Skyscape Archaeology: an emerging interdiscipline for archaeoastronomers and archaeologists

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Abstract. For historical reasons archaeoastronomy and archaeology differ in their approach to prehistoric monuments and this has created a divide between the disciplines which adopt seemingly incompatible methodologies. The reasons behind the impasse will be explored to show how these different approaches gave rise to their respective methods. Archaeology investigations tend to concentrate on single site analysis whereas archaeoastronomical surveys tend to be data driven from the examination of a large number of similar sets. A comparison will be made between traditional archaeoastronomical data gathering and an emerging methodology which looks at sites on a small scale and combines archaeology and astronomy. Silva’s recent research in Portugal and this author’s survey in Scotland have explored this methodology and termed it skyscape archaeology. This paper argues that this type of phenomenological skyscape archaeology offers an alternative to large scale statistical studies which analyse astronomical data obtained from a large number of superficially similar archaeological sites.

1. Introduction
The heart of a discipline lies in the methodology it employs to carry out its research. With overlapping disciplines this can give rise to dissimilar approaches despite generally common aims. Archaeologists and archaeoastronomers in their study of the prehistoric monuments of Britain whether they be stone circles, stone rows, henges, barrows or cairns, both attempt to understand the culture that gave rise to their construction. However because of their different methodologies, respectively ground-based or sky-based, their interpretations are not always compatible. Historically this has given rise to a divide between the disciplines and this paper briefly examines the reasons for this. Although landscape archaeology explores the spatial context of sites, archaeology investigations tend to concentrate on single site analysis whereas archaeoastronomical surveys tend to be data driven from the examination of a large number of similar sets. This has led to an impasse between the disciplines despite each discipline having much to offer the other. Skyscape archaeology attempts to bridge this gap by combining archaeology with archaeoastronomy. An emerging methodology which looks at sites on a small scale will be compared with archaeoastronomical surveys which use large data sets. Examples of both methods will be highlighted and discussed.
2. Historical Overview
At the beginning of the twentieth century Darwinian evolutionary ideas permeated social anthropology and were presented by Tylor and others in the guise of progression theory, claiming that the main tendency of humankind is to progress from savage to civilised state [1]. In the nineteenth century Christian Jürgensen Thomsen developed his Three Age System (Stone, Bronze and Iron Ages) in an attempt to establish the chronology of prehistory [2]. John Lubbock refined Thomsen’s system by splitting the Stone Age into the Palaeolithic and Neolithic periods and showed how the hunter-gathers ‘progressed’ to farmers in the prehistoric period [3]. The emerging discipline of archaeology adopted this ideology and drew up taxonomies of monuments, lithics and artefacts to present a picture of prehistoric culture. Archaeologists were primarily concerned with excavating, recording, collecting and drawing site plans to present this evolutionary picture of humankind progressing from the nomadic savagery of hunter-gatherer to settled farmers and the domestication of animals. The results of increasing prehistoric civilisation were monumentalised in earth and stone. There was little room for the sky in this model and Sir Norman Lockyer’s astronomical surveys and claims for a solar year and the advanced skills of astronomer priests were ignored in the archaeological narrative, mainly because so much of his work on dating using stellar alignments was discredited when radiocarbon dating showed his conclusions to be false [4].

An early work by Christopher and Jacquetta Hawkes, *Prehistoric Britain*, first published in 1943, exemplifies the archaeological model [5]. They described how archaeology has helped us to understand the development of humankind as an evolutionary journey with ‘no break in this procession of events’ [5, p. 11]. From mastering fire, ‘man’ learned ‘to farm, to weave, to shape pots, to make wheels, to cast bronze, to work iron, until imperceptibly we have reached the unfinished chapter of to-day’[5, p. 11]. They presented their work as a chronicle in an attempt to convey a sense of continuity between the past, present and future of humanity. This is fairly typical of the way archaeology was viewed at the time and it was difficult to contemplate anything other than a historical, evolutionary approach. Indeed the prominent archaeologist Vere Gordon Childe employed chapter headings such as ‘Palaeolithic Savagery’ and ‘The Higher Barbarism of the Copper Age’ in his influential book *What Happened in History* [6]. While the Hawkes’ acknowledged that Stonehenge was aligned to the midsummer sunrise and that there might have been sun-cults in the Bronze Age, religion and ritual behaviour was clearly secondary to economic advancement in the archaeological narrative in the 1940s [5, p. 77-79]. Subsequent archaeologists have favoured simple alignments but the prejudice against precision alignments was evident before the developments in archaeoastronomy in the 1960s. Generally the sky remains ignored in the archaeological narrative though there are notable recent exceptions such as the study of Thornborough by Jan Harding and others [7].

The 1960s are famously seen as a period when old ideas were questioned and changed by the counterculture. They were also characterised by technological advances which shook archaeology from its antiquarian roots. Firstly there was the radiocarbon revolution which enabled absolute dating of sites and artefacts without having to rely on cross-cultural comparisons and evolutionary assumptions, though it is still problematic when it comes to accurately dating a stone circle. Secondly the development of computer science made it possible for Gerald Hawkins to process thousands of different permutations of stones and alignments at Stonehenge. His research and analysis was published in *Stonehenge Decoded*, which became a best-seller [8]. Ironically it was Jacquetta Hawkes who famously said that each age ‘has the Stonehenge it deserves - or desires’ [9]. Hawkins’ analysis which was the first serious astronomical study since Lockyer became irrevocably linked with New Age esotericism. It was perhaps on the back of Hawkins’ speculative and controversial study that the work of Alexander Thom became widely known. Thom had first published an article on megalithic solar observatories in 1954 but it was not until after Hawkins created an appetite for megalithic science that Thom’s work found a following [10]. However, it is Thom who is credited with being the founder of modern archaeoastronomy with its rigorous, scientific approach. He detailed the metrology, geometry and astronomy of the megalith builders as he perceived it. His analysis was purely statistical, mathematical and astronomical and he projected these qualities onto the prehistoric builders
themselves. Thom’s scientifically advanced monument designer is far removed from Childe’s ‘Palaeolithic savage’. Megalithic science was an inadvertent threat to archaeology and at the time that Thom was developing his theories of astronomer-priests, Stuart Piggott, a leading archaeologist who specialised in the Neolithic, distanced druidry from megalithic monuments [11]. This divergence in both methodologies and ideologies between archaeology and the new discipline of archaeoastronomy created a language gap between the disciplines. Of the archaeologists at that time only a few such as Euan MacKie and Richard Atkinson gave Thom’s theories any credence. Ruggles reflected that archaeologists felt Thom was ‘falling into the trap identified earlier by Hawkes and simply seeing his own reflection in the past’ [12].

3. The Astronomical Method
Thom’s methods which were pioneering depended on a basic understanding of astronomy. To calculate whether or not an alignment is present in, for example, a stone circle, three measurements, horizon altitude, azimuth and latitude must be calculated. Horizon altitude is the number of degrees of elevation from the theoretical horizon of 0° at a selected viewing point and this can be measured with a clinometer. Azimuth is the particular measurement of a point on the 360° horizon so if from the observer’s position there is a stone due west, its azimuth will be 270°. Once true North has been established azimuth can be measured with a compass or a theodolite. Together with latitude (\( \phi \)), altitude (\( a \)) and azimuth (\( A \)) are the necessary factors for determining declination (\( \delta \)) at a given point, using the standard equation:

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\sin \delta = \sin \phi \sin a - \cos \phi \cos a \cos A
\]

It is necessary to calculate declination because this is the universal measurement for the relative positions of the Sun, Moon and stars at a given point in time in the equatorial coordinate system. The celestial sphere which contains the celestial bodies, is an imaginary sphere projected into the sky, with the earth at its centre. Declination is the angular measurement between the celestial equator and the celestial pole. It is measured in degrees starting with 0° at the equator and ending with +90° degrees at the north celestial pole and -90° at the south celestial pole. It reflects the earth’s terrestrial latitude projected into the sky. At each degree of geocentric latitude there will be a maximum declination at which a celestial body can rise or set. To find the value of this maximum declination, when dealing with a perfect mathematical horizon, the latitude degree of the location must be subtracted from 90°. Because of the precession of the equinoxes the declinations of the stars change slowly over time and additionally the limiting annual and monthly declinations of the Sun and the Moon also change because of the gradual decrease in the obliquity of the ecliptic.

This astronomical language was simply not understood by archaeologists and Thom added further refinements by adding refraction, parallax and lunar perturbation in order to minimise the error in modelling to just a few minutes of arc. He introduced the idea of upper and lower limbs to characterise the first or last glimpses of the Sun and Moon along the horizon and coined the terms major and minor standstills for the lunistics [13]. His work was discredited because of its ethnocentric assumptions that the builders were astronomers versed not only in the precise motions of the celestial bodies but also in Pythagorean geometry [14]. Thom also added a megalithic sixteen month year and megalithic yards and inches into the archaeoastronomical mix [15]. Bradley Schaefer wrote a series of papers in the following decades to aid archaeoastronomers to pinpoint accurate alignments to solar, lunar and stellar phenomena [16, 17, 18]. Clearly to predict backwards to see the horizon events that the monument builders saw, we need to be well-versed in astronomy if we are looking for precise alignments rather than general orientations and Thom and astronomers like Schaefer provided all the necessary tools to conduct this research with the rigour demanded by a scientific discipline. The fallacy Thom committed was to believe that prehistoric people had this level of knowledge and would have needed it to construct and make use of their monuments. They may certainly have been sky-watchers who regarded the cyclic movements of the celestial bodies with awe and reverence and
imputed terrestrial significance from them but they would not have had the sophisticated knowledge that we need in order to make sense of their constructions.

4. Methodological Advances

Thom’s work was the quantitative, ‘scientific’ archaeoastronomy that Aveni dubbed ‘green archaeoastronomy’ [19]. The archaeoastronomy that emerged in the 1980s mainly pioneered by Clive Ruggles on the basis of his critique of Thom only strengthened the scientific basis of the discipline. Cooke, Few, Morgan and Ruggles were astronomers who had been working together surveying megalithic sites for four years. Their paper on the Calanais (then popularly called Callanish) sites in 1977 was a contributory factor in the change of archaeoastronomy’s disciplinary methodology [20]. Ruggles and his colleagues based their new methodology on the basis of what they criticised in Thom. They defined set criteria for choosing the lines to be surveyed for both on-site and inter-site lines which enabled them to distinguish between rough indications of alignments and those they could reasonably test as alignments [20, pp. 115-117]. Of the 46 lines quoted by earlier authors, they found only six which may have been astronomical [20, p. 130]. Accurate indications were confined to horizons which contained features that enabled small changes in setting points to be distinguished. In this case there were only 19 lines to consider and by using probability testing, they considered that the only line which had an accurate astronomical indication could have occurred by chance [20, p. 131].

The Calanais paper must be regarded as a landmark event in the history of archaeoastronomy because it turned the tables on Thom’s megalithic man, removing his ethnocentric vision of the science of the megalith builders and placed science where it belonged, as a tool of 20th century archaeoastronomers. Ruggles went on to make similar surveys in the 1980s, the basis of which was the selection of a large number of similar sites in order to test the intentionality of Thom’s lunar sightlines for statistical probability [21, 22]. Ruggles’ surveys fulfilled two objectives: the provision of clear guidelines for archaeoastronomy practitioners and the assurance to archaeologists that the subject was methodologically sound. Yet whilst the methodology of the discipline was being scrutinised and honed and despite the addition of stringent criteria to be used for determining astronomical alignments, little attention was paid to what the results could add to the interpretation of prehistory, other than Thom’s original premise that the builders had advanced astronomical knowledge. It is little wonder then that archaeologists saw archaeoastronomy as little more than background noise.

While there are good reasons to examine a group of similar sites statistically, the problem then lies in the identification of a suitable data set. Clearly singular sites of individual significance such as Stonehenge and Avebury cannot be considered for statistical analysis. Ruggles concluded that a variety of stone circles only found in the north-east of Scotland was a suitable category for statistical examination [23]. This geographical area, some 80km by 50km spreading outwards from Aberdeen, is cut off from the west by the Highlands and because of its peninsular shaping it is bounded in the north and east by the sea. It is a distance of some 240km from the populated central lowlands and has a separate local identity which survives today. Unsurprisingly therefore, the stone circles here are distinctive from those built elsewhere in the megalithic era. They are called recumbent stone circles (RSCs) because they are characterised by a large reclining stone flanked on either side by a tall granite pillar. The circle stones are graded in height towards the recumbent and the circles themselves are usually located near the summits of low hills giving them extensive horizon views. Of the original 200-300 circles, there are good records of over 100, of which 74 survive today [24, 25, p. 151].

With eliminations for incomplete and inaccessible circles Ruggles initially surveyed 64 RSCs [23]. In his opinion the circles provided a principal axis from the centre of the circle to the centre of the recumbent but he took two measures because on visiting the sites it could not be clearly established whether the principal line of orientation was that which used the centre of the circle or whether, as the recumbent was often offset from the ring, the line should be taken as the line perpendicular to the recumbent. Ruggles measured the distances of the horizons and found a distinct preference for non-nearby horizons towards the south, and a preference for south or southeast facing slopes. The current state of the circles meant that it was not always easy to ascertain the centre and additionally,
depending on the shape of the recumbent, it was not always easy to measure its centre either. Thus Ruggles said that neither axis could be defined to less than 1° of accuracy. From the orientations observed, all the azimuths fell within a 90° band width, centred on the SSW. These azimuths are those which contain solstitial settings and both major and minor standstill settings.

It is a measure of how important alignment studies were at the time that Ruggles’ comment that ‘it is not unlikely that this entire stretch of horizon [the indicated horizon between the inner edges of the flankers], rather than just its centre point, might have been of significance’ was completely ignored until the recent reassessments of landscapes in relation to prehistoric monuments [23, p. S76]. The paper did not examine whether the alignments were predominantly solar or lunar preferring instead to say that ‘a highly significant general orientation trend is evident’ with an interest in celestial observations near to the horizon, so the statistical analysis revealed limited results [23, p. S77]. Recent research has pointed out certain flaws in Ruggles’ research questions, firstly the comment above that he highlighted but otherwise ignored. This author argues in a phenomenological study of Tomnaverie RSC that the recumbent arrangement frames a window through which a variety of celestial events could have been observed [26]. The conclusion is that the centre of the recumbent can only be a mythical fixed point as it is not marked in any way, yet all the measurements Ruggles made depend on it [26]. Finally, Ruggles’ research depends on using the circle centre as a backsight from which observations are made. There is no logical justification that the view from the circle centre over the recumbent was the one that the sky-watchers observed and indeed the archaeological evidence calls this supposition into question [27].

The second part of Ruggles’ analysis which was co-written with Burl, combined archaeology and archaeoastronomy in order to find a cultural explanation for the RSCs based on a range of common features and overall trends [28]. The lack of artefacts showed they were not domestic or industrial sites. The authors found that their location is invariably away from mountainous regions and low-lying valleys and as they are positioned near patches of fertile and well-drained soil there was the suggestion that their planners were agriculturalists. They believed that their construction would have involved a cooperative effort with neighbouring groups. Additionally they argued that as the RSCs are sited in conspicuous settings on hillsides with long views, the sites were ceremonial or ritual centres reflecting a tradition that spread over a large area in the northeast of Scotland. Much of this material can be gleaned from Burl’s earlier assessment of the RSCs but the archaeoastronomical approach differs from previous versions [29]. The recumbent azimuths of 57 sites ranged between 147° and 237°, the band of 90° centred on the SSW already detailed by Ruggles [23, p. S72]. Burl had earlier suggested that the RSC orientations were strongly influenced by the motions of the Moon, not as might have been expected on the rising and setting points, but upon the Moon high in the sky [30]. There was an avoidance of the azimuth for the setting solstitial Sun.

Earlier studies had only considered azimuths but in this study the horizon altitudes were taken into account and the declinations were measured. From this new data Ruggles and Burl 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 prominent hilltops at most sites were not used within the indicated horizon to pick out particular astronomical events and there were many sites without such hilltops. An analysis of cupmark declinations provided another indication that these were lunar sites yet the overall conclusion was that ‘there is no simple, all-embracing astronomical explanation for the Recumbent Stone Circles’ [28, p. S58]. Despite Ruggles’ earlier exhortations for a statistical methodology, an overall statistical test was not applied to the results. Instead Ruggles noted that the distribution of the recumbent azimuths made it a suitable case for Near Neighbour testing which had been developed by Neave and Selkirk [31]. At the time the two papers were further landmark events for archaeoastronomy as they moved the debate away from precision alignments to less precise orientations and thoroughly incorporated what archaeological evidence there was into the interpretation.
5. Discussion

From these results there is no immediate clear picture and surely this is the result of assuming that a large data set can provide answers for a large quantity of seemingly similar sites. The range of azimuths for the centre of the recumbent from 147° to 237° shows an immediate difference in the preferential siting of the recumbent. Clearly no single astronomical alignment fits this range and begs the question why the sites were not broken down into three categories of SSW, S and SSE and further examined by category. According to Shepherd the RSCs developed in the third millennium BC [25, p. 152]. Radiocarbon dating has placed them between 2500 BC and 1750 BC but the period in which they were constructed may be longer than 1000 years [28, p. S25]. Though few sites have been accurately dated a possible correlation could have been found between the three categories and the dates of construction over the possible period of 1000 years: it is a question which could have been legitimately asked. It does seem probable that cultural change would have occurred in this long period and though the declinations of the Sun and the Moon would have changed only slightly, supplementary evidence from the changing positions of the fixed stars could be considered. Additionally, given that the arrangement of the recumbent between two flankers dominates the circle, it seems questionable that only the centre of the recumbent was tested astronomically. Different results might have been determined if the range of declinations along the window between the two flankers had been used instead of just one central declination.

The use of the circle centre as the point from which measurements are taken is based on our modern conception of space that Cassirer calls the ‘logical space’ of empirical scientific astronomy, all azimuths being measured from 0° at North [32]. To measure alignments one must create from the microcosm of a compass dial, a notional or theoretical circle, the macrocosm being the horizon of the landscape, punctuated by the equidistant cardinal points of North, East, South and West. The coordinates of longitude and latitude together with the cardinal directions, define our maps and imbue these with a sense of place. It is by no means self-evident that the monument builders defined their space in this way and Massey suggested that we need to ‘rethink the unity of space and place in different terms’ [33]. The research of both Thom and Ruggles depends on the a priori assumption that celestial events were observed from the centre and then marked accordingly, though there is no archaeological evidence to suggest that the builders used a central post for a backsight. Additionally it is possibly a false premise to base research on the proposition that the notional circle is the same as the stone circle as few of the circles are truly circular, most of them being flattened circles. There are many circles where the recumbent does not follow the line of the perimeter but is at an angle to it which further belies the importance of a central observing point.

Richard Bradley’s archaeological excavations at Tomnaverie, Cothiemuir Wood and Aikey Brae RSCs have shed serious doubt on the convention of using the circle centre as a basis for archaeoastronomical measurements [34]. He says ‘it is clear that ring cairns or closely-related monuments were the earliest structures and that the recumbent stone circles were a secondary development’ [34, p. xi]. There is little evidence of material culture inside Tomnaverie circle: the largest quantity of pottery and lithic artefacts were found outside. It has also been established that generally the broader, flatter, more regular sides of the stones face outwards which implies that the circle was to be viewed from without rather than from within [35]. Bradley also found evidence of the intentional use of colour in the patterning of the stones and his modern interpretation associated white with the Moon and red with the bonfire at these cremation sites.

Another criticism of Ruggles’ statistically driven research is that he only focussed on one aspect of the circle, that of the recumbent. Admittedly the recumbent arrangement is the one feature common to all the circles but it has to be remembered that the circles included from seven to twelve stones in all and some consideration surely must be given to their existence and placing. Nor does a statistical evaluation take into account the variety of the shaped and dressed stones or their colour. Though Ruggles measured the horizons, he found no evidence to suggest that the circles were aligned on prominent landscape features. Nevertheless, despite these shortcomings, archaeoastronomy seems to be constrained by its astronomical bias which studies only the incorporation of celestial alignments,
orientations, or symbolism derived from the sky, in material monuments and architecture. Michael Hoskin measured the orientations of over 3000 megalithic tombs in Europe and produced impressive orientation data which because of the large data sets used adds little to the understanding of the motivations behind their construction [36].

Gail Higginbottom and Roger Clay looked at Ruggles’ data and statistical methodology for northwest Scotland where he had examined 300 megalithic sites [37, 38]. Ruggles had assessed his data using the Nearest Neighbour Test (NNT) to assess the statistical probability of preferential declinations whereas Higginbottom and Clay discussed an alternative method $Z_{2}^{m}$. Their thesis was that statistical data has difficulty in producing cultural and time-line divisions because of the lack of archaeological material. Therefore datasets may appear to be uniform by drowning out signals known as background ‘noise’. Either test can be used by archaeoastronomers to assess the probability that clusters of preferential orientations exist in the database. Using randomly generated datasets they found that the NNT test only performed well if there was no background ‘noise’. However the $Z_{2}^{m}$ test was more effective at detecting small clusterings that are superimposed upon a uniformly-distributed background. Using their method on 276 of Ruggles’ orientations, Higginbottom and Clay found significant levels of clustering for four of the geographical regions whereas only one was detected by NNT [38]. They looked at the region of Uist for a significant deviation from randomness and found definite peaks of azimuths which did not have a level of significance using NNT. Generally at this time, Ruggles was alone in using such statistical methods: Hoskin utilised histograms to ascertain the peak values to be interpreted for the large data sets he collected [36]. The potential of Higginbottom and Clay’s research was never explored; it would have been interesting if they had applied it to Hoskin’s group results or to the RSCs but neither they nor anyone following took up the mantle.

Through this mundane data lens there is no room for engagement with the meaning of the sky itself. However, Eliade wrote that we cannot ignore the direct and abiding revelation that the sky is something sacred, an observation we may find difficult to reconcile with our modern and secular uses of the sky. Space for Eliade is a divine manifestation. He said ‘Sacred space implies a hierophany, an irruption of the sacred that results in detaching a territory from the surrounding cosmic milieu’ [39, p. 26]. Eliade’s space, the imago mundi is the replica of the gods’ creation so it shares in the sanctity of the gods’ universe. Eliade posed a sequence which formed the cosmological system which he claimed was widespread throughout different cultures and religions [39, p. 37]. Firstly a sacred place breaks the homogeneity of space, then this space is symbolised by a passage to the gods or the underworld, with communication channels to heaven via cosmic pillars of varying forms depending on the culture. Around this axis, which is the centre of the three cosmic levels of earth, heaven and underworld, lies the existential world. The RSCs have all the characteristics of Eliade’s sacred spaces with the stones, particularly the flankers providing the cosmic pillars. Whilst Pauketat said that Eliade’s approach was highly reductionist and Trubshaw said it was simplistic, the sacred/profane dichotomy remains a reminder that there are continuing disciplinary differences in the way space is interpreted by archaeoastronomers and archaeologists [40, 41].

Bradley said that stone circles are permeable structures permitting a continuous relationship between the sacred space of the interior and the landscape beyond and he also acknowledged that circular constructions reflect a perception of space that extends outwards from the individual and upwards into the sky [42]. Bradley is the exception and most archaeologists tend to ignore the sky altogether. Now the archaeoastronomer is concerned with the horizon, because that is crucial for measuring alignments but has little interest in the cultural landscape. Without ethnographic evidence we can only theorise about the relationship between the microcosm of the earthly circle and the macrocosm of the heavens and somehow in the academic research the overriding sense of sacredness gets diluted. Archaeoastronomical studies which employ large data sets of similar monuments are reduced to histograms, tables and graphs so it is easy to forget, as Bradley said, ‘the fact that the operation of such complexes was first and foremost an experience’ [43].
6. Skyscape Archaeology - The Way Forward?

What is needed to draw the qualitative meaning of prehistoric monuments from quantitative data and encompass the nuances of individual landscapes and particular groupings of stones is a more encompassing approach to consider the role and importance of the sky in the interpretation of the material record. We can call this skyscape archaeology, a term that Fabio Silva and this author coined independently in new research papers which looked for alternative methodologies which avoided using large data sets [44, 45].

Silva’s paper concentrated on a small scale cluster of megalithic dolmens on the Mondego platform in central Portugal located near the city of the Carregal Do Sal. He measured the ‘window of visibility’ defined by the range of horizon azimuths visible from within the chamber [44, p. 27]. He found that at the time of dolmen construction, ca. 4300–3700 BC Aldebaran would have risen exactly within this window of visibility [44, p. 32]. Silva suggested the use of the heliacal rising of Aldebaran to be a seasonal marker when pastoralists would have moved to higher pastures on the Serra da Estrela or Mountain Range of the Star [44, p. 32]. There is archaeological evidence of this seasonal movement and additionally ethnographical support from folklore added weight to his theory. Silva employed a phenomenological methodology grounded on the archaeological record, using data at archaeologically-grounded scales, which he characterised as skyscape archaeology [44, p. 25].

My research used similar phenomenological methodology to look at a single site, that of Tomnaverie RSC [26]. This is a site which had been fully excavated by Richard Bradley so it was important to marry the archaeoastronomy to the archaeology. The site was first used for cremation pyres and levelling provided a platform for the internal ring cairn. This central platform included radial lines which pointed from the outer kerb towards the centre. Two of these outlined the limits of the straight stretch of kerb in front of the recumbent. The archaeology suggested a night-time use of the site in which the section of the sky behind the recumbent at the south-west of the circle was important. The early funereal function of the circle could have been associated with the setting of the Sun or the Moon in the winter. Therefore my observations were directed to what was visible during the winter months.

The azimuth range of the recumbent arrangement from Ruggles’ data is 32° but as the centre has been ruled out for observations it was important to find a point from which measurements could be taken. When positioned outside the ring at the north-east, between stones 8 and 9, the recumbent and flankers appear outlined against the sky and give the appearance of a window of just 14° (Figure 1). It was at this point that the largest number of pottery artefacts was found. To determine what the builders saw through this window I used Stellarium astronomy software enhanced by a landscape file created by Silva which is a virtual representation of the horizon, based on freely available digital elevation data. For the purposes of this experiment I took the earliest radiocarbon construction date, given by Bradley, of 2580 cal BC and began by looking at the winter sunsets. The movement of sunset from about 4° of altitude to less than 0° when the Sun disappears can stretch over as much as 10° of azimuth, an exaggerated effect at northern latitudes. So, the sunsets at Tomnaverie did not appear as a static event at a fixed point 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.

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 2½ months before it. After the winter solstice, as the Sun returned to set further north, sunsets could have been observed for another 2 months afterwards. This range on the south-westerly horizon is where the Sun set every night for over a third of the year, indeed 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 outwith this range.

Given the weight of the lunar hypothesis, I then looked at the Moon. The major and minor limits reached by the Moon in its 18.6 year cycle are the most sought events at these circles. At Tomnaverie because of its high latitude and the horizon altitude of 3° 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. The full Moon would have been the most spectacular sight in the winter night as it rode high in the sky over the recumbent at an altitude of 45°. These factors alone did not seem to account for a significant interest in the Moon.

In 2012, in collaboration with Fernando Pimenta, Silva observed that crossovers between the Sun and the Moon’s positions occur around the solstices for the First and Last Lunar Crescents [46]. No one has ever tested whether these events could be targets for the recumbents so having identified the winter solstitial orientation of the recumbent arrangement, I was curious to see if the set of the Solstitial First Lunar Crescent occurred in the recumbent window. Because the celestial crossover, which happens when the Sun and Moon have the same declination, is rarely visible, subsequent sun and moonsets have to be empirically observed to confirm that the crossover has occurred.

Despite Brown’s suggestion that Stellarium lacks the necessary precision to predict the position of the Moon again I used Stellarium to make these experimental observations for Tomnaverie, adding a couple of days to dark Moon until the Moon’s visibility was between 5% and 8% [47]. I looked at a period of twenty years from 2580 BC, longer than the Moon’s standstill cycle. The majority of the crossovers occurred outwith the recumbent arrangement but they all occurred within the range of the earlier radial divisions discovered by Bradley in the south-west of the circle. Only 30% of the crossovers occurred within the recumbent window. These results do not add weight to a lunar
explanation at this recumbent circle. Cupmarks have been associated with lunar symbolism and there are two cupmarks on the recumbent at Tomnaverie which are in the range of the First Crescent Moonsets. However 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.

To complete the research I looked at the stars. Previous studies have ignored the possibility of stellar alignments though in an earlier study I had identified a possible correlation between red stones and red stars [48]. One of the criticisms levelled at stellar archaeoastronomy is that there are so many potential targets, to select a few is obvious evidence of bias. Nevertheless, there is no evidence to suggest that the brightest stars were not observed in prehistory. Hoskin, for example found that orientations at some of the taula sanctuary sites in southern Menorca pointed to the Southern Cross around 1000 BC [49]. Ruggles lists many other examples in his recently published examination of stellar alignments [50]. Despite there being no corroborating folklore for the RSCs, the above evidence, coupled with Harding’s finding’s for Orion at Thornborough suggested that stellar observation may have been important at Tomnaverie. I looked for first magnitude stars which 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 (Figure 2). 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 11pm onwards on the night of the winter solstice 2580 BC though there would be some slight variation over the winter months as a whole. These stars would have created a spectacular display seen moving 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. This correlation could be criticised on the grounds that the colours of the stones would not be visible under low light conditions, but a similar argument could be applied to the use of quartz scatters representing the

Figure 2. Stellarmium night sky, January 2580 BC, showing Orion’s Belt setting over the Tomnaverie recumbent.
Moon, a notion which is commonly held [51]. However brightness differences at least should be observable under these conditions. The most exciting image is surely that of Orion’s belt which would have been seen setting almost horizontally on top of the recumbent.

7. Conclusion

What conclusions can be drawn from this phenomenological skyscape archaeology? It could be said that the recumbent arrangement at Tomnaverie provided the sacred window through which the Sun, Moon and stars entered and exited the builders’ world. Its orientation 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. At Tomnaverie, it is difficult to distinguish the prominence of one particular celestial body over another but 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. The observations were cyclical, occurring in the winter months and the pattern would have been repeated annually.

Does this new archaeoastronomical hypothesis fit the archaeology? In 2013, Richard Bradley presented his latest theories on the recumbent circles and in response to my question about archaeoastronomy he said he no longer believed that the sites were aligned to the Moon or the Sun. However, he said that he saw the circles as being related to the sky and to light and as they face the dark part of the sky where light decreases, that is how they are linked to the dead and 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 my astronomical analysis and for once archaeoastronomy and archaeology seem to be aligned.

This type of skyscape archaeology offers an alternative to large scale statistical studies which analyse astronomical data obtained from a large number of superficially similar archaeological sites. Its phenomenological approach allows space for the consideration of additional artefactual evidence, the site or sites’ location within a particular ritual landscape, related ethnographic evidence and relative dating. The examples here show how the disciplines of archaeology and archaeoastronomy can supplement each other’s narrative for a more comprehensive interpretation of our ancient monuments. In other words the background noise missing from probability tests is given due consideration and working from the particular to the general may provide a better idea of the culture that produced them and help identify cultural change.

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