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RESEARCH PAPER

The Archaeoastronomy of Tomnaverie Recumbent Stone Circle: A Comparison of Methodologies

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Introduction

The way we view the past is constantly modified by new evidence and methodological advances. Archaeological data is gleaned from the ground and archaeoastronomical evidence considers the use of the sky in relation to the archaeological record. Since the beginning of the 20th century the two disciplines of archaeology and archaeoastronomy have flirted with one another but there has never been a satisfactory marriage. This paper looks at the Recumbent Stone Circles (RSCs) of north-east Scotland to examine the methodologies, and compare the results, of both disciplines. The RSCs are a distinctive type of stone circle characterised by a large recumbent stone which is flanked on either side by a tall pillar. This recumbent arrangement is almost invariably located in the south-west of the circle. RSCs are generally located near the summits of low hills and enjoy clear horizon views. Over the years they have been the subject of extensive research. This research will be reviewed and Tomnaverie RSC will be singled out as a special case study to examine whether there still needs to be a divide between the disciplines.

Figure 1: Tomnaverie Recumbent Arrangement.

Historical Overview

In the early 1900s, as antiquarianism gave way to archaeology, Frederick Coles (1900) published the results of a survey which included his carefully measured plans of 23 recumbent circles. Similarly, A. L. Lewis (1900: 60) published his own survey of Scottish stone circles which he described as 'sun and star circles'. Lockyer (1908: 285) took Lewis's work a stage further by saying that alignments were made to the 'direction of the rising sun or star by sighting across the circle at right angles to the length of the recumbent stone'. According to Adam Welfare (2008: 13), Coles went on to conduct further surveys; directing his conclusions, that there was nothing to justify astronomical speculations at Lewis and Lockyer. Many of the circles have been robbed of their buried artefacts by antiquarians, some have been disturbed by natural elements and human intervention, and the

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majority of the 300 plus sites have disappeared from the landscape leaving a core legacy of some 70 circles. All these factors impinge on the archaeological integrity of the sites. Aubrey Burl provided Thom (1980) with useful archaeological data to complement Thom's plans and has written extensively (Burl, 2000) on the archaeology of the sites. Since that time there have been few archaeological investigations of these circles, other than revised plans and work necessary for reconstruction, mainly because the cost of a full excavation is generally out of the question. All the known archaeology of the RSCs, including details of excavations and finds can be found in Welfare's (2011) *Great Crowns of Stone*.

On the other hand the archaeoastronomical orientations of the recumbent arrangement have been the subject of many surveys. From the late 1950s, A Thom drew accurate plans of many of the circles and in 1969 Aubrey Burl (1970: 73) calculated the azimuths for the recumbents which were thought at that time to be oriented on the midwinter sunset. Despite his conclusion that the lines were astronomically meaningless, he felt that their limited distribution hinted at an astronomical basis and went on to propose that the main orientation might have been towards sunrise. Shortly after Burl wrote his article, Thom (1971) published *Megalithic Lunar Observatories* in which he suggested that many megalithic circles had been constructed to observe the 18.6 year lunar cycle which culminated in the major lunar standstill. Archaeological evidence of quartz scatters and cupmarks thought to symbolise interest in the moon gave additional weight to a lunar explanation. Indeed, such was the weight of the lunar hypothesis that all further archaeoastronomical surveys of RSCs looked only for a lunar solution.

Thom's work was severely criticised by archaeologists, but he left an unmatched legacy of accurate site plans. To restore archaeoastronomy's credibility Clive Ruggles wrote a series of papers that provided clear guidelines for archaeoastronomy practitioners and assurance for archaeologists that the subject was methodologically sound. In order to test the intentionality of astronomical alignments he believed that a large data set was necessary to statistically test for probability. The RSCs provided him with a suitable data set, so Ruggles and Burl (1985: S25ff.) resurveyed them. From this new data Ruggles and Burl (1985) concluded that it seemed possible that the recumbents were set up so that the major standstill moon (or at some sites the minor standstill moon) would be seen to rise or set over the recumbent, preferably near to its centre, though they pointed out that this was an overall trend which did not account for every site. The paper was possibly a landmark event for archaeoastronomy as it moved the debate away from precision alignments to less precise orientations and thoroughly incorporated what archaeological evidence there was into the interpretation.

In 1999 Ruggles (94ff.) reviewed the results once again and could not come up with a clear-cut answer. On the one hand he said that there was 'the hint of a correlation between the axial orientations of the monuments and the motions of the moon' and suggested that ceremonials were timed to the passage of the midsummer full moon low over the recumbent. However, he also said (95) that 'the most promising overall explanation of these data as they stand might be in terms of orientation upon the winter sun low in the sky'. The archaeoastronomical research has left a confusing picture which depends on whether celestial events were viewed from an observing position behind the recumbent or from an observing position opposite the recumbent. This basically gives two timings for associated rituals, midsummer or midwinter, both of which could be either solar or lunar. Richard Bradley (1993: 47) acknowledges that archaeoastronomical questions are legitimate but says that they are too limited. He regrets that analysts overlook the fact that the operation of the megalithic complexes was first and foremost an experience.

The establishment of an observing position is crucial because it is from this location that astronomical measurements must be taken. As both Thom and Ruggles took their measurements from the circle centre their results depend on the *a posteriori* assumption that celestial events were observed from the centre and then marked accordingly. Bradley's excavations have called this assumption into question, as will be shown below. Since then, little archaeoastronomical work has been conducted at the RSCs. This paper attempts to find a solution to this impasse and provide a new way of conducting archaeoastronomical research at these circles.

The differing approaches of archaeology and archaeoastronomy towards the RSCs have led to incomplete analyses by both disciplines. Purely data-driven archaeoastronomical surveys, which use a large number of sites to test for intentionality and probability, fail to address the individual differences between sites while archaeological investigations, which concentrate on stratification, radiocarbon dating and artefacts, take only a broad brush approach to the skyscape; thereby missing evidence of alignments which could enhance the cultural interpretation. The hypothesis of this paper is that if the complementary evidence provided by both disciplines is combined, then either a new picture will emerge for a particular site or alternatively the results will reinforce one another. To test this hypothesis Tomnaverie RSC has been chosen as a case study.

Tomnaverie RSC – A Case Study

In 2005 Bradley published the results of his excavations of three RSCs and this paper looks at his findings for Tomnaverie. This impressive RSC, which can be identified on the skyline from much of the surrounding area, is situated on the summit of a low ridge at 178 meters altitude, just south of Tarland Burn and close to an area of hut circles. The site has clear horizons with good views of the Grampian Mountains with Morven Hill eleven kilometers to the west and Lochnagar thirty kilometers to the south-west behind the recumbent. The site is at the edge of a fertile area subject to clearances from 4000 BCE onwards so views would have been unobstructed by local vegetation. Bradley (2005: 48ff.) found that the central platform surrounded by ring cairns was constructed earlier than the circle itself. The earliest possible date of construction for this central ring mound and platform was 2580 BCE – with the latest date being 2220 BCE. The stone circle with its recumbent and flankers was erected after the ring cairns and the Beaker fragments found near stones eight and nine yield an Early Bronze Age date range of between 2300–1700 BCE (Bradley, 2005: 34).

The first use of the site was for cremation pyres and the residue of burnt soil, charcoal and fragments of human bone formed a low mound about three metres in diameter. There was evidence of levelling to provide a platform for the internal ring cairn which was strengthened by an outer rubble platform. The surface of this central platform included radial lines which pointed from the outer kerb towards the centre. Constructed from substantial stones, they were a primary feature of the monument (Bradley, 2005: 21). There were 13 in all, seven of which are certain or probable and these seven were found mainly in the eastern hemisphere of the ring with an emphasis towards the north-east suggesting a north-east/south-west axis. Two of them outlined the limits of the straight stretch of kerb which was in front of the recumbent which was erected later. No fewer than eight of the divisions seem to point to where later stones were set and Bradley (2005: 49) believes that the entire sequence of building from platform and cairn to the final circle was conceived from the outset.

When viewed from the north-east, (**Figure 2**) stones eight and nine frame the view of the recumbent (Bradley, 2005: 30). Both these stones are very smooth, possibly

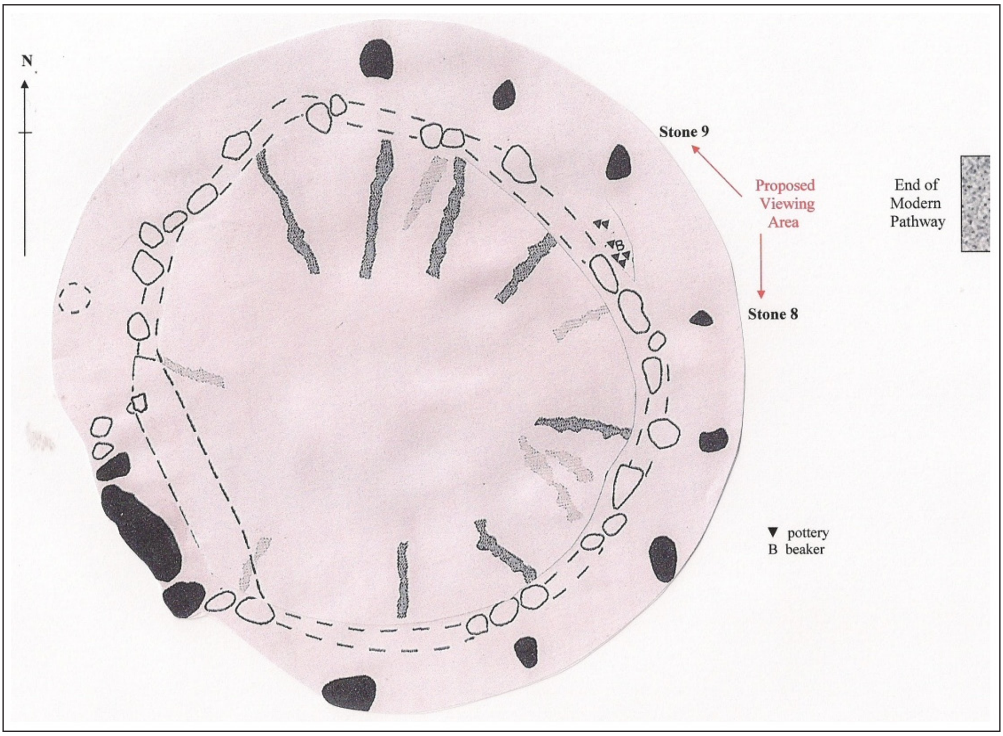

Figure 2: Plan of Tomnaverie showing circle stones, ring cairn, radial divisions, major pottery deposits, proposed viewing area between stones 8 and 9 and the end of the current approach pathway.[1]

from handling, which might indicate that they bounded a viewing area. The sides of the ridge are quite steep and the current approach path from the road, which terminates just short of the viewing area chosen for the research, is the easiest route. That is not to say that it was the route that the builders took but it seems the most likely. Additionally, it is in this area that the largest quantity of pottery and lithic artefacts were found (Bradley, 2005: 38). Bradley (2005: 99) says that the visual effect of approaching the site from the north-east is such that the immediate foreground is concealed but the middle ground and distance can be seen framed between the flankers. The hypothesis of a viewing area between stones eight and nine is based on Bradley's archaeological data combined with the above phenomenological observations. In terms of archaeoastronomical measurements it shifts the theoretical viewpoint from the circle centre to a point on the perimeter. This makes it difficult to compare the findings with Thom's and Ruggles' published datasets whose measurements were all taken from an assumed centre, without taking new measurements for all the circles. Such a project is ongoing, and the following analysis of Tomnaverie is a preliminary case study for this larger project.

Bradley (2005: 111) considered the existing archaeoastronomical theory and concluded that the RSCs may have been directed towards the moon and may, in some cases, have faced the winter sun. Having taken all the archaeological material into account and considered both the view of Lochnagar behind the recumbent and the use of white and red stones to symbolise the moon and the bonfire, Bradley proposed a night-time use of the site in which the section of the sky behind the recumbent was important.

In light of Bradley's excavation, Ruggles (2005: 361ff.) revised his ideas that rituals took place within the circle but maintained his view that the circles contained lunar symbolism and that the main event was the midsummer moon passing low over the recumbent. This does not fit with the association he (2005: 364) makes between the alignment and the dead because winter, not summer, is the season more commonly associated with dying.[2] Archaeological investigations such as Bradley's are essentially phenomenological, concentrating on the site and the surrounding topography, whereas archaeoastronomical surveys such as Ruggles' tend to be statistical and it is not easy to marry the two methods together. Current archaeoastronomers have recognised this and according to Ruggles (2005: 102), alignment studies 'have begun to dovetail within the agenda of archaeologists interested in wider issues of cognition and cosmology'.

Phenomenological Archaeoastronomy

Rationale and methodology

In the main much has been made of the features common to all the sites and little emphasis has been placed on their individuality. However Julian Thomas (1999: 46) says that though the orientation of the recumbent and its flanking pillars may have been an attempt to impose 'homogeneous and unified systems of meaning', the very fact of their being 'communal productions' has led to a wide variety of forms; governed perhaps by their individual landscapes, the difference in available building stones and the size of the community. Bearing his comments in mind, coupled with not being completely satisfied with the archaeoastronomy to date, I decided to look specifically at one site, Tomnaverie, for current purposes. As the statistical approach requires a large data set, I adopted a phenomenological method to look at the particular element of the recumbent arrangement which has been the focus of historical research. This involved several field trips to the site at different times of the year during which I approached the circle from different directions, examined the stones to consider their differing properties and fully immersed myself in the landscape. This fieldwork was carried out to eliminate bias as far as possible and helped reduce the extent to which I was influenced by prior research. The rest of the phenomenological fieldwork was desk-based and relied on Stellarium's planetarium software which enabled me to appreciate the sky events, albeit virtually, as they enfolded diurnally and annually. By uploading the horizon profile for Tomnaverie into the above software I was able to create a virtual reality of both the site and its location for periods which corresponded to the radiocarbon dates given by Bradley. This methodology, as with any phenomenological method, is painstaking and time-consuming but provided insights that would not have emerged from the traditional method of matching azimuth to declination.

By using this method another practical problem can be avoided. An important azimuth can match a variety of events signified by its declination, but if these events occurred in daylight or summer night-time, they could not have been witnessed in reality. So if the object of these studies is to tell us more about the culture of the builders, then the observations must be viewed in the light of what was practically possible. I concentrated on the section of the horizon which contains the recumbent arrangement which required so much effort to erect. I ruled out Ruggles' midsummer moon because in the summer, at Tomnaverie's latitude of 57°N, the sun sets late at night and the sky does not get completely dark so the viewing conditions throughout the night can be best described as half light. In the winter months however, the days are short since the sun sets early in afternoon and there are long hours of dark skies when there might have been little else to occupy the builders' time. The sepulchral function of the circle with its earlier funeral pyres could have been associated with the setting of the sun or the moon in the winter which metaphorically symbolises death before the spring renewal. Therefore my observations were directed to what was visible during the winter months.[3]

At the autumn equinox the sun sets due west and as it moves along the ecliptic it sets further and further south towards its extreme position at winter solstice. Then the motion is reversed until the sun sets due west again at the spring equinox, six months having elapsed from September to March. I was not so much looking for the precision alignments that have been criticised by archaeologists, but for movement along the horizon behind the recumbent. If you can imagine how the sunsets travel along the horizon from night to night, quickly around the times of the equinoxes but slowing down near the solstices, the extreme position of the solstice may well have been marked for a few days. However, this event may have taken second place to the cyclic movement along the horizon which would have been observed over a period of four and a half months, as will be demonstrated.

Bradley's research has discounted the centre of the ring for observation and certainly from that point none of the stones appear above the horizon, with the recumbent arrangement falling below the horizon created by the surrounding hills (see **Figure 1**). It is only when positioned outside the ring to the north-east, between stones eight and nine that the recumbent and flankers appear outlined against the sky and give the appearance of a window (see **Figure 4**). This presupposes a one-directional axis towards the south-west. This supposition is backed up by the location of the site and access to it, as well as by the physical property of the recumbent itself. Although it would be possible to stand behind the recumbent at Tomnaverie and look towards the north-east, at many sites this would not be possible because the recumbents are taller than the viewers, effectively blocking off the view in the opposite direction.

Historical research has concentrated on the declination at the centre of the recumbent. This research widens the arena by including the entire recumbent arrangement but does not include the complete layout of the circle. My earlier research (Henty, 2011a, 2011b) has fully explored the disadvantages of a single element of analysis and a full appraisal of Tomnaverie, to include the recumbent arrangement and the other circle stones, is in progress.

As discussed, all prior research has focussed (**Figure 3**) on alignments at a mythical fixed point, the centre of the recumbent, a point never marked in reality. From this central point the recumbent arrangement spans 32° of azimuth at Tomnaverie based on the plans of Thom, Ruggles, the Royal Commission for Ancient and Historical Monuments and my own measurements. However, as one moves away from the centre towards the perimeter the azimuth angle narrows to a window of just 14° at the midpoint of stones eight and nine. As the line from the centre of the recumbent to this midpoint does not pass through the circle centre, the resulting azimuth for the centre of the recumbent is also different from that measured from the circle centre.

The limits of the range at Tomnaverie from the circle centre are from 220° for the east flanker to 252° for the west flanker with the centre of the recumbent being 236°. From the north-east viewpoint, between stones eight and nine, the limits of the range are from 233° for the east flanker to 247° for the west flanker with the centre of the recumbent being 240°. At that viewpoint the recumbent arrangement forms a window to the sky unimpeded by the surrounding landscape. My archaeoastronomical quest was to find out what could be seen through this window.

Most scientific astronomy is a desk-based activity these days, which can produce results in isolation that are difficult to understand unless you take those results out in the field and experience for yourself what they mean. Because of the change in the obliquity of the ecliptic and the precession of the equinoxes we can no longer see what the builders saw

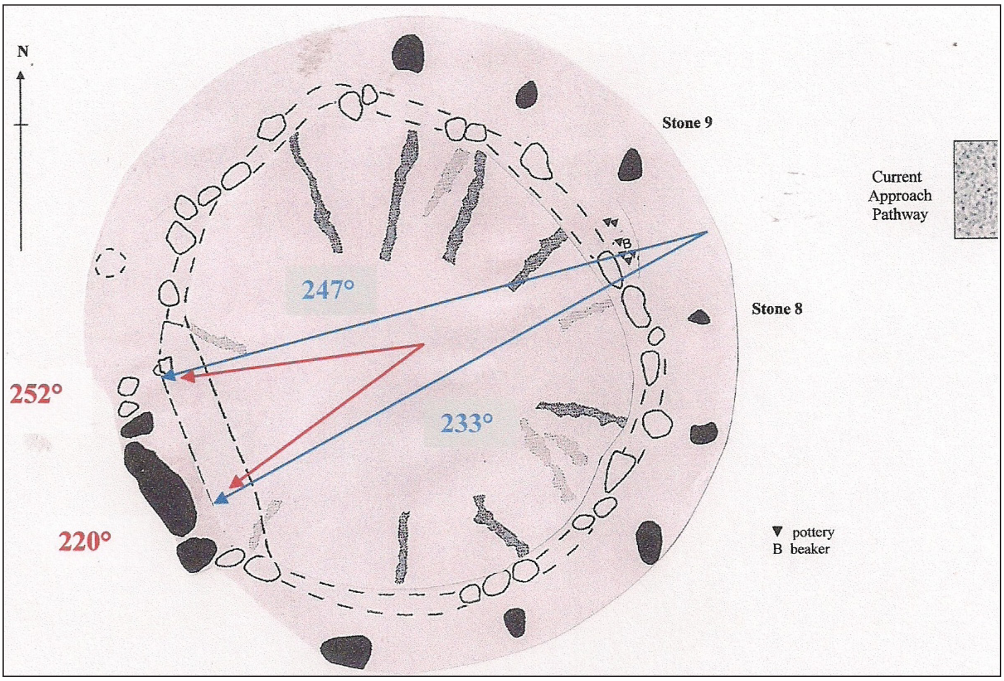

Figure 3: Plan of Tomnaverie showing proposed viewing point between stones 8 and 9 with azimuths for the recumbent window in blue and azimuths measured from the circle centre in red.

Figure 4: View from the north-east taken through stones 8 and 9, showing Tomnaverie recumbent arrangement window outlined against the sky.

so as I was familiar with the site, I watched events unfold by using Stellarium as mentioned above. This is astronomy software which allows visual reconstructions of the sky for any location on earth, through 360° of azimuth for prehistoric and future dates. By setting the dates and months required as well as the location and the altitude it is possible to record the azimuths at which the celestial bodies set. The following diagrams are visual representations of the astronomical data so derived. This is the story I have created to fit the events. The sunsets occurred between late afternoon and early evening in the period looked at, so after that observation it is possible that a couple of hours were used to light a bonfire and conduct a ritual before witnessing the later spectacle in the sky.

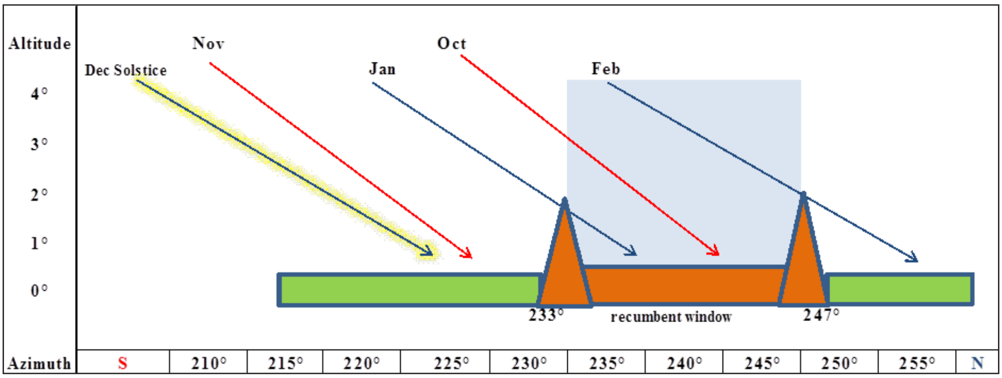

Figure 5: Subsequent sunset horizon positions for 21st of each month between October and February 2580–2579 BCE at Tomnaverie showing the sunsets travelling south (red arrows) until the solstice and travelling north (blue arrows) after it.

Research and results

I took the earliest construction date of 2580 BCE, because Bradley had identified the architectural connection between the early construction and the placement of the later stone circle, and I began by looking at the sun (**Figure 5**). This involved asking two questions, firstly how do you actually define a sunset as an observer and secondly what if any sunsets could be observed through the window. At sunset the sun gradually gets lower until it appears to graze the horizon and slide along it, getting lower and lower until it disappears from view. This movement, from about 4° of altitude to less than 0° of altitude when it disappears, can stretch over as much as 10° of azimuth, an exaggerated effect at northern latitudes. So, and this is the first part of the hypothesis, the sunsets at Tomnaverie did not appear as a static event at a fixed point (the solstices) but as a gradual movement from first to last graze along the horizon; therefore the term alignment and all that implies to archaeoastronomers and archaeologists alike, may be misleading.

To aid my research Fabio Silva (personal communication, 05.09.13) used horizon profiling software to create a landscape file for Tomnaverie. This is a virtual representation of the horizon, based on freely available digital elevation data, to input into Stellarium. I used this to establish the altitude of the horizon behind the recumbent window to see what sunsets could be seen through the opening. The most southerly sunset is the winter solstice sunset but on the sun's move south from the autumn equinox sunsets could have been observed nightly in this south-westerly quadrant for two and a half months before this. After the winter solstice, as the sun returned to set further north, sunsets could have been observed for a further two months afterwards. This range on the south-westerly horizon is where the sun set every night for over a third of the year throughout the long winter months which are the best times of the year for celestial observations. However from the proposed recumbent window only the October and January sunsets could have been observed, and the solstice sunset occurred outside this range. The diagram above and subsequent diagrams show in light blue the range of sky up to an altitude of 4° which could have been observed from the window.

Given the weight of the lunar hypothesis, I then looked at the moon. The monthly motions of the moon are rather complicated and depend on its different phases, but over a period of 18.6 years the range of the moonsets will cycle from a minimum (the minor lunar standstill) to a maximum (the major lunar standstill) and back again. Because of the inclination of the moon's orbit relative to the ecliptic, the moon's path at major standstill can reach its most northerly or southerly setting point several degrees further along the horizon than the degree reached by the sun at its solstice, whereas at a minor standstill the limits will be within the sun's maxima. These standstill events are the most sought by archaeoastronomers at the RSCs. At Tomnaverie because of the high latitude of 57° and the horizon altitude of 3° at the major standstill declination of -30°, the winter major standstill could not have been seen. Although the minor standstill could have been observed at Tomnaverie it would have occurred too far south to have been visible through the recumbent window. Though Morrison (1980: S69) has pointed out that there is no special uniqueness to be attached to the extreme azimuths at a minor standstill since during any month the moon rises and sets close to these points, the important factor here is what Sims (2007: 157) describes as 'the horizon properties of lunar standstills'. Additionally, the long length of the cycle precludes annual observation. The full moon would have been the most spectacular sight in the winter night as seen through the window as it rode high in the sky over the recumbent at an altitude of 45°. However, this factor alone did not seem to account for a significant interest in the moon.

Despite some modification by later archaeoastronomers such as Ruggles, the Thom paradigm has ruled archaeoastronomical methodology for decades and innovations are rare in archaeoastronomical theory (Henty, 2011a: 23). However, in 2004 Da Silva observed that there was a crossover between the sunrise and full moonrise positions at the spring equinox. Fabio Silva (2011) conducted further research into this phenomenon and coined the term Equinoctial Full Moon (EFM) to refer to crossovers at both the spring and autumn equinoxes. In 2012, in collaboration with Fernando Pimenta, Silva then proposed that similar crossovers occur around the solstices for the First and Last Lunar Crescents, generically known as CC (Crescent Crossover). No one has ever tested whether these events could be targets for the RSCs so, having identified the south-westerly orientation of the recumbent arrangement, I was curious to see if the set of the Solstitial First Lunar Crescent occurred in the recumbent window. Silva and Pimenta (2012: 192) pointed out that the actual or celestial crossover which happens when the sun and moon have the same declination is rarely visible, so subsequent sun and moonsets have to be empirically observed to confirm that the crossover has occurred (**Figure 6**).

Again I used Stellarium to make these observations for Tomnaverie for the winter months, adding a couple of days to dark moon until the moon's visibility was between five and eight percent. I looked at a period of 20 years from 2580 BCE to take in a period that was longer than the moon's 18.6 year cycle. The pattern observed (**Figure 7**) was that at the start of the period in October, the moon set south of the sun and at the end of the period in February, the moon set north of the sun. The crossover usually occurred in December, though there were a couple of examples of November and January dates which extended the overall date range to 60 days well within the range of 150 days observed by Silva and Pimenta (2012: 198) at latitude 40°N. The reduced range could be accounted for by two factors, namely that this research was conducted for 57°N and they stated that the number of days would decrease with latitude, and secondly that slightly different criteria for visibility of the lunar crescent have been used.

The majority of the crossovers occurred outside the recumbent arrangement but they all occurred within the range of the earlier radial divisions discovered by Bradley in the southwest of the circle. 55 percent of the crossovers occurred within 2° of the minor standstill limit, peaking at within half a degree of the minor standstill as predicted by Silva and Pimenta's model (2012: 198ff). which they satisfactorily tested on the Cork-Kerry stone rows. Silva and Pimenta (2012: 206) concluded that their results provided a 'new and alternative interpretation' of alignments believed to be towards the minor standstill direction. In the case of Tomnaverie, only 30

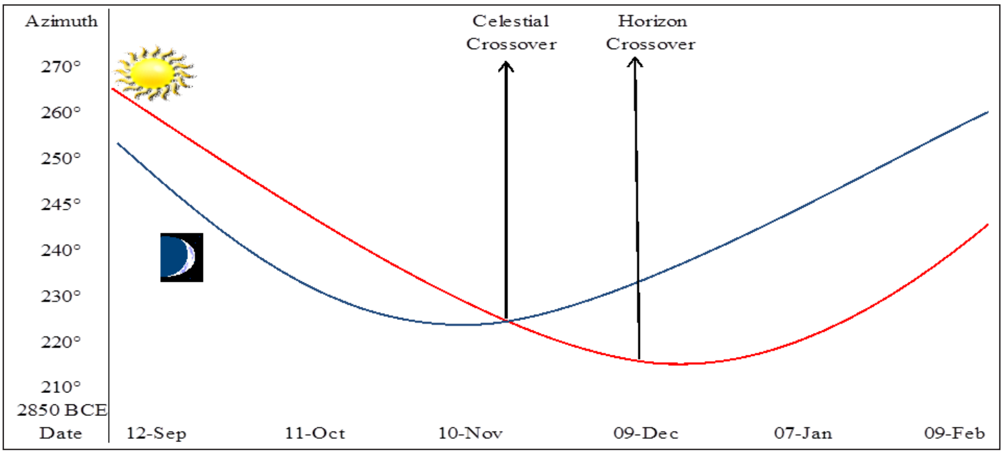

Figure 6: Passage of sun and moon at Tomnaverie showing celestial and horizon crossover for 2580 BCE.

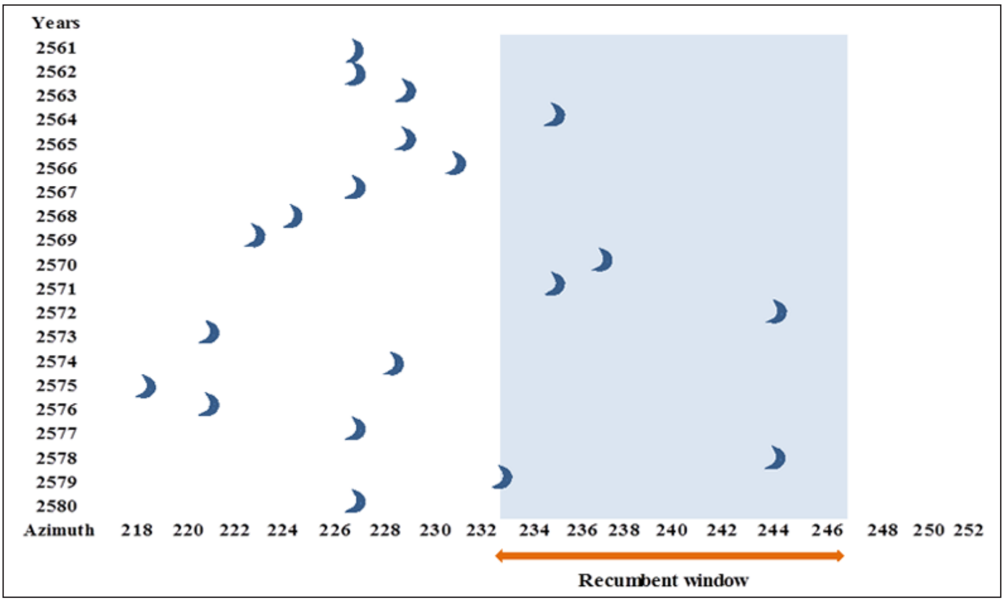

Figure 7: Scatter of Winter First Crescent Moonsets at Tomnaverie between 2580 BCE and 2561 BCE showing the majority occurred outside the recumbent window.

percent of the crossovers occurred within the recumbent window (**Figure 8**). The results of this research at Tomnaverie add weight to their theory overall but do not add weight to a lunar explanation at this RSC. Indeed the results for the minor standstill, the full moon and the crescent crossovers, based on what could be seen through the recumbent window, appear to negate the lunar paradigm.

At Tomnaverie there are three cupmarks in the south-west. There has never been a satisfactory archaeological explanation of cupmarks, though they are generally believed to incorporate lunar symbolism. At Tomnaverie, two are on the recumbent and neither matches the declination of the minor standstill but they are in the range of the Winter First Crescent Moonsets. The western edge

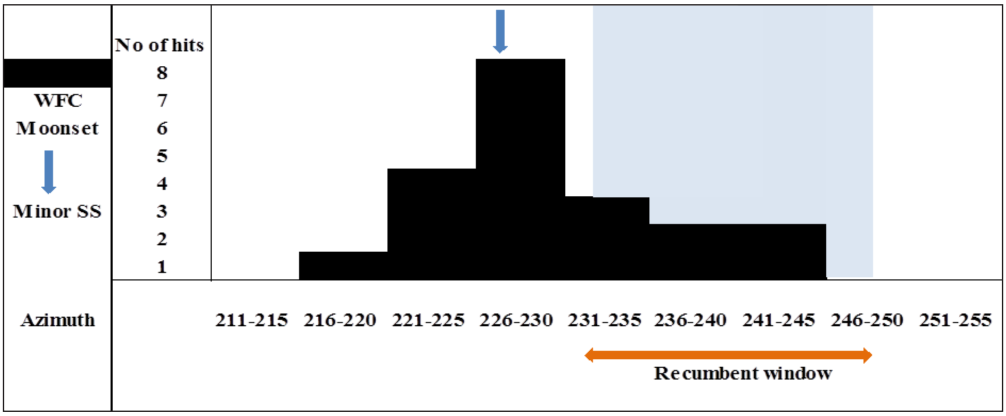

Figure 8: Winter First Crescent Moonsets at Tomnaverie between 2580 BCE and 2561 BCE, showing relationship between the Minor Standstill position and the recumbent window.

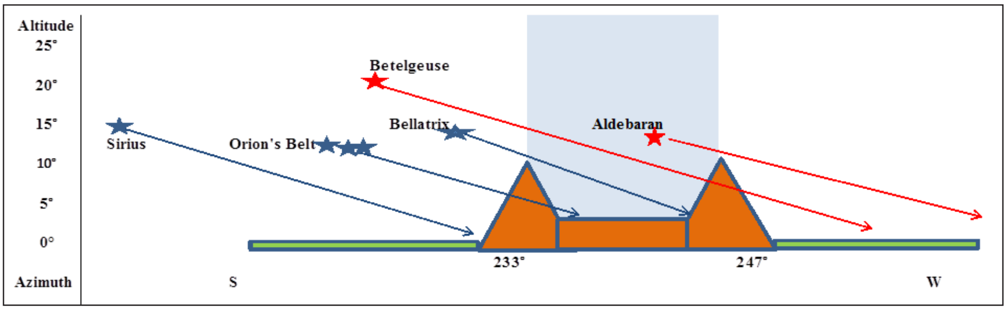

Figure 9: Representation of the paths the stars make in the sky and their subsequent setting points at winter solstice 2580 BCE.

of the site was destroyed by quarrying so the stones there are missing. However there is the evidence of the two radial divisions. The first at azimuth 212°, allows for the possibility of extending the range of the Solstitial First Crescent Moonset as mentioned earlier. The second division is much further north of the recumbent arrangement at azimuth 272°, close to the declination of Equinoctial Full Moon. The declination of the third cupmark is also in the range of the EFM. Following on from Silva and Pimenta's discussion (2012: 203ff). on the use of crossovers for calendrical purposes, the evidence at Tomnaverie could suggest that the layout of the site was designed for a similar purpose. I propose that this purpose may well have accounted for the earliest use of the site but, as ritual needs became more focussed on events in the south-west, it was only the crossover of the Solstitial First Crescent that was monumentalised in stone.

To complete the research I looked at the stars (**Figure 9**). Previous studies have ignored the possibility of stellar alignments, though in an earlier paper I have identified a possible correlation between red stones and red stars (Henty 2011b). The first magnitude stars I singled out all set within the azimuths defined by the two radial divisions. They included the two red stars Aldebaran and Betelgeuse which set further west of the window itself but inside the radial divisions. Similarly, Sirius set south of the window but within the divisions. The three stars which make up Orion's Belt appeared at the southerly edge of the recumbent window and set over the recumbent. Bellatrix set at the westerly edge and, together with Orion's Belt, seemingly defined the window itself. These stars all set within an hour of one another from 23:00 onwards on the night of the winter solstice in 2580 BCE though there would be some slight variation over the winter months as a whole. These stars would have created a spectacular display as they were seen to move across the recumbent window on the longest night of the year. The pastiche of red and white stars corresponds to the red and white stones. The most exciting image is surely that of Orion's Belt which would have been seen setting almost horizontally on top of the recumbent, something worth staying up for.

Discussion

Harding et al. (2006: 40) effectively pioneered this type of collaborative interdisciplinary approach to Neolithic monuments, and found that the three setting stars of Orion's Belt were framed by the closed western terminal at the Thornborough complex. They even speculated (2006: 47) that together with Sirius, Orion's Belt may have been part of a local or regional cult. Whilst no firm conclusions can be drawn from the Tomnaverie results overall, Orion's Belt does seem to have a special significance at the site. Fabio Silva (2014) has adopted a similar approach to a group of Portuguese dolmens where he suggests that in accordance with the material evidence the rise of Aldebaran could have been used as a seasonal marker. These independent studies show the importance of considering not just the sun and moon at prehistoric sites but also the stars.

As discussed earlier, since Bradley published his results, despite the implicit call for a re-evaluation of the published archaeoastronomical data, little has been done to re-examine the archaeoastronomy of the RSCs. The phenomenological methodology proposed in this paper attempts to find a solution to this impasse and provide a new way of combining archaeoastronomical data with archaeological results. Additionally, by looking at a combination of possible celestial events, it moves the discussion forward from the lunar paradigm which is now outdated. The results can be scientifically checked, though as with all prehistoric archaeoastronomy, the interpretations derived from them are conjectural and open to discussion. I have included all of the results for the sun, moon and stars in the hope of generating further discussion and research on these monuments. Indeed they are part of an ongoing project to reappraise the archaeoastronomy of these sites. The methodology used for the Tomnaverie case study could be extended to other sites in order to provide enough data for statistical analysis, although existing azimuths would have to be checked and/or revised from a viewing point outside the circle.

Zabriskie (2013) says that the justification for archaeoastronomy is that the results bring the glorious displays of celestial lights down to Earth, for the skyline provides the windows through which the sun, moon and stars enter and exit our world. The orientation of the recumbent arrangement at Tomnaverie is towards where the sun and moon metaphorically die when they set in the winter, which corresponds with the death of the year. This provides a cosmological link to its use as a cremation site far removed from artefactual evidence of the living. From this research carried out at Tomnaverie, it is difficult to distinguish the prominence of one particular celestial body over another, but it seems probable that they mutually reinforced beliefs about the sacredness of the sky. The observations were cyclical, occurring in the winter months with a pattern which would have been repeated annually.

This case study is phenomenological and attempts to combine archaeoastronomical findings with archaeological findings. Because of the lack of excavated sites, it would be difficult to exactly reproduce this type of research except by relying on archaeoastronomy alone, though some archaeological assumptions could be made based on the three circles excavated by Bradley. The view of Lochnagar behind the recumbent has been mentioned as an important feature at Tomnaverie and Bradley (1993: 45) suggests that many alignments can be found at a site, not just archaeoastronomical but also topographical. At Tomnaverie, a study of the landscape helped define an approach path to the site but from the hypothesised viewpoint, Lochnagar is not visible behind the recumbent. The use of detailed excavation data, the awareness of location and landscape and the integration of the sky with all its associated events, creates a multivalent approach to prehistoric archaeoastronomy which has no written history or ethnography to support cultural interpretation. This new approach (Silva, 2014; Henty, 2014) which moves archaeoastronomy away from orthodoxy and outdated paradigms could be better named as 'skyscape archaeology'; similar in scope to taskscape and landscape archaeology, but in relation to the sky.

Conclusion

What conclusions can be drawn from this phenomenological approach to archaeoastronomy? It seems evident that there was a section of the sky which contained particular configurations of the solar, lunar and stellar movements sacred to the builders and which they monumentally enshrined. These winter events may have become associated with ceremonies for the dead. It cannot be clear of course whether the rituals were in homage to the celestial events or whether the cosmos provided confirmation of the beliefs but it does seem clear that ideas about death were mirrored in the sky. Does this new archaeoastronomical hypothesis fit the archaeology? Recently, Richard Bradley (2013) presented his latest theories on the RSCs and in response to my question about archaeoastronomy he said that he no longer believed that the sites were aligned to the moon or the sun. However, he went on to say that he saw the circles as being related to the sky and to light and since they face the dark part of the sky where light decreases, this is how they are linked to the dead and the idea of going down into the underworld. He made it clear that he believed that it is a general direction that is involved and that the direction has cosmological significance. This is a conceptual alignment, the expression of a religious and cosmological idea, not a precise observation. Although we differ in the detail, Bradley's reinterpretation dovetails completely with this paper's astronomical analysis and for once archaeoastronomy and archaeology seem to be aligned.

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Notes

1. Composite plan using Bradley's plans 27, 46 and 52, (2005: 20, 29, 33).
2. See also Adam Welfare (2011: 200).
3. All dates and months are given according to the modern calendar where the winter solstice occurs in December.

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