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Astronomical orientations of the megalithic stone circles of Brahmagiri

N. Kameswara Rao
Indian Institute of Astrophysics, Bangalore 560 034

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Abstract. The megalithic stone circles at Brahmagiri which have been dated as 900 BC show clear astronomical orientations. The site lines from the centre of a circle to an outer tangent of another circle points out to the directions of the sunrise and moon rise (full) at the time of solar and lunar solstices and equinox. Site lines towards the maximum azimuthal elongation of the then circumpolar star β UMi (which also happens to be the brightest star near the pole) indicates that the time of the establishment of these Megaliths is earlier than 600 BC, may be between 900 to 600 BC. The megalithic people were probably aware of the 18.61 year period of the moon's solstice in addition to keeping track of the sideral day, the seasons and the year.

Key words : megaliths—the seasons

1. Introduction

It is known that south India is rich in megalithic monuments. The prime common characteristic of the megalithic monuments, is the almost universal presence of a bounding circle of dressed or unhewn stones of irregular shape and size varying in exterior diameter from 18 feet to 139 feet (Srinivasan and Banerjee 1956). The first systematic excavations of the megalithic sites were conducted by Wheeler in 1947 (Wheeler 1948) at Brahmagiri in Chitradurga district of Karnataka, which forms the basis of the present investigation. After surveying several hundred megalithic sites and stones circles in British Isles, Thom (1967) has concluded that the megalithic stone circles are lunar observatories where alignments with solar and lunar solstices directions have been marked, in some cases to a very high degree of accuracy (≤ 1 minute of arc). In some cases alignments with the rising and setting of bright stars were also indicated. He also concluded that a standard unit of length namely a megalithic yard (my) equivalent to 2.72 feet was used by megalithic astronomers. This unit was some times divided into four, but never three equal parts. For the larger lengths 10 my was frequently used, again subdivided into four parts when necessary. Thom also classified these stone circles into different types based on the

geometry as circular, Eg. Type I, Type II etc. Generally the mean date of these British sites is 1700 ± 100 BC. Thus it is of particular interest to see whether any astronomical orientations exist at Brahmagiri stone circles and how relevant are the ideas of Thom to these circles.

2. Description of the circles

The ten main megalithic structures excavated at Brahmagiri in 1947 fall into two categories : (1) Cist-Circles *i.e.* Cists are normally surrounded by a built or monolithic circles (Megaliths I, IV, V, VI, VIII, as numbered by Wheeler), and (2) Pit-circles *i.e.* built or monolithic circles enclosing unlined pits (Megaliths II, III, VII, IX). The cists are characterised by the presence of large number of human bones and pottery and other funerary materials placed in the cist covered by a capstone whereas the pits are characterised by the presence of all the funerary materials except bones located in a pit. The pits are oblong and are oriented in the general direction of east-west. According to Sundara (1973) most of the pit circle burials are found in the neolithic sites. He thinks that pit circles at Brahmagiri are not macerating pits but actually an indigenous form of megalithic burials of the local people who were in their neolithic stage. However, both categories occur in the same area (and thought to have been established at the same time) at Brahmagiri. On the average the pit circles are larger in diameter than the cist circles.

The megalithic sites explored at Brahmagiri occur on the gentle slopes on the eastern part of the hill (figure 1) as is generally the case with most of the megalithic sites. According to Narasimhaiah (1980), 'megaliths are concentrated invariably on the slopes of hills or on elevated ground'. (The probable reason being the visibility of the horizons.)

In addition to the stone circles, there are also few stone alignments (arrangement of stones in a row) and two menhirs (figure 1) at Brahmagiri. The present work is based mainly on the site plans published by Wheeler (1948). In addition to the major structures marked by Wheeler there are other smaller stone circles around these major ones which we denote as A, B, C etc. (see figure 2).

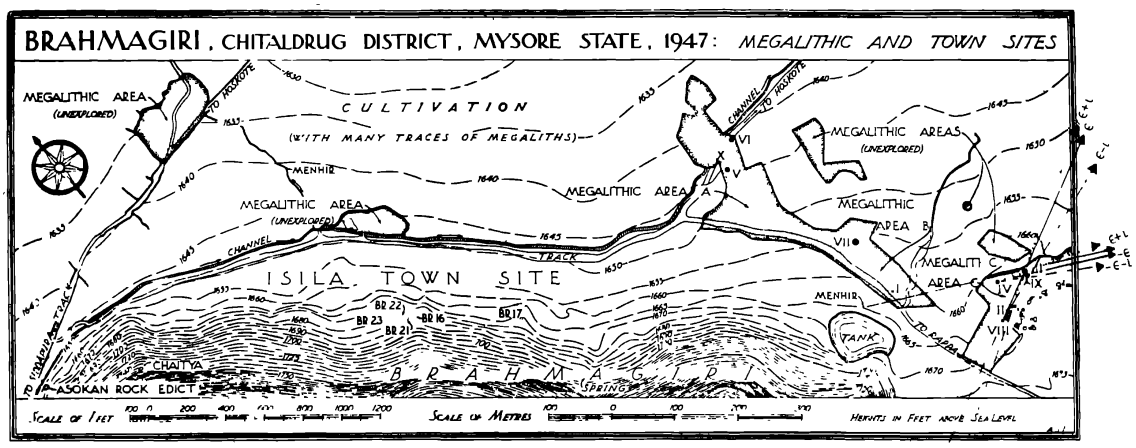

Figure 1. The general outlay of Brahmagiri showing the location of the megaliths. Note that western and most of the north western side of the megaliths is occupied by the hill so only the eastern horizons is easily accessible (i.e. risings). Some of the solar and lunar solstice direction are indicated.

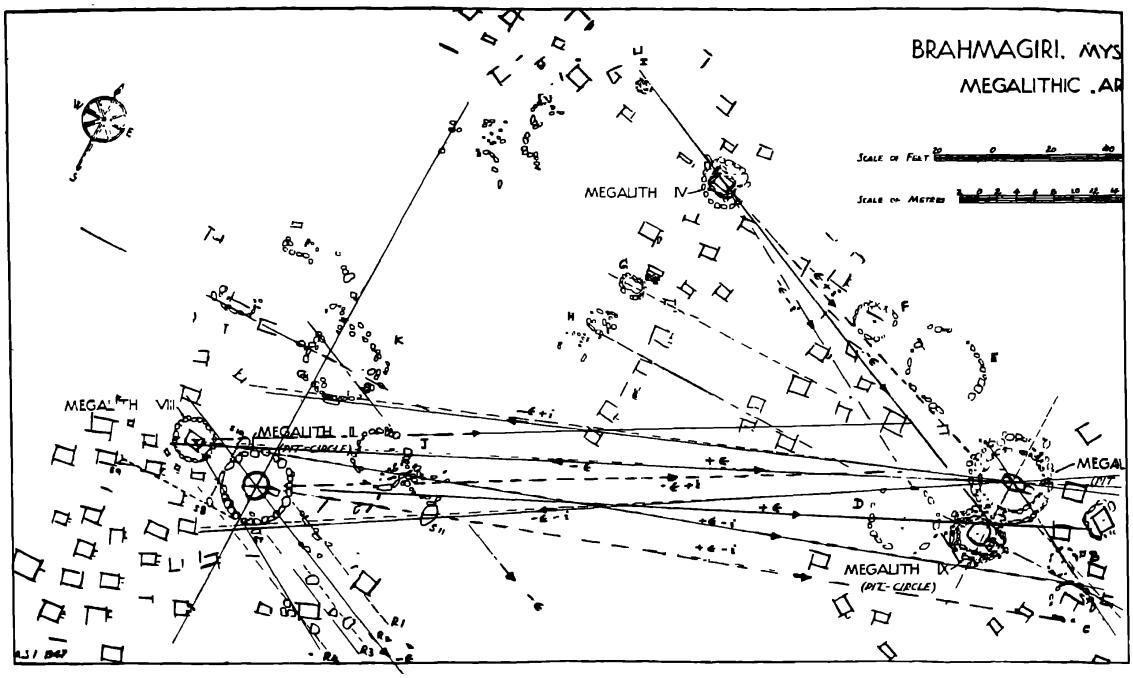

Figure 2. The solar and lunar solstice directions are shown for the megaliths II, III on the area marked as C—refers to the obliquity, in the inclination of moons orbit. The dashed lines refer to the lunar solstice directions. The risings and the settings are indicated by arrows (see table 1).

Based on the archaeological evidence, the Brahmagiri megalithic monuments are dated as between 1000 to 800 BC (Sundara 1975; Narasimhaiah 1980) (could even be extended to 600 BC) although stone circles appear in North Karnataka region around 1200 BC, if not earlier. We adopt the time of the establishment of these stone circles as 900 BC.

The procedure we adopt is to see whether there is any correspondence between the direction of the rising and settings sun, moon and stars. The solar and lunar solstices azimuths are calculated for the sun rise and moon rise for the location of Brahmagiri (latitude = 14°.73 longitude = 76°. 77E) by adopting the obliquity ε (as 23°.804 for 900 BC) and *i*, the inclination of the lunar orbit as 5°.1453 zenith distance of 90°.8 (the upper limb) is assumed for the sun rise and setting (as adopted in the almanacs). In case of the moon, the parallax factor is taken into account as indicated by Thom (1967). No special refraction and extinction have been applied.

3. Solar and lunar solstices

Several alignments towards the direction of solar and lunar solstices azimuths are immediately obvious. The megalithic people might have used the tangents to the circles as the best way to mark the directions. As an example the sun rise on the summer solstice as viewed from the centre of megalith II becomes a tangent to megalith III. The criteria for the pointer for the azimuth of a line given by Thom (1967) are : (1) an outlying menhir from the centre of a circle, (2) an outlying circle from the main circle, (3) an alignment of stones, and (4) a slab or slabs set upright with its longer face pointing to a foresight which may be (a) second stone, (b) a mountain peak, (c) a large natural boulder on a ridge or a notch in an elevated horizon. All these could be used singly or in combination. Out of this the people of Brahmagiri

seem to have used the tangents of circles from the centre of another circle as the main criterion. However, the alignment with distant peaks have to be investigated.

The various alignments towards the solar and lunar solstices (both to major and minor stand stills) are given in table 1. The accuracy, to which these alignments are made, can be estimated from the distances measured on the site plans (figures 1, 2 etc) as 5 to 6 minutes of arc. Since several site lines seem to have been used for the same event (table 1) the accuracy might have been even better than this. (An accurate survey of the site would be useful). The agreement of the azimuth with calculated ones suggests that the upper limb of the sun might have been used as a marker. The above alignments with the lunar solstices both major ($\varepsilon + i$) and minor ($\varepsilon - i$) suggests that the megalithic astronomers are aware of the 18.61 year nodal period of the moon (the revolution of the nodes around the ecliptic). Only an accurate survey would enable us to know whether they could have measured the ± 9 minutes of arc perturbation effect on the moon which has a 173 day periodicity.

Table 1. Solar and lunar alignments

From	To Tangent		Passing through
I. *Summer solstice sun rise (+ ε) : Azimuth Cal 65°.10*			
Megalith II	Megalith III (t)	Circle D(c)	Megalith IX (p)
Megalith VIII	Megalish II (t)	Megalith III (c)	
		Circle J (c)	
II(a). *Lunar summer solstice (major stand still) moon rise (full) (ε + i)*			
Azimuth Cal 60°.657			
Megalith II	May be circle J(t)	Megalith III (c)	
Megalith VIII	Circle J(t)		
(b). *Lunar summer solstice (minor stand still) moon rise (full) (ε – i)*			
Azimuth Cal 71°.316			
Megalith II	Circle D(t)	S 11 (c)	
	Circle C (t)		
	Megalith IX (t)		
Megalith VIII	Circle C (t)		
III. *Equinox sun rise*			
Circle H	Circle C (t)	Megalith IX (c)	Circle D(p)
Circle G		Megalith III (c)	Circle A (p)
S 10		S 11	
S 9		S 8, S 7	
IV(a). *Winter solstice sun rise (–ε) Azimuth Cal 114°.437*			
Megalith IV	Megalith III (f)		Megalith IX (p)
Circle K	Circle J(t)		Circle C (p)
Megalith VIII		Megalith II (c)	
		R2	
Menhir 1	Megalith III (f)	R1	Megalith II (p)
S8		R4	

(Continued)

Table 1. Continued

From	To Tangent		Passing through
(b)*Winter solstice sun set (– ε)*			
Megalith III	Megalith II(t)	Megalith VIII (c)	
		Circle J(c)	
		S 8	
V(a). *Lunar Winter solstice (minor stand still) (–ε + i) moon rise (full)*			
		Azi. Cal 109°.95	
Megalith IV	Circle F(t)		Megalith III (p)
	Circle E(t)		Circle B(p)
Megalith VIII		R3	
Megalith VIII	Megalith II(t)		
	Moonset		
Megalith III	Circle K(t)		
(b). *Lunar Winter solstice (major stand still) (– ε – i) moon rise*		Azi. Cal 120°.724	
Megalith IV	Megalith IX(t)		Circle D(p)
Megalith VIII		R5	
Megalith I	Megalith III(t)		
Megalith III	Circle C(t)		
	Moonset		
Megalith III	Megalith II(t)	S11	

c – centre of the circle, t – tangent to the circle, p – passing through the circle.

The megalithic circles II and VIII are of particular interest. The megalith II is surrounded by three stones marked S7, S8, S10 (in figure 2). Stone S9 becomes an extension of S7, S8 towards east-west (equinox sun rise) and the line joining S8 and S9 points to north-south. The line joining S10, S11 forms a tangent to megalith II and points to the equinoxial sun rise (figure 2). There are four rows of the stones near megalith II marked as R1, R2, R3 and R4 in figure 2. The line joining S10 to R1 points to the Winter solstice sun rise. Similarly the line joining stone S8 to R4 also points in the same direction. The line marked by R2 passes through the centre of megalith II and becomes a tangent to megalith VIII. The whole arrangement appears to have been done in such a way as to arrange the two circles megaliths II and VIII in the exact direction of the solstice (after arranging the directions by the rows) and incorporate the stone circle megalith II in the square formed by stones S7, S8, and S10. These two circles megaliths II and VIII form the nucleus for other alignments as given in table 1.

4. Stellar orientations

The most interesting and obvious orientation appears to be towards the star β UMi. In 900 BC the brightest star closest to the north pole was β UMi (declination + 83°.42) in addition it was also a circumpolar star (as such would never set). The maximum elongation in azimuth (towards east and west) occurs when the star is at the same zenith distance as the

celestial north pole (= 75°.27) at Brahmagiri. From figure 1 the line from the centre of megalith I passing through (tangent) megalith VII indicates the direction of maximum azimuth towards east (A + 6°.8). Similar line from megalith I passing through megalith VI (tangent) point to the direction of maximum azimuth towards west. The closer examination of the region (on larger scale) including megaliths I and VII (figure 3) showed more interesting details.

To the west of megalith VII there are two obvious rows of stones denoted as R7, R8 (and may be one more R9) in figure 3. Whose purpose is not immediately obvious (this arrangement is similar to show figure 1 of Thom). It is seen from figure 3 that when the direction of maximum azimuthal extent towards east is plotted, (for the epoch 900 BC) it falls close to the centre of the megalith circle VII. The same orientation for the epoch 500 BC (A = 7°.31) puts it away from the centre. The orientation towards the exact centre of the megalith VII (A = 7°.1) seem to occur for the epoch 600 BC. At the distance of 326.3 ± feet (120 my) from the megalith I, the 6°.8 orientation corresponds to 38.9 feet and for 7°.3 it is 41.9 feet. Similarly the direction of maximum azimuthal extent on the western side coincides with the orientation of row R8 very well. Thus the purpose of these rows of stones seems to use the circumpolar star β UMi to point to the exact north. This process also allows us to date the establishment of these structures as earlier than 600 BC, may be between 600 to 900 BC. (β UMi's declination changes by only 3 minutes of arc between 1300 BC to 900 BC).

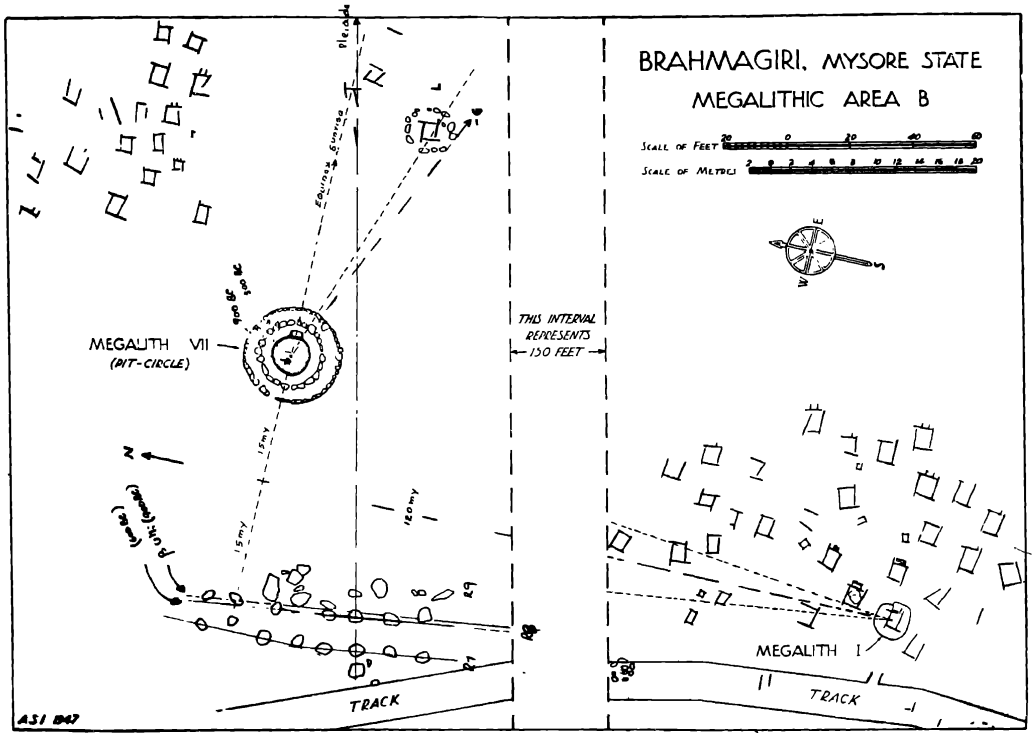

Figure 3. The directions (maximum azimuthal extant) of circumpolar star UMi from megalith I to megalith VII and the row of stones R8.

In the row R7 the southern five stones are arranged roughly parallel to R8, the northern four points to the direction of the pole. According to Thom (1967), a line of slabs was often used to define the meridian in megalithic sites. 'In several places these can still be used with the shadow cast by the sun to give local apparent noon to within few minutes of time'.

The orientation towards the raising of the bright stars like Capella, Castor etc. (figure 4) also seem to be present, and these might have been used not only as time keepers in the night but also to calibrate the solar calendar and to mark the progress of the seasons. In 900 BC the helical rising of Sirius might have indicated the arrival of summer solstice similarly the helical rising of Vega might have indicated arrival of the Winter Solstice. Table 2 list the orientations towards the rising (also possible setting of Capella) of bright stars. (Around the epoch 900 BC the three bright stars Capella, Denab and Vega had very similar declinations + 37°.01, + 37°.70 and 39°.42 as such their azimuths of rising only differ by 2°.5; in 600 BC they differ by 0°.85).

5. The megalithic unit and the geometry of the circles

The arrangement of most of these (megalithic) stone circles at Brahmagiri is very circular and compact. In addition to the circle a combination of an ellipse and a circle, which could be classified as Type I Eg. by Thom, also appears (megalith VI). May be megalith V could be classified as a flattened circle. The diameter and the separations of the megalithic circles are given in table 3. The diameters can be, in most cases, fitted to an integral number of megalithic yards (within ± 0.1 feet) (figure 5). Even the separations in several cases are within the prescription of Thom (1967) that the megalithic yard was used as an integral number or divided into four parts but never three equal parts. But it is still premature to conclude whether a megalithic yard was also used in Brahmagiri or another site in India.

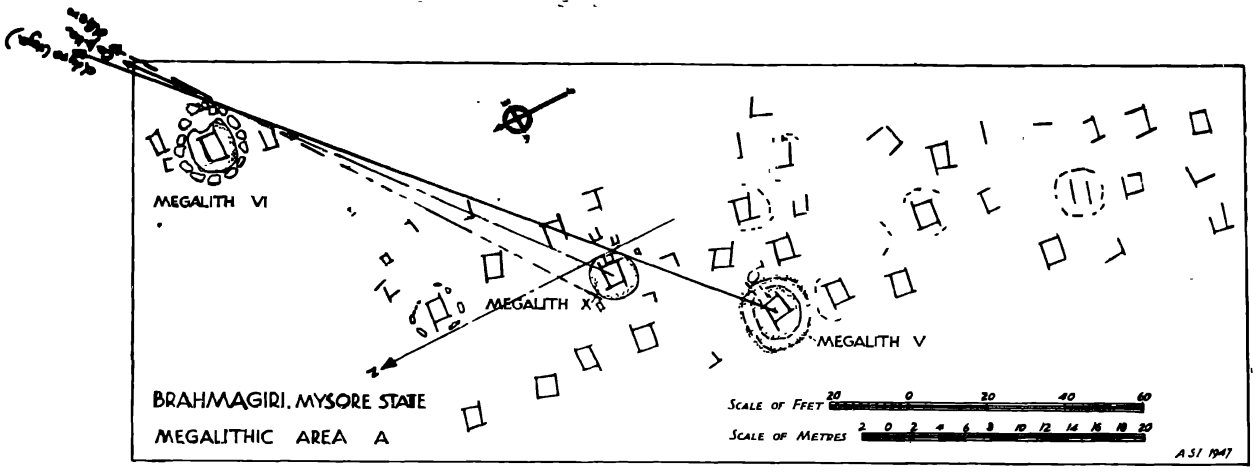

Figure 4. The region of the megaliths V, X, and VI. The directions of the rising of the bright stars Capella (α Aur), Vega (α Lyra) and Castor (α Gem) are indicated.

Table 2. Stellar orientations

From	To	Star (900 BC)
Megalith I (c)	Megalith VII (c)	βUMi (max. azi. eastern)
Megalith I (c)	R8	βUMi (max. azi. western)
	Megalith VI	Figure 3
Megalith VII (c)	Megalith V	UMa (A = 16.45)
Megalith VII (c)	Megalith VI	εUMa (Setting A = 10.81)
Megalith X (c)	Megalith VI (t)	la rising (A = 51°.5)
Megalith X (c)	Menhir (2)	Capella setting
Megalith V(t)	Megalith VI (t)	Capella rising
Megalith (c)	Megalith X(t)	α Lyra (Vega) rising (A = 49°) (Figure 4)
	Megalith VI (t)	
Menhir (1)	Megalith I(t)	Sirius rising (A = 107°.6)
Megalith VII (c)	Megalith IV (t)	α Car (Canopus) rising (A = 146°.0)
Megalith VII (c)	Megalith III	α Cen rising (A = 138°.74)
Megalith X (t)	Megalith VI (t)	α Castor rising (A = 56°.75)
RT		α Eri rising (A = 173°.56)
		at alti. = 1°

A : is calculated for altitude of O degrees; for an altitude of 1° the change in azimuth is 0°.3.

A: Rising of Tangent (Pleiades) A3: Rising of Ori.

Megalith VI (center) Rising of Leo.

6. Discussion and general remarks

There appears to be more site lines directed towards the sun rise on winter solstice day (– ε), which might have been an important event either because the skies generally were clearer to observe the events or the year began from this solstice.

The megalithic circles were not only used as places of burial but also as astronomical instruments. The stone circles of Brahmagiri seems to be more compact and well arranged, than several big circles illustrated by Thom. This might also indicate a time later than the British sites.

The astronomical alignments of these megaliths demonstrate that ancient people of Brahmagiri were capable of making basic (and fairly precise) observations of the natural phenomenon and astronomy played an important part in their lives. The answer to the question whether any random arrangement of the stone circles could have yielded the number of astronomical orientations seen here can be viewed in the following way. The pit-circles which are larger in diameter and form the basis for the solar and lunar orientations (figures 2 and 3) are very few (only four mentioned here and another group of four have also been found with an isolated outlier of exceptional size) in the whole area where more than 300 cists are excavated (Poonacha, personal communication). The pit-circles are certainly very few, and if they are arranged in such a way as to show astronomical orientations implies that they are constructed with an astronomical purpose rather than mere coincidence. The erection

Table 3. Diameters and separation of the stone circle

	Diameter my	Separation Feet	my	No. of stones	Remarks
From					
Megalith VIII	5			19	Cist circle
to Megalith II	9	22.45	8.25	25	average extended diameter 26, 27 feet according to Wheeler
to Megalith III	10 (outer)	282.8	104	29	Overall diameter 30 feet according
		8.0 (inner)		29	to Wheeler
to Magalith IV	6.0 outer	203.47	74.75	19	Cist circle
to Megalith IX	7.0	272.22	100.08	(25)	
to circle J		65.48	24.07		
to circle K					
Megalith VI	6.0 minorr axis (circle) 8.0 major axis			15 +	Egg type II. circle + ellipse
Megalith VII	11.0 (outer)			—	double circle extended diameter
	7.5 (inner)				31 feet according to Wheeler
Megalith X to			40.0		
Megalith VI					
To Megalith V		42.84	15.75		
From Megalith III	—				
to Circle A		33.96	12.5		
to Circle B		32.74	12.0		
to Circle C		47.24	17.37		
to Circle D		38.82	14.27		
to Circle E		44.90	16.50		
to Circle F		72.69	26.73		
R1 – R2		6.83	2.50		
R2 – R3		3.46	1.25		
R5 – R4		–	3 my		
S8		27.13	10.0		
R7 – R8		10.9	4.0		
R8 – R9		9.5	3.5		

of menhirs and the alignments of row of stones without any connection to burials in some cases indicates an astronomical basis. Particularly the north Karnataka menhirs are found to have been invariably arranged in regular alignments. They are huge granite boulders and are non-sepulchral (Narasimhaiah 1980; Sundara 1975). The Vibhutihalli (Narasimhaiah 1980;

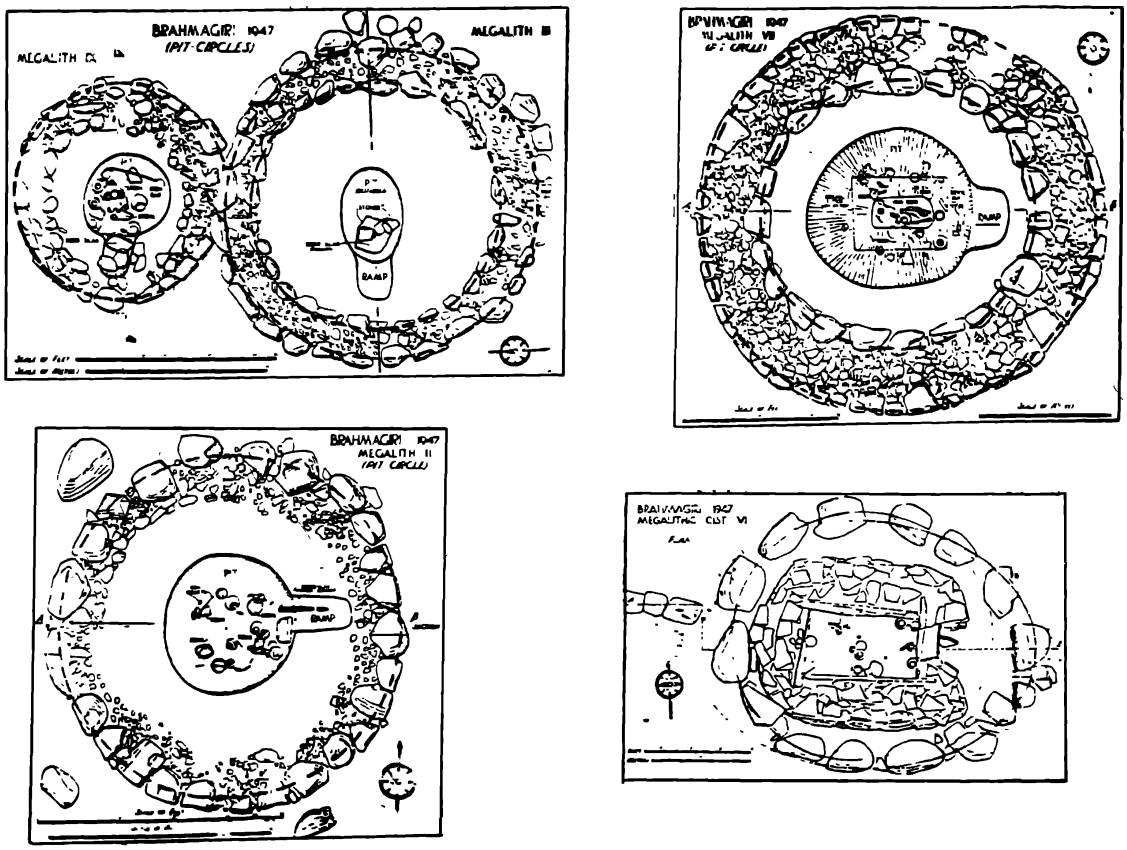

Figure 5. Shows the plan of four megalithic circles. The dashed line drawn are the circles drawn with diameters indicated in table 3 (in megalithic yards).

Allchin 1956) stone alignments, covering an area of 225 m and consisting of 34 rows by 37 rows of boulders appear to be very similar to the arrangement of fan shaped stone arrays in Scotland at Caithness investigated by Thom (1974). South India is very rich in megaliths and careful survey of atleast some of these sites is very important to understand not only the development of astronomy but also the social lives of the people. The stone circles of Brahmagiri demonstrate that the tradition of observational astronomy, where systematic observations were made, dates back to 900 BC and contradicts statements (Kochhar 1991) like, 'In the Indian scheme of things there was hardly any place for observations' or that 'earliest interest in astronomy was in making inexact calendars and observing stars near the zodiac'.

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