2016

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Frank Prendergast
Technological University Dublin, frank.prendergast@tudublin.ie

Recommended Citation

Prendergast, F. (2016) 'Interpreting megalithic tomb orientations and siting within broader cultural contexts' in Brown, D., ed., Journal of Physics: Conference Series 685, http://iopscience.iop.org/article/10.1088/1742-6596/685/1/012004/pdf: IOP Publishing, 1–25. doi:10.21427/hct4-5q94

Interpreting megalithic tomb orientation and siting within broader cultural contexts

Frank Prendergast

College of Engineering and Built Environment, Dublin Institute of Technology, Bolton Street, Dublin 1, Ireland

E-mail: Frank.prendergast@dit.ie

Abstract. This paper assesses the measured axial orientations and siting of Irish passage tombs. The distribution of monuments with passages/entrances directed at related tombs/cairns is shown. Where this phenomenon occurs, the targeted structure is invariably located at a higher elevation on the skyline and this could suggest a symbolic and hierarchical relationship in their relative siting in the landscape. Additional analysis of astronomical declinations at a national scale has identified tombs with an axial alignment towards the rising and setting positions of the Sun at the winter and summer solstices. A criteria-based framework is developed which potentially allows for these types of data to be more meaningfully considered and culturally interpreted within broader archaeological and social anthropological contexts.

1. Introduction

The analysis of prehistoric tomb orientations solely in terms of their axial alignment on rising/setting celestial targets is an arguably restrictive and culturally narrow perspective. Nonetheless, such approaches remain relevant by contributing to interpretations of the material record and the cosmology of ancient societies. This is particularly the case where ethnographic or other forms of appropriate evidence are lacking. The methodologies here endeavour to broaden such enquiries by recommending that the widest range of socially pertinent criteria be considered by archaeoastronomers during data collection and processing.

Non-astronomical factors that could alternatively explain the orientation variability or patterns encountered in prehistoric tombs are well attested in the Irish archaeological record. For example, at the Knowth complex in the Boyne Valley, Co. Meath, 11 of the 16 satellite tombs excavated by Eogan [1] have their passages generally facing the largest centrally-placed tomb (figure 1). Eogan and Cleary [2] further show that when the first phase of building was undertaken in the Middle Neolithic, the central space then had a considerably smaller contemporaneous Phase 1 monument. This may have been a feature of enduring importance and an alternative orientation determinant as the satellite tombs which comprise the complex were constructed over time. At the adjacent passage tomb complex distributed on three proximal hilltops at Loughcrew in the same county, the entrances of many of the tombs clustered on Carnbane West (the most westerly of the three summits) generally face towards Carnbane East at the centre of the complex and its crowning passage tomb ‘Cairn T’. This site is the highest in the surrounding landscape. Because Cairn T is also elaborately constructed and decorated with passage tomb art, it is often described by archaeologists as the dominant and most ‘focal’ of the 31clustered monuments in this locality.

Figure 1. Knowth passage tomb complex (looking north-southeast).

At a wider regional level, Cooney [3, 4] and McMann [5] argue that some tomb entrances were deliberately directed/orientated towards key focal places/sites. The idea of such apparent planned structure in tomb placement and orientation is now well known and indicative of strategic spatial organisation and layout of key architectural elements, inscribed art and grave goods associated with this Neolithic burial tradition *e.g.* see Eogan [1], Bergh [6], Nash [7], Robin [8] and Hensey [9]. Excavations of the Knowth tombs similarly indicate that placement of grave goods were, as with orientation of the passages, selective and considered. Grave goods are objects that belonged to the dead and were deposited by mourners. The most common artefacts were pendants, beads and pins used for personal adornment and wear and rarely included stone implements.

In Orkney, Davidson and Henshall [10] describe 59 sites which belong to a specific regional tradition of passage tomb dated to the Middle/Late Neolithic. These are part of a group of at least 300 such monuments known as the Orkney-Cromarty type which are found in the northern and western islands of Scotland and have mostly round cairns and centrally placed chambers. Such tombs are characterised by a division of their chambers into stalls separated by upright slabs of stone, sometimes double-tiered. At least 12 other monuments known as the Maes-Howe group differ from the Cromarty group in having rectangular chambers, low entrances, more symmetrically placed side-cells, and long narrow access passages. With few exceptions, the Maes Howe type is encountered within a round cairn and their design, and other characteristics, have a claimed affinity with the Irish passage tomb building tradition. Fraser [11, 12] has shown that with the exception of the Maes Howe type, there is a marked preference for cairns to be sited such that they have a wide extent of distant visibility of the

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horizon. Orientation of horizon visibility and azimuthal clustering of the axes of the entrance passages with an emphasis between east and southeast are also evident.

Studies of cairns in southeast Wales by Cummings *et al* [13] indicate that their siting and orientation were probably interrelated and influenced by the morphology of the surrounding hills *i.e*. 'the primary concern of the builders was to orientate the long axes of the cairns not so that they pointed directly towards significant places , but so that the landscape around the monument would be asymmetrical'.

Beyond the British Isles, Dehn and Hanson [14] describe the orientation of Scandinavian passage tombs and suggest possible links with a sacred point/place far out in the landscape. Alternatively, later aspects of the building process such as the erection of an enclosing ring of kerbstones (in which the entrance feature into the tomb had to be accommodated) may have been the primary dictating factor in the alignment. In Denmark, Clausen *et al* [15] have detected significant evidence of axial alignment directed at other distant tombs (for 75% of cases in a sample drawn from three different clusters) in addition to an emphatic clustering of their azimuths between east and southeast (70% of azimuths fall between 80° and 135°, with two peaks around 100° and 120°). In a study of 81 dolmens in Bulgaria, Kolev *et al* [16] use topographical analysis to show that axial orientation is significantly towards distant prominent mountain peaks while in the northern Sakar Mountains in the same region, some tombs are directed at other typologically similar monuments. In southwest Iberia, the largest Neolithic tomb in Europe (*Cueva de Menga*) is shown by Belmonte [17] to be topographically aligned on a distant conspicuous peak. This monument is part of a broader group which share similar architecture and claimed astronomical alignments in some cases.

The above examples are selectively drawn from a numerically large and geographically spread *corpus* of monuments across Europe. Their orientation variability/patterns collectively encompass the maximum possible range in azimuth and thus astronomical declination. This suggests that in addition to alignment on solstices and lunar maxima for example, other factors governing orientation and siting that are culturally specific to time and place at a local/regional level are evident. Backing for this hypothesis is provided by Ruggles [18] who argues that in order to explore a wider range of 'thematic ideas (…) it is too restrictive to limit our data to structural orientations and alignments'. Thus, for example, his observation that certain ritual monuments were deliberately situated in highly visible places. Such apparent planned marginality in relation to inhabited places suggests liminality and a preference for intervisibility with distant typologically similar structures and places. Were such factors likely determinants for site selection and tomb building purposes? Tentative support for this proposition is available in studies undertaken by the Royal Commission of Historic Monuments England [19] of Bronze Age barrows in Dorset. Because of their skyline locations in many cases, individual barrows, and groups of barrows, are thought to have been sited so as to afford multiple intervisible links reflecting 'a considerable degree of control and deliberation' on the part of the builders. Extensive evidence of not only tomb clustering and intervisibility, but of entrances facing other elevationally higher tombs in many cases, has also been detected in the Irish passage tomb tradition by Prendergast [20]. These phenomena are shown to occur at greater geographical scales and frequencies than previously known. Such a finding raises critically important interpretative questions that are contingent on knowledge of the sequence of monument construction being known.

Where a tomb passage/entrance is shown to face a distant typologically related structure, the source monument is termed here a 'directed tomb' (see Section 2.1). Such a linkage establishes a tie between both entities and this property of pairing, and the relationship, is termed a dyad – a key concept fundamental to the discussion of social networks [21]. Any claim for social or symbolic linkage between a dyadic pair (of prehistoric monuments) is heavily dependent on their radiocarbon dating and the resulting chronological information on building sequence. In the absence of such data, the assumption that the elevationally higher focal tomb/cairn was built first and that the satellite tomb(s) was erected later, or the converse, are equally likely. Fraser [12] has confronted these issues in his analysis of intervisibility and orientation data relating to the Neolithic tombs in Orkney. He suggests that 'Intervisibility is a possible way of approaching the study of dominant locations' but where a dominant-subservient relationship between tombs is apparent or argued, it cannot be assumed from such a relationship which was constructed first. In a study of the Neolithic tombs in Co. Sligo, Bergh [6] notes (in the absence of radiocarbon dates) that the dominant focal tomb was built after the satellite monuments. Such a claim does not invalidate the alternative idea that subservient tombs at lower elevations were deliberately orientated instead towards bare earth summits already regarded as sacred. Where this may have been the case, supporting evidence of pre-tomb activity at such elevationally dominant locations should be sought in the archaeological record. On this point, Cooney and Grogan [22] argue that where 'the site was first perceived and chosen as appropriate' for subsequent tomb building then 'the first formal activity connected with construction was in some cases what appears to be a foundation deposit, literally making the site sacred'. Recent investigation of a Neolithic passage tomb on the Hill of Tara, Co. Meath by O'Sullivan [23] provides archaeological support for this hypothesis based on finds from beneath that summit cairn. The discovery of a large flake of chert (thought to be of Mesolithic origin) signifies early human activity on the hill. More importantly for this discussion, the recovery of six charcoal deposits from underneath the tomb and four samples of unburnt and cremated bone from within the tomb yielded radiocarbon dates. These finds have allowed O'Sullivan to propose that pre-tomb activity began there in the early part of 3350–3100 BC and that the tomb was constructed shortly afterwards sometime within the date range of 3335–3210 BC. Overall however, comparatively few Irish megalithic tombs have been dated and this limits the provision of a relative chronology considered critical to understanding the spread and succession of all types of tomb. Whittle *et al* [24] show how the analysis of available dates for the Neolithic in Southern Britain and Ireland can yield an improved chronological model using Bayesian statistical methods. Ultimately, such approaches will be decisive in aiding future efforts at interpreting sequences in such data.

This paper considers the measured orientations and siting of extant passage tombs in Ireland and explores three thematic ideas: the prevalence and attributes of directed tombs as earlier defined, the frequency and significance of astronomically aligned tombs, and the significance of elevation in tomb siting. The findings on orientation are contextualised within a broadly-based interpretative framework for burial orientation (Section 3).

2. Data

The data here are drawn from a broader study of Irish and British passage tombs undertaken by the author. Irish passage tombs primarily date to *c*. 3300–2900 BC in the Middle Neolithic [e.g. 24, 25]. The type is also widely encountered along the Atlantic seaboard from the Iberian Peninsula to Scandinavia as described in Joussaume *et al.* [26]. For the benefit of the reader unfamiliar with this class of monument, a summary description is given.

Passage tombs in Ireland are mostly encountered on locally elevated ground/ridges in lowland settings or on the summits of prominent hilltops and mountains. Chronological overlap between them and court tombs is known from recent radiocarbon dating analysis by Cooney [27] and Schulting *et al* [28]. The chronology of portal tombs is less certain although Whitehouse [29] and Kytmannow [30] describe this type of tomb as occurring comparatively early in the Neolithic. Analysis by Prendergast [20] has also shown that where there is spatial overlap between court, portal and passage tombs at a local scale, passage tombs are elevationally dominant above the other types without exception.

The typical passage tomb is contained within a round cairn delimited by a kerb of contiguous stones (see figure 4 (a)). However, not all passage tombs may have had a covering cairn when built. Incised art on the structural stones - internally and externally, hidden and visible, is common in the eastern part of their Irish distribution. The burial chamber may be circular, rectangular or polygonal in plan and accessed through the entrance/passage. In cases where the circular chamber is differentiated by an end-recess and two side recesses, these are described as cruciform. Of the extant passage tombs in Ireland (221), the chambers of 10 have a corbelled roof and 60 have a lintel capstone roof. The burial rite was most commonly cremation after which the remains of some individuals were placed

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within the tomb accompanied by diagnostic grave goods as previously described. Quartz was sometimes used to embellish an external façade/wall or pavement at the entrance. In the case of the tomb at Newgrange, Co. Meath, Cooney [31] and Eriksen [32] have debated this issue in terms of O'Kelly's [33] restoration. Whether quartz was originally and exclusively used to decorate the entire front of the cairn as interpreted by O'Kelly, or was laid as a pavement, is a matter of continuing discussion. Either way, the visually striking exterior is argued here as being an architectural threshold that demarcated and emphasised the separation between the world of the living and the realm of the dead. The intricate design and orientation of the entrance, passage and chamber also allow the rays of the rising Sun to penetrate and illuminate the chamber for a period of time centered on the date of winter solstice. This phenomenon of solar alignment was empirically discovered by O'Kelly during the restoration phase and was later scientifically analysed by Patrick [34] and Ray [35]. In the decade during which Patrick undertook his research on passage tombs, it was common practice then to primarily limit such studies to measuring orientations and declinations for determining indicative astronomical alignments.

2.1. Directed passage tombs

The number of Irish passage tombs where the axis/entrance is observed to be directed at a distant intervisible tomb/related cairn is shown in figure 2. This schematic visualization of the phenomenon was created using UCINET 6, a software for Social Network Analysis compiled by Borgatti and Everett [36]. The graphs are derived from a symmetrical data matrix which records relationships considered important to the investigator such as agency. Here, agency is defined as the axis of one tomb being directed at another. Each such relationship is shown in the graph by an edge (line with an arrowhead) representing the so-called 'directed view'. This creates a 'directed graph' as described by Wasserman and Faust [21].

The findings are summarised here and in Appendix 1:

- instances of where passages/entrances are directed at a target tomb/cairn are island-wide;
- the phenomenon occurs at 52 of the 132 tombs with extant passages (the remaining 89 are unopened cairns or have their passages ruined/destroyed). This result is considered to be statistically significant (χ^2 = 5.9, p-value = 0.015). If the 12 satellite tombs surrounding the central and largest tomb at Knowth, Co. Meath are removed from the sample (because of their highly unusual concentrated spatial distribution and orientation pattern as previously shown in figure 1), the statistical significance of the outcome is not negated;
- in 49 of the above 52 cases, the target tomb/cairn is elevationally above that of the source tomb. In one of two cases it is not, and in the other, the pair have an equivalent elevation;
- in three cases where the passage/entrance faces another tomb, the alignment simultaneously coincides with either sunrise or sunset at the summer solstice. These are shown italicised in Appendix 1 and one example is illustrated (see figure 4 (d)). Ruggles [18] offers commentary on this phenomenon by stating 'the idea no longer seems far-fetched that a monument may have been located so that an important astronomical event might have taken place behind an existing, perhaps much older, monument';
- where the target is a tomb with an extant passage, the orientation of those passages (13 cases) are never directed back to the source tomb *i.e.* there is not a single instance of orientation reciprocation towards the elevationally lower source tomb.

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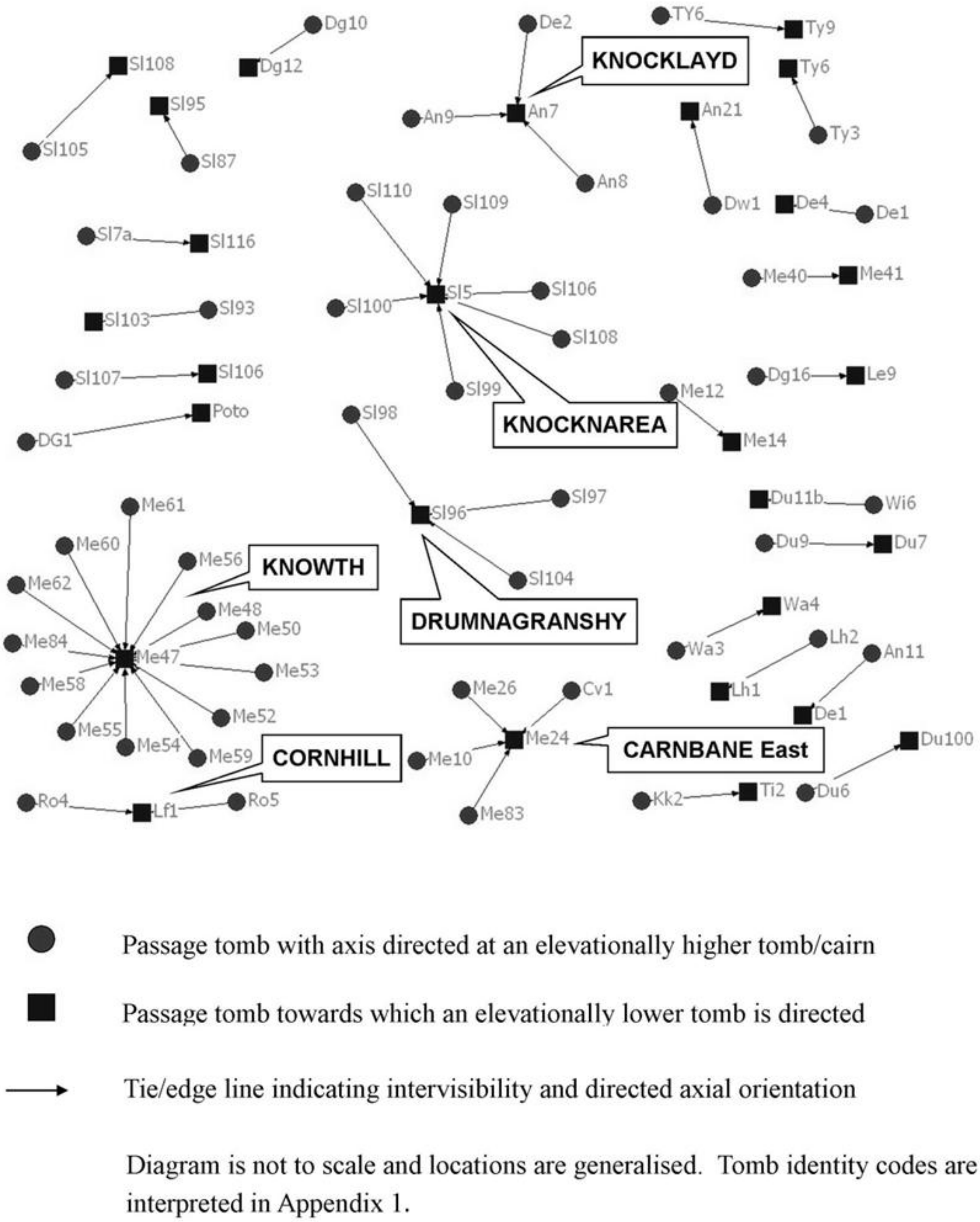

Figure 2. Sociogram of Irish passage tombs with passages/entrances directed at elevationally higher tombs/cairns.

Figure 3 shows the distribution of Irish passage tombs, the locations of tombs with passages/entrances directed at elevationally higher tombs/cairns, and the locations of tombs aligned on the solstices. It is evident from the data that the phenomena occur throughout their distribution range.

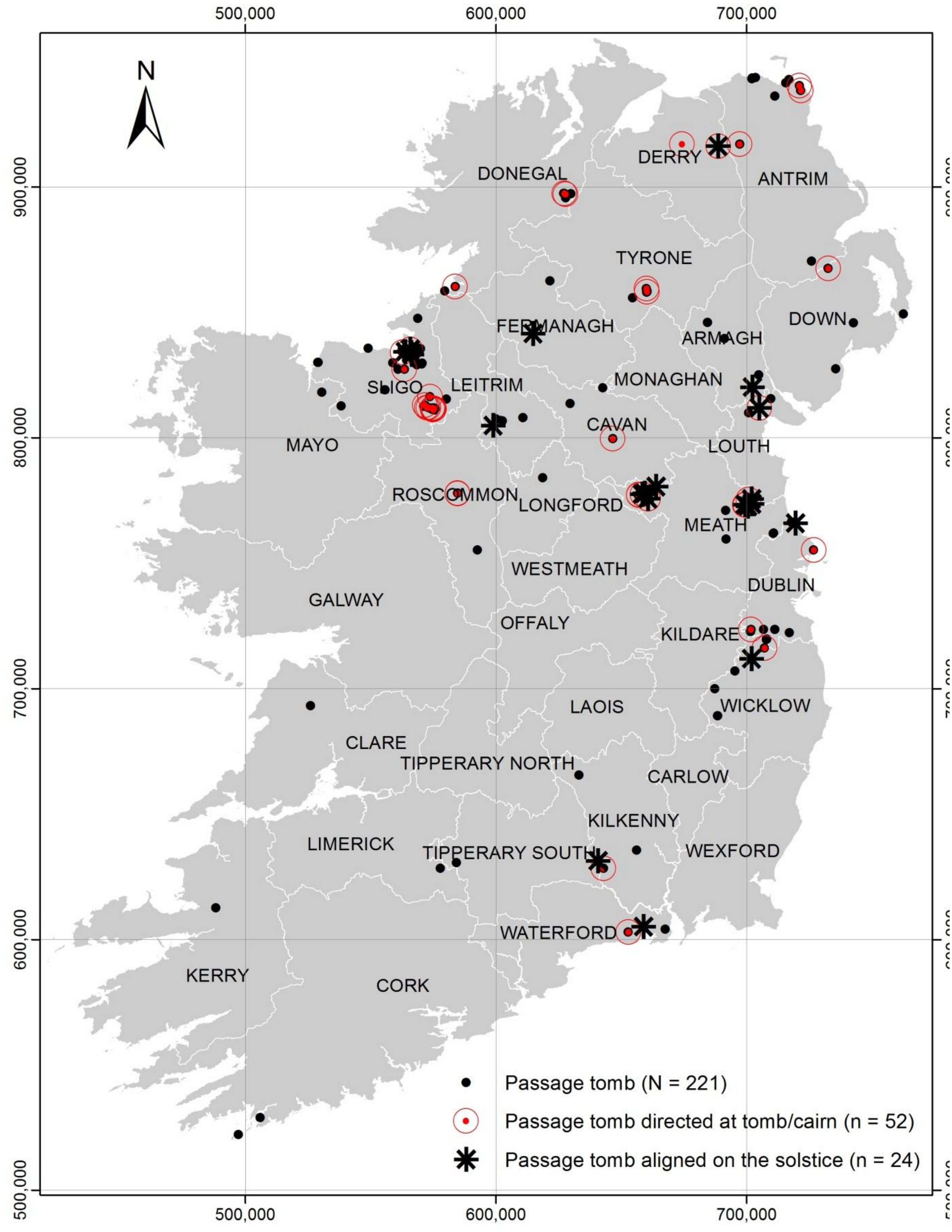

Figure 3. Distribution map of Irish passage tombs and orientation phenomena.

Figure 4. (a) Site 12, Knowth; (b) Site I, Carnbane West directed at Cairn T, Carnbane East; (c) Thomastown passage tomb; (d) Sunset at summer solstice behind Cairn T.

The territorial boundary between Ireland and Northern Ireland is not shown in figure 3.

Figure (4) illustrates examples of these phenomena. Figure 4 (a) shows Knowth Site 12 which has a lintelled entrance, a passage lined with orthostats and a polygonal burial chamber. The covering cairn is round in plan (diameter 15 m, height 4 m) and enclosed by contiguous kerbstones. The passage/entrance of this tomb faces the focal tomb Knowth 1 at the centre of the complex (see figure 1).

Figure 4 (b) shows the axial view from the ruined chamber and passage of Site I (source tomb) located on the summit of Carnbane West at Loughcrew, Co. Meath. This passage is directed towards the elevationally higher focal Cairn T (target tomb) on the summit of Carnbane East. Both monuments have incised art on many of the structural stones (visible in the figure on the left-hand orthostat of the passage). The passage of Cairn T is not reciprocally aligned on Site I. Instead, that tomb has an easterly azimuth with an astronomical declination of -1° which equates to a time of year when the direction of sunrise is approximately midway between its limiting directions at the winter and summer solstices (See Appendix 2). Shortly after sunrise, the lavishly decorated back-stone of the end recess of the burial chamber in Cairn T is illuminated by the rays of the rising Sun for a period of a few days. The phenomenon has endured over the intervening *c*. 5000 years because the apparent direction of sunrise on/near the equinoxes is unaffected by changes in obliquity of the ecliptic ε due to symmetry in orbital mechanics. Figure 4 (c) shows the ruined passage of the tomb at Thomastown, Co. Meath aligned towards the passage tomb Cairn T on the summit of Carnbane East, Loughcrew. Figure 4 (d) shows the recorded phenomenon of the Sun setting behind Cairn T at the summer solstice and on the alignment shown in figure 4 (c). In the Neolithic, when ε was 24°, the Sun would have set slightly

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north of its present position. To an observer located at the passage tomb in Thomastown, the lower limb of the Sun would then have appeared approximately tangential with the top of the cairn just before sinking below the horizon.

2.2 Astronomically aligned passage tombs

The astronomical declination of tombs with an extant passage (N = 132) was determined from the azimuth of the passage/entrance, the indicative angular altitude of the horizon and the latitude of the monument. Each was assessed for any evidence of alignment on the rising/setting Sun and Moon. The assessment criteria are based on the limiting values of declinations indicated in Table 1 and are valid for *c*. 3000 BC and the latitudinal range of the tombs.

Table 1. Limiting declinations of the Sun and Moon in *c*. 3000 BC (valid for Ireland).

Astronomical Body	North Major Limit	Summer Solstice	North Minor Limit	South Minor Limit	Winter Solstice	South Major Limit
Sun	-	+24°.0	-	-	-24°.0	-
Moon (P not applied)	+29°.2	-	+18°.9	-18°.9	-	-29°.2
Moon (P applied)	+28°.4	-	+18°.1	-19°.8	-	-30°.1

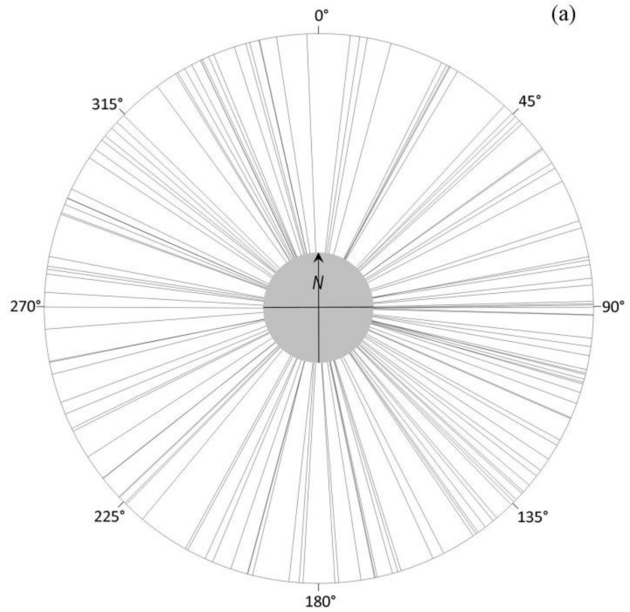
The declination limits of the Sun in *c*. 3000 BC were ±24°.0 and equate to the magnitude of ε at that time. The declination limits of the Moon are determined from ± ε ± i, where i is the inclination of the Moon’s orbital plane (+5°.15). These yield the limits ± (ε + i) = ± 29°.2 and ± (ε - i) = ± 18°.9 as shown in table 1. Furthermore, and because of the Moon’s greater proximity to the Earth than the Sun, a lunar parallax correction (-0°.85) is used to correct the lunar geocentric limits of declination to their topocentric equivalent (the limits that would be observed at ground level).

Concluding whether, or not, a passage/entrance is astronomically aligned is additionally guided by the field-of-view (or window of visibility) as dictated by the lateral limits of the horizon sector as seen from within a burial chamber. Such an approach sensibly allows for a relaxation in the acceptable tolerance when deciding if a computed declination is astronomically significant. This makes sense given the wide aperture of the sky-view encountered in many tombs and uncertainty due to the crude or damaged nature of many megalithic structures.

The axial azimuths of Irish passage tombs are shown in figure 5 (a). These encompass the full horizon and thus the greatest possible range in astronomical declination. For comparison purposes (because of their suspected affinity with the passage tomb tradition), figure 5 (b) shows the orientation of 175 court tombs determined by De Valera [37]. In those, there is an apparent easterly bias in their distribution relative to the meridian and slight evidence of clustering in east-northeast. No such pattern is evident in figure 5 (a). Moreover, both orientation patterns are in marked contrast with the apparent clustered patterns of orientation encountered in portal tombs as described by Ó Nualláin [38].

The categories and frequencies of the 24 astronomically aligned tombs are shown in figure 6.

Appendix 2 lists the astronomically aligned tombs and gives the morphology of their burial chamber, if passage tomb art is extant, and whether the passage/entrance is simultaneously directed towards another tomb/cairn.



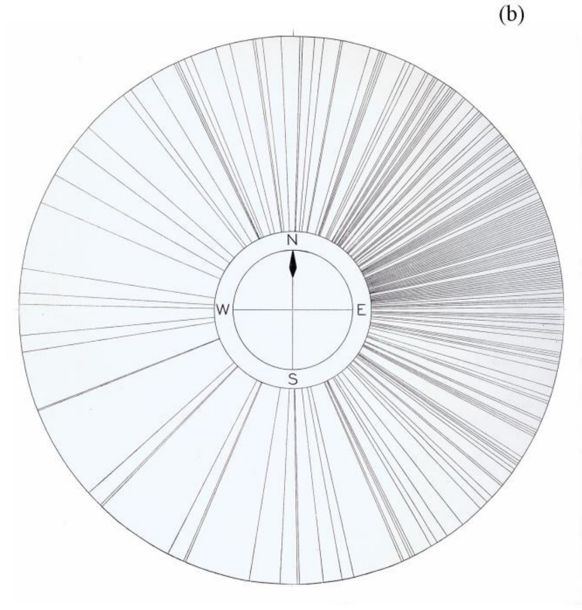


Figure 5. (a) Axial azimuth of 132 Irish passage tombs; (b) Axial azimuth of 175 Irish court tombs (from De Valera [37], Plate XXXV).

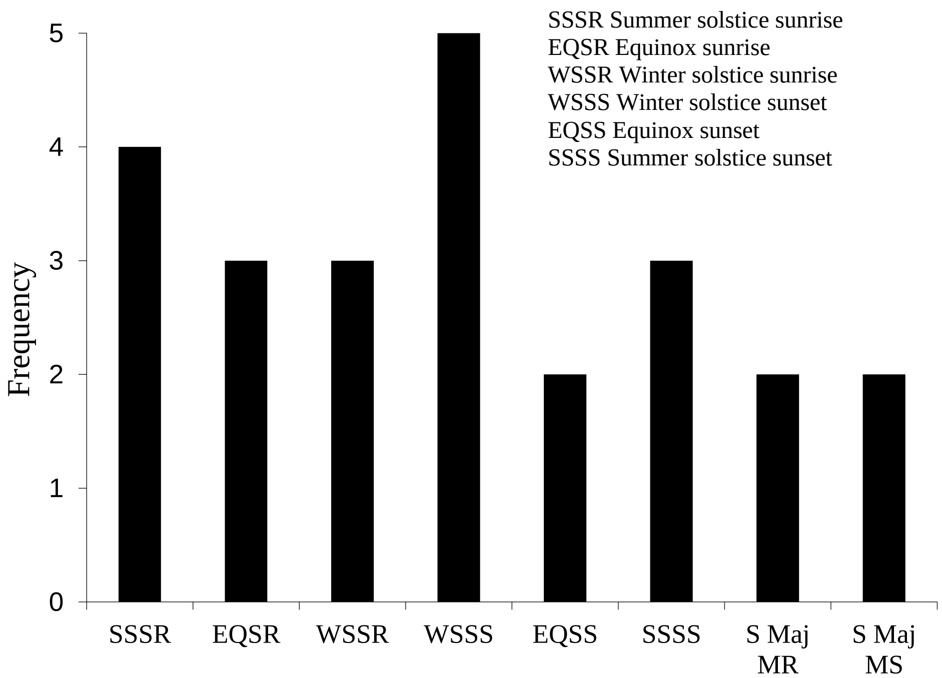


Figure 6. Histogram of astronomical orientation in 24 Irish passage tombs.

In summary, these data indicate that:

- the incidence of astronomically aligned tombs (n = 24) is 18.2% of the total number tombs with an extant passage (N = 132);
- the greater incidence of solar alignment in comparison with lunar alignment is statistically significant (χ^2 =10.7, p = 0.001);
- the greater incidence of solstitial alignment in comparison with equinoctial alignment is statistically significant (χ^2 = 5.0, p =0.025);
- there is no significant difference between the number of alignments on the winter and summer solstice (χ^2 = 0.067, p = 0.796);
- there is no significant difference between the number of alignments on sunrise and sunset (χ^2 = 0.067, p = 0.796);
- evidence of astronomical alignment is significantly more frequent in non-cruciform tombs than in cruciform tombs (χ^2 = 8.167, p = 0.0043);
- the geographical distribution of astronomically aligned passage tombs is an island-wide phenomenon.

These findings are discussed in Section 3.

3. Framework for orientation and alignment criteria

In the 1980s, methodological approaches and data testing criteria for the analysis of orientations encountered in megalithic monuments were proposed by Ruggles [39]. Those incorporated information drawn from archaeological excavations and reports, horizon and archaeoastronomical surveys, and a clearly categorised tabular approach to data presentation. The motive then was to advance the debate relating to the wider role and meaning of such data across relevant disciplines in a more consistent and inclusive manner. Three general classes of assessment criteria were proposed:

- astronomical declinations to identify possible coincidence of built structures with rising or setting points of prominent celestial bodies;
- azimuthal directions to identify possible preferences for preferred directions such as cardinal or other indicative points;
- topographical features that may have been symbolically linked with tomb construction.

These have largely shaped the manner in which archaeoastronomers have acquired and tested data ever since. In the early 1980s, Burl [40] also recognised the need to consider other orientation possibilities in addition to astronomical ones, including tombs directed at prominent natural landforms, ancestral man-made structures, and the ‘conjunction of art and astronomy’ in certain tombs. In the intervening decades, there have been significant advances in theory, method and interpretation which are firmly grounded in newer archaeoastronomical principles often supported with ethnographic evidence. Ruggles [41] illustrates this in a new series of wide-ranging papers globally drawn from temporally varied cultural and geographical contexts and case studies. These demonstrate how scholarly concepts, knowledge and opinion are shaping interdisciplinary approaches to understanding the role of the sky and landscape in the prehistoric past. In this context, the need to consider structural/axial orientations from the broadest of perspectives, including a funerary one, is therefore advised prior to seeking any astronomical meaning.

The nomenclature used by archaeologists and anthropologists to record the physical aspects of burial and tomb deposition/construction/orientation/siting can be as varied as the cultures they study. The classification system and synthesis of terminologies proposed by Sprague [42], for example,

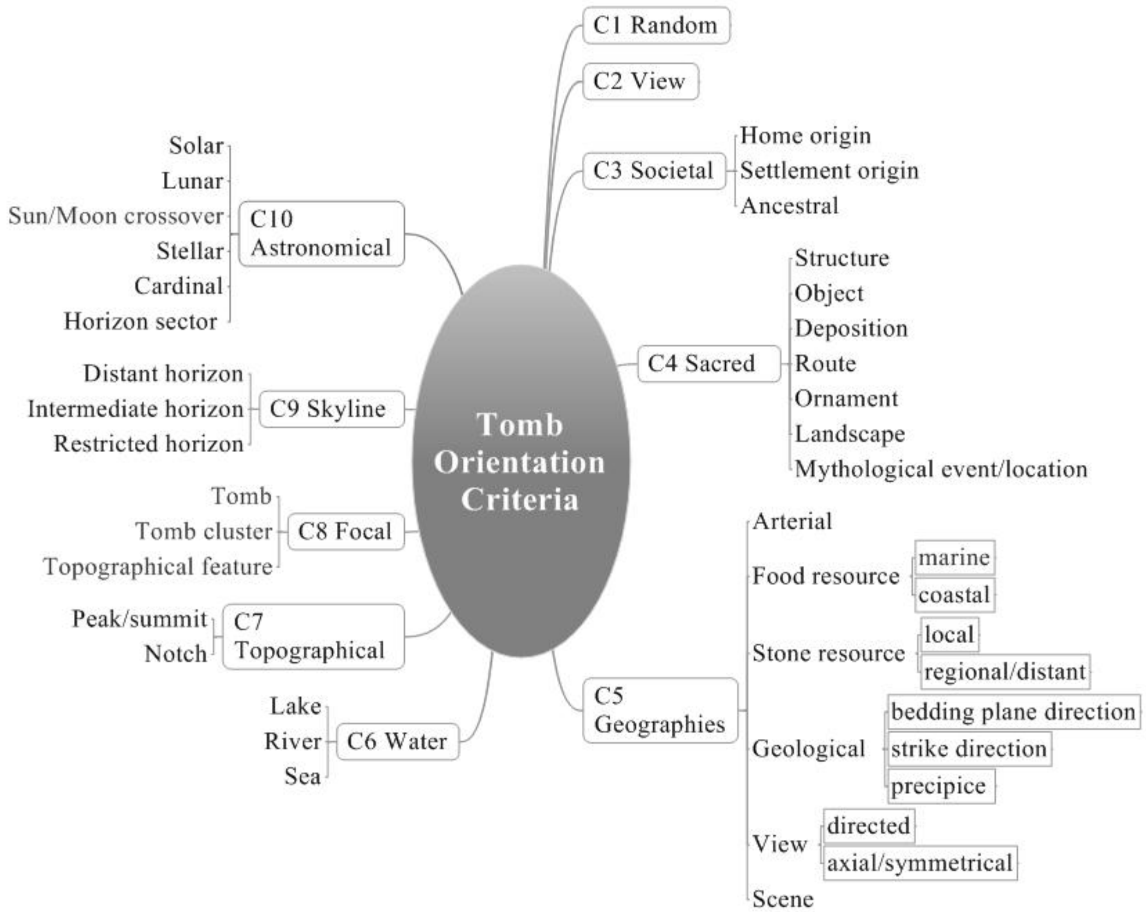


Figure 7. Criteria for assessing megalithic tomb orientation.

provides a relevant standardised nomenclature compiled in a single source for all forms of burial-related evidence (skeletal, grave goods, tombs etc.). The variables include forms of body preparation and disposal, deposition (articulation and position), orientation (of the body and the grave/tomb) and a description of grave goods. Accordingly, the framework shown in figure 7 is an amalgamation of the criteria proposed by Sprague [42] and Burl [40] with additions by the author drawn from findings detected in the Irish passage tomb tradition in particular.

3.1. Random (C1)
Tomb orientations that cannot be modelled for evidence of pattern or clustering, or which lack any apparent explanatory causal factor, are sometimes described as being random. Such orientations might reasonably be attributed to the personal whim of the builder.

3.2. View (C2)
Orientation is the direction of an object or structure angularly expressed relative to a reference direction (true north, magnetic north, map/grid north or an arbitrary point). Alignment signifies intentionality in the orientation where the forward and reciprocal cases should be considered. In the case of a tomb, these dictate what are termed here as 'in-view' and 'out-view'. In-view is obtained as one enters the tomb via the passage and proceeds towards the burial chamber. Out-view is the reciprocal of this *i.e.* the view from the chamber through the passage and entrance towards the horizon. Whether alignment was ever planned with regard to the concerns/rituals of the living as they

entered a tomb (in-view), or whether the priority was out-view as might have been conferred on the remains of the dead by the living, becomes a key question. In his analysis of more than 1500 prehistoric sanctuaries and communal tombs of the central and western Mediterranean regions, Hoskin [43] was confronted with this conundrum and, by selecting out-view, he concluded 'Our measured orientation reflects the view of the dead (…) Why we select this direction rather than the opposite, is not easy to put into words'. Scott [44] considers this same question 'from an entirely different viewpoint' by challenging the (then) prevailing assumption that in long-chambered cairns at least, 'the entrance faces in a direction that was ritually significant'. In his study of 10 Clyde cairns on the Mull of Kintyre, Scotland, he proposes instead that 'if the cairn were the means whereby the dead returned to join their ancestors, then the tail of the cairn might be the taken to point in the direction from which those ancestors had come'.

In a study of passage tombs in Västergötland, Sweden, Tilley [45] encountered variation in the external dimensions of the mounds, chambers and passages but also a 'remarkable degree of regularity in form, shape, orientation and construction'. Except for in a minority of cases (seven) where the chambers are irregular, oval or polygonal in plan, all exhibit a 'rigidly standardised' T-shape relationship between the burial chamber axis and the entrance passage. The chambers are consistently orientated north-south and the entrance passages face east. This orthogonal relationship is described by Tilley as being of 'fundamental importance'. He further suggests the orientations of the passages as having potential solar significance, and the north-south orientations of the tombs as 'fixing the dead into the landscape' and indicating 'an ancestral track, a path of movement'.

In the Irish passage tomb tradition, the horizon range 'D' behind the burial chamber (coincident with in-view) is generally restricted (D < *c*. 0.5 km). In comparison, the horizon range in front of the entrance (coincident with out-view) is invariably either distant (D > *c*. 5 km) or between these limits. In the latter direction, the number of instances where out-view faces a distant tomb or a potentially significant sector of the horizon (in an astronomical sense) is more emphatic (see Section 2). Moreover, in the case of 25 of the 36 passage tombs with a cruciform chamber, the larger and more elaborate of the two side recesses occurs on the left-hand side as dictated when out-view is taken (in the remainder, the difference in size between the left and right-hand chambers is indistinguishable). Overall, this finding could suggest a link between internal tomb architecture, burial practices, orientation and a dictated view. More generally, these ideas are broadly known *e.g.* Hertz [46], Aveni [47], Krupp [48] and Sims [49].

Another example of how axial orientation may have been influenced by architecture and view preferences are found in the 14 chambered long cairns of the Cotswold-Severn group in the Black Mountains, South Wales. Cummings [13] shows that where a view is taken along the axis of such cairns, in every case this is restricted in one direction but open/distant in the reverse direction. Interestingly, there is no evidence of axial alignment towards other cairns or prominent hilltops, there or elsewhere amongst the Welsh cairns.

3.3. Societal (C3)

Cooney [4] proposes that megalithic tombs be broadly considered as *foci* for ancestral remains, places of ritual, and as houses, temples and shrines for the ancestral dead. Where a particular monument is argued as having an association with the home/origin of those interred, such ideas are legitimate factors when interpreting the orientation of an outlying tomb directed back towards a focal tomb (see Section 2.1). Extensive support for these ideas is to be found, for example, in ethnological research on contemporary indigenous people in Indonesia. Such early studies of practices concerning the burial of the dead and the orientation of houses and other structures by Perri [50, 51] provide highly relevant data in the context of this paper. Studies of orientation of a more general nature by Rose [52, 53] and Rahtz [54] provide additional evidence to demonstrate the diversity of cultural factors that can explain grave and tomb orientation.

3.4. Sacred (C4)
A structure, object, place or path that instigates or is imbued with reverence by a community sharing a common belief system could be described as sacred. Pathways and avenues created for ceremonial access to liminal spaces may have been similarly regarded. Norberg-Schulz [55] asserts that 'In the environment, the sacred places function as 'centres'; they serve as objects of man's orientation and identification, and constitute a spatial structure'. Where the desire for planned orientation was inspired by the symbolism of light and cosmic events on the horizon (see C10), this could have amplified the symbolic meaning of the design as well as the space/landscape in which the structure was situated. The solstitial alignment of the entrance passage at Newgrange provides convincing support for this hypothesis and interpretation. From the geographer's perspective, Weightman [56] relevantly describes light as 'fundamental to religious experience, and how its symbolism pervades the geography of sacred landscapes'.

3.5. Geographies (C5)
Geography is taken to mean here the activities of humans in relation to the physical landscape. In the Archipelago of Åboland in south-west Finland for example, investigations by Tuovinen [57] of 253 Bronze Age and Iron Age burial cairns show that orientation of the axes of long cairns appears to be correlated with the strike direction of the exposed bedrock. The cairns additionally appear to be aligned in the direction of a brink or precipice at one end. Furthermore, those orientated north-south are numerically the largest (32%) but other directions are evenly represented (southwest–northeast 23%, west–east 26% and northwest–southeast 19%). A statistical analysis of those orientations by this author allows the null hypothesis to be rejected (χ^2=9.4, p=0.02) and the conclusion that their distribution is not random. Investigation of Bronze Age stone rows in Ireland by Ruggles [58] provides added evidence of view direction being dictated by height gradation of the stones. There is a consistent preference for greater distance to the horizon in the axial direction indicated by the view from the shortest to the tallest stone of the row. This architectural feature is also evident at the Boleycarrigeen stone circle in Co. Wicklow. Grogan and Kilfeather [59] describe how the stones there appear to rise in height from the entrance in south-southwest to the tallest stones in north-northeast. Convincing evidence of a link between architecture, view direction and distant horizon range is also evident in orientation studies of recumbent stone circles in Ireland by Ruggles and Prendergast [60], and in Scotland by Ruggles [61].

3.6. Water (C6)
Burial of the dead is described by Sprague [42] as simple or compound. Simple forms consist of surface disposal of remains by aquatic or terrestrial placement. Compound disposal includes inhumation or cremation. Where a human body or its cremated remains was consigned to water, Lewis-Williams [62] suggests that water demarcated an 'Isle of the Dead and linked it to the great water, the sea'. If ever regarded in this fashion, water may thus have been a 'realm of the dead'. There is no evidence that people in Neolithic Ireland were ever buried in water but a symbolic link with water could be argued where tomb orientation is towards or parallel to water bodies and courses. In his assessment of 14 Neolithic long cairns in the Welsh Black Mountains, Tilley [63] proposes two determining principles for their orientations: cairns orientated with their axes running parallel with major rivers or their tributaries, and cairns orientated towards prominent natural spurs.

3.7. Topographical (C7)
The summits of prominent hills and mountains may have been symbolically important places to locate tombs and cairns. Lewis-Williams and Pierce [62] argue a multi-stage journey of the Neolithic dead, the final leg of which took the deceased upwards through the roof of the burial chamber and mound (situated on a ridge or summit) to the sky, where 'the dead, now revived, joined the cyclic Sun, and very likely, a god or gods associated with it in the eternal rounds of cosmological life, death and

rebirth'. Such a proposition makes cultural sense in terms of why humans chose elevationally high places for ceremonial or burial purposes. Summits offer expansive views, are the interface between two worlds, and have a perceived proximity to the cosmic zone above. The crest of a hill or mountain is also a boundary that acts as an edge between the terrestrial world and the celestial domain. Such a perceived division suggests zoning, a process that humans may have used to rationalize the indeterminate division between the intangible 'above' and the familiar terrain below. This idea is broadly compatible with findings obtained in the study of land use patterns and human movement and perceptions of landscape at lower levels in the landscape e.g. O'Sullivan [64], Bradley [65], Cummings and Whittle [66] and Bamforth and Woodman [67]. Mountain summits forming distinctive profiles or notches when viewed from afar can also act as culturally meaningful targets for megalithic alignment. Silva [68] provides evidence for this in a cluster of Neolithic dolmens in Central Portugal where a link between the monuments of the region, a prominent mountain range and the rising of the bright star Aldebaran is argued and supported by local folklore.

3.8. Focal (C8)
A focal monument, place or direction captures the interest of an audience and channels its view. This is achieved by architecturally emphasizing a key design element such as an axis that directs the gaze in the intended direction towards a distant place, structure or an event. To have religious meaning, such entities are constructed where people are intended to gather for celebratory, ceremonial or ritual purposes. Cooney [4] proposes that in certain megalithic complexes, the existence of focal tombs 'has not only been posited because of their larger size, but also because of their commanding topographical locations and the occurrence of smaller tombs in their vicinities, sometimes with their entrances facing the focal tombs, all suggesting the concept of an interrelationship between the monuments'. Distant focal points/structures, sacred sectors of the skyline, or cosmic events, may therefore have been linked in a religious sense with the concept of out-view.

3.9. Skyline (C9)
Contemporary architects such as Ritchie [69] attest to a new monument and its landscape setting being capable of creating emotions more powerful than the structure itself. Moreover, he argues why visibility of the skyline matters in design terms, and that a skyline should be considered as the domain of power and thus a monument and monumental in itself. Arguably, those ideas have a shared relevance with the prehistoric past in terms of site selection for monument building purposes. Broda [70] provides ethnographic evidence from the Central Mexican highlands of Mesoamerica for site selection of the temple site at *Cuicuilco* so that the special properties of the eastern horizon could be harnessed for calendrical purposes. Studies of Neolithic chambered tombs in Wales by Cummings [66, 71] note that one of the characteristics of virtually all megalithic constructions is that they have a restricted view in one direction. By implication, the intermediate and distant horizon in terms of range from the tomb in the reciprocal direction was a probable factor in terms of a preferred orientation of their entrances. Moreover, in northwest Wales, 75% of the tombs are located with a view of the sea. Collectively, such landscape studies contribute to our understanding of societal preferences for tomb and site selection during that period of prehistory at least.

3.10. Astronomical (C10)
Archaeoastronomy is the scientific investigation of naked-eye practices of observing the cyclical/seasonal movements of prominent stars and planets (and the appearances of comets and supernovae) and its role in the lives, culture and belief systems of indigenous peoples worldwide. As stated by Silva [72], 'the horizon motions of the Sun and the Moon, especially their extremes, are well attested targets for alignments of archaeological sites since prehistoric times, for many cultures across the globe'. Furthermore, studies of megalithic dolmens in Portugal by Silva and da Silva [73] raise the possibility of an additional cultural interest in the phenomenon termed the crossover of the Sun and

Moon. This biannual event occurs around the dates of spring and autumn Full Moons close to the equinoxes and at an azimuth peak of about 97° (declination about -6°). Such a finding could explain the north-southeast axial alignment encountered in many of the monuments in that region at least.

Contrasting views are evident regarding the relevance of such studies to archaeology. Bergh [6] states 'The problem is not whether Neolithic man had knowledge of solar and lunar movements but rather to what extent and for what purpose this knowledge was expressed in the megalithic monuments'. On a cautionary note, Ó Ríordáin and De Valera [74] state 'There is no doubt that orientation was considered important by Prehistoric Man, not only in stone circles but in some megalithic tombs; its importance has been obscured by the extravagant claims made by its protagonists who have sometimes argued about orientation as if primitive man used precision instruments'. Modern archaeoastronomy now largely concerns itself with the low-level precision of orientated prehistoric structures. This is consistent with their likely symbolic role for the farming communities who erected them. Such concerns show no sign of abatement, especially where the debate is paradoxically invigorated in a self-critical view on astronomical alignment by Ruggles [18]. He states 'It is certainly true that insomuch as archaeoastronomy consists of approaching prehistoric monuments looking for astronomical alignments, then it is at best misleading and at worst completely useless. The simple reason is that many factors could have influenced a monument's orientation and position in the landscape, and while we should not ignore orientations, as archaeologists have often done in the past, we should certainly study them open-mindedly, not starting from the assumption that astronomy is the (sole or primary) motivation'.

4. Tomb siting and elevation

All prehistoric built structures exhibit orientation regardless of whether or not an architectural element (passage, chamber, facade etc.) may have been intentionally aligned towards a target considered meaningful to the builder. Without ethnographic or documentary evidence, inferences of an embedded design aim are highly subject to conjecture and misinterpretation. The futility and inherent dangers of drawing conclusions based on a single alignment are well recognised but this weakness can be overcome by meaningful analysis of broader regional groups of typologically similar monuments considered within archaeological and cultural contexts e.g. Ruggles [39]. Here, emphasis has been given to Irish passage tombs because of the large sample size (N=221) and elaborate design features (especially the parietal art) when compared with other prehistoric tomb types. Moreover, Prendergast [20] has shown that they exhibit the maximum degree of spatial clustering compared with Neolithic court and portal tombs. In addition, and where mingling of different tomb types occurs in the same landscape, passage tombs are always elevationally dominant above the other tomb types. This suggests a hierarchy in terms of their relative elevation in the landscape. There is also a strong tendency for such tombs to aggregate on locally elevated ground. An analysis of categorised horizon ranges by the author further suggests that landscape siting may have been a determinant so as to afford the greatest degree of view of the distant horizon *i.e*. range >5 km.

As one ascends from lowland onto the summits of hills and mountains where the majority of passage tombs are located, this can provide empirical experience on an intangible 'other world'. Landforms have not changed since the Neolithic and this provides an immutable link with prehistoric people undertaking the same journeys in that sense. Where the difference in elevation above lowland becomes significant, the senses become acutely heightened due to the exposed nature of the location. Feelings of power engendered by topographical gradient, elevation, expansive view, and the tangible sense of being close to another domain, could partly answer the question as to why such locations were chosen for tomb building purposes. The motivation to place them in such physically challenging and remote parts of the landscape perhaps likely emanated from such attributes.

Elevation of place could also reflect an intentional and hierarchical binary layering of the landscape in order to rationalise the two worlds of everyday existence and the afterlife. This is consistent with the basic human need for balance and equilibrium in life. It is argued that because of the spatial setting of many passage tombs on ridges and summits, such burialscapes became elevated sacred spaces within the broader landscape. As such, they would likely have held intense emotions and meaning for those who viewed or approached them. Thus situated, additional attributes realised by view, horizon, sky and cyclical celestial events could have fulfilled the design intent in addition to their funerary role, and made such places focal.

The character and meaning of any perceived division between these two worlds - one above and the other below, may have been regarded as a transitional zone, boundary or edge. In a sense, boundary or edge is the intangible demarcation between such worlds. The 'above' is hostile, remote, mysterious and seemingly closer to the perceived celestial dome - a gateway to the afterlife. The 'below' is familiar, lived-in and understood. If such interpretations suggest liminality, then a neuropsychological approach could be a basis to explain the link between the mind and the landscape as interrelated causal mechanisms for such observed/experienced perceptions (of landscape). The dynamic of moving up or down a mountainside from one zone to another, is an experience that is sharpened by the indefinable but conscious state of passing through such a metaphysical threshold created in the mind. Similar ideas are shared by Fraser [75] in an examination of human engagement, the role of the senses, monumentality and social order with reference to the passage tomb complex and the wider cultural landscape at Loughcrew, Co. Meath.

In order to position the investigation of tomb elevations within archaeological contexts, current theory relating to the development of Irish burial practices in the Neolithic are relevant. Cooney and Grogan [22] propose that the nature of deposition and the elaborate treatment of human remains are now seen as being the central aspect of tomb design and siting. Embedded within this universal human concern for burial of the dead is a tapestry of very specific and interlinked motivations and actions. These are expressed through local and regional variations in customs and rites (inhumation, cremation), tomb morphology and embellishment, the nature and depositional patterns of grave goods, axial orientation, the scale of the tomb, and hierarchy in site selection (visibility and elevation). Importantly, where a tomb may have ceased to be used for burial purposes, its continued existence in the landscape is argued by Cooney [3] to have imbued it with special meaning and significance in perpetuity. Whittle *et al* [24] advise that where the tradition of building tombs is known to have had a time depth spanning many generations, this knowledge (although based on a limited number of radiocarbon dates and inadequate knowledge as to their construction sequence) can help to develop a framework for the theoretical exploration of elevation and visibility as one of several contributing but interdependent cultural response variables for the siting of a tomb.

The long-range visibility of, and intervisibility between, many of the passage tombs in Ireland is striking in the majority of cases. This occurs either as a result of their elevated skyline position or because of the inordinately large volume of the cairn in some cases (in proportion to the incongruously small volume of the internal burial chamber). Where such characteristics are evident, then additional functionality for the tombs other than being receptacles for the dead must be considered. Such approaches in thinking by others already mentioned here have yielded new perspectives and insights on the probable symbolism and meaning of tombs. Early studies (of megalithic tombs) principally concentrated on their morphological structure, material culture and, to a limited degree, on their distributional patterns [e.g. de Valera 37]. More recent theoretical studies now use a broader range of interpretative paradigms and the term 'complex' is preferred to better reflect their probable wider role and meaning. Such interpretive approaches can thus allow for the inclusion of additional attributes such as the phenomenology of the tombs, in addition to their more obvious funerary and ceremonial roles.

5. Conclusions

Particularly in the last decade or so, interdisciplinary research of the prehistoric past by archaeoastronomers, historians of science, ethnologists and astronomers has significantly coalesced in terms of interpretative method. As part of that research agenda, cultural astronomy - an overarching discipline which integrates archaeoastronomy, ethnoastronomy and ancient cosmology - is now shaping a more culturally relevant understanding of symbolism, belief systems and structural alignments.

The criteria-based framework for tomb orientation proposed in this paper potentially allows for such data to be more meaningfully assessed in its broadest social sense. Its use could help to overcome the challenge often encountered where observed axial directions are seen to be distributed, evenly or not, around the horizon (as is the case for Irish passage tombs and court tombs). In that context, alternative meanings for such data should advisedly be sought prior to deducing astronomical ones. More generally, major scholarly compilations such as by Ruggles [41], Aveni [76], and Silva and Henty [77] which communicate the diversity in ancient ways of sky watching in the New World and the Old World will influence method, interpretation and best practice for the foreseeable future.

APPENDICES

Record details of tomb locations and descriptions discussed in the text and in Appendix 1 and 2 can be queried on the Archaeological Survey Database of the National Monument Service of Ireland website [78] and on the Northern Ireland Environment Agency website [79].

For both jurisdictions, the query tools enable users to search for site records using three methods:

- by site record number (given in table A.1 and A.2);
- by database query (text-based description as given in table A.1 and A.2);
- by geographic location using coordinates expressed in the:
  - Irish ITM coordinate reference system [78];
  - Northern Ireland IG coordinate reference system [79].

Table A.1. List of directed passage tombs

Source tomb			Facing	Target tomb/cairn		
Townland & County name[a]	Site record number	Elevation above mean sea level (m)		Townland & County name[a]	Site record number	Elevation above mean sea level (m)
CRAIGS, ANTRIM	ANT022:024	163	→	DRUMSURN UPPER	LDY017:017	403
EAST TORR, ANTRIM	ANT010:001	379	→	KNOCKLAYD	ANT008:001	512
WEST TORR, ANTRIM	ANT009:019	298	→	KNOCKLAYD	ANT008:001	512
BANAGHER, CAVAN	CV026-004004-	235	→	CORSTOWN	ME015-012004-	274
FINNER, DONEGAL	DG107-106----	36	→	ARROO	LE023-030----	523
GORTNAGOLE , DONEGAL	DG070-070----	89	→	CROAGHAN	DG070-074002-	223
KILMONASTER , DONEGAL	DG070-063008-	77	→	CLOGHROE (portal tomb)	DG069-018----	180
BALLYNAHATTY, DOWN	DOW009:036	46	→	BALLYCOLLIN	ANT064:001	328
DRUMSURN UPPER, DERRY	LDY017:017	403	→	INISCARN	LDY041:018	496
MONEYDIG, DERRY	***LDY019:008***	***49***	→	***KNOCKLAYD***	***ANT008:001***	***512***
SESS KILGREEN, TYRONE	TYR052:013	117	→	SHANTAVNY IRISH	TYR052:032	171
SHANTAVNY IRISH, TYRONE	TYR052:032	171	→	SESS KILGREEN	TYR052:008	118
CROCKAUNADREENAGH, DUBLIN	DU024-005001-	346	→	SLIEVETHOUL	DU024-034----	397
RUSH, DUBLIN	DU008-013001-	10	→	LAMBAY ISLAND	DU009-001002-	126
BAUNFREE, KILKENNY	KK034-031----	261	→	BALLYPATRRICK	TS078-001----	721
FAUGHART LR., LOUTH	***LH004-062----***	***51***	→	***RAVENSDALE PARK***	***LH004-004----***	***508***
CORSTOWN, MEATH	ME015-012005-	260	→	CORSTOWN	ME015-012004-	274
KNOWTH, MEATH	ME019-030004-	69	→	KNOWTH	ME019-030001	78
KNOWTH, MEATH	ME019-030006-	67	→	KNOWTH	ME019-030001	78
KNOWTH, MEATH	ME019-030007-	66	→	KNOWTH	ME019-030001	78
KNOWTH, MEATH	ME019-030008-	71	→	KNOWTH	ME019-030001	78
KNOWTH, MEATH	ME019-030009-	68	→	KNOWTH	ME019-030001	78
KNOWTH, MEATH	ME019-030010-	66	→	KNOWTH	ME019-030001	78
KNOWTH, MEATH	ME019-030012-	71	→	KNOWTH	ME019-030001	78
KNOWTH, MEATH	ME019-030013-	68	→	KNOWTH	ME019-030001	78
KNOWTH, MEATH	ME019-030014-	68	→	KNOWTH	ME019-03001	78

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Table A.1. continued

KNOWTH, MEATH	ME019-030015-	70	→	KNOWTH	ME019-030001	***78***
KNOWTH, MEATH	ME019-030016-	69	→	KNOWTH	ME019-030001	78
KNOWTH, MEATH	Uncoded in SMR	65	→	KNOWTH	ME019-030001	78
MONKNEWTOWN, MEATH	ME019-017----	40	→	DOWTH	ME020-017----	73
NEWTOWN, MEATH	ME015-003002-	244	→	NEWTOWN	ME015-003010-	248
NEWTOWN, MEATH	ME015-003006-	249	→	CORSTOWN	ME015-012004-	274
THOMASTOWN,MEATH	***ME015-111----***	***128***	→	***CORSTOWN***	***ME015-012004-***	***274***
SCURLOCKSLEAP, WICKLOW	WI006-003----	621	→	BALLINASCORNEY UPPER	DU024-047002	645
SHROUGH, TIPPPERARY SOUTH	TS073-007----	369	→	BALLYPATRICK	TS078-001----	721
MATTHEWSTOWN, WATERFORD	WA026-003----	78	→	COUMARAGLIN	WA014-001----	725
SHEEGEERAGH, ROSCOMMON	RO028-135----	73	→	CORNEDDAN	LF005-017----	278
SHEEGEERAGH, ROSCOMMON	RO028-134----	73	→	CORNEDDAN	LF005-017----	278
ARDLOY, SLIGO	SL034-109----	92	→	KNOCKNAREA SOUTH	SL014-076003-	323
BARNASHRAHY, SLIGO	SL014-096002-	30	→	CARROWNAMADOO	SL020-129----	217
CARNAWEELEEN, SLIGO	SL040-006001-	242	→	DRUMNAGRANSHY	SL040-008----	361
CARROWKEEL, SLIGO	SL040-086----	270	→	DRUMNAGRANSHY	SL040-008----	361
CARROWKEEL, SLIGO	SL040-087----	270	→	CARROWKEEL	SL040-089----	300
CARROWKEEL, SLIGO	SL040-089----	300	→	KNOCKNAREA SOUTH	SL014-076003-	323
CARROWKEEL, SLIGO	SL040-090001-	305	→	KNOCKNAREA SOUTH	SL014-076003-	323
CARROWKEEL, SLIGO	SL040-093----	320	→	KNOCKNAREA SOUTH	SL014-076003-	323
CARROWKEEL, SLIGO	SL040-095----	320	→	KNOCKNAREA SOUTH	SL014-076003-	323
CARROWKEEL, SLIGO	SL040-096----	310	→	CARROWKEEL	SL040-095----	320
GLEN (LEYNY BY.), SLIGO	SL020-181----	176	→	BARROE NORTH	SL034-155----	228
KNOCKNAREA S., SLIGO	SL014-076019-	270	→	MULLANASHEE	SL019-177----	270
TREANMACMURTAGH, SLIGO	SL040-016001-	247	→	KNOCKNAREA SOUTH	SL014-076003-	323
TREANMORE, SLIGO	SL040-013----	219	→	DRUMNAGRANSHY	SL040-008----	361

A site shown in bold and italics is axially directed at another tomb/cairn and has a dual astronomically meaningful alignment.

[a] In column 4, county names (and as shown in figure 2) are omitted but can be inferred from the first two characters of the site record number (see Col. 1)

Table A.2. List of astronomically aligned passage tombs

Townland & County Name	SMR CODE	Project Code	Azimuth (°)	Declination δ (°)	Astronomical Event	Morphology	Art	Directed at tomb /cairn
CORSTOWN, MEATH	ME015-012004-	Me24	92	-1.1	EQSR	Cruciform	Yes	No
CARROWMORE , SLIGO	SL014-209007-	Sl16	92	1.1	EQSR	Polygonal	No	No
GRANGE NORTH, SLIGO	SL014-088----	Sl8	89	0.6	EQSR	Polygonal	No	No
SHEEMORE, LEITRIM	LE027-054001-	Le4	270	0.4	EQSS	-	No	No
KNOCKNASHAMMER, SLIGO	SL014-211----	Sl88	266	-0.7	EQSS	Undiff.	Yes	No
MONEYDIG, DERRY	LDY019:008	De2	48	23.3	SSSR	Polygonal	No	Yes
FAUGHART LOWER, LOUTH	LH004-062----	Lh2	55	23.7	SSSR	Polygonal	No	Yes
TOWNLEYHALL, LOUTH	LH024-008002-	Lh6	47	24.6	SSSR	Polygonal	No	No
CARRIGLONG, WATERFORD	WA017-057----	Wa1	46	24.9	SSSR	Undiff.	No	No
BREMORE, DUBLIN	DU002-001001	Du1	313	24.5	SSSS	Uncertain	No	No
THOMASTOWN , MEATH	ME015-111----	Me83	308	23.9	SSSS	Uncertain	No	Yes
CARROWMORE , SLIGO	SL014-209049-	Sl42	311	22.9	SSSS	Cruciform	Yes	No
MOYLEHID, FERMANAGH	FER210:050	Fe2	134	-24.7	WSSR	Cruciform	No	No
RUSH, DUBLIN	DU008-013001-	Du6	136	-24.4	WSSR	Polygonal	No	Yes
NEWGRANGE, MEATH	ME019-045----	Me34	135	-23.8	WSSR	Cruciform	Yes	No
KNOCKROE, KILKENNY	KK034-019001	Kk4W	225	-22.9	WSSS	Cruciform	Yes	No
DOWTH, MEATH	ME020-017----	Me41b	225	-25.2	WSSS	Polygonal	Yes	No
KNOWTH, MEATH	ME019-030015-	Me61	227	-24.3	WSSS	Undiff.	Yes	Yes
PATRICKSTOWN, MEATH	ME009-071001-	Me29	227	-24.3	WSSS	Cruciform (possible)	Yes	No
LACKAN, WICKLOW	WI005-092----	Wi5	232	-23.8	WSSS	Undiff.	No	No
BANAGHER, CAVAN	CV026-004004-	Cv1	153	-30.9	S Maj MR	Undiff.	Yes	Yes
KEENTAGH, DOWN	DOW032:015	Dw10	195	-30.1	S Maj MS	Undiff.	Yes	No
SLIEVETHOUL, DUBLIN	DU024-005001-	Du9	199	-30.6	S Maj MS	Undiff.	No	Yes
NEWGRANGE, MEATH	ME019-044004-	Me76	155	-31.1	S Maj MR	Undiff.	No	No

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