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THE ASTRONOMICAL SIGNIFICANCE OF MEGALITHIC STONE ALIGNMENTS AT VIBHUTHIHALLI IN NORTHERN KARNATAKA

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Abstract: A megalithic site at Vibhuthihalli in Karnataka, India, contains alignments of stones that are arranged in a square pattern with rows and columns showing a diagonal arrangement. Such structures are non-sepulchral, and although their purpose is not clear it has been suggested that they have astronomical significance. We investigated this possibility and our observations showed that the rows of stones point to the direction of equinoctial sunrise and sunset. It is likely that calendrical events were monitored at this site.

Keywords: Megalithic astronomy, stone alignments, equinoxes, solstices

1 INTRODUCTION

Observing and recording the positions of the Sun, the Moon and the stars as objects of wonder and realizing that their movements are repetitive was a major step in the intellectual growth of ancient man. In tracing the history of observational astronomy in India, it is of interest to see how prehistoric people became aware of the passage of time, such as the seasons, the year, the month, etc. Knowledge of the changing seasons was crucial for pastoral societies.

What kind of 'tools' did ancient people use in tracing the movements of celestial objects? In this context it is appropriate to study megaliths, which are the earliest existing structures erected by the prehistoric Indians, with a view to establishing whether they may have been used for astronomical (or calendrical) purposes. However, many megaliths were associated with rituals relating to human burials, where the astronomical requirements may have been compromised or combined with religious rites. It therefore would be preferable to seek out non-sepulchral megalithic structures that seem to exhibit astronomical characteristics.[1]

In 1956 F. Raymond Allchin published an important paper in which he identified forty non-sepulchral megalithic alignments that according to him were oriented to cardinal directions. These sites, and a few additional sites added later by K. Paddayya and others, are all restricted to a limited geographical region within the districts of Raichur, Gulburga in Karnataka and Mahabubnagar and Nalgonda in Andhra Pradesh, in what used to be known as southern Hyderabad (see Figure 1).

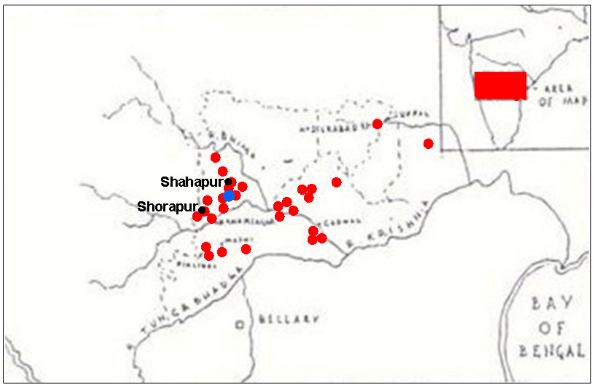

Figure 1: The geographical distribution of non-sepulchral stone alignments in Southern India (adapted from Allchin, 1956). The Vibhuthihalli site is marked by the blue dot.

These alignments consist of parallel lines of standing stones which are spaced at regular intervals. Most of the stones are between 0.91m (3ft) and 1.83m (6ft) in height, although in one case (at Mudumala, in the Mahbubnagar district of Andhra Pradesh), the stones are 4.3-4.9m (14-16ft) high. The diameters of the individual stones were found to vary between 0.61m (2ft) and 1.23m (4ft). The stones are generally of granite, gneiss or dolerite. In Kannada these structures were known as *Salgal* (rows of stones), and *Niluvurallu* (standing stones) or *Enugurallu* (elephant stones) in Telugu. None of the stones shows evidence of having been quarried or dressed.

Allchin (1956) identified two different types of stone arrangements, which he termed 'square' and 'diagonal'. In the square alignments the stones are laid out like a checker board (Figure 2). Mostly the smaller alignments are of this type, with 3 × 3 rows of stones, 4 × 4, 5 × 5, and so on. Meanwhile, the diagonal alignments consist of one more stone in the centre of the squares formed from a sets of four rows of stones (from odd numbered rows), as shown by the example in Figure 2. The effect is to stress the diagonal lines. Diagonal alignments always contain larger numbers of stones than square alignments.

Our limited survey of the sites mentioned by Allchin revealed that many of the smaller alignments have disappeared, and some of the larger alignments have also been affected or are in the process of disruption (such as those at Hanamsagar and Karnataka).

The purpose of these non-sepulchral megalithic alignments is unknown,[2] but Allchin (ibid.) suggests that "It may well be that sunrise was employed as it is in some Buddhist countries to orient religious structures … [and] the problem merits further study." This prompted us to take up the challenge, and in this paper we report on our investigation of the stone alignments in Vibhuthihalli, which are in a better state of preservation than many of the other extant sites of this kind.

2 THE VIBHUTHIHALLI STONE ALIGNMENTS

2.1 Location and Archaeological Setting

The Vibhuthihalli stone alignments are located at latitude 16° 39′ 53″ N and longitude 76° 51′ 29″ E, and lie 4km south of Shahapur at the foot of the Shahapur hill range in Yadgir district of Karnataka (see Figure 1). They begin ~20m north of Vibhuthihalli village, and lie on the east side of the Shorapur-Shahapur main road. This locality is part of Shorapur Doab, in the semi-arid Deccan zone. About 20km east of Shahapur is the Bhima River.

Several Neolithic and megalithic sites and monuments exist within a 10km radius of the Vibhuthihalli alignments (Sundara, 1975). The Benkanahalli ashmound discovered by Mukherjee (1941) is about half a kilometer away to the north, and Paddayya (1973) found a small number of potsherds and artifacts of the blade industry in the surrounding fields. Neolithic habitation sites at Kannekolur are about 4.5km away. An ashmound with a disrupted stone alignment on top of it was discovered by Paddayya at Shakapur, and is about 10km to the north.

The stone alignments are not the only signs of prehistoric occupation at Vibhuthihalli, for Sundara (1975) has reported the existence of a megalithic habitation site on the other side of the Shorapur-Shahapur main road opposite the alignments "… and within a distance of about 500m." Thus, the Vibhuthihalli alignment site is situated in an environment where Neolithic communities practised pastoralism and possibly some agriculture as well, and we suggest that it was constructed some time between 1800 and 1400 BC (see Section 5.3 below). The name 'Vibhuthi' refers to ash from cow dung—so 'Vibhuthihalli' literally means 'village of ash'. The association of stonecists or stone circles in the vicinity of the alignments has been pointed out by Allchin (1956).

2.2 The Discovery and Later Descriptions of the Stone Alignments

The first published account of the Vibhuthihalli stone alignments was by Colonel Meadows Taylor (1852), and was followed by descriptions by Walhouse (1878) and Mukherjee (1941). In a colorful paper titled "Notices of cromlechs, cairns and other ancient Scytho-Druidical remains in the principality of Shorapur", Taylor gives the following detailed description of the site.

> I presume it to have been ground regularly marked out for a cemetery of cairns, and the labour bestowed upon it has been enormous. The ground has been marked out in parallel or diagonal lines, leaving a square of from eighteen [5.5m] to twenty-four feet [7.3m] between each four points, which would be enough for an ordinary cairn; the points of squares and the lines being formed of large granite rocks, which have evidently been rolled down the neighboring hills, and placed in the situation they now occupy - but at what expense of labour, and with what patience!

Taylor found that the

> … sides of the square, as it very nearly is, gave twenty rocks west, by twenty south, if the whole were complete ... but a portion of the north east corner and north side has not been completed … [On average, the rocks are] … not less than six [1.85m] to seven feet [2.1m] long by three [0.91m] to four [1.22m] thick or high, and very many are at least half as large again.

Taylor's paper (ibid.) also included a 'scaled' plan, which we reproduce here as Figure 3. He gives the dimensions of the site as 360ft (109.7m) from east to west and 340ft (103.6mm) from north to south.

The Annual Report of Hyderabad Archaeological Department for 1940-1941 (Ahmad, 1941) includes a 1940 photograph of the site which we reproduce on page 76 as Figure 4. The report (ibid.) also states that:

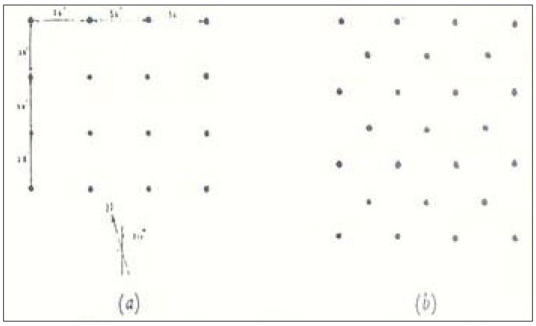

Figure 2: Idealized plans of the (a) square and (b) diagonal types of stone alignments (after Allchin, 1956).

> … steps have been taken to mark the boundaries of this site. Obelisk shaped pillars have been now set up, one at each corner of the field and a permanent notice board has been put up to mark the field [which] has been protected under the Ancient Monuments Act.

At about the same time Mukherjee (1941) published an interesting but rather inaccurate account of the site:

> … a group of stone alignments ... on a plot of land about 300 yards square ... are found to occur in parallel rows, lying at about 10 yards [9.1m] apart from each other. Some boulders lie singly and others in groups arranged in ellipses or circles ... Many stone circles are seen lying along these rows of single boulders. From the large number of boulders crowded in one place, it is suggested that the group would mark the site of a prehistoric grave yard and each of these boulders, the grave of a prehistoric man.

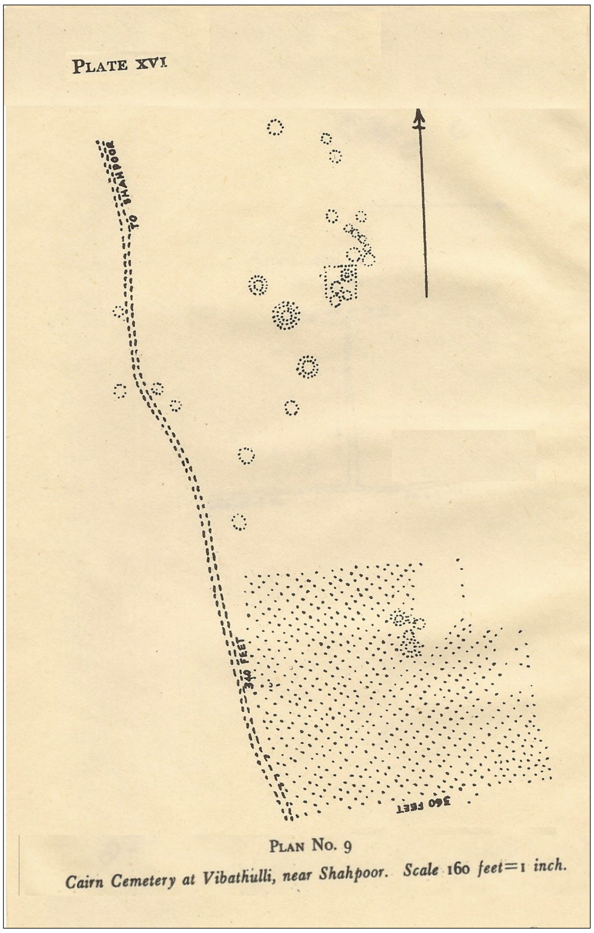

Figure 3: The layout of the Vibhuthihalli stone alignments according to Taylor (1852).

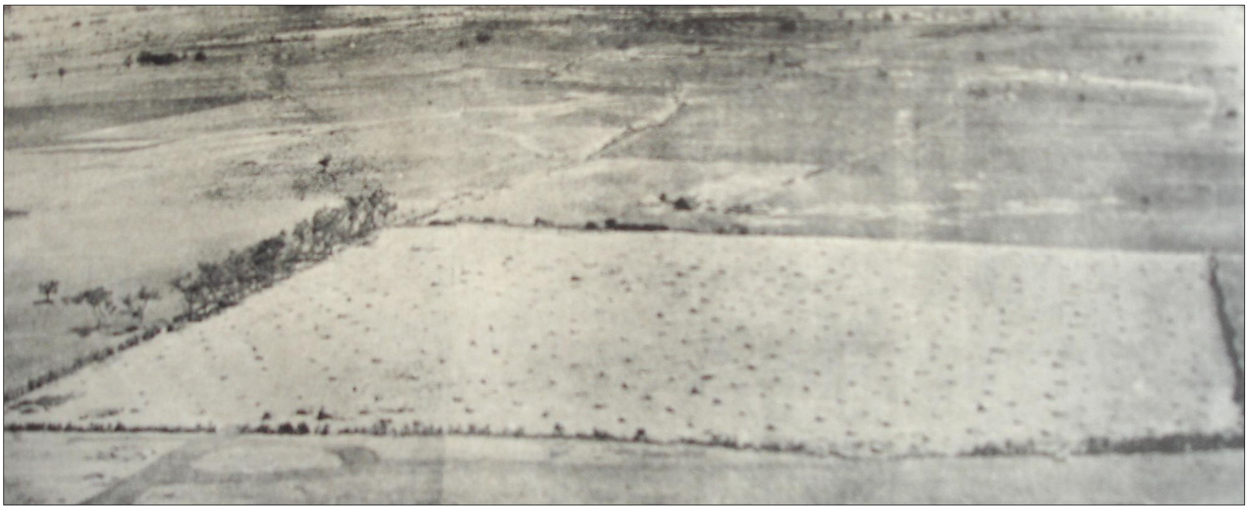

Figure 4: Panoramic photograph of the Vibhuthihalli stone alignments in 1940 showing a diagonal arrangement (Ahmad, 1941: Plate XIVb).

The 1940 photograph (Figure 4) shows otherwise. Meanwhile, Alchin (1956) used this photograph to estimate that there were about 36 alternating rows of 15 or 14 stones at the site.

Finally, Sundara published a detailed account of the site in 1975, where he gives overall dimensions of 200m × 225m, which differ markedly from Taylor's values. Sundara reported that the site contained approximately equidistant and parallel rows of stone boulders, 34 on the north-south side and 37 on the east-west side, that presented a diagonal effect. The distance between any two stones in each row on average was from 8m to 11m (again differing from Taylor's account). The boulders were undressed, medium sized, and on average measured 1.60m in girth. Most of the boulders were not driven into the ground but were simply placed on the surface. Taylor's plan (Figure 3) clearly shows five stone circles within the alignment and some more to the north of the site, but Sundara could not find any of these.

Figure 5 shows the site as photographed by Sundara in 1970. This photograph and the 1940 photograph clearly show that the stone alignments are on barren land devoid of trees with well marked rows of stones and clear horizons.

Figure 5: Photograph of the Vibhuthihalli stone alignments in 1970 showing clearly the parallel rows of stones (after Sundara (1975).

2.3 Our Investigation of the Site

Sometime between 1970 and 2008, the administration of the area was taken over by the State Forest Department, which fenced the site, planted trees (including tamarind and teak), dug bore wells and began using it as a nursery. In the process some stones were uprooted and the horizons were blocked increasingly by trees and bushes. The photograph in Figure 6 was taken in March 2009 from a similar perspective to the 1940 image, and it shows that the site is now full of trees.

Figure 7 shows some of the stone rows as seen from the west, looking east, and not a single row can now be seen fully from end to end. The inset shows a typical stone (granite?) in one of these rows. These boulders are very similar in size and shape to ones seen on the nearest hill to the west of the stone alignment, and it is very likely that they were simply rolled down the hill and arranged in rows.

When we came to measure the dimensions of the site we found that the pillars installed in 1940 still existed,[3] which allowed us to clearly identify the boundaries. Our re-measurement of the site agreed with the dimensions given by Sundara (200m E-W with 19 rows, and 220m N-S with 19 rows). We sampled the separations of the stones at various randomly-selected places in the alignment and found that the average distance (both east-west and north-south) was 11.4 ± 0.91m (37.5 ± 3ft). The separation from one of the corner stones of a mini-square formed from four stones, two each; from two adjacent parallel rows to a diagonal stone in between the mini-square was on average 7.9 ± 0.76m (26.0 ± 2.5ft). If 11.4m is one side of the mini-square, then the expected diagonal is 16.16m (53ft) and the half of it is 8.08m (i.e. the expected separation between a corner stone of the mini-square and a stone at the middle of the diagonal), whereas the measured value was 7.9m—very close to our estimate. Thus, the site is made up of a succession of mini-squares.

In arriving at the number of rows, Sundara (1975) seems to have counted the main row and the diagonal stone row together i.e. 19 main rows and 18 diagonal stone rows, which combine to provide 37 rows in the east-west direction amounting to 225m. Similarly, 18 main rows and 17 diagonal stone rows add up to 35 stones (but one stone row would be common for both N-S and E-W).

There seems to be a very gentle slope downwards from west to east. In some places close to the centre of the western boarder the stones appear to be much larger (adjacent to the present entrance to the site). We also looked for the stone circles mentioned by Taylor (1853) inside the alignment, but were unable to clearly identify any stone arrangement that looked like a circle; only one small group of six stones slightly north east to the middle of the site gave an impression of circular arrangement.

3 THE HORIZONS

The view of the horizons is very important in any assessment of the suitability of a site for observing sunrises and sunsets. Currently, the Vibhuthihalli site is bordered by a fence and several trees planted in recent years, but the horizon is still clearly visible through gaps between the trees and bushes.

A hill to the west dominates the view from the eastern edge of the site. There is a significant dip in the hill contour and the skyline drops low and rises again along the more distant hill contour. This dip is important, as will be shown later.

The southern horizon has a hillock with two prominent naturally-occurring stone pillars, as shown in Figure 8. These pillars seem to act as markers, the taller one being in line with the north-south rows of stones

4 THE CALENDRICAL EVENTS

From September 2008 we tried to observe sunrises and sunsets from the site during the equinoxes and solstices. Since the megalithic astronomers only made visual observations, we likewise made visual observations (i.e. no instruments were used, other than a camera). We defined sunrise as when the lower limb of the Sun grazed the horizon (i.e. allowing for refraction, the zenith distance was 90° 20′).

4.1 Equinox Sunrise

The September 2008 equinox was to occur on 22 September at 21:14 (IST), however both 22 and 23 September were cloudy and we could only observe the sunrise on 24 September at 6:18 a.m. (IST). The computed azimuth (A) and zenith distance (Z) were A = 90° 45′ and Z = 89° 20′, being about one and half solar diameters south of the expected equinox sunrise. The observation was made from a spot ~45.7m (150ft) from the eastern end of the site. A 1.22m (4ft) diameter stone would subtend an angle of 18′ from a distance of 220m (720 feet; i.e. at the western end of the alignment). Thus the accuracy of the estimation of direction would be within half a solar diameter.

On 24 September we noted that the row of stones which we took the observations from was in line with the sunrise (within the uncertainty of a semi-diameter of Sun's disk). We chose this particular row for one main reason: it was in the middle of the site (i.e. 110m from the southern edge). Coincidently, it was also one of the few areas of the site that currently offers a clear unobstructed view of the eastern horizon.

Figure 6: A similar view to the 1940 photograph but taken by the authors on 20 March 2009. The site is now fully covered by trees.

Figure 7: The rows of stones as they exist now in between rows of trees. The inset (bottom left) shows a typical stone.

Since the rows of stones are parallel, the same alignment was also seen from the neighboring rows during the equinox sunrise. The equinox was to occur on 20 March 2009 at 17:30 (IST), and Figure 9 shows a series of images of the Sun's disk that morning. The sequence was extrapolated to see the location of the Sun's disk on the horizon, which showed that this row of stones was in line with the sunrise. Similar observations were made on 21 September 2009, close to the 23 September equinox.

Figure 8: The southern horizon from the Vibhuthihalli stone alignments. Note the two stone pillars on the hillock marked by the two black arrows. The taller one, in particular, might have had a role in defining the rows (see the text).

Figure 9: A composite photograph of the sunrise on 20 March 2009. The stone rows point to the equinoctial sunrise. By extrapolating the track to the horizon one can pinpoint the location of the sunrise on the horizon.

4.2 Equinox Sunset

The equinox sunset seems to be more dramatic and significant and occurs in the dip shown in the western horizon (although trees presently block this view). Moving a little further to the east one can see the western skyline and the sunset. The equinox occurred on 23 September 2009 at 02:49 (IST) and the closest sunset to the equinox was on 22 September, but clouds prevented us from making any observations. However, what could be expected on that day can be extrapolated from observations made on 19 and 21 September, when we used a series of photographs to chart the progress of the sunset. On the 19th, the setting Sun was still slightly north of the dip in the western horizon when viewed with the last stone of an east-west row in the foreground (as seen in Figure 10). We calculated that the Sun was 54′ north of the expected equinoctial sunset position, which would occur right in the middle of the U-shaped depression in the skyline. Using these sorts of observations and horizon markers, the ancient megalithic astronomers at Vibhuthihalli would have been able to pinpoint the date of the equinox with an accuracy of a day.

4.3 Summer Solstice

Monitoring the other calendrically-important events—solstices—is presently hampered by trees, so we could not observe sunrises from the western edge of the site overlooking the stone rows. We wanted to see whether solstice sunrises were aligned with any sets of stones (including diagonally-aligned ones), that is, if one chooses a position in between the stone alignments, is it possible then to observe both the solstice and the equinox sunrises from the existing stones?

Figure 10: A photograph of the sunset on 19 September 2009 from the Vibhuthihalli stone alignment. This was three days before the equinox.

Figure 11: Three diagonal stones point to the sunrise on 22 June 2009. The lower stone and the one on the right point to the equinox sunrise.

4.3.1 Sunrise

In order to observe the solstice sunrise we chose the same row of stones mentioned earlier in the middle of the alignment on the eastern side of the site. Figure 9 also shows the position adopted from which both the equinoctial sunrise as well as summer solstice sunrise can be viewed. The solstice was expected to occur on 21 June at 11:16 (IST), and on the 22nd three (or possibly more) diagonal stones pointed to the solstice sunrise.

Another set of stone rows which is oriented towards the summer solstice sunrise as well as equinox sunrise is shown in Figure 11. A set of three stones points to the sunrise on 22 June a few hours after the expected solstice.

4.3.2 Sunset

The position of the summer solstice sunset seems to be marked by one of the hills on the western horizon, as viewed by us from the eastern side of the site less than one day prior to the solstice (which occurred on 21 June at 11:16 IST).

4.4 Winter Solstice

4.4.1 Sunrise:

Figure 12 illustrates the direction of the winter solstice sunrise from the chosen position. Three stones mark this position. The expected winter solstice was to occur on 21 December 2008 at 17:34 (IST), and the image was obtained just 13 hours later.

It is clear that solstice directions can be marked from the existing stones at the site once a fixed position is chosen.

4.4.2 Sunset

Winter solstice sunset was observed to occur on the peaks to the south west of the site, as viewed from the same location as the summer solstice and equinox sunset. The most southerly sunset occurs at a distinctive position on the horizon that is easily recognizable.

5 THE ANATOMY OF THE STONE ALIGNMENT

It is clear that calendrically-important events, particularly during the equinoxes, are well marked by the rows of stones (sunrises on the eastern side) or distinctive features on the horizon (sunsets on the western side). Heggie (1981) has pointed out the many issues that need to be addressed if such alignments are to be seriously considered as having astronomical significance. One of these is: how can one distinguish between intentional astronomically-motivated alignments and those that are coincidental? And why did the constructors of a particular monument decide to use a certain geometrical design?

There are two things that are distinctive about these Indian alignment sites: their restricted geographical distribution and their distinctive design. This suggests there is nothing coincidental or accidental about them: they were built for a common purpose.

5.1 The Plan

All the sites discussed by Allchin (1956) are located between latitude 16° and 17° N, and the total azimuthal range of the Sun's position on the horizon from summer to winter solstice was 49° 03′ 14″ in about 1500 BC. The Sun's diameter is ~30′, with horizontal refraction adding a further 15-20′ to the size, so the total extent of the Sun's traverse along the horizon would have been ~26° on either side of the equinoctual point.

From any location, if the Sun's position on the horizon was of interest, then it was likely that both sunrises and sunsets were monitored. A direction could be accurately specified if viewed from a corner (a point defined by the intersection of two lines). Thus for a square plan, a diagonal line drawn from the centre of a side to the opposite corners would subtend an angle of 26° 30′, very similar to the angle expected for the Sun's position on the horizon at the solstices. A square plan would therefore seem very appropriate for a stone alignment site at this latitude.[4]

In the particular case of Vibhuthihalli, the dimensions of the site and the total number of stones are uncertain. The present dimensions and those measured by Sundara (1975) are double those given by Taylor in 1853. Clearly Taylor's figures are wrong, but it is hard to know why he was out by a factor of two. Moreover, it is likely that part of the E-W arrays were reduced at the time the present boundaries were established in 1941 (as we could only account for about 17 stones in a row in the E-W direction and 19 in the N-S direction). If we double the dimensions given by Taylor, the E-W side would be 220m (720ft) long and N-S side 207m (680ft) long, and the angle between the E-W line at the centre of the most westerly line to the two corners of the most easterly row is 25° 18′ (which is very close to the angle expected for the solstice direction to the equinox east at the mid-point of the most westerly row). This is shown graphically in Figure 13.

Figure 12: A photograph of the sunrise on 22 December 2008. Three diagonal stones from the stone at the lower right point to the winter solstice sunrise, while the former stone and the one to its left point to the equinox sunrise.

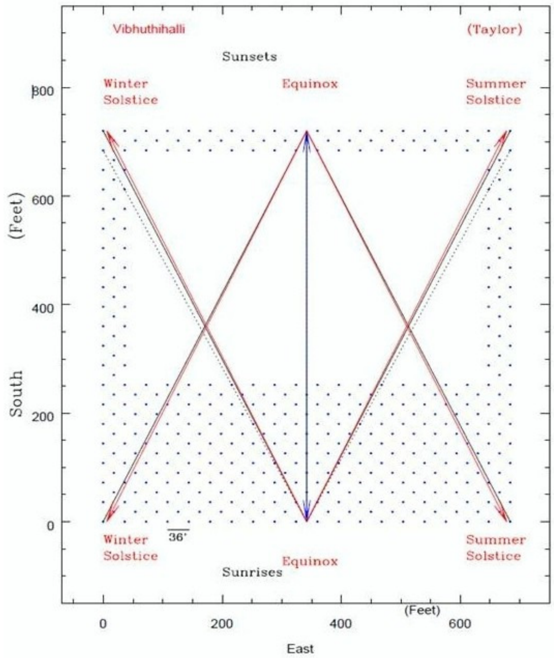

Figure 13: A schematic view of the Vibhuthihalli site as described by Taylor but doubling the size to 20 rows, (20+19) N-S and (21+20) E-W. The solstice sunrises and sunsets are shown in red as viewed from the middle of the extreme western and eastern rows. The black lines join the corners of the site to the middle of the extreme eastern and western rows. Note that the red and black lines coincide. The dashed lines show a similar view if the alignment is a square.

5.1.1 The Degree of Precision

Sundara (1975) states that "In the arrangement of stones there is a mathematical precision." Allchin (1956) also remarks that "… the alignments consist of parallel lines of standing stones set out with mathematical precision." We randomly measured how much the stones in an alignment deviated from a straight line and found that three or four stones tended to follow a straight line, then the fourth or fifth stone would deviate by as much as a stone length ~0.91m (3ft), then the next stone would be back in line ±0.3m (1ft), as though the lines are constructed by sighting a distant land mark (on the horizon) and positioning the stones in line with it.

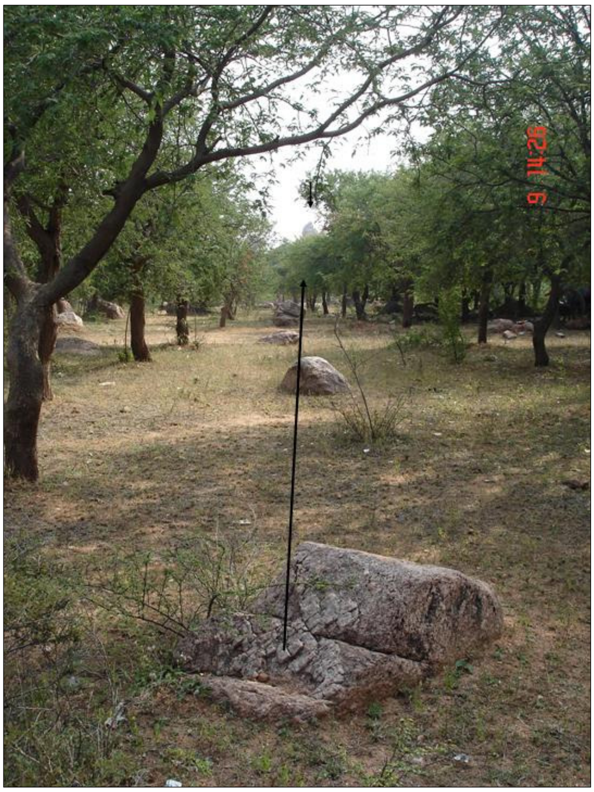

Figure 14: A photograph of a N-S stone row at Vibhuthihalli that points to one of the two stone pillars on the horizon shown in Figure 8.

For example, Figure 14 shows a N-S row of stones in line with the taller stone pillar on the southern horizon and this pillar probably was used as a land mark when setting up the row of stones. We arrived at the N-S direction very simply by using a stick as a gnomon to measure the shadow. The meridian direction was established by marking the direction of the shortest shadow (when the Sun was on the meridian), and the N-S direction was thus marked on the ground. This was repeated over several days.

The E-W lines might have been established from equinox sunrises and sunsets. The equinox sunset could be marked to better than a half a solar diameter, and in constructing the alignment this line of sight must have been used as a primary marker, since all the E-W rows are parallel to the primary row.

Since there is a mild downward slope of the ground from west to east, a view from the middle of the western end row would presumably provide a clear view of the eastern corners (the solstice directions). Viewing to the west was done from the eastern end, to record the Sun's horizon movement among the various notches and dips on the hills there.

It might be asked why so many stone rows were needed to monitor the major calendrical events. This is not an easy question to answer, but the Sun's movement on the horizon was not uniform, as it was more rapid near the equinoxes and slower near the solstices. The same uniform spacing of ~11.6m (38ft) at the eastern end of the site, as viewed from the mid-point of the western end row, would correspond to 3° 00′ near the equinoxes and 2° 42′ near the solstices. Maybe there was a need to measure smaller increments near the solstices, and this could be achieved with the approximately uniform spacing of the rows.

5.2 Is the Vibhuthihalli Site Unique?

Allchin (1956) lists a few sites that have stone alignments that are similar to the configuration seen at Vibhuthihalli. Moreover, its diagonal arrangement is not unique as a similar kind of alignment, but on a much larger scale can be found at Hanamsagar, on the banks of the Krishna River ~75km from Vibhuthihalli.

5.2.1 The Hanamsagar Site

Detailed accounts of this site, including photographs, have been presented by Allchin (1956), Paddayya (1995) and Rao (2005). Many parts of this large site have already been disturbed, and other sections could soon disappear as the land is under cultivation and is owned privately.

We measured the separations of stones in a few randomly-selected rows that seemed undisturbed. The average spacing between successive stones was 11.3 ± 1.9m (37.2 ± 6.3ft) and the diagonal stone was at 7.9m (26ft). Note that these figures are about the same as those obtained at Vibhuthihalli. Meanwhile, Allchin (1956) measuring a spacing of 11m (36ft) at a much smaller square alignment of 4 × 4 stones at Jamshed I. Maybe this measurement is a kind of basic standard. In any case, these results suggest that the sites are connected, were established with the same basic plan, for the same purpose, and at around the same time.

5.3 The Age of these Stone Alignment Sites

When were these sites established? No absolute dates have been obtained from any of the sites, but as mentioned earlier, the Vibhuthihalli site is located close to Neolithic habitation sites and ashmounds, and Sundara (1975) also discovered a nearby megalithic habitation site. In addition, Ahmad (1941) seems to have discovered 'flakes' (of probable Neolithic antiquity) at the Vibhuthihalli alignment site.

Paddayya (1995) also noted similar associations with neighbouring Neolithic sites and ashmounds at Hanamsagar. The Kodekal ashmound is only 2.4km to the west. Although the ashmound at Benkanhalli has not been dated, the Kodekal ashmound has a date of ~2893 BC (Johansen, 2004). Boivin et al. (2007) and assert that

> … by the mid-third millennium BC, Southern Neolithic sites had a mixed economy of pastoralism and indigenous crop cultivation, although which came first (the domesticated plants or animals) and where precisely

this happened (e.g. Western Andhra or Shorapur Doab, etc.) remains to be resolved. (cf. Boivin et al, 2005).

The ashmound tradition in early Southern (Indian) Neolithic society seems to have changed from a food foraging economy to one dependent upon agricultural production by late Neolithic times and during the transition to the Megalithic period. Around 1900-1800 BC, introduction of wheat and barley occurred at some southern Neolithic sites (Boivin et al., 2007). Seasonality and scheduling of such crops have been discussed by Fuller et al. (2001). Such scheduling required awareness of the seasons and their repeatability. Thus there was a demand for individuals with astronomical knowledge, and there was a need to predict calendrical events. According to Boivin et al. (2005: 83), "The replacement of ashmounds with megaliths as the primary monuments in the landscape at the tail end of the Neolithic signals wider ritual and cosmological changes."

Fuller, Boivin and Korisettar (2007: Table 9) provide a revised chronological framework for the Southern Neolithic based on radiocarbon dating and major trends in archaeological evidence. The Neolithic III and Megalithic (pre-Iron Megalithic) periods ranged between 1800 and 1400 BC. The fact that the Vibhuthihalli stone alignment site is immersed in a Neolithic environment and lacks any suggestion that iron was in use, would seem to indicate that it was constructed between 1800 and 1400 BC.

5.3.1 Society

The construction of a site like Vibhuthihalli involved a lot of planning, and employment of large numbers of people, which indicates the seriousness of its purpose. If it was astronomical, as we suggest, foreseeing the coming seasons and monitoring the movements of the Sun god would provide a deep sense of purpose. We also suggest that the construction of the Vibhuthihalli site was not a one-off venture, but evolved after a few smaller alignments were constructed and successful observations were carried out.

Was Neolithic Indian society then mature enough to undertake such a venture? According to Boivin et al. (2007)

> …it seems likely that the emergence of Megalithic societies had much to do with the external contacts and complexity engendered by the ongoing expansion of Neolithic exchange networks. There are clear signs of such expansion, particularly, as our recent researches indicate, in the archaeo-botanical record.

Thus, it was not only indigenous local knowledge but also information obtained through exchanges with other communities to the north that may have provided the impetus for this ambitious project.

5.3.2 Earlier Evidence of Astronomical Activity and Interest

Is there any evidence in southern India to suggest an earlier awareness of astronomical phenomenon which possibly led at a later time to astronomical constructions like the stone alignment sites? Studies of the South Indian ashmounds, their surroundings and the environment seem to suggest deliberate attempts were made to orient (or to locate) the ashmounds with respect to each other in certain directions which highlighted special solar events. The ashmounds are now viewed as the result of repeated ritualistic cycles of cow dung accumulation followed by fires that sometimes involved enormous conflagrations (Allchin and Allchin, 1968; Foote, 1887; 1916; Korisettar et al., 2002) performed by Neolithic pastoralists. Boivin (2004) has studied two extremely large ashmounds at Kudatini and Toranagallu, in Bellary district (about 180km south of Vibhuthihalli), and he suggests that (1) their locations were deliberately selected so that they not only lay on an E-W axis but (2) the view from Kudatini was chosen such that the Sun on two special occasions (23 April and 24 August) would set on top of Toranagallu Hill, thereby providing for spectacular ritualistic events. Thus, an awareness of the movement of the Sun was already present in southern India almost a millennium before the stone alignments were constructed. This would seem to indicate the emergence of a local astronomical tradition that was restricted to this particular area of India.

6 CONCLUDING REMARKS

The stone rows at the Vibhuthihalli site point towards equinoctial east-west. The directions of the corners of the site when viewed from the middle of the rows on the extreme east and west might also point to sunrises and sunsets during the solstices. Thus, this site could have been used for calendrical astronomy. The period during which the site was erected is not certain but the accumulated evidence suggests the late Southern Neolithic to the early Megalithic (i.e. between 1800 and 1400 BC). At that time, the socio-cultural needs of a pastoral and agricultural society relied upon the predictability of the seasons and a knowledge of the passage of the year. Archaeobotanical evidence and the presence of some domesticated animals suggest possible contacts with societies in the northern part of the country. Thus, astronomical knowledge that accumulated locally and through interaction with outside communities allowed the construction of elaborate sites like Vibhuthihalli.

The existence of other large and small stone alignment sites of similar basic design in this area of India suggests the need for calendrical monitoring at this time. The larger alignment sites might have evolved from smaller ones as the need emerged to monitor closely the rate of motion of the Sun (and maybe other celestial objects, such as the Moon) on the horizon.

These stone alignments are either on private land or on Government land that has been distributed to people for cultivation, and in most instances the land-users are totally unaware of their historical and scientific importance. Consequently, many of the stones have been relocated and used for other purposes; some sites have disappeared altogether; and other sites are in the process of disappearing. Clearly, there is an urgent need for their preservation, but unfortunately, even those Government agencies which are supposed to protect these sites sometimes make inappropriate decisions (such as the planting of trees, the digging of wells and the use of the area for a nursery in the case of the Vibhuthihalli site).

It is to be hoped that a less disturbed stone alignment site can be found which can be subjected to more systematic and thorough investigation. More precise dating of these sites is also urgently required.

7 NOTES

1. Thom and Thom (1971) have suggested that similar stone alignments in Europe at sites such as Le Ménec have astronomical significance.
2. Allchin (1956) quoted local fables that they are either cattle petrified by curses or king's camping places where the horses and elephants were tethered to the stones (Taylor 1852). The locals at Hanamsagar (a similar site to the Vibhuthihalli alignments) told us that the stones were cursed thieves who stole jewels from heaven.
3. The notice board had disappeared long ago, but at some date after April 2009 the Archeological Survey of India installed a new board.
4. It is of interest to note that a similar arrangement is seen in some medieval Sun temples (e.g. Modhera and Marthanda), where the corners of the rectangular tank (*Kund*) define the directions of the solstice sunrises as seen from the centre of the *Gudha Mandapa* (see Kameswara Rao 1995; 1998).

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