The Astronomy of Indigenous Stone Arrangements

Ray P. Norris¹,², Duane W. Hamacher³, Robert Fuller¹

¹ Department of Indigenous Studies, Macquarie University, NSW, 2109, Australia
² CSIRO Astronomy & Space Science, PO Box 76, Epping, NSW, 1710, Australia
e-mail: RayPNorris@gmail.com
³ Nura Gili Indigenous Programs Unit, University of New South Wales, Sydney, NSW 2052, Australia

Draft of 21 July 2013

Abstract:
The traditional cultures of Aboriginal Australians include a significant astronomical component, perpetuated through oral tradition, ceremony, and art. Here we explore the extent to which this is also reflected in stone arrangements. We show that some stone arrangements are carefully aligned to astronomically significant directions such as the point on the horizon at which the solstitial Sun sets. Moreover, many stone arrangements were aligned by the builders to cardinal directions with a precision which implies that astronomical observations were used to determine their orientation. These include (a) a stone arrangement in Victoria with alignments to the position on the horizon of sunset at midwinter, midsummer, and the equinoxes, (b) linear stone arrangements in NSW which appear accurately aligned in a N-S direction, apparently derived from astronomical orientations, (c) Bora sites in NSW and Queensland, which appear to be aligned due South. We test whether such alignments might be generated by chance, using Monte Carlo tests, and find that the probability of obtaining these distributions by chance is extremely small, implying that these alignments were deliberately chosen by the builders of the stone arrangements.

1 Introduction

The art and oral traditions of many traditional Aboriginal cultures contain references to celestial bodies such as the Sun, Moon, and stars (Stanbridge 1857, 1861; Mountford 1956; Haynes 1992; Johnson 1998; Cairns & Harney 2003; Norris & Norris 2009; Norris & Hamacher 2011). For example, in many Aboriginal cultures, the constellation of Orion symbolises a young man or group of young men and the Pleiades (Seven Sisters) symbolise a group of girls pursued by Orion. Another well-known “constellation”, the emu (Cairns & Harney 2003; Massola 1963; Norris & Norris 2009), consists not of stars but of the dark clouds within the Milky Way, and is important in many different cultures across Australia.

Of even greater interest is the deep understanding of the sky evident in many Aboriginal traditions. Evidence of this deep understanding consists of traditional songs and stories that explain, in an appropriate cultural context, tides, eclipses, and the motion of the Sun, Moon, and planets (Norris & Norris 2009; Hamacher & Norris 2012) and the ability to predict the rising and setting places of celestial bodies (Norris et al. 2013), suggesting that traditional Aboriginal people sought to understand how the sky worked, within their own cultural context. The sky was also used for practical applications including navigation, time keeping, and the maintenance of a calendar (Cairns & Harney 2003; Clarke 2009).

Here we show that this interest in the sky is also evident in some Aboriginal stone arrangements. It should be noted that we are not asserting that all stone arrangements have an astronomical connection, nor that the prime function of the stone arrangements discussed in this paper is astronomical. Instead, we restrict ourselves to presenting evidence that astronomical knowledge played a role in the construction of the stone arrangements discussed here, from which we may deduce that Aboriginal people in pre-contact times had a good understanding of the motion of the Sun, and made careful measurements to determine cardinal directions.
Throughout New South Wales (NSW) are many stone rows, whose use is uncertain but which are presumed to have a ceremonial function. Hamacher et al. (2012) have compiled a sample of 32 of these stone arrangements, selected to have an unambiguous direction, and some of which are shown in Fig. 1. The measurements were taken from the site cards held by the National Parks and Wildlife Service, and the sites were selected so that only reliable surveys were included (see Hamacher et al. (2012) for full details). However, the original surveyors did not always indicate whether their directions were relative to true or magnetic north, thus introducing an uncertainty of $\sim 12^\circ$, corresponding to the magnetic declination (the difference in bearing between true north and magnetic north). Here we have accommodated this ambiguity by rebinning the data used by Hamacher et al. (2012) into 15-degree bins, which is larger than the $\sim 12^\circ$ magnetic declination, thus minimising the effect of the ambiguity. The results are shown in Figure 2. Over half the stone rows are oriented either north-south or east-west.

To determine whether this result could be caused by pure chance, we have performed a “Monte Carlo” test on these results, which means that we have constructed a large number of models of stone rows in a computer program, varying the bearings randomly. Of the one million tests conducted, less than 1000 showed peaks as high as those shown in Fig. 2, which means that the probability of getting the result shown in Figure 2 by chance is less than 0.1%. It is therefore clear that, unless there is an error in either the surveys or in the site selection, the builders of the rows deliberately aligned them either north-south or east-west, with an accuracy of a few degrees.

Without a compass or similar technology, it is very difficult to find due north, or due west, to this accuracy. For example, the position of the setting sun is a poor guide, as it ranges over the year from north-west to south-west in New South Wales. While a geometrical construction based on the Southern Cross is sometimes used nowadays to find due south, it only works because someone else has already worked out the required construction, using careful astronomical observations. Ultimately, to measure the cardinal directions to an accuracy of a few degrees requires astronomical observations. For example, one technique is to view the setting sun from a particular place over the course of a year, using a stone or stick to mark the position on the horizon at which it sets. The mid-point of the resulting line of markers then indicates due west. Thus the existence of these stone rows, accurately aligned north-south and east-west, indicates indirectly that the builders used astronomical observations to determine the direction of north-south and east-west.

3 Bora sites

Bora sites are sacred places in which young Aboriginal males were initiated. They generally consist of two circles of different diameter connected by a pathway. The larger circle is regarded as a public space, while the smaller circle is restricted to the initiates and elders. Fuller et al. (2013) have conducted an analysis of the orientation of Bora sites in NSW and Queensland, and find that they are preferentially aligned to the south, as shown in Figure 3. This is consistent with the hypothesis (Love 1987, 1988) that Bora ceremonial grounds in southeastern Australia have a preferred orientation to the celestial emu in the Milky Way in the south-southwest skies. Not only does this support the idea that orientation is an important factor in the construction of Aboriginal ceremonial sites, but it also supports the putative link...
between these sites and the sky.

Figure 2 Histogram of the orientation of the stone rows, adapted from Hamacher et al. (2012). 0° corresponds to north-south, and 90° corresponds to east-west.

Figure 3 Histogram of the orientation of the bora sites, taken from Fuller et al. (2013).

4 Stone arrangements in Victoria

4.1 Wurdi Young

Wurdi Youang is an egg-shaped Aboriginal stone arrangement in Victoria, Australia, shown in Figure 4. Norris et al. (2013) have presented a new survey of the site, which shows that its major axis is aligned within a few degrees of east-west, and confirms a previous hypothesis (Morieson 2003) that a selection of outlier stones have been placed so that, when viewed from the largest stones in the arrangement, they are aligned to the position on the horizon of the setting sun at the equinox and the solstices. Furthermore, Norris et al. find that the straight sides of the arrangement also indicate these same directions to the solstices, and that the three prominent stones at the western apex of the arrangement, as viewed from the eastern apex, mark the point where the sun sets at equinox. The astronomical alignments at this site are therefore indicated by two independent sets of indicators, shown in Figure 5. Norris et al. also use a Monte Carlo analysis to show that these alignments are unlikely to have arisen by chance. They therefore conclude that the builders of this stone arrangement appear to have deliberately aligned the site on the astronomically significant positions of the setting sun at the solstices and equinoxes. It should be noted that, unlike stars, the apparent position of the Sun is not affected by precession of the equinoxes, and so this position on the horizon does not vary significantly with time, and cannot be used to date the site.

Wurdi Youang is the only Aboriginal site known to indicate significant astronomical positions on the horizon other than the cardinal points, and, unless it is a statistical freak or a hoax, suggests that other such sites may be discovered in the future.

4.2 Carisbrook

Massola (1963) reported the rediscovery of a remarkable stone arrangement near Carisbrook, Vic., shown in Figures 6 and 7. It is described by Massola as a boomerang shape. While its purpose is unknown, it is likely to have been a ceremonial site, and it is possible that the large and small rings represent Bora rings similar to those found in NSW. The position of the rings relative to the large boomerang arrangements also resembles the position of the large and small Magellanic Clouds relative to the Milky Way, although we know of no
Figure 5 A plan of the Wurdi Youang stone arrangement, adapted from Norris et al. (2013). The arrows indicate the directions to the equinoxes and solstices, and are superimposed on the outliers, left, and the ring (right). Note that these directions are not adjusted to fit the ring, but are defined astronomically. Thus while the straight sections of the ring are not well defined, and not exactly straight, this diagram shows that they are well aligned to the same astronomical directions as the alignments over the outliers.

Additional evidence to support this hypothesis.

Here we point out that the arrangement is remarkable in that the “boomerang” turns through a full right angle along its length, and is therefore unlike conventional boomerangs used in south-east Australia, which typically turn through a smaller angle. Furthermore, we point out that one end of the arrangement is oriented east-west, while the other is oriented north-south, each with an accuracy of a few degrees. As in the case of the linear stone arrangements described above, such precision can only be achieved by making astronomical observations.

4.3 Other Victorian Stone Arrangements

These studies of stone arrangements are hindered by the sparsity of data. For example, only four major stone arrangements in Victoria have been reported in the literature, and so the evidence of knowledge of the position of the Sun at the solstices relies on just one site - Wurdi Youang. However, several other putative stone arrangements are known to the authors, such as that shown in Figure 8, and there may well be others, but they lack the archaeological or ethnographic evidence that would enable them to be classified as Aboriginal stone arrangements.

5 Conclusion

The published literature already shows unequivocally that Aboriginal Australians had a deep knowledge of the sky, and were aware of many celestial phenomena. Their knowledge went far beyond simply telling stories of the constellations. Instead, they appear to have been engaged in building a self-consistent, but culturally appropriate, framework which explained the phenomena observed in the sky. This search for understanding resembles modern-day science, and so is sometimes labelled “ethnoscience” (e.g. Ruggles 1997).

Here we have shown that this knowledge is evident in the construction of stone arrangements. We are careful not to imply that the stone arrangements are “astronomical observatories”, as we do not know the function or purpose of the stone arrangements. However, it is clear from the evidence presented in this paper that their construction reveals a significant knowledge of astronomy, and particularly knowledge of the motion of the Sun.

Stone arrangements tend to be under-represented in the literature, and evidence suggests that there are many stone arrangements that have not yet been recorded or classified. It is important that they be examined and classified, and if appropriate catalogued and protected, so that we may use them to understand more of the pre-contact Aboriginal cultures that were so badly damaged by the European occupation of Australia. Perhaps that knowledge may even be used to help repair some of the damage inflicted on those cultures in the past.

Figure 6 Aerial view of the Carisbrook stone arrangement, reprinted with permission of VAS (1996).
Figure 7 Plan of the Carisbrook stone arrangements, adapted from Coutts & Witter (1977). Azimuths are measured relative to true north.

6 Acknowledgements

We acknowledge and pay our respects to the Australian Aboriginal people and elders, both past and present, and in particular to the builders and the traditional owners of the stone arrangements discussed in this paper. We thank John Morieson for initially introducing us to the Victorian stone arrangements.

Figure 8 View of a putative stone arrangement on Mt. Barker, Vic. The arrangement appears similar to those studied in NSW by Hamacher et al. (2012), and has an orientation roughly north-south, but it has not yet been classified in the literature as an Aboriginal stone arrangement.
References

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