Mediterranean Archaeology and Archaeometry, Vol. 18, No 4, (2018), pp. 477-484

DOI: 10.5281/zenodo.1477964

THE REAPPEARING SUN IN NEOLITHIC ORCADIAN LANDSCAPE AND CULTURE

Victor Reijs

Independent citizen scientist
(victor.reijs@archaeocosmology.org)

Received: 28/02/2018
Accepted: 16/05/2018

ABSTRACT

This paper attempts to answer the question if the skyline phenomenon of the reappearing Sun can be seen from several monuments as part of an Neolithic Orcadian culture? Several sites are evaluated.
Within Maeshowe (a chambered cairn) one can experience the Winter Solstice Sun, but also the reappearing setting Sun some 20 days before/after Winter Solstice day behind Ward Hill and reappearing for a few minutes at the right slope of Ward Hill. This phenomenon looks not to have been witnessed in historic past.
As this reappearing Sun is a phenomenon of the skyline (fore sight) due the steep slope of the two hills; it can also be witnessed at other locations (back sights) on Orkney. Based on visual 4D computer simulations; the Sun's reappearance has been recorded at Ness of Brodgar and Breckness settlements in 1999. At that time Historic Environment Scotland was informed about the possible archaeological importance of the Ness of Brodgar and Breckness. Chance artefacts and recent excavations at Ness of Brodgar show that there is indeed significant archaeology in the form of a large likely ceremonial centre.
Interviews were broadcasted in 1997, 2000 and 2012 by Radio Orkney and BBC Scotland to ask listeners/viewers for experiences around the reappearing Sun. This provided a link to a contemporary sighting of light reflections on Ward Hill.
Several interpretations of the landscape with its built environment are provided: from the possible conscious perception of the reappearing Sun; through a symbolic link with the possibly sacred Hoy hills; to the incorporation of such foci into humanised space that links sky, land and humans with an annual rhythm: a possible pilgrim route.

KEYWORDS: Visual 4D simulation, Orkney, Hoy, Neolithic monuments, Archeaoastronomy, Maeshowe, Ness of Brodgar, Breckness

1. INTRODUCTION

This paper presents an overview of horizon phenomena relating to the reappearing Sun from several monuments part of Neolithic Orcadian culture in Scotland. A well-known monument on the Mainland in Orkney is Maeshowe, a chambered cairn dating from between 3100 to 2700 BCE (Ashmore, 1989). It is commonly known that the Sun gets into Maeshowe's chamber around Winter Solstice (WS), but there is more to experience inside that chamber. Well before and after the present-day Winter Solstice (some 20 days) the Sun sets and then reappears from behind Ward Hill, a hill on the island of Hoy (Figure 1). Witnessing this phenomenon in 1998 for the first time in historic times (no documentation has been found that mentions this), was a very exciting and unforgettable event.

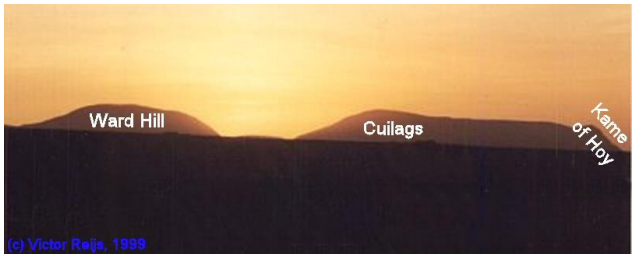

Figure 1 Skyline seen from Maeshowe, Orkney.

To an observer standing in front of Maeshowe; some 41 days before/after present day WS, the Sun reappears from behind the right slope of Cuilags (Kame of Hoy), before it finally sets. This reappearance can though not be witnessed from within Maeshowe (Reijs, 2001).

As this reappearing Sun is due the steep slope of the hills, aka a horizon phenomenon (fore sight), it can also be witnessed at other locations on Orkney. Based on computer simulations, the Ness of Brodgar and Breckness were recorded in 1999 (Reijs, 2001).

The Sun's yearly play with the skyline has been broadcasted (from December to February) over the Internet from 1997 (Reijs, 1997; Tait, 2002).

1.1. Methodology

A selection of monuments (back sights), with reappearing Sun on different days, has been observed with theodolite and recordings. To allow future desktop evaluation of locations, computer based skyline profiles have been benchmarked with theodolite measurements. Unstructured interviews were held with landowners, observers and an astronomer. Interviews were broadcasted on December 1997, November 2000 and April 2012 by Radio Orkney to ask listeners for experiences around the reappearing or reflecting Sun. For cultural/anthropological interpretation, literature was studied.

2. OBSERVING THE LANDSCAPE

This section will cover observations and recordings perfomed during visits to Orkney.

2.1. Geography and geology of Orkney

Mainland, the biggest island of Orkney, is some 35 km north of mainland Scotland: ~59° North and ~3° West. Mainland's geology consists of Middle Old Red Sandstone flagstone, which provides good building material. Hoy is an island south of Mainland, separated by Hoy Sound. The Hoy hills are relatively high, barren, wet and they consist of Hoy sandstone, which is Upper Old Red Sandstone (Davidson and Henshall, 1989).

2.2. Earlier research

A 4D (3D plus time) computer model of Maeshowe's passage, chamber, landscape and skyscape was constructed (Reijs, 1996, 1998). This provided the visual proof that, beside the broad WS Sun, the Sun light reappears within the chamber for about one minute, when the Sun reappears from behind Ward Hill about 20 days before and after WS. This was recorded on December 1st, 1998. The main reason why this was not witnessed in the past, is that the reappearing happens some 10 minutes after the usual Sun light has disappeared and people would have left by then the chamber (Reijs, 1999a).

In 1997 MacKie (1997) described also Maeshowe's broad WS Sun setting, and a reappearing Sun around 23 and 45 days before/after WS 2700 BCE. MacKie relates these events to Alexander Thom's Megalithic Month (Thom, 1967), which are 22 to 24 days long. MacKie did though not recognise that the reappearing Sun light can be seen within Maeshowe's chamber.

If Maeshowe was located with such a horizon phenomenon in mind, there might be a chance that other monuments on Orkney were also related to such reappearances. Furthermore Ward Hill's and Kame of Hoy's steep slopes can be seen from many Neolithic monuments (Reijs, 1999b). The many chambered cairns on Orkney might have been placed at the boundary of visibility/non-visibility of the summits of Ward Hill and the Cuilags (Reijs, 2012).

The reappearing Sun would have occured near WS 3000 BCE at Ness of Brodgar from behind Ward Hill) and at Breckness from behind Kame of Hoy) (Reijs, 2001). This reappearing can be witnessed over a distance of several hundred meters centred around Brodgar Farm, due to the relative small distance of the hills. In 1999 this was communicated to Historic Environment Scotland and the local archaeologist was asked if there was significant archaeology pre-

sent at these locations, which could indicate a ceremonial environment. According to their knowledge and the then Canmore database: no significant archaeology was known.

In 2002 a geophysical survey was done at the Ness of Brodgar and when a notched stone was ploughed up, an excavation was performed in 2003 (Ballin Smith, 2003). Considerable archaeology, in the form of a large likely ceremonial centre, was found and further excavations were done from 2004 and are still continuing (Card, 2017). No recent archaeological work has been done at Breckness, although the author has found considerable evidence of archaeological remains while walking ploughed fields in 2012.

2.3. Tools to determine skyline profile

2.3.1. Theodolite skyline profiling

Skyline altitude (in this paper 'altitude' is equivalent to 'apparent altitude', so including refraction and parallax) were based on theodolite measurements. A workflow was designed to evaluate the measurements through: computation of Sun/Moon azimuth altitude and their semi diameters; compensation of altitude scale; precision/accuracy analysis; and graphing to sanity check measurements (Ghilani, 2004; Reijs, 2006).

Some results from the theodolite measurements:

- From Maeshowe the right slopes of Ward Hill and Cuilags cause a reappearing Sun several days before WS day. Around its construction time (~2900 BCE) the reappearance would be respectively ~26 and ~45 days from WS.
- Standing (around 3150 BCE) at the north-west of the Ness of Brodgar's lesser wall, the Sun would reappear from behind the right slope of Ward Hill some 5 days before/after WS. The reappearing Sun around 3150 BCE would happen at WS more or less at the Brodgar Farm location.
- As Breckness is close to the Cuilags' right slope (around 5km), a large area will experience a reappearing WS Sun over many epochs (Reijs, 2001).

2.3.2. Computer generated skyline profiling

Two computer skyline profiling services were evaluated: standalone software by Fernando Patat (2011); and the Web Service called HeyWhatsThat from Michael Kosowsky (2012). All use height-data gathered during the Shuttle Radar Topography Mission (SRTM). For American locations the height is averaged over 30 m (SRTM30) and for the rest of the world it is averaged over 90 m (SRTM90), with an average-height precision of 2 to 8 m. In environments with steep hills, the accuracy of the average-height compared to the actual height can be lower and some STRM data can be missing if the surface was in the radar's shadow. The CGIAR initiative (CGIAR-CSI, 2017) has tried to eliminate most of the SRTM data limitations (but not all, see below). Patat's software use CGIAR and HeyWhatsThat uses raw SRTM. The skyline profile can be off due to limitations of SRTM data. This has been checked with photometric surveys, and no significant errors were seen.

2.3.3. Evaluation of tools

Comparing Maeshowe's skyline points measured by MacKie with author's measurements gives average difference for azimuth ~0.03° and for altitude ~0.003°. Including the theodolite's standard deviation this gives and overall standard deviation for azimuth ~0.03° and for altitude ~0.004°. This translates into a declination's standard deviation σ_{decl} ~0.01° (in this paper 'declination' is equivalent to 'topocentric declination', aka including parallax and excluding refraction).

By comparison: measurements with a compass/clinometer would have an accuracy of around: σ_{azi} ~1° and σ_{alt} ~0.25°.

The computer based skyline profiles have a σ_{azi} ~0.8°/distance and σ_{alt} ~0.15°/distance (distance in [km]) (Patat, 2011). In the Orcadian environment (around 5km horizon distance): the σ_{azi} ~0.15° and σ_{alt} ~0.03°. Computer based skyline profiles are in most instances more accurate than compass/clinometers, **but** checking at the monument (ground-truthing) is essential (Ruggles, 1999), as computer generated skyline profiles can have severe limitations!

2.4. Interaction between landscape and skyscape

The phenomena in Orkney happen somewhere on the horizon (the fore sight) and the phenomenon can be seen (best) from a certain position in the landscape (the back sight).

As the steepness of the Hoy hills is larger than the set angle of the Sun's path, reappearing can happen. The approximate rise/set angle of the Sun's path is (North, 1996):

Angle = arcos(sin(latitude) *cos(declination))

At the solstices, this rise/set angle would be ~20° in Orkney. The natural angle of repose for most granular natural material (sand, gravel, clay, etc.) is between 30° and 40° (Lowrie, 2002), so naturally settled hills of such material can results in a reappear-

ing Sun. Solid rock formations can of course have any slope angle.
Another observed phenomenon that could strengthen the importance of the Hoy Hills, is the reflection of Sun light.: Sir W. Scott (Scott, 1871; Harte, 1999) quotes from Dr. Wallace's description (1700 CE) that the Sun around summer months might reflect on Ward Hill's wet surface. A 2001 Radio Orkney interview resulted in finding someone who witnessed the Sun reflections from Bu on Hoy in 1990s.

3. CULTURAL INTERPRETATIONS

Beside the possible alignments at Orcadian Neolithic monuments, both Keith Kintigh (2008) and Brad Schaefer (2004) mention that it is important to investigate the possible anthropological/cultural interpretations of such possible alignments. This section will examine a few possible interpretations. Thomas (2002) points out the existence of a multitude of readings of the landscape during Neolithic times itself: "... as with any symbolic system, the essentially arbitrary nature of this way of attributing meaning to place meant that an endless series of alternative readings was always possible".

And these readings can be seen in the different archaeological layers found at the Ness of Brodgar, Maeshowe and many other places (Richards, 1991). According to David Williams-Lewis & David Pearce (2009), a tension is present between one form of cosmology "which arises 'spiritually' from within human beings ... and another that derives from people's observations of what they see and measure."

In the case of ethnography (where we still can interact with the people) the difference of interpretation between the findings and the initial assumptions of the analyst is called alterity. And according to Martin Holbraad (Holbraad, 2007); the greater the level of alterity the more the analysts have to theorise. For pre-historic studies ethnography is not really possible, so it is likely to have a range of possible interpretations of the Neolithic readings of the landscape.

Amiria Henare (Henare, Holbraad, and Wastell, 2007) reasons that a 'thing' and its 'meaning' can be experienced the same: "things might be treated as sui generis meanings". So keep in mind that 'things' could be "encountered in the field as they present themselves, rather immediately assuming that they signify, represent, or stand for something else." So, for instance 'Thunder is the god Thor' and thus not stating that the thunder represents the Thor and also not analysing thunder and Thor on their own.

Below several cultural interpretations around the reappearing phenomena will be investigated, while the last three interpretations might be more speculative.

3.1. Perception of reappearing Sun

A natural phenomenon (like Sun appearing at a slope) just happens, regardless if a human perceives it or not. It is important to recognise that perception happens at least at two levels: unconsciously and consciously. The difference between the two is that for a human his/her attention has to be captured for a conscious perception of the phenomenon. As soon as one's attention is captured to e.g. the reappearing Sun, it almost looks so obvious; but it needs this essential attention. Arien Mack and Irvin Rock (2000) found that without this explicit attention a human does not perceive consciously a phenomenon. Mack and Rock (2000) found that they could increase the likelihood that a phenomenon gets attention, by positioning it relative to a spatial focus of attention.

Such a spatial focus can be a human or natural construction (aka back sight) as long as the focus in the landscape could be pointed out (also with attention) to others. If that spatial focus is not recorded in some way (verbally, written, rock art or construction), it will be very difficult to get proof beyond reasonable doubt that the phenomenon or not-pointed-out focus was consciously perceived/used (Schaefer, 2004). So, there is always a chance that the phenomenon has not been perceived, even though it looks at present days to be an (obvious) conscious perception.

The reappearing Sun could also have been experienced as an entity (thing/being) from another realm of existence and that such entity could interact with people in the material world. Shifts/alternations in the human consciousness can stimulate such experiences, according to Lewis-Williams and Pearce (2009).

3.2. Symbolic importance of Hoy hills

Tilley describes the likely deliberate spatial organisation of monuments around the Swedish's Ålleberg mountain, which is enveloped in a wealth of mythology (Tilley, 1993). A similar spatial organisation might have taken place on Orkney (Reijs, 2012). Furthermore the type of sand stone on Hoy is different from the Mainland's: On the Mainland the sandstone can be split easily in flags (so good building material) (Davidson and Henshall, 1989). No Hoy sandstone was found in Mainland monuments (Richards, 2013). Beside the reappearing phenomenon that relates to the right slopes of the Hoy hills, there is also the midsummer phenomenon of the reflecting Sun on Ward Hill's wet surface (Scott, 1871). These different phenomena could provide an environment to perceive these Hoy hills as sacred.

A story reported by Sigurd Towrie (Anonymous, 2000) could be related to reappearing Sun rays between Hoy and Breckness region: "When the preach-

ing of Christianity became too much for the trows/fairies, they decided to abandon the Mainland and head out to Hoy. To do this, they strung a straw rope from the Black Craig (2km North of Breckness) to Ward Hill of Hoy and began to climb across. Unfortunately, however, the rope snapped and they fell to their deaths. The one trow who was waiting for them on Ward Hill, upon seeing the others die, howled in anguish before casting himself into the sea".

So, as discussed by Anthony Aveni (Aveni, 2008), a symbolic link between periphery (Hoy hills) and centre (Mainland monuments) might be present.

3.3. Megalithic Calendar

Thom proposed the Megalithic Calendar, where the year is divided in 16 months of 22 to 24 days (Thom, 1967). The distribution of the calendar months was derived from Thom's measurements, assuming building epoch of 1800 BCE. Thom's Megalithic Calendar is not generally accepted in archaeoastronomy (Ruggles and Barclay, 2000). Calendars are reported to be linked to the skyline, such as for the Pueblos of Southwest USA (Zeilik, 1985). This could also be the case for the Hoy hills. Sun rise/set skyline locations could also indicate a date that anticipates the upcoming event (Zeilik, 1985); the problem with an anticipatory date is that one can designate any upcoming event, if there are no historic records.

For Maeshowe at 2900 BCE, the right slope of Ward Hill ($\delta = -21.631^{o}$) is ~26 days from WS and the right slope of Kame of Hoy ($\delta = -17.066^{o}$) is ~45 days from WS. Thom's Megalithic Calendar transposed to 2900 BCE would give: Megalithic Month11/13 ~24 days and Megalithic Month10/14 ~46 days from WS. So, these periods are comparable. At the Ness of Brodgar or Breckness the Megalithic Months certainly don't match up like at Maeshowe.

3.4. A priest-elite in British Isles

The existence of a possible priest-elite in megalithic Britain is a topic of some controversy between MacKie and Ruggles (Ruggles and Barclay, 2000). Thom started this idea by stating that his Megalithic Yard and Calendar were expected to be managed centrally in the British Isles (Thom, 1967).

If such an elite was present in Neolithic times, is not for sure. The supporting argument of Mackie is that large settlements like: the Ness of Brodgar; Barnhouse; and Skara Brae are labelled by archaeologist as ceremonial as they don't have much domestic artefacts. Mackie's standpoint is that full-time professionals are needed to generate and protect knowledge and these groups utilised learning centres, which were stocked/supported by lay people (Towrie, 2012).

In other cultures such elites might have existed. There are recorded examples in the Pueblos of Southwest USA) where astronomical observations could be corrected by other people (Zeilik, 1985). In Babylon vast amount of data was recorded and other people were consulted to audit first lunar crescent observations (Stern, 2008). And according to Klaus Schmidt; Göbekli Tepe could have been a ritual centre for religious purpose (Lewis-Williams and Pearce, 2009).

3.5. Human interaction with Orcadian landscape

Tilley (1994) states that one can't see the landscape as just something natural and opposed to people, but better to see the landscape as totally socialised. Landscape becomes intricately embedded in society: "Humanised places become fashioned out of landscape through the recognition of significant qualities in that what has not in itself been culturally produced (rocks, rivers, trees, etc.) by association with current use, past social actions or actions of a mythological character."

As Thomas (2002) states, if humans construct monuments at their place, these monuments are "thoroughly bound up with human existence and we should be able to interpret them in social terms." Such monument (a spatial focus) could have been built to mark a specific phenomenon. This phenomenon can now be seen in social terms, as the building of this spatial focus changed the way the place is or will be experienced.

This links with Tilley's ideas that rhythms of land/sky will be part of the rhythms of lives/societies: "A fundamental part of daily experiences in non-industrial societies is the physical and biological experience of landscape – earth, water, wood, stone, high places and low places, the wind, rain, sun, stars and sky. The rhythms of the land and the seasons correspond to and are worked into the rhythms of life." The Neolithic monuments in the Mainland's landscape can have such linkage with the rhythms of the sky as several seem to have alignments with celestial events.

Enclosures, walls, platforms, doorways, passages and inner chambers regulated the way people can have access to these places (Thomas, 2002; Stout, 2010). When the Ness of Brodgar settlement got a stone (lesser) wall after 3150 BCE, would there have been a platform at each of the entrances to observe the reappearing Sun? No excavations have yet been performed near these entrances.

3.6. *Mortuary practices*

According to Hedges, the individual's body was first excarnated outdoors and at some moment, perhaps annually, the bones were placed, possible with a public ceremony, into a chambered cairn like Isbister, Mainland Orkney (Hedges, 1984). So the dead keep being important for the living, as they are given a new resting place inside their own territory.

Thomas (2002) states the change from individual to ancestor, comparable to Hedges reasons: "... bones were considered and treated as being representative of a person, someone who was remembered by those that lived after. In time, however, their identity will have been forgotten – they will have simply become one of the ancestors." (Hedges, 1984). Hedges also references to a possible annual event to place the excarnated bones inside a chambered cairn. This could have happened at reappearing Sun: when that phenomenon happens, it signalled the (re)burial of the ancestors.

3.7. *Pilgrimage routes in Orcadian landscape*

The Mainland landscape can be described as special/sacred as it is "a massive ceremonial complex, fragments of which are only now coming to light" (Richards, 1991). In such an environment pilgrimages could have happened. Peter Jan Margry (Margry, 2008) gives a definition of pilgrimage: "... a journey based on religious or spiritual inspiration, undertaken by individuals or groups, to a place that is regarded as more sacred or salutary than the environment of everyday life, to seek a transcendental encounter with a specific cult object for purpose of acquiring spiritual, emotional or physical healing or benefit."

It is likely that pilgrimage routes existed between the major monuments in this area as there exist directions from: Standing Stones of Stenness towards Barnhouse Structure 8; and Ness of Brodgar's Structure 10 towards Maeshowe area. The precise dates of all these monuments are not known, but one could see the Standing Stones of Maeshowe contemporary with the Standing Stones of Stenness and Barnhouse Structure 8 but earlier than the Ness of Brodgar's Structure 10. These monuments could serve as 'stations' in the landscape for people's movement (Thomas, 2002). No evidence has been found or excavated.

4. CONCLUSIONS

This research project has looked at several aspects of the reappearing Sun in Neolithic Orcadian culture.

First of all the skyline profiles were measured more accurate/precise with a theodolite. Computer based skyline profiles have been checked against these theodolite measurements and were found to be more accurate/precise than compass/clinometers readings; but one always has to verify by ground-truthing, certainly for nearby skylines.

The phenomenon of a reappearing Sun (Figure 2) behind a slope that is steeper than the Sun's path has been analysed for a few Orcadian monuments/settlements (Maeshowe, Ness of Brodgar and Breckness) and this showed that reappearing does not always happen on specific celestial events (like equinox/standstill), but regardless of that; it happens. This reappearing could have been seen as a special phenomenon or entity/thing.

The reappearing phenomenon can be witnessed at many places in the Orcadian landscape and Neolithic monuments are (still) unearthed at many places. So what makes a Neolithic monument a human spatial focus for a reappearing phenomenon?

Several interpretations of the landscape with its built environment have been provided, from the possible conscious perception of the reappearing Sun and a symbolic link with the possibly sacred Hoy hills, through incorporating such foci into humanised space that links sky, land and humans with an annual rhythm. The journeys between the foci can be just as important as the foci themselves and these journeys might have been indicated by certain pointers included in the foci.

The reburial of ancestors' excarnated bones could be regulated by annual events and a (horizon) calendar could have been used to synchronise the different societies/tribes on Orkney. If this calendar was a formal calendar managed by a priest-elite, is not known, but non-utilitarian settlements could point to a class society.

This research leaves a lot of questions unanswered and new questions are added. Such as: Were there platforms near the (lesser) walls at the Ness of Brodgar?; Are there artefacts linking the monument to the reappearing phenomena?; Did humans made spatial foci at Breckness (even though the horizon is so near)?; etc.

So on the journey of understanding Neolithic Orcadian culture, another small step has been placed. I am sure more steps will be placed.

Figure 2 Reappearing Sun behind Ward Hill on December 21st 1999 seen from Ness of Brodgar.

ACKNOWLEDGEMENTS

I want to thank everyone, and in particular: staff of Historic Environment Scotland, Joke Jansman, Doug Schwartz and Charles Tait, who all helped me with informing, producing and reviewing this paper. I also want to thank the reviewers for their constructive contributions. Any remaining errors in methodology or results are my responsibility of course.

REFERENCES

Anonymous. (2000) The death of the mainland trows. Orkneyjar.com, In http://www.orkneyjar.com/folklore/trows/trowdeath.htm [accessed 15 September 2017].

Ashmore, P. (1989) *Maes Howe.* Edinburgh, Howie&Seath.

Aveni, A. (2008) The role of astronomical orientation in the delineation of world view: A center and periphery model. In A. Aveni (ed.), *Foundations of new world cultural astronomy: A reader with commentary.* pp. 253–272. Boulder, University Press of Colorado.

Ballin Smith, B. (2003) *A new late Neolithic house at Brodgar Farm, Stenness, Orkney.* Glasgow, GUARD.

Card, N. (2017) Excavation background. Ness of Brodgar trust, In *https://www.nessofbrodgar.co.uk/the–discovery/* [accessed 5 Februari 2018].

CGIAR–CSI. (2017) SRTM 90m Digital Elevation Data. The CGIAR consoritum for spatial information, In *http://srtm.csi.cgiar.org/* [accessed 5 Februari 2018].

Davidson, J. L., and A. S. Henshall. (1989) *The chambered cairns of Orkney: an inventory of the structures and their contents.* Edinburgh University Press.

Ghilani, C. D. (2004) *Astronomical observation handbook.* (The Pennsylvania State University). In *https://www.scribd.com/document/192238972/Astronomical–Observations–Handbook–Charles–D–Ghilani* [accessed 30 June 2017].

Harte, J. (1999) The enchanted carbuncle of the northern hills. *3rd stone,* Vol. 33, p 35.

Hedges, J. W. (1984) *Tomb of the eagles: A window on stone age tribal Britain.* Oxford, Tempvs Reparatvm.

Henare, A. J. M., M. Holbraad and S. Wastell. (2007) *Thinking through things: Theorising artefacts ethnographically.* Routledge.

Holbraad, M. (2007) The power of powder: Multiplicity and motion in the divinatory cosmology of Cuban Ifa. In Amaria Henare, Martin Holbraad and Sari Wastel (eds.), *Thinking through things; Theorising artefacts ethnographically.* pp. 189–225. Abingdon, Routlege.

Kintigh, K. W. (2008) I wasn't going to say anything, but since you asked. In A. Aveni (ed.), *Foundations of new world cultural astronomy: A reader with commentary.* pp. 803–805. Boulder, University Press of Colorado.

Kosowsky, M. (2012) HeyWhatsThat. In *http://www.heywhatsthat.com/* [accessed 10 March 2012].

Lewis–Williams, D., and D. Pearce. (2009) *Inside the Neolithic mind: Consciousness, cosmos and the realm of the gods.* Thames & Hudson.

Lowrie, R. L. (2002) *SME Mining reference handbook.* Society for mining, metallurgy, and exploration.

Mack, A., and I. Rock. (2000) *Inattentional blindness.* The MIT Press.

MacKie, E. W. (1997) Maeshowe and the winter solstice ceremonial aspects of the Orkney grooved ware culture. *Antiquity,* Vol. 71, pp. 338–359.

Margry, P. J. (2008) Secular pilgrimage: A contradiction in terms? In Peter Jan Margry (ed.), *Shrines and pilgrimage in the modern world: New itineraries into the sacred.* pp. 13–48. Amsterdam University Press.
North, J. D. (1996) *Stonehenge: Neolithic man and the cosmos.* London, HarperCollins.
Patat, F. (2011) Horizon synthesis for archaeo–astronomical purposes. *Astronomische Nachrichten,* Vol. 332, pp. 743–749.
Reijs, V. M. M. (1996) Maeshowe. In http://www.archaeocosmology.org/maeshowe/eng/scot10.htm [accessed 30 June 2012].
Reijs, V. M. M. (1997) Geniet: Research on Maeshowe, Orkney, UK. In http://www.archaeocosmology.org/maeshowe/ [accessed 8 February 2018].
Reijs, V. M. M. (1998) Maeshowe's Megalithic Month alignment. *3rd stone,* pp. 18–20.
Reijs, V. M. M. (1999a) Reappearing sun light in Maeshowe, Orkney. YouTube. In http://www.youtube.com/watch?v=Wsp2LAE12ho.
Reijs, V. M. M. (1999b) Views towards Ward Hill and Cuilags, Orkney. In http://www.archaeocosmology.org/maeshowe/eng/horizons.htm [accessed 4 March 2012].
Reijs, V. M. M. (2001) The reappearing sun at Orkney. In http://www.archaeocosmology.org/maeshowe/eng/flashing.htm [accessed 4 March 2012].
Reijs, V. M. M. (2006) ARCHAEOCOSMO. In http://www.archaeocosmology.org/eng/archaeocosmoprocedures.htm [accessed 5 July 2012].
Reijs, V. M. M. (2012) The reappearing Sun in Neolithic Orcadian culture. In http://www.archaeocosmology.org/eng/VictorReijs–ReappearingSun–014–web.pdf [accessed 15 October 2012].
Richards, C. (1991) *Maeshowe 1991 Phase 3 structures report.* University of Glasgow.
Richards, C. (2013) *Building the great stone circles of the North.* Windgather Press.
Ruggles, C. L. N. (1999) *Astronomy in prehistoric Britain and Ireland.* London, Yale University.
Ruggles, C. L. N., and G. Barclay. (2000) Cosmology, calendars and society in Neolithic Orkney: a rejoinder to Euan MacKie. *Antiquity,* Vol. 74, pp. 62–74.
Schaefer, B. E. (2004) Case studies of three of the most famous claimed archaeoastronomical alignments in North America. in *Oxford VII.* Flagstaff Az.
Scott, W. (1871) *The pirate.* Edinburgh, A. & C. Black.
Stern, S. (2008) The Babylonian month and the new moon: sighting and prediction. *Journal for the History of Astronomy,* Vol. 39, pp. 19–42.
Stout, G. (2010) Monumentality and inclusion in the Boyne Valley, County Meath, Ireland. In T. Darvill, J. Leary and D. Field (eds.), *Round Mounds and Monumentality in the British Neolithic and Beyond.* pp. 197–210. Oxbow Books.
Tait, C. (2002) Maeshowe Winter solstice Sunset. In http://www.maeshowe.co.uk/ [accessed 5 December 2017].
Thom, A. (1967) *Megalithic sites in Britain.* Oxford, Oxford University Press.
Thomas, J. (2002) *Understanding the Neolithic.* London, Routledge.
Tilley, C. (1993) Art, architecture, landscape: Neolithic Sweden. In B. Bender (ed.), *Landscape: Politics and perspective.* pp. 49–84. Oxford, Berg Publishers.
Tilley, C. (1994) *A phenomenology of landscape: places, paths and monuments.* Oxford, Berg Publishers.
Towrie, S. (2012) Resurrecting the Neolithic priesthood… Interview with MacKie. In https://web.archive.org/web/20171012072730/http://www.orkneyjar.com/archaeology/2012/01/10/resurrecting–orkneys–neolithic–priesthood/ [accessed 12 October 2017].
Zeilik, M. (1985) The ethnoastronomy of the historic Pueblos, I: Calendrical Sun watching. *Archaeoastronomy,* Vol. xvi, pp. S1–S24.