Is it possible to demonstrate that some of the standing stones of south-west Meirionnydd are positioned on long distance intentional alignments of celestial significance?

by Ingrid O'Donnell

Prehistoric stone rows of western Europe remain unexplained, commonly assigned funerary or ceremonial functions, but with little further explanation being provided. Previous research has focussed on short stone rows, since long distance associations between standing stones are considered very difficult to prove. This paper presents evidence for the existence of two separate, high precision, long distance alignments of standing stones within a topographically-distinct study area in Snowdonia (Wales, UK). The possible celestial significance of both alignments is examined and reviewed in the context of the rich ethnographic folklore heritage of the study area, additionally revealing interesting potential cross-cultural skylore parallels

Introduction

The primary aim of this paper is to argue for the existence of intentional, long distance, linear arrangements of standing stones, which, in length, far exceed not only the 10–25m long 'short' stone rows studied by Clive Ruggles[1], but also the 'long' rows (*c.* 1 km) mentioned by Aubrey Burl.[2] A secondary aim is to suggest possible reasons of celestial significance for such alignments, which may therefore be indicative of prehistoric astronomical activities within the study area, possibly relating to the study area's folklore heritage.

The study area comprises a topographically-distinct region of south western Meirionnydd (Gwynedd, Wales, UK) which is part of the Snowdonia National Park and is defined by the River Dyfi to the south, the River Mawddach to the north, Cardigan Bay to the West and an arbitrary eastern

[1] Clive Ruggles, *Astronomy in Prehistoric Britain and Ireland* (New Haven and London: Yale University Press, 1999), p.102.

[2] Aubrey Burl, *From Carnac to Callanish: The Prehistoric Stone Rows and Avenues of Britain, Ireland and Brittany,* New Haven: Yale University Press, (1993), pp. 91–93.

boundary producing a manageably-sized study area of *c.*24 km x 20 km (see Figs 1a & 1b). The centre of the study area is dominated by the highest mountain of the region, Cadair Idris (893m) and, also includes the scenically dramatic upland plateaux of Cregennan and Allt Lwyd. Due to the density of prehistoric archaeological remains found on these plateaux, they have been described[3] as foci of ritual and funerary significance. George Smith[4], who recently carried out a survey of the prehistoric funerary and ritual sites of Meirionnydd for Gwynedd Archaeological Trust, has suggested that the Cregennan area is likely to have been a prehistoric ceremonial centre.

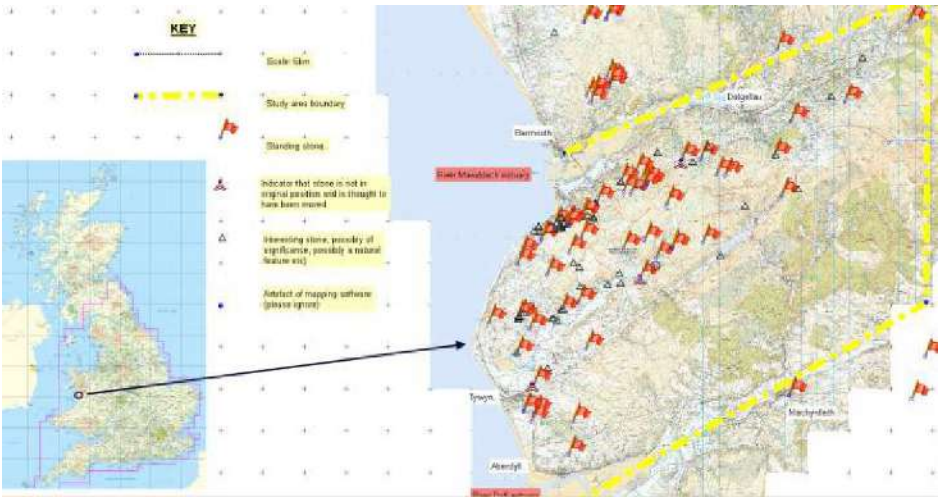


Figure 1a: Map depicting distribution of standing stones within south-west Meirionnydd study area. (Grid North is at the top of the map. Standing stone coordinates either from literature review or GPS site visit.)

[3] Gwynedd Archaeological Trust 'Heneb: Mawddach Character' http://www.heneb.co.uk/mawddach/mawddachcharintro/mawddachintro.html [accessed 22/10/16].

[4] George Smith, 'A Survey of Prehistoric Funerary and Ritual Sites in Meirionnydd, 2000–2001', *Journal of the Merioneth Historical and Record Society*. Vol XIV (II) (2003), p. 115.

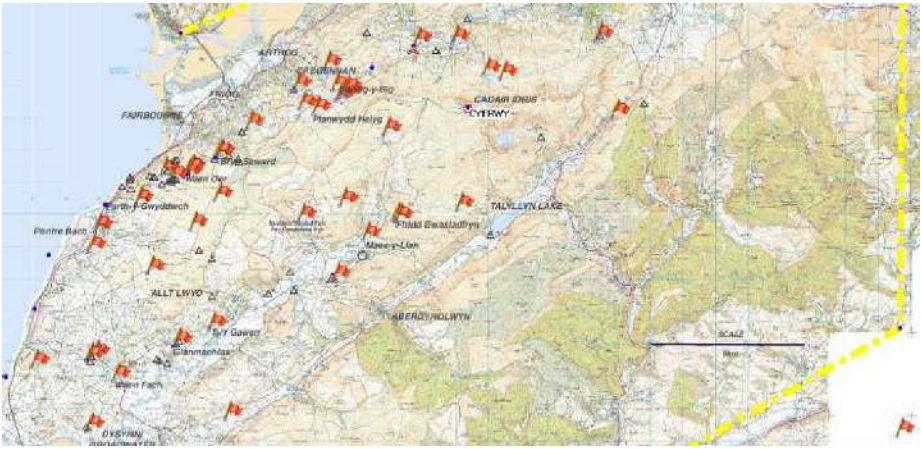


Figure 1b: Close up of standing stones within centre of study area. (Grid North is at the top of the map. Standing stone coordinates either from literature review or GPS site visit.)

Local folklore reveals a rich ethnographic heritage associated with the study area. The name of the central mountain, Cadair Idris, translates into English as 'seat' or 'stronghold' of Idris. In Welsh legend, Idris was a giant, credited as being the 'father of astronomical science'.[5] It is said that he would sit on his mountain-top seat to study the stars.[6] Perhaps the most well-known legend of the area is that anyone who spends a night on the mountain will awake in the morning either a poet or a fool.[7] Other legends of the mountain are that it is the home of Gwyn ap Nudd (also known as Arawn[8]), the black-faced King of the Otherworld and, that his white, red-eared hunting dogs — the

[5] Saint George Armstrong Williams, *The English Works of the late Rev. E. Williams, with a Memoir of his Life*, (London, Craddock & Co, 1840) https://books.google.co.uk/books?id=jQxXAAAAcAAJ&printsec=frontcover&source=gbs_ge_summary_r&cad=0#v=onepage&q&f=false [accessed 21/10/16].

[6] John Koch, *Celtic Culture: A Historical Encyclopaedia*, Vol. 1. ABC-Clio (2006), p. 312.

[7] Sion Dafydd Rhys, 'The Giants of Wales and their Dwellings' in www.maryjones.us/ctexts/giants_wales.html [accessed 22/7/2016].

[8] *Jones's Celtic Encyclopedia*, 'Arawn', http://www.maryjones.us/jce/arawn1.html [accessed 21/10/16].

'Cwn Annwn', chase departed souls to the ancient Welsh Otherworld[9, 10] — a place of bliss, abundance and eternal youth.

Literature review

Definitive dating of the study area's archaeological remains is difficult, with few radiocarbon dating results reported. Whilst a variety of monuments (including standing stones, stone circle, cairns, ring cairns and cists) in the Bryn Seward / Cyfannedd forest area are said to have been "firmly" dated to the Neolithic / Bronze Age period[11], archaeological reports typically date the remains as 'Prehistoric', 'Bronze Age' or, at the most precise 'Early Bronze Age'. This dating is based primarily on the opinion and expertise of the archaeologist(s) making the assessment, but also on the proximity of other monuments (such as cairns) where dating results are available for similar sites in other parts of Wales. For example, with regard to standing stones, George Williams[12] has observed that in Wales as a whole, standing stones are frequently found close to burials dating from the Early Bronze Age. The Bronze Age period for the current study area is frequently referenced by entries in the Gwynedd Archaeological Trust Historic Environment Record online database 'Archwilio' to date between 2,300 BCE to 800 BCE.[13]

Despite Smith's[14] assessment of the importance of the area, and although a number of other detailed archaeological surveys[15] of the wider region have

---

[9] Geraint Roberts, *The Lakes of Eryri*, Gwasg Carreg Gwalch, Iard yr Orsaf, Llanrwst, Gwynedd, Wales (1995), p. 136.

[10]Oxford Reference, http://www.oxfordreference.com/view/10.1093/oi/authority.20110803095655441 [accessed 27/7/16].

[11] Richard Kelly, 'A Pre-Afforestation Survey at Cyfannedd, Arthog, Gwynedd', *The Bulletin of the Board of Celtic Studies*, XXX (III–IV) (1983), p. 451.

[12] George Williams, *The Standing Stones of Wales and South West England*, Bar Brit. Ser. 197 Oxford (1988).

[13] *Gwynedd Archaeological Trust Historic Environment Record Database*, Archwilio': http://www.cofiadurcahcymru.org.uk/arch/gat/english/gat_interface.html [accessed 21/10/16].

[14] Smith's *A Survey of Prehistoric Funerary and Ritual Sites Survey in Meirionnydd, 2000-2001*, p. 115

[15] 'Gwynedd Upland Survey 1995–1996. *Cadair Idris SSSI. Report and Gazetteer*, Report no 198A. Gwynedd Archaeological Trust; Richard Hayman and Wendy Horton, 'Llanuwchllyn—Llanymawddwy: An Archaeological Survey', *The Uplands Initiative for*

been carried out relatively recently, still little archaeological excavation work seems to have been undertaken since the antiquarian period. However, chance finds have led to the occasional discovery of significant portable artefacts deriving from a wide date range, referenced by separate Primary Record Numbers (PRNs) within the 'Archwilio' Historic Environment Record online database[16], for example: Neolithic stone axes PRN 4879 at Bwlch Gwyn, Fairbourne and PRN 4883 Fegla Fawr, Friog; bronze axes (of Middle to Late Bronze Age type) have been found on the hills between Fairbourne and Arthog (eg PRNs 3286, 4881, 4882, 4877) and a prehistoric gold torc PRN 4104 was found near the prehistoric ancient trackway / drovers' road, known as the Ffordd Ddu (trans. Black Road). These finds confirm the significance of the study area to communities sophisticated for their Neolithic and Bronze Age times.

Previous researchers[17,18] have noted that the "distribution of standing stones in Meirionnydd is dominated by two linear groups", one outside the scope of, and to the north of, the present study area (above the town of Harlech) and, the other within the present study area, above the village of Arthog." Emrys Gresham[19] uses this observation to argue that these groups of standing stones each constitute an extensive line of stones marking ancient routeways e.g. the Fonllech Hir trackway to the north and the previously mentioned Ffordd Ddu track above Arthog which connects with the Broadwater (mouth of the River Dysynni, see Fig. 1b). Smith[17] goes on to argue that the primary function of the stones appears to have been as route markers since they are generally oriented to face tracks.

---

the Royal Commission for Ancient and Historic Monuments Wales, (2012); Richard Hayman and Wendy Horton 'Dinas Mawddwy — Brithdir: An Archaeological Survey', *The Uplands Initiative for the Royal Commission for Ancient an Historic Monuments Wales, (2013).*

[16] 'Archwilio': http://www.cofiadurcahcymru.org.uk/arch/gat/english/gat_interface.html [accessed 24/7/16]

[17] George Smith, 'Prehistoric Funerary and Ritual Sites Survey: Meirionnydd', *Gwynedd Archaeological Trust Project No. G1629*. Report No. 415. Section 6.9.

[18] Smith's *A Survey of Prehistoric Funerary and Ritual Sites Survey in Meirionnydd, 2000-2001*, p. 112.

[19] Emrys George Bowen and C. A. Gresham, *History of Merioneth. Vol 1.*, Merioneth Historical and Record Society, Dolgellau (1967), pp. 56–63.

These arguments are relevant to the present study because they refer to "lines" of standing stones. However, whilst the Ffordd Ddu could be argued to constitute a line, it is not a particularly straight one, since it frequently curves and changes course to follow the easiest approach for walking the mountainous and boggy terrain of the route. To consider alternative possible interpretations of the motivations of the monument-builders of the study area, the siting of the monuments themselves was investigated. The stones are generally sited in locations with dramatic views, often across Cardigan Bay. This setting conforms with Chris Fowler and Vicki Cummings[20] hypothesis of metaphorical associations between water and stone and transformation between life and death in the Neolithic. Therefore, the setting is therefore potentially indicative of carefully considered design.

The fact that the standing stones of the study area do on occasion appear to be oriented on straight lines is exemplified at the most basic level by the straight line formed by the *c.* 80m long Waen Oer Standing Stone Row ('Archwilio' reference PRN 4884[21]) (see Fig 1b), the stones of which appear to be oriented along a straight line with an azimuth of approximately 64º NE / 244º SW from True North).[22]

However, closer inspection of the Waen Oer locality reveals another observation that a straight line with azimuth from True North of 58º NE / 238º SW appears to connect the Waen Oer Stone Row with many of the other significant standing stones of the area over a range of around 27 km. This observation can be confirmed with a ruler and visual inspection of the Outdoor Leisure 23 Cadair Idris & Bala Lake / Llyn Tegid Ordance Survey 1:25,000 map (see Appendix Table A for relevant standing stone National Grid References).

In a wider context, Ruggles states that a considerable number of short standing stone rows were erected across north-west Europe during the Bronze Age. These short stone rows vary in length, typically between 10–25 m with very large stones weighing more than 3–4 tonnes being used only relatively

---

[20] Chris Fowler and Vicki Cummings, 'Places of Transformation: Building Monuments from Water and Stone in the Neolithic of the Irish Sea', *Journal of the Royal Anthropological Institute*, Vol. 9 No. 1 (Mar 2003), p. 1–20.

[21] Gwynedd Archaeological Trust Historic Environment Record Database 'Archwilio': http://www.cofiadurcahcymru.org.uk/arch/gat/english/gat_interface.html [accessed 21/10/16].

[22] Laurence Main, *Lynnau Cregennan Stone Row*, http://www.leyhunters.co.uk/llynnau.html, The Society of Ley Hunters [accessed 19/01/17]

rarely. Although such monuments therefore appear fairly simple to construct, Ruggles states that their purpose remains "completely unclear".[23] He continues that whilst it is generally accepted that short stone rows were not domestic or defensive sites and often appear to have funerary associations, the exact nature of their function remains elusive. He goes on to suggest that the fact that "the rows are 'pointing at' something is an obvious suggestion"[24], but towards the end of his chapter on stone rows he also suggests that perhaps the views perpendicular to the orientation of the row could have been important.[25]

Also relevant to the present study is Burl's[26] suggestion that many short stone rows may originally have evolved from longer linear monuments; however, Burl has previously also commented that long rows are only known to be found in association with short rows in the north of Ireland.[27] Burl comments that on Dartmoor, where exceptionally long rows are found, the average length is around 183m and that these rows are associated with the Early–Mid Bronze Age 1,600 BCE–2,100 BCE.[28] Burl also mentions here that the stone row at Stall Moor is a "startlingly long line" (859m long with 119 stones).[29] Whilst this may be the best–preserved row, the longest stone row in Britain is the Upper Erme (3,320m, 922 stones).[30] It is noteworthy that photographs of these long stone rows, reveal that the rows are rarely strictly linear.[30] Where

---

[23] Clive Ruggles, *Astronomy in Prehistoric Britain and Ireland*, Yale University Press (1999), p. 102.

[24] Ruggles, *Astronomy in Prehistoric Britain and Ireland*, p.103.

[25] Ruggles, *Astronomy in Prehistoric Britain and Ireland*, p. 111.

[26] Aubrey Burl, *From Carnac to Callanish: The Prehistoric Stone Rows and Avenues of Britain, Ireland and Brittany*, (New Haven: Yale University Press, 1993), p. 151.

[27] Burl, *From Carnac to Callanish: The Prehistoric Stone Rows and Avenues of Britain, Ireland and Brittany*, p. 91.

[28] Burl, *From Carnac to Callanish: The Prehistoric Stone Rows and Avenues of Britain, Ireland and Brittany*, pp. 91–93.

[29] *The Stone Rows of Great Britain*, https://stonerows.wordpress.com/gazetteer/region/dartmoor/stalldown/ [accessed 27/7/16].

[30] *The Stone Rows of Great Britain* https://stonerows.wordpress.com/gazetteer/region/dartmoor/upper-erme/ [accessed 27/7/16].

standing stones may be more widely separated, Ruggles maintains that "long distance relationships are very difficult to prove."[31]

Method

Local knowledge and the results of a literature review of online archaeological data[32,33] and archaeological reports[34,35,36,37,38,39,40] were used to attempt to plot every standing stone in the region of south-west Meirionnydd falling between the River Mawddach and the River Dyfi on proprietary mapping software (Memory-Map, Version 5, OS Explorer 1:25,000 (2012), EVO-Distribution Ltd, Aldermaston, UK. PC, GPS, iPhone, iPad, compatible Android devices) over a study area of approximate dimensions 24 km x 20 km. During the course of the study, other standing stones discovered outside of the study area were also recorded (for potential local relevancy to the study area). Basic information about the stones, such as dimensions, age and interesting features were also noted. The initial mapping results (see Figs 1a and 1b) indicate that the standing stones appear not to have a completely random

---

[31] Clive Ruggles, *Records in Stone*, (Cambridge University Press, 2003), p. 322.

[32] *The National Monuments Record of Wales (NMRW)*, 'Coflein', www.coflein.gov.uk [accessed 21/10/16]. Derived from information compiled by RCAHMW and/or Crown copyright.

[33] *Gwynedd Archaeological Trust (GAT) Historic Environment Record (HER) Database*, 'Archwilio', http://www.cofiadurcahcymru.org.uk/arch/gat/english/gat_interface.html [accessed 21/10/16].

[34] 'An Inventory of the Ancient Monuments in Wales and Monmouthshire. VI County of Merioneth', *Royal Commission on Ancient and Historic Monuments in Wales* (1921).

[35] Bowen and Gresham, 'History of Merioneth…'.

[36] Cullen E., Flook R., Burnett A. 2011: 'Better Woodlands for Wales Management Plan.' *Heritage Management Information (WHE1) Tyd Farch Farm BWW Reference No 22127*. Gwynedd Archaeological Trust.

[37] 'Gwynedd Upland Survey 1995-96. *Cadair Idris SSSI (Part) G1322 Report and Gazetteer*. Report No 198A. Gwynedd Archaeological Trust.

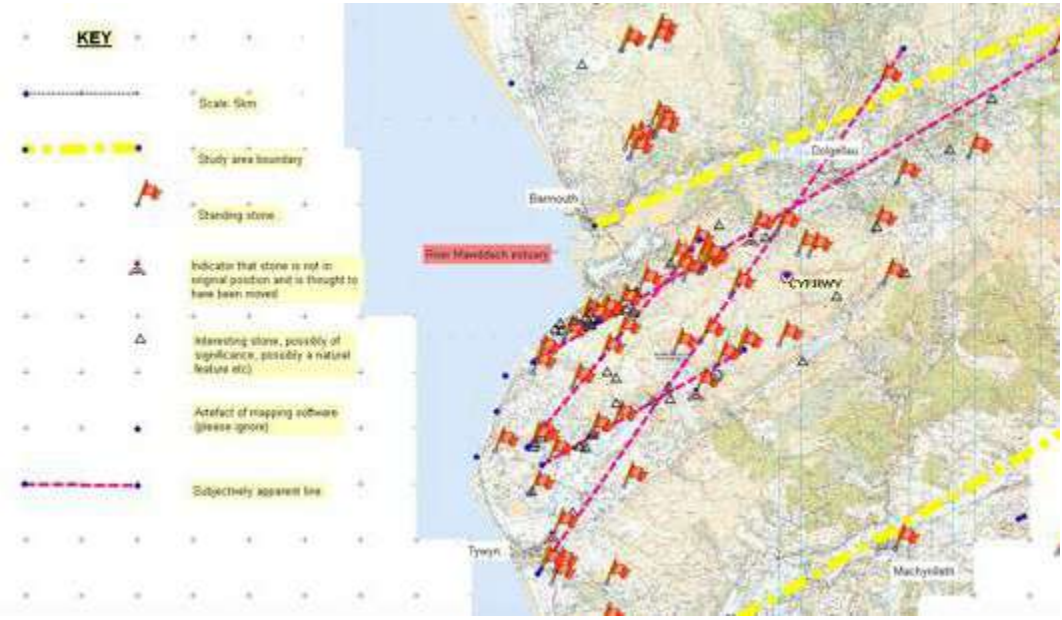
[38] Kelly, Richard Kelly, 'A Pre-Afforestation Survey at Cyfannedd, Arthog, Gwynedd', *The Bulletin of the Board of Celtic Studies*, XXX (III–IV) (1983).

[39] Smith's *A Survey of Prehistoric Funerary and Ritual Sites Survey in Meirionnydd, 2000-2001*.

[40] George Smith, *Fairbourne Waste Water Treatment Scheme Archaeological Assessment 2. The Treatment Works Site*, Prepared for the Symonds Group Ltd. Gwynedd Archaeological Trust (2002).

distribution, with several different linear relationships seeming subjectively apparent over distances of around 10 km–30 km (see Fig. 2).

Figure 2: Map depicting subjectively 'obvious' potential linear relationships between standing stones of south-west Meirionnydd (Grid North is at the top of the map. Standing stone coordinates either from literature review or GPS site visit).



In order to counter any criticisms of selection bias that could be raised if only alignments that seem subjectively apparent (as portrayed in Fig. 2) were investigated, a more objective methodology was attempted which involved drawing out every straight line appearing (on visual inspection) to link three or more standing stones (ignoring those which were reported to have been moved from their original positions and those associated with stone circles). The 49 linear relationships identified by this approach are depicted in Figs 3a and 3b.

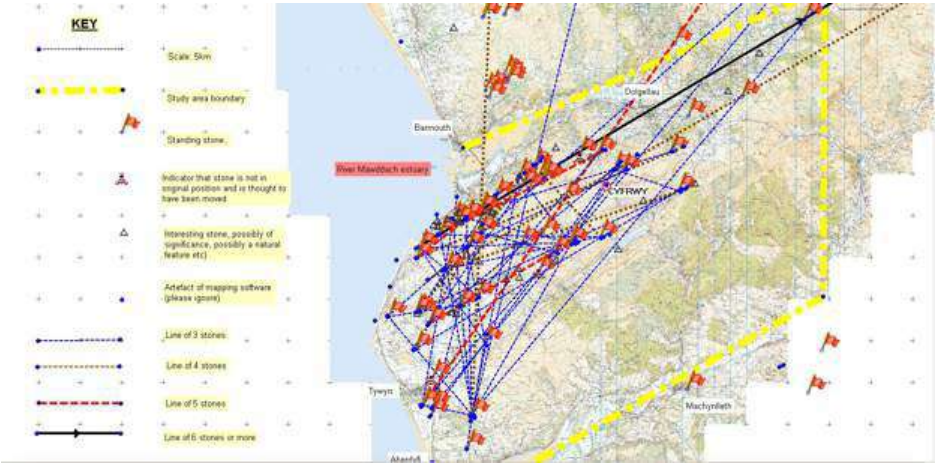


Figure 3a: Map depicting linear relationships between three or more standing stones within the study area (and also those lines which appear to align with standing stones beyond the study area boundaries). (Grid North is at the top of the map. Standing Standing stone coordinates either from literature review or GPS site visit).

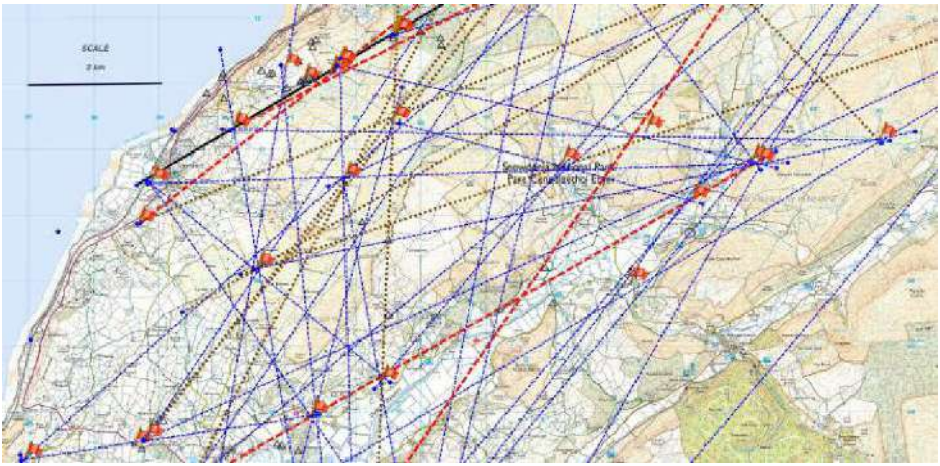


Figure 3b: Close up of linear relationships between three or more standing stones in the centre of the study area (Grid North is at the top of the map. Standing stone coordinates either from literature review or GPS site visit).

It should be noted that since it is possible for any of the linear relationships indicated in Fig. 3 to extend beyond the study area, lines not appearing particularly significant in Fig. 3, say with only three standing stones, may appear more significant if a larger, or different-shaped study area is considered.

The results obtained for the given study area indicate that, it is fairly easy to find linear relationships of three stones (thirty six in total); lines of four stones are less frequent (eight in total); lines of five stones rarer still (four in total); and only one line of six stones or more could be identified (that extending in both directions from the Waen Oer Stone Row).

As this method is dependent on visual inspection alone, its accuracy is not as high as might be achieved using a computer programme, and consequently there is a possibility that some lines may have been overlooked (although this is thought to be more likely for lines of fewer stones). However, since the results produce such a large number of lines and there is such a dramatic differentiation between the number of lines with the minimum number of points (three) and those with the maximum number of points (more than six), then this method appears to offer a good approach to the objective assignation of standing stones to certain alignments and also an objective exclusion of

standing stones from other potential alignments. Overall, therefore, this approach can be argued to provide an objective and accurate determination of the most probable long distance alignments within the study area, with lines consisting of the greatest number of standing stones being most worthy of further, more detailed investigation.

Since intensive investigation of all 49 objectively-determined alignments was outwith the scope of this study, just two of the most probable long distance alignments, (i.e. those consisting of the greatest number of standing stones) were selected for more detailed investigation:

Line 1: The single identified line consisting of six or more standing stones (solid black line, c.27 km long) which includes a line extending in both directions from stones forming the Waen Oer Stone Row;

Line 2: The line consisting of five standing stones that appears to run south of, and approximately parallel to, Line 1 above (red-dashed line, 10 km long) was selected from the set of alignments consisting of five stones, as it was unique in its set as being independent from, and not crossing, Line 1 above.

Standing stones along these two potential long distance alignments were then subject to the following more intensive investigations. Firstly, linear regression analyses were performed for both lines using the literature review standing stone coordinates which were inputted into the statistics function of Microsoft Excel for Mac Version 15.25.1. to determine (a) line azimuths; (b) coefficients of determination (R^2) as an indication of the precision with which the standing stones conform to a straight line; and (c) *F*-values to assess the probability that the variation explained by the regression is due to chance.

Then, each standing stone on both lines was visited. The Ordnance Survey National Grid Reference (OS NGR) and elevation for each stone were checked to within a precision of <10 m using a Garmin eTrex 12 Channel GPS, by placing the GPS on the ground by the base of the stone and waiting for the specified level of precision to be attained.

During the site visits, an Iris 50 Plastimo hand-bearing sighting compass (with precision to 1^{o}) and 2 no. wooden ranging poles were used to mark out the previously calculated line azimuths in both directions (to check for the presence of magnetic anomalies). The azimuth measurements were taken from a standing position directly in front of the standing stone (with heels making contact at the basal midpoint of the stone) facing the azimuth direction. A Suunto PM5 clinometer was then used to measure the horizon altitudes that were associated with both directions of the identified azimuths.

All horizon altitude results obtained were double-checked with the www.heywhatsthat.com website [accessed 27/07/16]. The website www.nearby.org [accessed 27/07/16] was used to convert OS NGRs to latitude and longitude where necessary. Where it was not possible to obtain actual horizon altitudes in the field due to difficulties accessing the stones or sightlines being obscured by buildings or trees, etc, then the 'Heywhatsthat' methodology was employed. Horizon altitude points associated with the azimuths in question were identified by name or description, to determine whether the use of the same horizon point is ever repeated for different stones along the alignment. Additionally, individual stones were photographed in both azimuth directions.

Results were tabulated and the original linear regression analyses double-checked using the newly GPS-acquired OS NGR data for the standing stone positions. The declinations associated with the identified horizon azimuths and altitudes were calculated using Microsoft Excel for Mac, Version 15.25.1 to calculate required trigonometric functions.

Open source Stellarium planetarium software (Fabien Chereau, Stellarium, available at www.stellarium.org [downloaded 15/06/15], for PC) was used to compare values of the calculated declinations with the declinations of events of celestial significance at three sample dates spanning the Bronze Age period, which the literature review had indicated as a likely time of erection of the standing stones.

Results

See Appendix for Tables A–H detailing basic data and photographs of identified standing stones.

Statistical analysis: confirmation of preliminary determination of line azimuths by linear regression analysis (using GPS confirmed OS NGR coordinates for standing stones, rather than literature review coordinates)

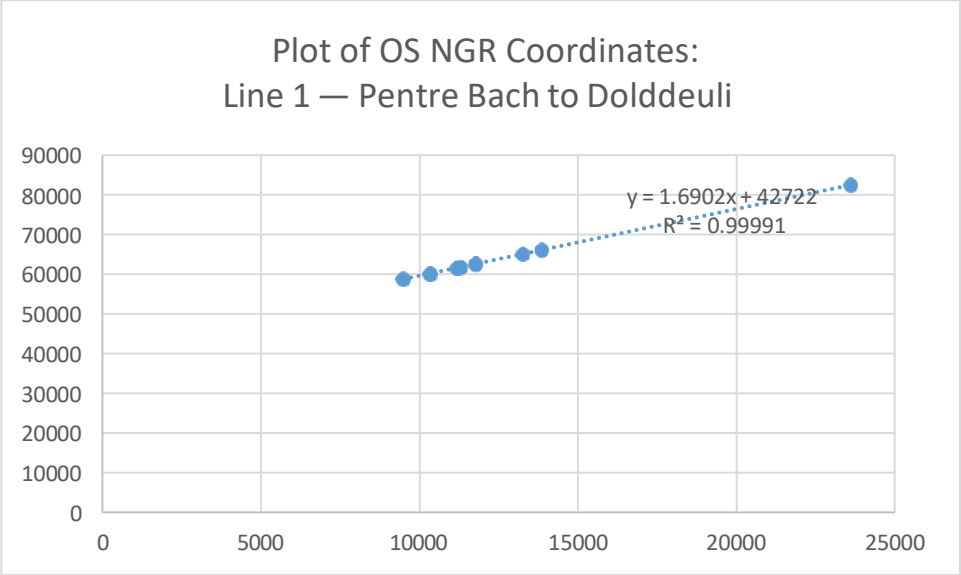


Figure 4: Results of Linear Regression Analysis for Line 1 using GPS coordinates for standing stone positions (OS grid ref. x,y).

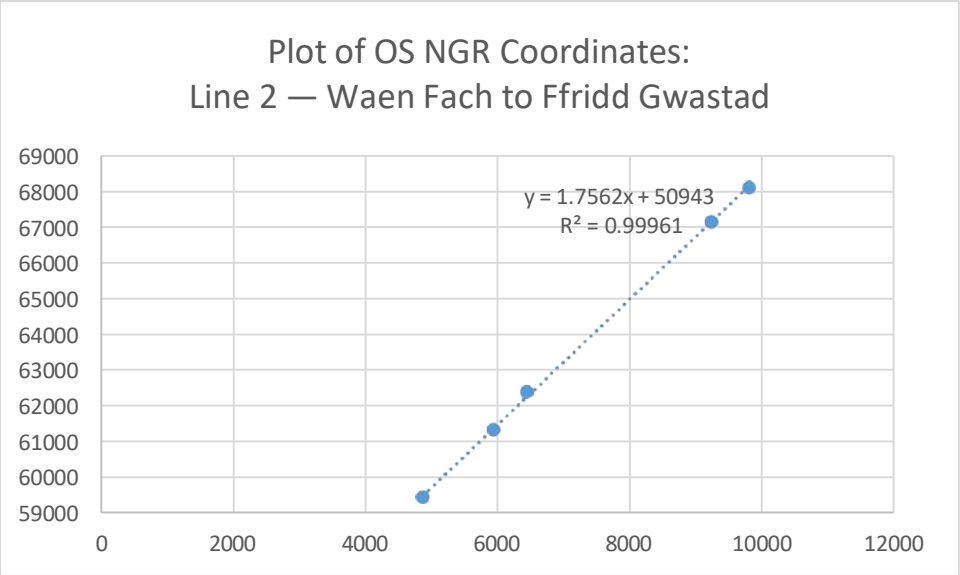


Figure 5: Results of Linear Regression Analysis for Line 2 using GPS coordinates for standing stone positions (OS grid ref. x,y).

Table 1: Summary of results from linear regression analyses

No.	Variable	Line 1	Line 2
1	R^2	0.99991	0.99961
2	m	1.6902	1.7562
3	Azimuth (º)	59.38949041	60.34232789
4	OS Grid True North[41]	1º 34′ E of Grid 1.56667º	1º 34′ E of Grid 1.56667º
5	Azimuth after correction from OS Grid North to True North	57.82282041 => 58º(N) / 238º(S)	58.77565789 => 59º(N) / 239º(S)
6	*F* value	128055.885	7655.43757
7	Degrees of Freedom	(1,12)	(1,3)
8	$p_{(0.05)}$	4.75	10.13

[41] Outdoor Leisure 23, Cadair Idris & Bala Lake / Llyn Tegid Ordance Survey 1:25,000 map

9	$p_{(0.01)}$	9.33	34.12
10	$p_{(0.001)}$	18.64	167.03

The R^2 values approaching 1, for both Lines 1 and 2, are a good indication that the standing stones are sited on straight lines with an extremely high degree of precision.

Additionally, the calculated F values being very much higher than tabulated F values (for $p_{(0.05)}$, $p_{(0.01)}$ and $p_{(0.001)}$) are an excellent indicator (i.e. greater than 99.9% probability at $p_{(0.001)}$) that the variance between the x and y coordinates is not due to random chance and therefore the result of intentional siting of standing stones.

Ethnographic information obtained during site visits.

Potentially relevant ethnographic information was obtained from conversations with the site owners. Generally, not much is known about the standing stones. However, the owner of the farm where the large Dolddeuli standing stone is located, mentioned that that old people of the area think that this standing stone is part of a line of stones running from the area of Llanegryn on the coast to either Llanderfel or Llandrillo near the Berwyn Mountains to the east. They think that this line represents some sort of ancient religious or pilgrimage route. The owner also mentioned that he has seen another small stone (*c.*1m high, but leaning) to the east in a boundary wall on the hill, Foel Fach, and says that it is his understanding that this stone is in line with the one at Dolfeili Farm. He also reported that the archaeology expert from CADW who recently visited the site thought that the stone could be as old as 2,500 BCE. During the site visit, the owner also recognised that the broad sides of the Dolddeuli stone face the midwinter sunrise (130º) / midsummer sunset (313º), whilst the narrow sides appear to be aligned with the midwinter sunset (230º) / midsummer sunrise (47º) and a quick check with the compass seemed to verify this.

Similarly, the owner of the farm where the Waen Fach stone is located reported that the standing stone on their family's land was thought to either mark the route to a settlement on the mountain or, be the burial place of an ancient chieftain with his horse, metal weapons and other valuables.

The literature review results reflect a consensus opinion that the standing stones in the study area were erected in the Bronze Age, i.e. between 2,300 BCE–800 BCE. Ignoring anomalous outliers, the relevant eastern azimuth horizon points of both Lines generally fall within a declination range of 15º to 25º, whilst the relevant western azimuth horizon points fall within a declination range of –15º to –25º. Rising and setting of celestial bodies over these declination ranges during the Bronze Age were investigated for potential celestial associations with the siting of the standing stones.

As the Bronze Age timespan is so wide, three representative time periods within the range were selected for investigation: 1,000 BCE, 1,600 BCE and 2,200 BCE. 1,600 BCE was selected as a median point within the timespan since this approximates to the catastrophic eruption of Thera / Santorini in the eastern Mediterranean, which was a pivotal time in the Bronze Age causing major environmental and social upheaval in Europe and further afield[42]; 1,000 BCE and 2,200 BCE were selected as respective relatively early and late dates within the identified Bronze Age timespan, both separated from the median date by 600 years, but not lying exactly on the Iron Age and Neolithic extremes of the range.

The Sun

The specific azimuths and declination range recorded for both lines fall well within the range of the Sun's movements. However, they do not appear to mark any obviously significant points in the solar year (see Table 2a and 2b).

The Moon

The azimuths and declinations recorded for both lines therefore also fall well within the range of the Moon's movements. According to the ArchaeoLines plug-in (v. 0.1.0, author: Georg Zotti) available for use with open source Stellarium planetarium software (www.stellarium.org), the 58º/59ºand 238º/239º azimuths for Lines 1 and 2, match the azimuths of the minor lunar extremes during the Bronze Age (allowing an error of (±1º).

[42] P. E. LaMoreaux, 'Worldwide environmental impacts from the eruption of Thera', *Environmental Geology*, 26 (3) (1995), pp. 172–181.

A more tenuous potential association between the lines of stones in the study are and the extreme positions of the Moon is suggested by the observation that another two lines observed in Figs. 3a and 3b (one brown line consisting of four stones and one blue line consisting of three stones) conform with 58º/238º (±1º) azimuths associated with Bronze Age minor lunar extremes in the study area. Whilst another four lines in Figs 3a and 3b (three blue lines each consisting of three stones and one brown line consisting of four stones) conform with the 37º/216º (±1º) azimuths of the Bronze Age major lunar extremes in the study area (according to the Stellarium ArchaeoLines plug-in). Further investigation would be required to determine whether it is possible to attribute any significance to these observations.

The Stars and Planets

Stellarium planetarium software was consulted and all planets and stars of brighter magnitude than 3.0 which fell within the required declination and timespan ranges were recorded (see Tables 2a and 2b).

Table 2a. Stars with magnitude brighter than 3, setting within the –15.0º to –25.0º declination range of the western horizon points of Lines 1 & 2

No	Time Period	Name of Celestial Body	Magnitude	Declination (º)
1	1,000 BCE	Rigel	0.15	—16.2128
2		Saiph	2.05	–15.4837
3	Sun within	Mirzam	1.95	—21.0454
4	declination	Sirius	–1.45	–17.1130
5	range	π-Pup	2.80	–19.8584
6	December –	I–Cen	2.75	–20.3686
7	February	Menkent	2.05	–20.0008
8		E–Scorpius	2.25	–23.4340
9	Sun sets at	Alniyat	2.80	–17.0801
10	*c.* 238º around	Alnasl	2.95	–24.1141
11	1st February	Kaus Borealis	2.80	–20.8005

12	&	Nunki	2.05	–23.5764
13	26th November	Albaldah	2.85	–19.5722
14	1,600 BCE	Rigel	0.15	–18.7816
15		Saiph	2.05	–17.7037
16	Sun within	Mirzam	1.95	–22.7389
17	declination	Sirius	–1.45	–18.30
18	range	π-Pup	2.80	–20.0689
19	December –	I–Cen	2.75	–17.2795
20	February	Menkent	2.05	–16.6737
21		λ]–Cen	2.30	–23.2418
22		E–Scorpius	2.25	–20.3342
23		Nunki	2.05	–21.5685
24		B–Lup	2.65	–24.6934
25		Ψ–Lup	2.95	–23.8546
26		Alnasl	2.95	–21.5907
27		Kaus Media	2.70	–22.2678
28		Kaus Borealis	2.80	–18.5157
29		Albaldah	2.85	–17.8195
30	Sun sets at	Cursa	2.75	–16.1675
31	c. 238º around	Hatsya	2.75	–15.0587
32	6th February &	Saturn	variable	variable
33	26th November	Venus	variable	variable
35		Mars	variable	variable
36	2,200 BCE	Menkar	2.50	–17.1263
37		Cursa	2.75	–19.0422

38	Sun within	Rigel	0.15	–21.5903
39	declination	Hatsya	2.75	–17.7245
40	range	Saiph	2.05	–20.2075
41	December –	Mirzam	1.95	–24.7474
42	February	Sirius	–1.45	–19.8340
43		π-Pup	2.80	–20.6511
44		λ]–Cen	2.30	–20.0121
45		B–Lup	2.65	–20.4065
46		Ψ–Lup	2.95	–20.5133
47		μ1–Sco	3.00	–21.0364
48		E–Sco	2.25	–17.0833
49		Shaula	1.60	–22.7729
50		Kaus Australis	1.75	–24.0018
51		Kaus Media	2.70	–19.5509
52		σ–Cen	2.55	–24.7892
53		λ]–Cen	2.30	–20.0134
54	Sun sets at	Nunki	2.05	–19.1832
55	around 238º	Albaldah	2.85	–15.6643
56	10th February	Kaus Borealis	2.80	–15.8971
57	&	Venus	variable	variable
58	1st December	Jupiter	variable	variable
59		Mars	variable	variable
60		Moon	variable	variable

Table 2b. Stars with a magnitude brighter than 3.00, rising within the 15.0º to 25.0º declination range of the eastern horizon points of Lines 1 & 2

No	Time Period	Name of Celestial Body	Magnitude	Declination (º)
1	1,000 BCE	Regulus	1.35	22.7007
2		Unukalhai	2.60	19.3507
3	Sun within	Ras Alhague	2.05	19.3193
4	declination	Matar	2.90	17.0538
5	range	Mirach	2.05	19.3933
6	June – August	B–Tri	3.00	19.0063
7		σ–Per	2.80	18.7670
8		Hassalah	2.65	22.9342
9		Al Nath	1.65	20.2972
10		Tejat Posterior	2.85	17.9122
11		Jupiter	variable	variable
12	Sun rises at	Saturn	variable	variable
13	around 58º	Venus	variable	variable
14	23rd May	Mars	variable	variable
15	& 11th August	Moon	variable	variable
16	1,600 BCE	Regulus	1.35	23.5792
17		Unukalhai	2.60	22.5509
18	Sun within	Ras Alhague	2.05	21.6787
19	declination	Deneb	2.95	15.4564
20	range	Matar	2.90	15.2503
21	June – August	Almaak	2.15	23.0560
22		Mirach	2.05	16.3920
23		Algol	2.05	22.8218
24		E–Per	2.90	23.6220

25		Al Nath	1.65	17.5182
26	Sun rises at	Hassaleh	2.65	19.9078
27	around 58º	Tejat Posterior	2.85	15.6541
28	27th May &	Mars	variable	variable
29	15th August	Moon	variable	variable
30	2,200 BCE	Regulus	1.35	23.9422
31	Sun within	Ras Alhague	2.05	24.3052
32	declination	Deneb el Okab	2.95	17.0605
33	range	Cabalrai	2.75	15.5945
34	June – August	Almaak	2.15	19.9497
35		Algol	2.05	19.5229
36	Sun rises at	E–Per	2.90	20.2975
37	around 58º	Hassaleh	2.65	16.7172
38	1st June	Mars	variable	variable
39	& 21st August	Moon	variable	variable

The results of Table 2a indicate that for the western horizon at an azimuth of 238º to 239º, the brightest star falling within the relevant declination range is Sirius, the "Dogstar". Sirius is not only the lucida of the constellation Canis Major, but is also the brightest star in all of the night sky. Furthermore, Sirius is apparent throughout all three selected Bronze Age time periods within the identified declination range. Since Sirius is the brightest and most prominent star in the sky, it would therefore seem that this is the most likely setting star to be associated with both Lines 1 and 2 at an azimuth of 238º to 239º and declination range of –15º to –25º during the Bronze Age. This conclusion is further supported by the fact that since the declination of the western-most extent of Line 1 is very low, at sea level, Sirius would be the only star bright enough to be seen at this low altitude, after the effects of stellar extinction are taken into consideration.

An additional consideration is the ethnographic history associated with Sirius, known since at least the 3rd millennium BCE for its dog symbolism. Geoffrey Cornelius[43] emphasises that this association is particularly relevant in ancient Egypt, where the star Sirius is associated with the psychopomp jackal-headed god Anubis and his role of guiding the dead. Cornelius goes on to refer to the fact that the heliacal rising of Sirius near midsummer was important in the ancient Egyptian calendar and was thought to herald the flooding of the Nile. He also mentions that, perhaps because of the fact that Sirius rose in the hottest time of the year, "classical authors often identified the power of Sirius with that of the Sun", giving rise to the phrase 'dog days of summer'.

To the ancient Greeks, both Canis Major and Canis Minor were viewed as the hunting dogs of Orion and there are also reflections of this story in Mesopotamian myth as well. In Egypt during the period 2,700–2,600 BCE (the time of the construction of the great pyramids, which have been proposed to align with Orion's belt), Orion was thought to represent the Egyptian god of the dead, Osiris.[44] The association of the star Sirius with a hunting dog has cross-cultural parallels not only between cultures that could be considered relatively geographically close, such as Egypt and Mesopotamia, but this association is also reflected in cultures further afield, even as far as China, where Sirius is known as T'ien-lang, the celestial jackal[45]

The constellation Canis Major consists of Sirius, a white star, which forms the head of the dog, whilst the star that falls in the region of the hound's ears is the red giant Theta-Canis Major, which today appears a yellowish colour. A similar astral colour scheme exists, for the other of Orion's hunting dogs, Canis Minor, which has whitish stars forming its body (Procyon and Gomeisa) and a yellow-coloured star epsilon–Canis Minoris occupying the approximate position of the ears.

These astral hunting dogs of Orion or Osiris (ancient Egyptian Lord of the Netherworld) therefore present an unexpected resonance with the ancient Welsh folklore white, red-eared, hunting hounds (the 'Cwn Annwn') of the ancient Welsh Lord of the Otherworld, black-faced, Gwyn ap Nudd. As previously mentioned, Gwyn ap Nudd is also known as 'Arawn' which may be pronounced phonetically in Welsh as 'ah-RA-oon', exhibiting some similarity with the pronunciation of 'Orion'. Similarly, the Welsh 'Annwn' (from Cwn

[43] Geoffrey Cornelius, *The Starlore Handbook*, (Duncan Baird, London 1997), 52–53

[44] Cornelius, *The Starlore Handbook*, p.93.

[45] Cornelius, *The Starlore Handbook*, p. 54.

Annwn / Hounds of the Otherworld) is pronounced 'Ann-oon', exhibiting an initial similarity with 'Anubis'.

A similar analytical approach for the eastern azimuths of Table 2b indicates that Regulus (the lucida of the constellation Leo, the lion) is the brightest star rising over both Line 1 and Line 2 within the range of relevant declinations throughout the Bronze Age period. According to Cornelius, "The lion has been identified with the Sun since the early civilisation of Mesopotamia. The Egyptians connected Leo with the heliacal rising of Sirius…[as this] coincided with the Sun's passage through Leo".[46] Since the constellation of Leo is associated with the time of midsummer, it is possible that the solstitial observations regarding the orientation of the Dolddeuli stone may be significant. Cornelius also mentions that Regulus has been known since Mesopotamian times, where it was listed as the leader of the Royal Stars and one of the 'Four Guardians of Heaven' (or "Watchers"), reflecting the belief that it ruled the affairs of the heavens. Its name means 'Little King'.

Regulus is an interesting star from the perspective of the study of astronomy, because its path is the closest to the ecliptic, the apparent path of the sun in the sky. According to Clive Ruggles, "the ecliptic coordinate system is very convenient for defining the relative position of the sun, moon and planets and was of particular importance in the historical development of mathematical astronomy.."[47] If there ever was a great Idris, ancient astronomer, the study of the ecliptic is likely to have been of the utmost importance to him, and therefore the finding that both Lines of the study area may possibly mark the rising of Regulus, and thereby a means to follow the path of the ecliptic in the night sky, is highly significant and supportive of the secondary aim of this paper to find prehistoric astronomical associations within the study area.

Discussion

It can be seen that the linear regression analyses confirm the presence of two high-precision, separate long distance alignments (of 10 km and 27 km) over the study area and this observation is further supported by local ethnographic evidence. The linear regression statistical analyses indicate that

[46] Cornelius, *The Starlore Handbook*, pp. 86–87.

[47] Clive Ruggles, 'Basic Concepts of Positional Astronomy', *Handbook of Archaeoastronomy and Ethnoastronomy* (Springer Science & Business Media, New York (2015), pp. 459–463.

the positioning of the standing stones on both Line 1 and Line 2 is so extremely precise that such an arrangement must have been intentional, as there is less than a 0.1% chance that the arrangement could be due to chance. This conclusion validates the initial subjective identification of these lines, but raises the further question of how such astonishing precision in siting the stones could have been achieved in prehistoric times. It is therefore possible that the class of long alignments identified in this study should be considered entirely different in form and function to the types of traditional stone rows previously identified in the literature.

The linear regression analyses performed above support the methodology of employing mapping software, such as Memory Map TM (Evo Distribution), as an initial assessment tool in the identification of potential long distance alignments. The mapping approach reported in this study has indicated the presence of other potentially significant alignments across the study area (as depicted in Fig. 3) and has also raised the possibility that these lines may be interconnected, potentially representing some sort of grid system — for example, the Bryn Seward gate stone of Line 1 is linked via another standing stone at Pen-y-Garn (Coflein,[48] NPRN 500999) to the stone at Ty'r Gawen on Line 2 by a brown line (of four stones) with an azimuth of 0º (Figs. 3a and 3b). This north-south line extends c. 7 km south to another standing stone at Nantycynnog and possibly also northwards to include further standing stones outside the study area.

There is evidence for both lines having celestial significance with respect to the Sun, the Moon and the Stars. However, the evidence linking both lines of standing stones to the setting of Sirius in the Bronze Age ties in particularly well with ethnography concerning Sirius and local folklore relating to 'Hounds of the Otherworld' chasing / guiding souls of the dead to their resting place. Similarly, the rising of Regulus over both lines of standing stones is highly significant, since Regulus has been a star of great importance to the study of astronomy since ancient times, as its path in the night sky is closest to that of the ecliptic.

---

[48] *The National Monuments Record of Wales (NMRW)*, 'Coflein', http://map.coflein.gov.uk/index.php?action=do_details&cache_name=cG5wcm4sNTAwOTk5X3NlYXJjaHR5cGUsYWR2YW5jZWRfb3Jh&numlink=500999#tabs-4 [accessed 21/10/16]. Derived from information compiled by RCAHMW and/or Crown copyright.

Determination of the definitive purpose of the extremely precise long distance alignments remains difficult. Since an efficient walking route will avoid high mountains, bogs, etc, the standing stone lines are not likely to have been erected as route markers (although they may subsequently have found use as such, particularly for relatively shorter stretches eg along the Ffordd Ddu). Conversely, it could be argued that pilgrimage routes may not necessarily be chosen for an easy journey. However, the requirement for an extremely precise straight line pilgrimage route would require an explanation — and furthermore, the evidence that the Ffordd Ddu track is not a precise straight line would seem to discount any 'arduous pilgrimage route' hypothesis.

Other potential purposes for the lines include that the lines perhaps do not mark routes for the living, but instead delineate routes for the dead to the afterlife. This is in keeping with the designation of the local area as an area of ritual and funerary significance and the work of Fowler and Cummings.[49] This hypothesis also has synergy with the ethnographic funerary and psychopomp associations of Sirius in Canis Major along with Orion / Osiris and the local Welsh folklore of the Cwm Annwn (hunting hounds of the Otherworld) and Arawn (Lord of the Otherworld).

More tenuously, it could be argued that the alignments could have been set out as some ancient mapping activity. It is known that Ptolemy produced a relatively accurate map of the British Isles in 2nd C AD.[50] However, whilst this suggestion might offer an explanation for the need for high precision siting of the stones, it is not immediately obvious why certain alignment bearings should be selected or why these particular celestial associations would be required.

It may be that the alignments reflect some sort of geomorphological aspects of the landscape. It is a strange coincidence that the azimuth of the southern boundary of the study area is also 58º / 238º. This was selected on topographical grounds alone. It is also interesting that the most major of the geological fault lines over the study area (eg the Talyllyn fault line) also follow this bearing.[51] Such observations may concur with the mapping hypothesis, or

---

[49] Chris Fowler and Vicki Cummings, 'Places of Transformation: Building Monuments from Water and Stone in the Neolithic of the Irish Sea', *Journal of the Royal Anthropological Institute*, Vol. 9 No. 1 (Mar 2003)

[50] Henry Bradley, *Remarks on Ptolemy's Geography of the British Isles,* (Nichols and Sons, London, 1884)

[51] Geological Survey of England and Wales 1:63,360/1:50,000 Geological Map Series. Sheet number 119 'Snowdon' (British Geological Survey1997)

perhaps could even be argued to support Earth Mystery-type theories concerning ley lines, or may simply indicate an importance to prehistoric man of emphasising natural landscape features — in a similar manner to Mike Parker-Pearson's suggestion that the site for the Avenue at Stonehenge was selected to highlight the natural peri-glacial fissures in the chalky landscape, formed thousands of years previously, but coincidentally following a solstitial axis.[52]

Conclusion

The astonishing degree of precision with which the standing stones conform to linearity, the fact that the distances covered by the lines can be measured in kilometres, the fact that it is possible to determine some significant celestial alignments in association with the lines (with interesting potential cross-cultural parallels) and the fact that both lines flank the mountain Cadair Idris, the folklore stronghold of the giant Idris, an ancient astronomer of Welsh legend, suggest that the primary purpose of the alignments is perhaps most likely to have been for astronomical reasons, with perhaps a combined religious and scientific purpose.

Further research is required to investigate the 47 lines not subject to detailed examination in this study, as well as the different types of monuments which should also perhaps be considered within studies of long distance alignments in addition to standing stones (e.g. rock art, hillforts, cairns, cairn circles, *etc*). Additionally, whilst the standing stones studied all generally appear to be shaped in an individual manner, the observation that the orientation of the faces of the Dolddeuli standing stone appear to exhibit solstitial alignments is potentially indicative that some undeciphered celestial meaning / coding may underlie the shapes. Such a view would be in keeping with the studies of Lynne Kelly[53] and also warrants further study.

This investigation appears to corroborate the ethnographic claims of the Dolddeuli locals as it supports the claim that the Dolddeuli standing stone is part of an alignment running eastwards from the coast. Therefore, an intriguing question remains for further research: does the Dolddeuli Line 1 extend further eastward to Llanderfel and Llandrillo as is maintained by Dolddeuli folkore?

---

[52] Mike Parker Pearson, 'Researching Stonehenge: Theories Past and Present' *Archaeology International*, 16 pp. 72–83, http://www.ai-journal.com/articles/10.5334/ai.1601/ [accessed 23/10/16].

[53] Lynne Kelly, *The Memory Code*, (Allen and Unwin, 2016).

An examination of the standing stones discovered by chance during the study (but outside the study area) indicates that Line 1 does in fact pass through another standing stone around 25km further east at Cefn Pen Llety (Coflein,[54] NPRN 283030, SJ 04210 36070) in the region of Llanderfel and Llandrillo as stated by the owner of Dolddeuli Farm (see Fig 6). Linear regression to include this point gives an R^2 value of 0.99997 and maintains the 58º azimuth, so indications are that Line 1 could very well extend this far. A short further extension of less than 2 km to the east takes Line 1 through the Bronze Age cairn / stone circle of Moel-ty-Uchaf (Coflein,[56] NPRN 306555) which has been described by Critchlow as "perhaps the most geometrically sophisticated of all the Neolithic structures"[55], although it is currently referenced as a Bronze Age monument by Coflein[56]. However, further work would be required to verify these observations and to confirm the exact length of the alignments.

[54] *The National Monuments Record of Wales (NMRW),* 'Coflein http://map.coflein.gov.uk/index.php?action=do_advanced&pnmrsname=&pnprn=283030&pclasssub=&pclassgrp=&pfreetext=&pperiod=&pcommunity=&pcouname=&poldcounty=&ngr=&radiusm=&submit=Search [accessed 21/10/16]. Derived from information compiled by RCAHMW and/or Crown copyright.

[55] Julian Cope, *The Modern Antiquarian*, (Thorsons, 1998), p. 326.

[56] *Royal Commission of the Ancient and Historical Monuments of Wales online Historical Environmental Record Database*, 'Coflein', http://map.coflein.gov.uk/index.php?action=do_details&cache_name=cG5tcnNuYW1lLE1vZWwgdHkgdWNoYWZfc2VhcmNodHlwZSxhZHZhbmNlZF9vcmE=&numlink=306555#tabs-4 [accessed 25/10/16]. Derived from information compiled by RCAHMW and/or Crown copyright.

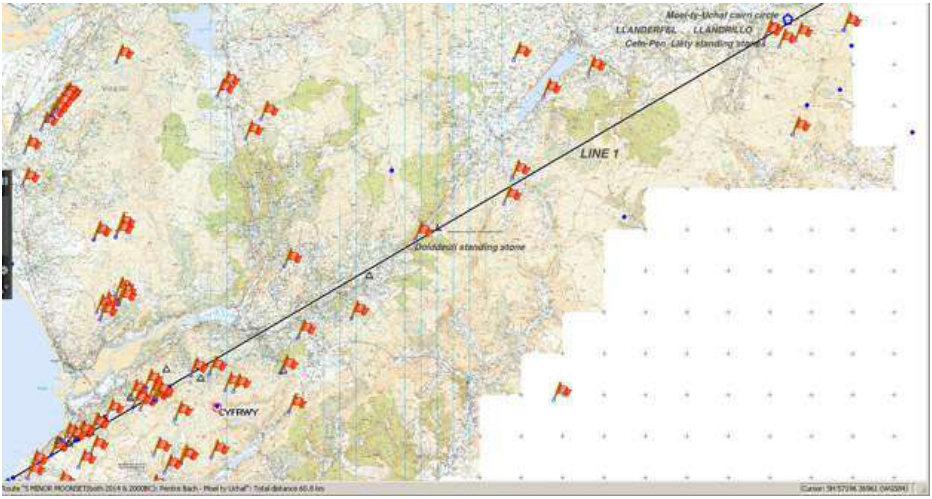


Figure 6: Extrapolation of Line 1 to Moel-ty-Uchaf cairn circle

Bibliography

Allen, Richard Hinckley, '*Star Names, Their Lore And Meaning*' (Dover Publications Inc. New York, 1889), 255. http://www.constellationsofwords.com/stars/Regulus.html [accessed 26/7/16]

'An Inventory of the Ancient Monuments in Wales and Monmouthshire. VI County of Merioneth', *Royal Commission on Ancient and Historic Monuments in Wales (1921)*, 1–185

Archwilio: Gwynedd Archaeological Trust Historic Environment Record Database, http://www.cofiadurcahcymru.org.uk/arch/gat/english/gat_interface.html [accessed 26/7/2016]

BBC webpage: *Seven Man-made Wonders* (archived) http://www.bbc.co.uk/england/sevenwonders/yorkshire/flamborough/ [accessed 26/7/16]

Bradley, Henry, '*Remarks on Ptolemy's Geography of the British Isles*' (Nichols and Sons, London, 1884)

Bowen, George E., and C. A. Gresham '*History of Merioneth. Vol 1.*', Merioneth Historical and Record Society, Dolgellau (1967), 1–298

Burl, *Aubrey From Carnac to Callanish: The Prehistoric Stone Rows and Avenues of Britain, Ireland and Brittany,* New Haven: Yale University Press, (1993), 1–286

Coflein: the online database for the National Monuments Record of Wales (NMRW) www.coflein.gov.uk [accessed 26/7/2016]. Derived from information compiled by RCAHMW and/or Crown copyright.

Cope, Julian '*The Modern Antiquarian*', (Thorsons, 1998), 1–448

Cornelius, Geoffrey '*The Starlore Handbook*', (Duncan Baird, London 1997), 1–176

Cullen, Edward, Roland Flook and Adele Burnett, '*Better Woodlands for Wales Management Plan*', Heritage Management Information (WHE1) Tyd Farch Farm BWW Reference No 22127. Gwynedd Archaeological Trust (2011), 1–29

Fowler, Chris and Vicki Cummings, 'Places of Transformation: Building Monuments from Water and Stone in the Neolithic of the Irish Sea', *Journal of the Royal Anthropological Institute*, Vol. 9 No. 1 (Mar 2003), 1–20

'Geological Survey of England and Wales 1:63,360/1:50,000 Geological Map Series'. Sheet number 119 'Snowdon' (British Geological Survey1997)

Gwynedd Archaeological Trust, *Gwynedd Upland Survey 1995–1996*. Cadair Idris SSSI. Report and Gazetteer', Report no 198A (1996), 1–22

Hayman, Richard and Wendy Horton, '*Llanuwchllyn—Llanymawddwy: An Archaeological Survey*', The Uplands Initiative for the Royal Commission for Ancient and Historic Monuments Wales, (2012) 1–44

Hayman, Richard and Wendy Horton '*Dinas Mawddwy — Brithdir: An Archaeological Survey*', The Uplands Initiative for the Royal Commission for Ancient an Historic Monuments Wales, (2013) 1–63

Heneb: Gwynedd Archaeological Trust website page 'Mawddach Character' <http://www.heneb.co.uk/mawddach/mawddachcharintro/mawddachintro.html [accessed 22/10/16].

Kelly, Lynne, '*The Memory Code*', (Allen and Unwin, 2016), 1–336

Kelly, Richard 'A Pre-Afforestation Survey at Cyfannedd, Arthog, Gwynedd', *The Bulletin of the Board of Celtic Studies*, XXX (III–IV) (1983), 451

Koch, John '*Celtic Culture: A Historical Encyclopaedia*', Vol. 1. ABC-Clio (2006), 1–2128

Oxford Reference Dictionary http://www.oxfordreference.com/view/10.1093/oi/authority.20110803095655441 [accessed 27/7/16]

Parker Pearson, Mike, 'Researching Stonehenge: Theories Past and Present', Archaeology International, 16 (2013) pp. 72–83, http://www.ai-journal.com/articles/10.5334/ai.1601/

Rhys, Sion Dafydd, '*The Giants of Wales and their Dwellings*', www.maryjones.us/ctexts/giants_wales.html [accessed 22/7/2016]

Roberts, Geraint, '*The Lakes of Eryri*', Gwasg Carreg Gwalch, Iard yr Orsaf, Llanrwst, Gwynedd, Wales (1995), 1–256

Ruggles, Clive '*Astronomy in Prehistoric Britain and Ireland*' Yale University Press (1999), 1–286

Ruggles, Clive '*Records in Stone*', Cambridge University Press (2003), 1–518

Ruggles, Clive 'Basic Concepts of Positional Astronomy' in *Handbook of Archaeoastronomy and Ethnoastronomy* (Springer Science & Business Media, New York (2015), 1–2297

Smith, George, '*Prehistoric Funerary and Ritual Sites Survey: Meirionnydd, 2000-2001*', Gwynedd Archaeological Trust Project No. G1629. Report No. 415. Section 6.9 (2001), 1–76

Smith, George, 'Prehistoric Funerary and Ritual Sites in Merionnydd', *Journal of the Merioneth Historical and Record Society*, Vol XIV (II) (2003), 105–117.

Smith, George '*Fairbourne Waste Water Treatment Scheme Archaeological Assessment 2. The Treatment Works Site*', Prepared for the Symonds Group Ltd. Gwynedd Archaeological Trust (2002), 1–14

'*The Stone Rows of Great Britain*' https://stonerows.wordpress.com/gazetteer/region/dartmoor/stalldown/ [accessed 27/7/16]

Williams, George, 'The Standing Stones of Wales and South West England', *Bar Brit. Ser. 197* Oxford (1988)

Williams, St George Armstrong, 'The English Works of the Late Eliezer Williams with a Memoir of his Life', (London, Craddock and Co., 1840) https://books.google.co.uk/books?id=jQxXAAAAcAAJ&printsec=frontcover&source=gbs_ge_summary_r&cad=0#v=onepage&q&f=false

Appendix

Tables of basic data for selected standing stones with photos to indicate presence and impact of stones within surrounding landscape

Table A. LINE 1: Descriptive information

No.	Name	OS NGR	Validation of standing stone status (ie Coflein NPRN, Archwilio PRN, Scheduled Ancient Monument (SAM) or direct observation)	Description (taken from validation source)	Photo
1	Pentre Bach	SH 58877 09485	Direct observation	1.2m tall,0.5m deep, 0.5m wide.	

2	Parth-y-Gwydd wch (big)	SH 60120 10310	PRN 4867 SAM Probably dated to Bronze Age	One of a pair with (3) below. 1.6m tall; 3 sided: 1.3m, 0.9m & 0.7m (at ground level). 2300BC–800BC.	
3	Parth-y-Gwydd wch (small)	SH 60136 10328	PRN 4867 SAM	One of a pair with (2) above. 1.0m tall; 1.0m wide, 0.5m deep	
4	Waen Oer road stone (1)	SH 61599 11178	Direct observation	1.45m tall, 1.2m wide at widest point. Set within wall running alongside straight section of Ffordd Ddu	

5	Waen Oer road stone (2)	SH 61690 11201	Direct observation	1.28m tall, 1m wide at widest point. Set within wall running alongside straight section of Ffordd Ddu	
6	Waen Oer Row (groove)	SH 61721 11273	PRN 4884 75. SAM	A massive boulder 5′ high, 3′ wide and 2′6″ thick (in foreground, with recumbent stone and gate stone beyond to NE)	
7	Waen Oer Row (recumbent)	SH 61728 11277	PRN 4884 76. SAM	A fallen thin slab 6′ long, 3′3″ wide and 1′6″ thick. (Also in centre of photo below)	

8	Waen Oer Row (gate)	SH 61739 11284	PRN 4884 77. SAM	A pointed slab 6′ high, 2′ wide and 3′6″ thick	
9	Waen Oer Row (north)	SH 61760 11295	PRN 4884 78. SAM	A small pointed stone 3′ high, 2′6″ wide and 1′ thick	
10	Bryn Seward (gate)	SH 62602 11761	PRN 4873 SAM prehistoric alignment (other stones mentioned as part of alignment, but unable to definitively discriminate from stones associated with adjacent wall)	A standing stone 2.1m tall and triangular in section with sides of 0.8m, 0.9m and 0.5m. Oriented parallel to significant ancient routeway, Ffordd Ddu.	

11	Bryn Seward (forest)	SH 62650 11768	PRN 4873 SAM prehistoric alignment. (as above)	A standing stone measuring 1.5m tall. Rectangular in section measuring 0.6m wide, 0.5m thick and pointed at top. Oriented parallel to significant ancient routeway, Ffordd Ddu.	
12	Planwyd d Helyg	SH 65180 13256	PRN 4214 NPRN 302890 SAM Prehistoric	Erect monolith / tapering pillar on low knoll in middle of wide valley 1.9m high x 0.5m x 0.5m. [Close to intersection of two branches of the Ffordd Ddu].	
13	Carreg y Big	SH 66192 13849	PRN 4215 SAM prehistoric	Tapering pillar on level ground at foot of hillock 1.9m tall x 1m wide x 0.5m thick. [Close to Cregennan Lakes]	

14	Dolddeuli	SH 82610 23606	PRN 4845 SAM Early Bronze Age standing stone	Earthfast stone of granophyre adjacent to boundary (railway embankment) on valley floor 1.5m x 1.2m x 0.7m	

Table B. LINE 2: Descriptive information

No.	Name	OS NGR	Validation of standing stone status (ie Coflein NPRN, Archwilio PRN, Scheduled Ancient Monument (SAM) or direct observation)	Description from validation source	Photo
1	Waen Fach	SH 59448 04874	PRN 4796 SAM. Early Bronze Age (c 2000–1500 BC)	Situated in a valley bottom position on a locally prominent knoll, it is 1.8m tall, 0.8m wide and 0.6m deep.	
2	Glanm achlas	SH 61329 05937	Direct observation	0.5m tall, 0.5m wide, 0.5m deep	

3	Ty'r Gawen	SH 62388 06445	Direct observation	1m tall, 0,5m wide, 0.5m deep	
4	Maes y Llan	SH 67150 09223	PRN 4933 / 4932. Prehistoric. The stone appears to be firmly placed in the ground, but amongst a small pile of other large stones, possibly indicative that they have all been moved.	References including OS NGRs are confused. This stone at this location (with possible remains of cairns nearby) was the only potential stone that appeared to match the reference's descriptions.	
5	Ffridd Gwastad	SH 68104 09794	Mentioned in 'An Inventory of the Ancient Monument of Wales & Monmouthshire'[57] (see last column). PRN 4935 Prehistoric	(Unlocated and unknown to farmer)	"On a slope of Ffridd Gwastadfryn is a standing stone in shape like an equal armed cross, but showing now signs of man's handiwork. It is 5'6" high, 5'4" broad across the arms, 3'4" broad at the base, 3' at the top and about 3' thick. It is difficult to discover among the huge masses of natural rock around. Visited 27/7/1914"

[57] '…Inventory … ancient Monuments of Wales …' 111

Table C: Line 1 Base Data

ID	OS NGR	Accuracy (m)	Latitude (converted from OS by nearby.org)	Longitude (converted from OS by nearby.org)	Site Elevation (m)	Magnetic Declination (°)	+/- Error (°)	Required Azimuth (°)	Magnetic. Azimuth (°)
Pentre Bach	SH 58877 09485	8	52.665647	4.088213	30	2.28	0.37	58	56
Parth-y-Gwyddwch (big)	SH 60120 10310	6	52.672511	4.070069	199	2.26	0.37	58	56
Parth-y-Gwyddwch (small)	SH 60136 10328	5	52.672592	4.070029	200	2.26	0.37	58	56
Waen Oer Wall Stone (1)	SH 61599 11178	5	52.680569	4.048704	260	2.25	0.37	58	56
Waen Oer Wall Stone (2)	SH 61690 11201	6	52.680799	4.047368	268	2.25	0.37	58	56
Waen Oer Row (groove)	SH 61721 11273	5	52.681454	4.04694	270	2.25	0.37	58	56
Waen Oer Row (recumbent)	SH 61728 11277	5	52.681492	4.046838	269	2.25	0.37	58	56
Waen Oer Row (gate)	SH 61739 11284	6	52.681492	4.046838	272	2.25	0.37	58	56
Waen Oer Row (north)	SH 61760 11295	5	52.681662	4.046373	272	2.25	0.37	58	56
Bryn Seward (gate)	SH 62602 11761	5	52.686063	4.034121	265	2.25	0.37	58	56

Bryn Seward (forest)	SH 62650 11768	5	52.686138	4.033414	266	2.25	0.37	58	56
Planwydd Helyg	SH 65180 13256	8	52.700142	3.99662	257	2.24	0.37	58	56
Carreg-y-Big	SH 66192 13849	6	52.705721	3.981895	264	2.23	0.37	58	56
Dolddeuli	SH 82610 23606	6	52.79690	3.74132	160	2.19	0.38	58	56

Table D: Line 1 Measurements for Azimuth 58º (True North)

ID & date visited	Measured Azimuth (º)	Magnetic Anomaly Check Reading (º)O	Azimuth horizon ID	Measured Altitude (º)	Calculated Declination (º)	Heywhatsthat Altitude (º)	Calculated Declination (º)	Horizon point of interest
Pentre Bach (22/6/16) (56º is directly behind stone)	56	236	Obscured by trees	—	—	7.08	24.64	

Parth-y-Gwydd wch (big) (23/7/16)	56	236	Slope in foreground	6	23.75	5.25	23.13	
Parth-y-Gwydd wch (small) (23/7/16)	56	236	Slope in foreground	6	23.75	5.53	23.36	
Waen Oer Wall Stone (1) 56º is approximately direction of wall (23/7/16)	56	*	Slope of hill in foreground	**	—	3.98	22.07	

Waen Oer Wall Stone (2) (56º is approximately direction of wall) (23/7/16)	56	236	Slope of hill in foreground	–3	16.21	5.14	23.03	
Waen Oer Row (groove) (23/7/16)	56	236	Slope of hill in foreground	–2	17.06	3.92	22.02	
Waen Oer Row (recumbent) (23/7/16)	56	236	Slope of hill in foreground	–2	17.06	3.83	21.94	
Waen Oer Row (gate) (23/7/16)	56	236	Slope of hill in foreground	–2	17.06	3.83	21.94	
Waen Oer Row (north) (23/7/16)	56	236	Slope of hill in foreground	-2	17.06	4.2	22.25	

Bryn Seward (gate) (13/7/16)	56	236	Forestry obscures horizon point	—	—	0.98	19.56	
Bryn Seward (forest) (13/7/16)	56	236	Forestry obscures horizon point	—	—	1.17	19.72	
Planwyd d Helyg (13/7/16)	56	236	Craig-y-Castell Hillfort PRN 810. Prehistoric SAM	–1	17.89	0.29	18.97	

Carreg-y-Big (13/7/16)	56	236	Craig-y-Castell Hillfort PRN 810. Prehistoric SAM	–1	17.89	0.53	19.17	
Dolddeuli (8/5/16)	56	236	Summit of slopes of Foel Fach (in background of photo)	7	24.53	8.6	25.84	

**Unable to measure due to interference from barbed wire fence along top of wall*

*** Unable to measure as stone wall obstructs measuring position*

Table E: Line 1 Measurements for Azimuth 238º (True North)

ID & date visited	Measured Azimuth (º)	Magnetic Anomaly Check Reading (º)O	Azimuth horizon ID	Measured Altitude (º)	Calculated Declination (º)	Heywhatsthat Altitude (º)	Calculated Declination (º)	Horizon point of interest
Pentre Bach (22/6/16)	236	56	Obscured by trees (but altitude of sea horizon at 240º used)	0	–18.75	–0.21	–18.92	
Parth-y-Gwydd wch (big) (23/7/16)	236	57	Sea	0	–18.74	–0.55	–19.20	

Parth-y-Gwyddwch (small) (23/7/16)	236	56	Sea	0	–18.74	–0.62	–19.26	
Waen Oer Wall Stone (1) (23/7/16)	240 *	56	Slope of hill above Parth-y-Gwyddwch	1	–17.90	–0.41	–19.08	
Waen Oer Wall Stone (2) Direction of 236º is behind car (23/7/16)	236	56	Slope of hill above Parth-y-Gwyddwch	1	–17.90	–0.59	–19.23	

Waen Oer Row (groove) (23/7/16)	236	56	Slope of hill above Parth-y-Gwyddwch	1	–17.90	–0.63	–19.27	
Waen Oer Row (recumbent) (23/7/16)	236	56	Slope of hill above Parth-y-Gwyddwch	1	–17.90	–0.65	–19.28	
Waen Oer Row (gate) (23/7/16)	236	56	Slope of hill above Parth-y-Gwyddwch	1	–17.90	–0.65	–19.28	
Waen Oer Row (north) (23/7/16)	236	56	Slope of hill above Parth-y-Gwyddwch	1	–17.90	–0.62	–19.26	
Bryn Seward (gate) (13/7/16)	236	56	Slope of hill in direction of Waen Oer	–8	–25.391	5.29	–14.27	

Bryn Seward (forest) (13/7/16)	236	56	Slope of hill in direction of Waen Oer. Horizon obscured by tree, but altitude assumed to be the same as that for nearby stone above.	–8	–25.391	5.26	–14.30	
Planwyd d Helyg (13/7/16)	236	56	Saddle to N. of Cwm Pen-y-Llydan domed hill (left of photo)	–7	–24.562	6.96	–12.85	
Carreg-y-Big (13/7/16)	236	56	Cwm Pen-y-Llydan domed hill (central apparaent "hillock" in photo)	–3	–24.240	1.91	–17.12	

Dolddeuli (8/5/16)	236	56	Obscured by railway embankment	—	—	3.1	–16.07	

** Unable to measure azimuth of 236º because measuring position obstructed by wall. Long flat hill on horizon at approximately 236º, therefore altitude measured at 240º azimuth should give good approximation.*

Table F: Line 2 Base Data

ID	OS NGR	Accuracy (m)	Latitude (converted from OS by nearby.org)	Longitude (converted from OS by nearby.org)	Site Elevation (m)	Magnetic Declination (º)	+/- Error (º)	Required Azimuth (º)	Magnetic. Azimuth (º)
Waen Fach	SH 59448 04874	5	52.622704	-4.078488	51	2.27	0.37	59	57
Glanmachlas	SH 61329 05937	5	52.633426	-4.050482	16	2.27	0.37	59	57
Ty'r Gawen	SH 62388 06445	5	52.638282	-4.034999	32	2.26	0.37	59	57
Maes-y-Llan	SH 67150 09223	5	52.664314	-3.966415	26	2.24	0.37	59	57
Ffridd Gwastad	SH 68104 09794	–	52.669438	-3.951987	–	–	–	59	–

Table G: Line 2 Measurements for Azimuth 59º (True North)

ID & date visited	Measured Azimuth (º)	Magnetic Anomaly Check Reading (º)O	Azimuth horizon ID	Measured Altitude (º)	Calculated Declination (º)	Heywhatsthat Altitude (º)	Calculated Declination (º)	Horizon point of interest
Waen Fach (16/5/16)	57	237	Tip of stone indicates relevant horizon position	–3	15.7	2.38	20.21	
Glanmachlas (16/5/16)	57	237	Obscured by trees. Tip of stone indicates relevant horizon position	—	—	2.88	20.62	

Ty'r Gawen (16/5/16)	57	237	Obscured by trees. Tip of stone indicates relevant horizon position.	–	–	3.78	21.36	
Maes-y-Llan (26/5/16)	57	237	Relevant horizon position is slope of hill in central backgroun d of photo.	– 10	9.76	11.18	27.43	
Ffridd Gwastad	57	237	Stone not located	—	—	6.89	23.92	—

Table H: Line 2 Measurements for Azimuth 239º (True North)

ID & date visited	Measured Azimuth (º)	Magnetic Anomaly Check Reading (º)O	Azimuth horizon ID	Measured Altitude (º)	Calculated Declination (º)	Heywhatsthat Altitude (º)	Calculated Declination (º)	Horizon point of interest
Waen Fach (16/5/16)	237	57	Tip of stone indicates relevant horizon position	–5	–20.72	4.63	–16.22	
Glanmachlas (16/5/16)	237	57	Obscured by trees. Tip of stone indicates relevant horizon position.	–	–	2.78	–15.88	
Ty'r Gawen (16/5/16)	237	57	Obscured by trees. Tip of stone indicates relevant horizon position.	–	–	1.25	–17.17	

Maes-y-Llan (26/5/16)	237	57	Tip of stone indicates relevant horizon position	–1	– 19.04	0.47	– 17.81	
Ffridd Gwastad	237	57	Stone not located	–	–	–0.71	–12.4	–