruments did they use to observe the celestial phenomena and keep track of the time, then arises. Are there any artifacts to suggest that they were used. In his article on the development of astronomical observations in vedic and post-vedic India, Ohashi (1993) mentions that the two earliest instruments that have been used to track time are Clepsydra (the water clock see Figure 3) and gnomon (Sanku see, Figure 4). It appears that two artifacts from Mohenjadaro and Harappa might correspond to these two instruments. Joshi and Parpola (1987) lists a few pots tapered at the bottom and having a hole on the side from the excavations at Mohenjadaro (Figure 3). A pot with a small hole to drain the water is very similar to clepsydras described by Ohashi to measure the time (similar to the utensil used over the lingum in Shiva temple for abhishekam).

Wheeler (1946) excavated several brick working platforms in and around Harappa (Figure 4). These are circular and wide. The Harappan brick platform is about 11 feet in diameter. It consists of five concentric rings of burnt bricks set on edge, and one brick in thickness. The centre contained 'a wooden object had been embedded in the socket and had projected above the brick platform'. The use of these platforms was unclear, although Wheeler speculates that 'it is inferred that the platform surrounded a wooden mortar where grain was pounded by one or more workers with long pestles'. It is very unlikley that one would lay the bricks on edge to collect grains particularly the large Harappan bricks, since it would be more useful to have the larger flat surface of the brick to collect the grain than an edge on one. Secondly the platform is much too wide for one or two people to pound grain in the central one or two feet wide mortar peg. (Anyone who has seen grain pounding in villages using mortar (stone) would realise this.) It is striking that the layout of the bricks in rings is very similar to some of the sundials seen in later years (e.g. kiranada kalu (Figure 4) of 11 century sculputure or the Greek sundials). The central wooden peg (or shaft) casting a shadow to measure the time is one ideal use of such a brick platform. The circular rings providing the path of the shadow on specific days (equinoxes, solstice etc.) and the finer graduations provided by the edge on bricks denoting the more accurate way of estimating the time from the shadow. Wide clear space is needed to see and measure the shadow. Thus it is very likely this structure could represent a gnomon.

4. Megalithic structures

Awareness of the sky became a necessity of life for neolithic and megalithic man. Agriculture in India is supposed to have started during 7000 to 5000 BC (Agrawal 1985), as such, a knowledge about passage of seasons (time to plant or sow the seeds etc.) became a necessity. Even for non-agricultural activities of food gathering like hunting required awareness of the night sky (passage of time during night etc.,) became a necessity of life is exemplified by the neolithic pit dwellers of Burzahom (Rao 1995). Monitoring sunrises

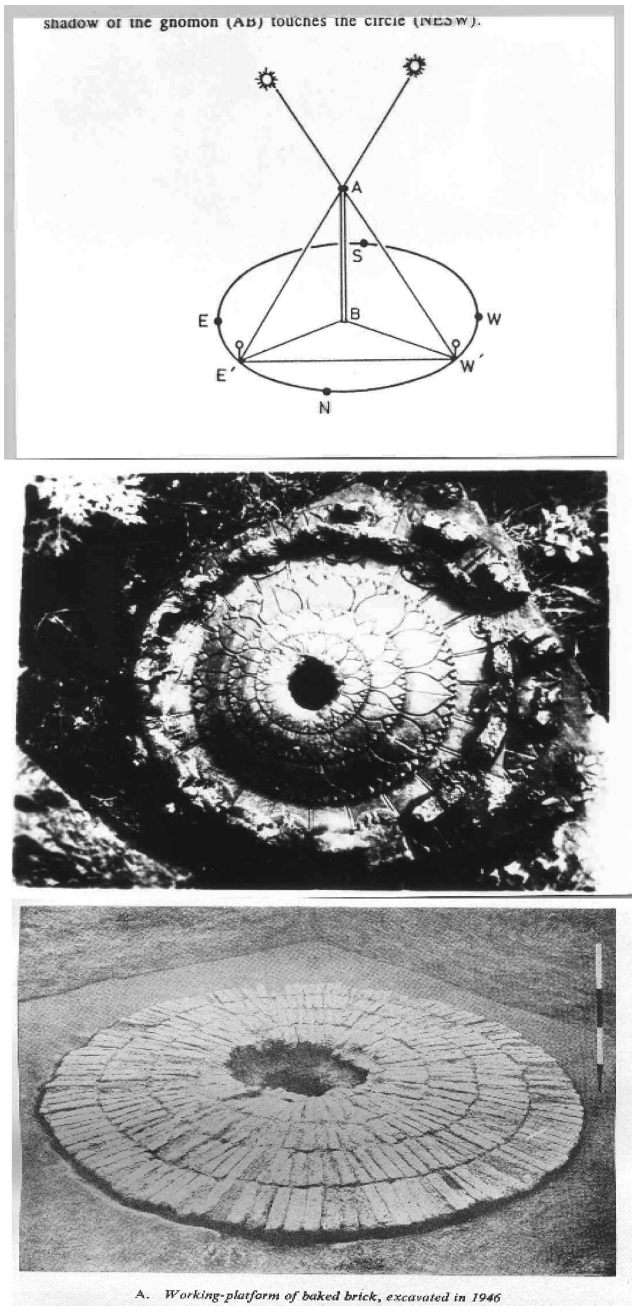

Figure 4. (top) Sketch of gnomon (Ohashi 1993); (middle) Kiranada kallu with zodiacal signs on the border (courtesy M.V.Visweswara); (bottom) Harappan brick platform (Wheeler 1946).

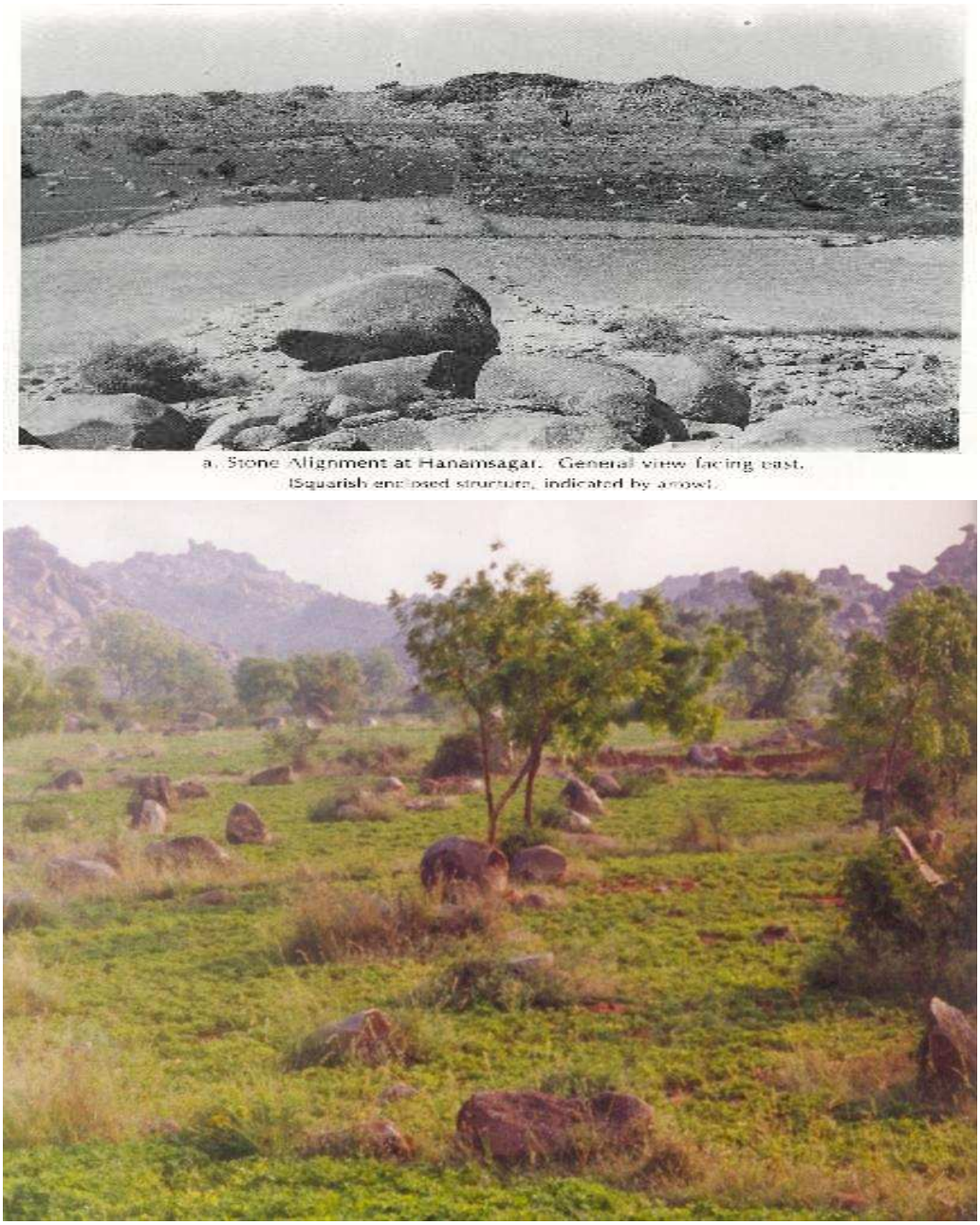

Figure 5. (top) Stone alignment at Hanamsagar (Peddayya); (bottom) recent view of a part of stone alignment at Hanamsagar.

and sunsets over the horizon to estimate and predict the coming of seasons and the passage of the year is done by arranging sight lines towards these directions. Some of the megalithic structures suggest such a purpose. Stone alignments (of nonsepulchral conotations) are of special interest in the astronomical context. Allchin (1956) located 40 sites of stone alignments in his systematic survey of northern Karnataka and Hyderabad regions. Several of them if not all of them are arranged in a squarish fashion. Some of them are 14 to 16 feet high stone arrangements (e.g. Murar doddi - 2000 ft. square). The lines are often oriented on the cardinal points in all recorded cases. Generally these are located in proximity to megalithic graves, several of them lie on the outskirts of settlements. Marks of chisels or drills have never been reported. The purpose of their establishment is totally unknown. Similar alignments (rows of stones) have been seen in Megalithic site in Europe eg. Le Mence in France. Thom(1974) has suggested astronomical significance to these monuments. It is worth while to examine the sites in India also. One of the prominent sites where a large number of stone arrays exists is at Hanamsagar discovered by Mahadevan(1941) and recently investigated in some detail by Peddayya (1995) (Figure 5). Although several speculations exists, the main purpose of the structure is unknown (Peddayya 1995).

The site is located on a flat area in between the hills about 6 km north of the Krishna river in Belgaum district. The site is known as Salgal-Bayalu, meaning open ground with rows of stones. It is a square with a diagonal pattern each side measuring about 600 meters. The stones used are mostly granite without any marks resulting from quarying or dressing. They were probably rolled down from the hills and arranged in lines. The stones are between 1 to 2.5 m in height with a maximum diameter of 2 to 3 m. According to Peddayya there are 50 rows each having 50 blocks (about 2500 stones) and are separated by 12 m from each other. The lines are oriented in cardinal directions. There is a squarish central structure known as chakri katti (squarish construction). The arrangement is schematically shown in Figure 6 mainly derived from Peddayya's description. The longitude and latitude of Hanamsagar is $76^\circ\ 27'\ 10''$ and $16^\circ\ 19'\ 18''$. As shown in the figure, the stones have been uniquely arranged to show the directions of summer and winter solstice. Sunrise passes through the corners of the eastern side as viewed from the centre of the western most column. Similarly the solstice sunset directions could be viewed through the corners on the western side from the centre of the eastern most column. The arrangement of stones in the diagonal way might also suggest that. The unique position to view from the centre of the first (or last) column is indicated by the position of chakra katti and (apparently a similar structure exists on the other side from our own investigation). More number of sight lines (rows of stones) help in monitoring the motion of the sunrise on the horizon i.e slow near the solstice and rapid near the equinoxes. In principle it can be used for many other functions like the time of the day from the shadows to the prediction of months, seasons and passage of the year. It is also likely that it could have been used to study lunar motions but needs to be investigated.

The site at Hanamsagar is one of the several such megalithic structures, which are probably established for astronomical purposes, mainly to monitor and predict the seasons

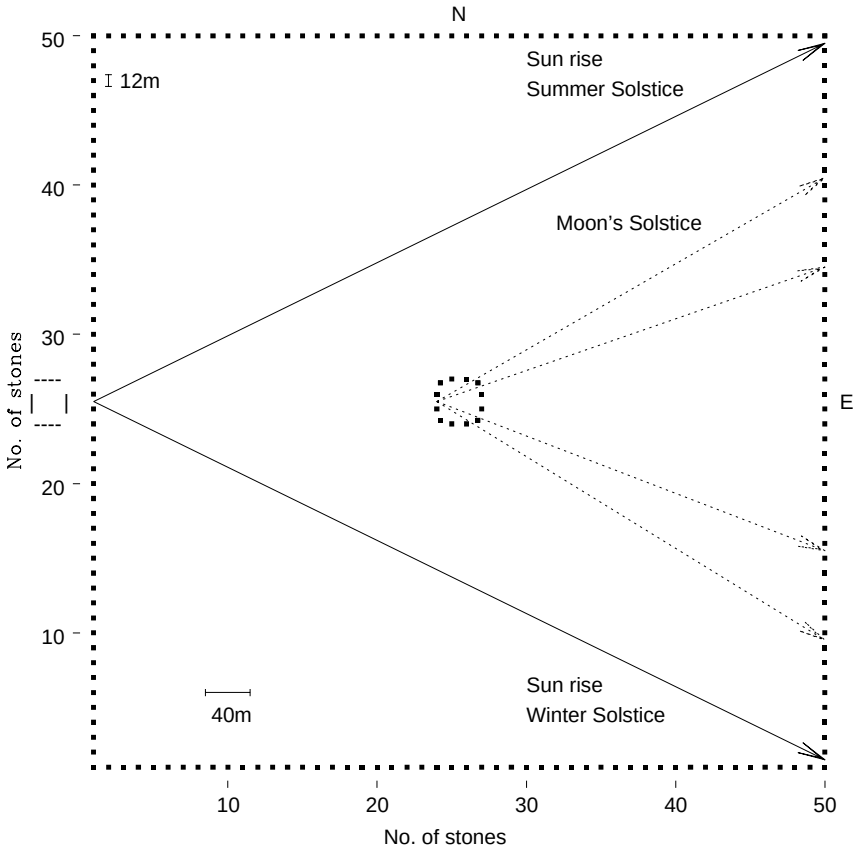

Figure 6. Schematic stone arrangement at Hanamsagar with astronomical orientations indicated. The rows are not shown filled-in for clarity .

(times of sowing, harvesting etc.) which are very important for agricultural communities in addition to predicting the religiously auspicious days. The Hanamsagar site itself is located in private agricultural lands which are being cultivated, as a result the stone arrangement has already got disturbed to quite an extent. It is urgently required that such sites be preserved for posterity.

In the above account, I have tried to project some of the developments of astronomy, mostly the observational aspects based on archeological data (artifacts). Some of the interpretations might look speculative but then very little work is done in the country in the field of archeoastronomy. Hopefully this might stimulate others to take up some of these aspects for detailed studies.

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