MEGALITHIC SOCIETIES

OLD QUESTIONS, NEW NARRATIVES

Edited by

Gail M. Higginbottom, Jadranka Verdonkschot, Chris Scarre,
A. César González-García, Felipe Criado-Boado

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Front cover: Chan de Castiñeiras 2, the remains of a dolmen from the megalithic complex of Chan de Castiñeiras in Pontevedra, sitting between the municipalities of Vilaboa and Marín. Back cover: Compilation of drawings of the first monument of Forno dos Mouros do Bocelo´s lay-out (by Jadranka Verdonkschot, after Criado-Boado *et al.* 1991).

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Tony Axelsson
Tony Axelsson has researched various aspects of the Neolithic society in central Västergötland. His other research interests include cultural heritage, public archaeology, archaeology and communication, material culture and materiality, and cultural environment conservation. He participates in several research projects, including 'Symbolism and local variation in the Falbygden Neolithic' (on the use of different stone materials in passage graves) where he demonstrated previously unknown complex patterns in the use of stones with different colours. In the project 'Neolithic lifeways' 2015-2018, he worked with issues around diet, cultivation and economy. He has worked on applying ground penetrating radar in various archaeological contexts since 2015. Between 2020-2023 he worked on the project 'Uncovering a hidden neolithic landscape. Locating neolithic monumental sites through remote sensing, geophysics, and archaeology'. From 2025-2029 he will be working on the project 'A multi-species study of biological and social relatedness in Neolithic Sweden'.

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Richard Bradley is Emeritus Professor of Archaeology at Reading University, where he worked until 2013, and an Honorary Research Associate at Oxford University. Recent publications include *Monumental Times* (2024), *Maritime Archaeology on Dry Land* (2022), *Temporary Palaces* (2021), *A Comparative Study of Rock Art in Later Prehistoric Europe* (2020), *The Prehistory of Britain and Ireland* (revised edition 2019), *A Geography of Offerings* (2017), *The Later Prehistory of Northwest Europe* (2016), co-authored with Colin Haselgrove, Marc Vander Linden, and Leo Webley, and *The Use and Reuse of Stone Circles* (2016), co-edited with Courtney Nimura.

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Stephen Davis
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Marta Díaz-Guardamino is Associate Professor in Archaeology at Durham University, specialising in the prehistory of Atlantic Europe, digital archaeology, and monumentality. She is currently the Principal Investigator of the Leverhulme-funded project 'Megalithic Origins' and leads a subproject within the international 'Maritime Encounters' programme, involving researchers from eight countries. Her publication record includes the co-authored monograph *Bronze Age Rock Art in Iberia and Scandinavia* (2024) and recent articles in *Science Advances*, *Antiquity*, and *Cambridge Archaeological Journal*. She has also co-edited several volumes, including *The Lives of Prehistoric Monuments in Iron Age, Roman, and Medieval Europe* (2015) and *Current Archaeological Debates from the Perspective of Gender Archaeology* (2024).

Leonardo García Sanjuán

Over the past 30 years, Leonardo García Sanjuán (Seville 1967) has conducted research on Late Neolithic, Copper Age, and Bronze Age Iberian societies, focusing on topics such as social complexity, monumentality, funerary practices, megalithic landscapes, and stelae. He is currently leading research at the Copper Age megasite of Valencina (Seville) and the megalithic complex of Antequera (Málaga), resulting in the publication of seventy articles in top-tier scientific journals, as well as several monographs dedicated to exceptional monuments such as Montelirio (2016) and Menga (2018 and 2022). Between 2015 and 2016, he was the lead scientific advisor on the nomination of the Antequera Dolmens for UNESCO's World Heritage List, which was approved by the organisation at its General Assembly held in Istanbul in July 2016. In 2019, he received the Christiane and Jean Guilaine Foundation Award from the Académie des Inscriptions et Belles-Lettres of the Institut de France. In 2020, he received the Charlemagne Prize for Best Researcher in the Humanities Branch of the University of Seville. In 2023, he held the Honorary Chair of the Johanna Mestorf Academy at the University of Kiel (Germany).

Ricardo Miguel Godinho

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Preface

The European Megalithic Studies Group is an informal association of researchers who come together to present their latest research methods, outcomes and interpretations roughly biennially at small, dynamic, highly interactive meetings. This volume contains papers from the *European Megalithic Studies Group* symposium held at Instituto de Ciencias del Patrimonio (Incipit, CSIC) de Compostela (Spain) in September 2022, and covers cultures and monuments from across northern Europe and the Atlantic façade, from Scandinavia and northern Germany to Britain and Ireland, France, Iberia and and the Western Mediterranean. Issues discussed in this volume include temporality and mobility (both at the broad scale and at the local scale), social organisation and external relationships, landscapes and interconnections. The methods used to investigate these themes are various: bio-molecular and isotopic analyses, typo-chronology, targeted excavations and radiocarbon dating, material culture analyses, 3D models, ceremonial and funerary practices, skeletal analysis (including osteometrics) and large-scale prospection. New methods researching the materiality and symbolism of megalithic monuments are also presented, including several that highlight the role of the natural world (both terrestrial and celestial). Alongside them are contributions focusing on other key characteristic of megalithic monuments – the skilful and purposeful arrangement of large blocks of stone, and their interpretation. Recent discoveries reported here include the intriguing large and complex ceremonial timber circles in active megalithic areas in southern Portugal, presenting a significant contrast to what has hitherto been considered the main Neolithic and Chalcolithic funerary expressions in Iberia.

This volume is primarily method-driven, presenting new, significant and compelling results. These illustrate that 1) methodological development is key to understanding past peoples and 2) what is discovered compels us to want to know more. The authors include leading specialists whose regional research outcomes are not only fascinating in themselves but will be essential references for all those working on megalithic monuments from different times and places, and most particularly those concerned with the megalithic traditions present from the transition into farming through to the end of the Bronze Age within Europe. Thus, through new, or novel applications of technologies and ways of thinking, this volume offers a series of studies that dispel some of the mystery that surrounds these mementos of another time.

We are indebted to the many reviewers who assisted us in the creation of this volume. We take this opportunity to thank you all for your contribution of time, energy and commitment. A full list of our reviewers can be found in the preliminary pages prior to this preface.

We would like to thank those involved with the initial discussions for the Santiago de Compostela symposium: Chris Scarre, Karl-Göran Sjögren, Luc Laporte and Leonardo García Sanjuán. Many thanks also to the volunteers Alejandra Galmés Alba and Pablo Gutiérrez de León Juberías for assisting with the symposium set-ups and other daily symposium tasks.

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Chapter 1
Time, mobility and society: new approaches to megalithic monumentality in western and northern Europe

Chris Scarre

Abstract

The study of European megalithic tombs has been greatly enhanced over the past 20 years by new methods of chronological analysis and by the characterisation of the buried populations through laboratory analysis of stable isotopes and ancient DNA. Together, these have driven a reconsideration of long-standing issues in the study of both the megalithic and non-megalithic monuments of Neolithic Europe. One central issue is temporality: did particular types of monument continue to be built over long periods of time, or were they the result of short, concentrated bursts of activity? A second is mobility, both at the broad scale (does the expansion of monument-building indicate the movement of people?) and at the local scale: were the societies who built these monuments settled cultivators or mobile pastoralists? The new research also provides insight into questions of social organisation: were megalithic tombs the burial places of particular lineages or families, or of communities as a whole? Our understanding of megalithic origins has been transformed by growing evidence for migration at the onset of farming in western and northern Europe, and the contrasting chronologies of first farmers and first monuments in different regions. That enables us to revisit older arguments that saw megalithic monuments emerging through the interaction between first farmers and indigenous Mesolithic communities. It is also now possible to study genetic relationships among those buried within individual monuments. The new insights will here be reviewed against the evidence for megalithic origins in specific regions.

The past 20 years have seen a revolution in European Neolithic studies. It has been driven in large part by the development of innovative analytical techniques that have led to a reappraisal of earlier competing hypotheses. They have also opened new and detailed insights into aspects of the past that would previously have been considered far beyond our reach. Kristian Kristiansen has labelled this the Third Science Revolution (following on from those of 1850-1860 and 1945-1955) and identified its key components as the use of 'Big Data' approaches to the past, new quantitative modelling, and ancient DNA, strontium isotopes and related scientific methods (Kristiansen 2021: 17). Within the field of European megalithic studies, it could be argued that stable isotopes, ancient DNA and chronological modelling (notably Bayesian analysis) have made the greatest impact. Yet these innovations must be viewed against a backdrop of ongoing research exploring more traditional themes, including the geology and symbolism of megalithic monuments. Why did these communities choose to deploy such large blocks of stone? At the same time, there have been important changes in field techniques (including the recording and analysis of skeletal remains), a new attention to the internal structure of the mounds or cairns that cover many megalithic monuments, and a multiplication of publications giving detailed information from across the entire European megalithic domain, from the Baltic to the Mediterranean and from Spain to Switzerland.

The concept of the 'megalithic monument' remains problematic. How large do the stone slabs have to be in order to qualify? Furthermore, such monuments cannot properly be separated from related structures of timber, turf, and other materials. These different materials will have carried different meanings, different structural properties, and different levels of durability, and cannot be regarded as simple equivalents or regional alternatives to each other. Nor did their use depend entirely on cultural choice and availability of materials. Then there is the interplay between analogous structures built of dry-stone rather than megalithic components, or those that are partially or entirely rock-cut. Hence megalithic tombs are but one category within a broader, more fluid family of Neolithic chambered tombs. Yet the megalithic element is a crucial and distinctive feature, and the manipulation of such large blocks implies a specific intent and meaning, as well as a social and organisational context. The concept of the 'dolmen' with its impressive mass and dominant capstone, conjuring feelings of enchantment, exemplifies the powerful significance conveyed by the deployment of megalithic blocks (Cummings and Richards 2021: Figure 1).

The new approaches and analytical techniques introduced over the last 20 years have focused not only on the overall significance of what we may term the 'megalithic phenomenon', but on key features that underlie it: the chronology of the tombs, the identities and genealogies of the individuals buried within them, and the mobility and origins of those individuals. In some cases, that new information provides a snapshot of an individual place and time; in others, it returns

Figure 1. A classic 'dolmen' with prominent capstone oversailing more slender supports: Gaulstown portal tomb, Co. Waterford, Ireland. Photo: Chris Scarre.

us to long-standing, broader debates about the origins and development of these impressive structures.

New chronologies

Developments in radiocarbon dating have had a particularly significant impact on the study of megalithic monuments. Radiocarbon dating has of course been available to prehistoric archaeologists since the 1950s, and megalithic monuments have been a particular target for this technique. One of the primary difficulties, however, has been to achieve a secure relationship between the organic material to be dated and the inorganic structure of the monument itself. In the early years of radiocarbon dating, reliance on charcoal samples from buried ground surfaces or insecure contexts gave sometimes misleading or inconsistent results (for example the 9th/8th millennium cal BC dates on charcoal or charred wood from one of the ancillary cists at the Tumulus de Saint-Michel at Carnac, attributed to old wood effect: Coursaget *et al*. 1962). The importance of 'chronometric hygiene' (retaining only well-stratified samples of short-lived species, with small standard deviations, and correction where necessary for marine reservoir effect) was established in the 1980s. Coupled with the introduction of AMS dating and its application to smaller samples, it has substantially improved the reliability of the dates that are now used. For megalithic monuments, the focus on dating skeletal material, the multiplication of samples from individual sites and burial assemblages, and the increasingly precise results provided by AMS dating have together established an entirely new understanding of their chronology, and the timescales of their construction and use. That has been further enhanced by mathematical modelling and the widespread application of Bayesian analysis in assessing sequences of radiocarbon dates (Bayliss *et al.* 2007).

Fifty years ago, in an interesting article entitled 'Old Mortality' (a title borrowed from a 19th century Scottish novel), British archaeologist Richard Atkinson noted that radiocarbon dating had radically lengthened the timespan of the British Neolithic to over 1000 years. Noting the presence of Beaker as well as Early Neolithic material in the burial chambers of long mounds, he assumed that they had been in use throughout the whole of the Neolithic period (Atkinson 1968). By the mid-1980s, that had been thrown into doubt by the dated material from sites such as Hazleton North where multiple dates on skeletal material suggested a much shorter period of funerary deposition (possibly little more than a century: Saville *et al.* 1987). The targeted application of precise AMS dating to a small number of long mounds coupled with new standards of sample selection and Bayesian analysis has since confirmed and refined that conclusion. In 2007, a chronological study of five southern British long mounds (including Hazleton North) showed with unprecedented precision when this type of mound had been built; indicated how long the period of funerary deposition had lasted, and whether that formed a single phase or a number of phases; and enabled precise chronological relationships between the different mounds to be proposed (Whittle *et al.* 2007a). The results allowed the authors of the study to ask, for example, whether the building of Ascott-under-Wychwood might have been witnessed by a child or juvenile who then in old age was able to direct the construction of Hazleton North

(Whittle *et al.* 2007b: 132). Further dating programmes have broadened the scope of chronological analysis to include early chambered long mounds in South Wales, and to explore how their foundation may have related in chronological and social terms to the establishment of the first farming communities in that region (Britnell and Whittle 2022).

Even where human remains are not so readily available, in areas of predominantly acid soils such as northern Europe, the multiplication of dates, the careful evaluation of sample context, and the application of Bayesian analysis has allowed precise chronologies to be established. In northern Germany, the chronological relationship between long mounds, dolmens and passage tombs has been defined more closely and securely than ever before. And as in southern Britain, it has been possible to interrogate the internal sequences of monuments. At Rastorf LA 6a, near Kiel in northern Germany, the sequence began with a trapezoidal TRB house and an adjacent single flat grave around 3650 cal BC. The house was burned down and the site ploughed, but shortly afterwards a dolmen covered by a round mound was constructed above the centre of the house. Additional graves were added, and the round mound enlarged, but in around 3300 cal BC, it was extended more dramatically by the addition of a long mound with megalithic kerb, mirroring the shape and the orientation of the TRB house of three or four centuries before. Each of the successive phases was clearly linked by memory (Müller 2018).

Where human remains are available, AMS dating can be used to reconstruct episodes of past activity that are otherwise difficult to detect. At Tomb 10 at Panoría near Granada in southern Spain, systematic sieving recovered 11,551 human skeletal elements or fragments, and 368 teeth. An initial study suggested two short phases of use, the first from 2510/2460 cal BC to 2475/2385 cal BC, the second from 2225/2065 cal BC to 2140/1985 cal BC (Aranda Jiménez *et al.* 2018). Further analysis, however, revealed a more surprising pattern, with several of the teeth dating back to the final centuries of the 4th millennium cal BC (3230/3095 cal BC). They appear to represent the residue of an initial phase of burials that had subsequently been removed, leaving behind only some of the teeth. The human bones that were dated, by contrast, gave no indication of that earlier episode but belonged to a final intense period of funerary deposition in the second half of the 3rd millennium cal BC (Aranda Jiménez *et al.* 2020). Hence, in this instance, the human bones on their own do not provide a reliable proxy for the date of tomb construction. Evidence for the clearance and reuse of megalithic burial chambers is known from a number of other sites (e.g. La Chaussée-Tirancourt in the Paris basin: Leclerc and Masset 2006; Sion Petit-Chasseur Dolmen MVI in the Italian Alps: Bocksberger 1976; Desideri and Besse 2009; and possibly Cubillejo de Lara in northern Spain: Tejedor Rodríguez 2015: 495-96).

The growing availability of radiocarbon dates from secure contexts has also enabled a new assessment of the chronology of the megalithic phenomenon in western and northern Europe as a whole. Until the 1960s, it was widely accepted that megalithic tombs from the Mediterranean to the Baltic formed somehow part of single tradition. Much debate focused on megalithic origins and the geography, chronology and mechanism of their spread (e.g. Childe 1950; Daniel 1941; Daniel 1967; Forde 1930). In the 1970s, alternative models of parallel regional evolution were proposed, on the basis of the newly available radiocarbon and TL dates. The possibility of a strong Mesolithic input was also proposed, especially in relation to sites such as Téviec and Hoedic in Brittany, and the Muge shell middens in Portugal (Kinnes 1984; Renfrew 1976). In recent years, the greatly increased number of more secure and more precise radiocarbon dates has allowed a re-examination of the issue of megalithic origins. The radiocarbon evidence (with a focus on skeletal remains) has been assembled and evaluated, and Bayesian modelling has been applied (Schulz Paulsson 2017, 2019). The results suggest that the earliest megalithic monuments were constructed in northwest France around the middle of the 5th millennium cal BC, and that the idea of megalithic tombs may have spread from there along the sea routes of the Mediterranean and Atlantic coasts in three successive phases (Schulz Paulsson 2017: 3463). In the Atlantic zone, this process may have been associated with the circulation of greenstone beads and amulets from Iberia, and of greenstone axes from the western Alps (Pétrequin *et al.* 2019).

Identifying samples that directly relate to monument construction remains difficult, however, and especially so in the case of standing stones. It has been suggested that standing stones in south-western Iberia may have been raised as early as the late 6th millennium cal BC, although the evidence is not yet conclusive (Calado 2015: Figure 2). Furthermore, whereas areas with well-preserved human remains offer the opportunity for multiple sampling, in other regions dating has still to rely on charcoal and similar materials, and radiocarbon dates themselves are often less numerous in those regions. Hence there is an inevitable and persistent unevenness in the distribution and reliability of the available dates. Most of the current models for the origins and spread of megalithic monuments place emphasis on the seaways and maritime connections, yet the overall distribution of megalithic tombs in northern and western Europe is far from being exclusively maritime in character. Recent dates on skeletal material from slab-lined cist burials in the Aosta valley in the western Alps are as early as those from northwest France, and remind us that inland regions such as this may also have been

Figure 2. The Menir da Meada near Castelo da Vide in southern Portugal. Charcoal from the socket at the base of the stone indicated a date of *c*. 5000-4800 cal BC although the possibility that this was residual material cannot be excluded. Photo: Chris Scarre.

involved in the development of monumental funerary architectures from an early stage of the Neolithic (Steuri *et al*. 2023). Similar slab-lined cists with material of early date are known in other regions, for instance at La Goumoizière in western France, and at Campo de Hockey at Cádiz (Soler 2007; Vijande Vila *et al*. 2022); they may be precursors of the megalithic monuments that follow, although whether they themselves are strictly 'megalithic' – given the dimensions of the slabs employed, and the fact furthermore that they are often constructed in pits sunk into the ground – has been the subject of some debate.

The chronological framework is of course only part of the story, and we need to understand not only the timetable but also the nature of connections between the different regions where megalithic monuments appeared. Here, their very diversity is one of the most striking features. Megalithic monuments in France or Spain or Scandinavia may share certain fundamental features (for example, the deployment of uprights and capstones to create an above-ground burial space) but each region has its own distinctive monument forms. They are not merely copies of each other. Sequences of monument forms in different regions also show very different patterns of development, with earthen (unchambered) long mounds at the head of the sequence in northern Europe, for example, and proto-megalithic burials (e.g. slab-lined pits) in southern Iberia. The overall family resemblance must not mask the fact that the acceptance and adoption of megalithic forms by one region from another, in so far as that was part of the process, was very variable. Each region, indeed, must be studied in its own terms.

Ancient DNA

Radiocarbon dating is a well-established technique, in use by archaeologists for over half a century. Ancient DNA analysis, on the other hand, is a more recent innovation. For Neolithic specialists, its greatest impact has been the evidence it has provided for major population change across virtually the whole of Europe at the Mesolithic-Neolithic transition (Hofmanová *et al*. 2016; Lazaridis *et al*. 2016; Mathieson *et al*. 2015). The earlier hypothesis of a Neolithic revolution largely the result of the uptake of new domesticates and material culture by indigenous communities has largely been set aside in favour of incoming groups of farmers, notably those with Bandkeramik pottery in Central Europe, and, in the Western Mediterranean, maritime colonists bringing *Impressa* and Cardial ware pottery. There appears nonetheless to have been considerable regional variation in the degree to which indigenous Mesolithic communities participated in these changes, as farming communities spread inland away from the coastal zone (Perrin and Manen 2021; see also Mathieson *et al*. 2018; Rivollat *et al*. 2020).

This variation has a direct bearing on the processes and timescales through which Neolithic monumentality first appeared in parts of western and northern Europe. In some regions, the first megalithic monuments appeared several centuries after the Neolithic transition, whereas in others, the Neolithic farmers may have brought with them the tradition of funerary monumentality, or the memory of such a tradition. We shall return to that issue below.

Alongside population-level changes, the employment of ancient DNA to trace biological relationships and identities within individual burial chambers has provided remarkable insights. The existence of genetic relationships among burials in megalithic tombs was first formally documented in a group of two Irish and one Swedish tomb in 2019 (Sánchez Quinto *et al*. 2019). These are often referred to as 'kin' relationships although in a societal context, kin will include unrelated people linked by marriage along with others whose membership of the kin group was socially rather than biologically ascribed (Brück 2021). Kinship relationships within megalithic tombs achieved greater attention with the publication of DNA analysis from

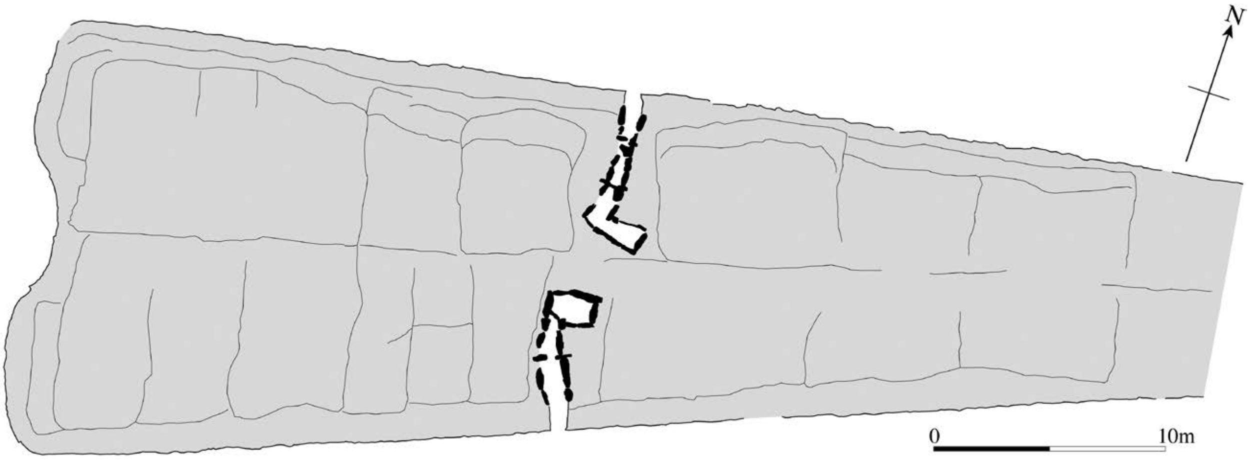

Figure 3. Hazleton North, a Cotswold-Severn tomb in southwest England: plan of the long mound showing the lateral chambers (redrawn after Saville 1990).

Newgrange in Ireland, where one individual from the most elaborately decorated recess of the cruciform burial chamber was shown to be the offspring of a first-order incestuous union (Cassidy *et al.* 2020). The interpretation was broadened and strengthened by the discovery that the Newgrange individual was also related (more distantly) to individuals buried in other Irish passage tombs, including Carrowkeel, Carrowmore in western Ireland, and Millin Bay on the northeast coast. The implication was that passage tomb societies in Ireland were hierarchical and that the tombs had been used for the burial of interrelated élites (Cassidy *et al.* 2020). First-degree relatives have also been identified in DNA analysis of Late Neolithic megalithic tombs with collective burials at Aesch and Oberbipp in Switzerland, and at Bougon in western France (Cheronet *et al.* 2022; Furtwängler *et al.* 2020).

The most striking evidence for kinship relationships within megalithic burial chambers comes from the recent study of Hazleton North, a Cotswold-Severn long mound in south-western England (Figure 3). DNA analysis of 35 individuals buried in the two lateral chambers determined that 27 of them came from a single five-generation family (Fowler *et al.* 2022). One adult male (NC1f) had offspring from four separate females (NC2f, NC3f, SC1f and U3f) and the descendants of these different mothers were buried in a specific and patterned way between the two main burial chambers, as indicated by their mitochondrial (mtDNA) maternal lineages:12 individuals, 9 belonging to the same mtDNA lineages SC1f and U3f were buried in the south chamber, and 9 out of 13 belonging to the mtDNA lineages NC2f and NC3f in the north chamber. The north chamber held three of the four first-generation mothers.

The patterning of burials between the two chambers at Hazleton North is strongly suggestive of patrilineal descent in determining access to those chambers (Fowler *et al.* 2022). It can also be inferred that those buried here were founders and the descendants of leading individuals within the particular social group. The duality implied by the provision of two matching burial chambers within a single mound was clearly a feature designed from the very outset and indicates that the divided nature of this community was present or anticipated from the start. It confirms previous suggestions that tomb structure was related to kinship or community organisation (Fowler 2022; Powell 2005). It does not in itself demonstrate that all megalithic tombs were the burial places of related kin or dominant lineages – there are indeed instances where that does not seem to apply (e.g. Carrowkeel: Kador *et al.* 2018; Poulnabrone: Cassidy *et al.* 2020; see also Whittle 2024) – but it is consistent with the nature of megalithic tombs as labour-intensive products of conspicuous effort and display.

Stable isotopes

The third new technique which has thrown light on the life histories of those buried in megalithic tombs is stable isotope analysis. This divides into two subsets: analysis of diet, through C and N isotopes; and analysis of human mobility, through isotopes of strontium, sulphur, oxygen and lead. C and N analysis, and more recently sulphur, has been used to identify differences in dietary status or dietary pattern between individuals buried in individual tomb chambers, or in different tombs or graves within the same area. Thus, in the Paris basin, a recent study has shown considerable dietary homogeneity among Cerny burials from monumental Passy-type-structures. That contrasts with substantially more variability in burials from other Cerny burials, and to a still greater degree among non-Cerny burials (Cheung *et al.* 2021). Individuals associated with richer graves or more elaborate tomb structures did not, however, have a higher level of animal protein intake, such as might have been expected in individuals of higher status. In northern Iberia, a recent study combining C, N, Sr and O analysis found dietary differences between individuals buried in caves and in megalithic monuments in the Rioja Alavesa region. This suggested that during the Late Neolithic there were two adjacent communities with differing burial practices and subsistence strategies, the megalithic population more reliant on agriculture, those buried in caves on a more diverse set of resources with more restricted access to valley floors (Fernández-Crespo and Schulting 2017; Fernández Crespo *et al.* 2020). Patterns such as these may be specific to particular periods and particular regions: a similar comparison in Portuguese Estremadura found higher status diets at the burial cave of Cova de Moura than in burials in adjacent *tholo*s and rock cut tombs (Waterman *et al.* 2016).

Strontium isotope analysis has provided direct insights into human mobility patterns and the homogeneous or heterogeneous origin of the population buried within an individual tomb or group of tombs. One of the most important early examples was the study of burials the megalithic passage tombs of the Falbygden area of Sweden, an island of sedimentary geology surrounded by igneous and metamorphic rocks. 260 of the 400 known Swedish passage tombs are found within this relatively limited area (Sjögren *et al.* 2019). Strontium isotope analysis of tooth enamel showed that three sites had a substantial minor component of non-local individuals: one individual at Gökhem 94, three at Falköping 3, and three at Rössberga. The remaining 25 individuals sampled in these tombs had strontium signatures consistent with the local sedimentary geology, suggesting that over 20% of the individuals came from outside the region (Sjögren *et al.* 2009). The concentration of megalithic tombs at Falbygden raises the possibility that people from the broader region had moved to this restricted area after childhood, or that they came here (or were brought here) specifically for burial.

There may have been similar practices elsewhere. Recent dating of the rock cut hypogeum of Les Mournouards II cut into the soft chalk of the Marne region of northern France concluded that the tomb had been in use for a period of perhaps a little more than a century; and that given the number of such hypogea in such a limited area it was possible they had served as the burial places for communities across a broader region (Chambon *et al.* 2017). Strontium analysis may eventually be able to resolve that.

At Perdigões in the Alentejo region of southern Portugal, analysis of strontium isotopes has distinguished different proportions of locals and non-locals in different tombs. A group of four *tholos* tombs dating to *c.* 2900 cal BC are clustered on the eastern edge of a large Late Neolithic/Chalcolithic enclosure with multiple ditch circuits. The majority of the individuals buried in Tomb 1 (55%) were from the local area, whereas all of the analysed individuals from Tomb 4 were outsiders. Most of those buried in Tombs 2 and 3 were also non-locals (Tomb 2: 81%; Tomb 3: 92%) (Valera *et al.* 2020). Strontium analysis of individuals from the Bom Santo cave in Portuguese Estremadura suggest that these elevated levels of mobility may extend back into at least the earlier 4th millennium (Carvalho 2014; Carvalho *et al.* 2019).

While strontium analysis can distinguish locals from non-locals (where the geological contrasts are sufficiently pronounced), it is more difficult to determine the origin of those individuals and the direction of movement. Two recent strontium isotope analyses of burials from megalithic chambers within Early Neolithic long mounds in Britain have tantalisingly identified individuals who may have come to Britain from northern France, as part perhaps of the movement of colonist farmers identified in the ancient DNA evidence. At Penywyrlod in South Wales, the majority of the individuals who were analysed had strontium values indicating that they had not lived locally during childhood but must have moved into this area at some later stage of their life (Neil *et al.* 2017; Neil 2022). Their area of origin may have lain in the Malvern Hills to the east and would be consistent with the movement of new farming communities into south Wales during the 38th century cal BC. One individual sampled, however, adult 74.23H/9.2.3/P23, had isotope values exceeding any currently known from England and Wales. While Scotland and Northern Ireland have biosphere values within this range and hence are possible source areas, an origin in northwest France is also a distinct possibility. At Whitwell in Derbyshire, a female single burial from the oval cairn at the centre of the monument again dating from the 38th century cal BC also gave strontium isotope values consistent with a continental origin, although Dartmoor and Scotland could not be excluded (Neil *et al.* 2020). In this case the difference in values between second and third molars indicated that this particular individual may have moved to Whitwell during childhood (Figure 4).

Megalithic origins revisited

Neither at Whitwell nor at Penywyrlod could the presence of individuals with a continental origin be determined with certainty, but both cases provide further evidence for the long-distance movements that are also revealed by DNA. This level of human mobility immediately raises the possibility that the building of megalithic monuments might have been a tradition carried from place to place by people on the move. The idea is far from new, and is reminiscent

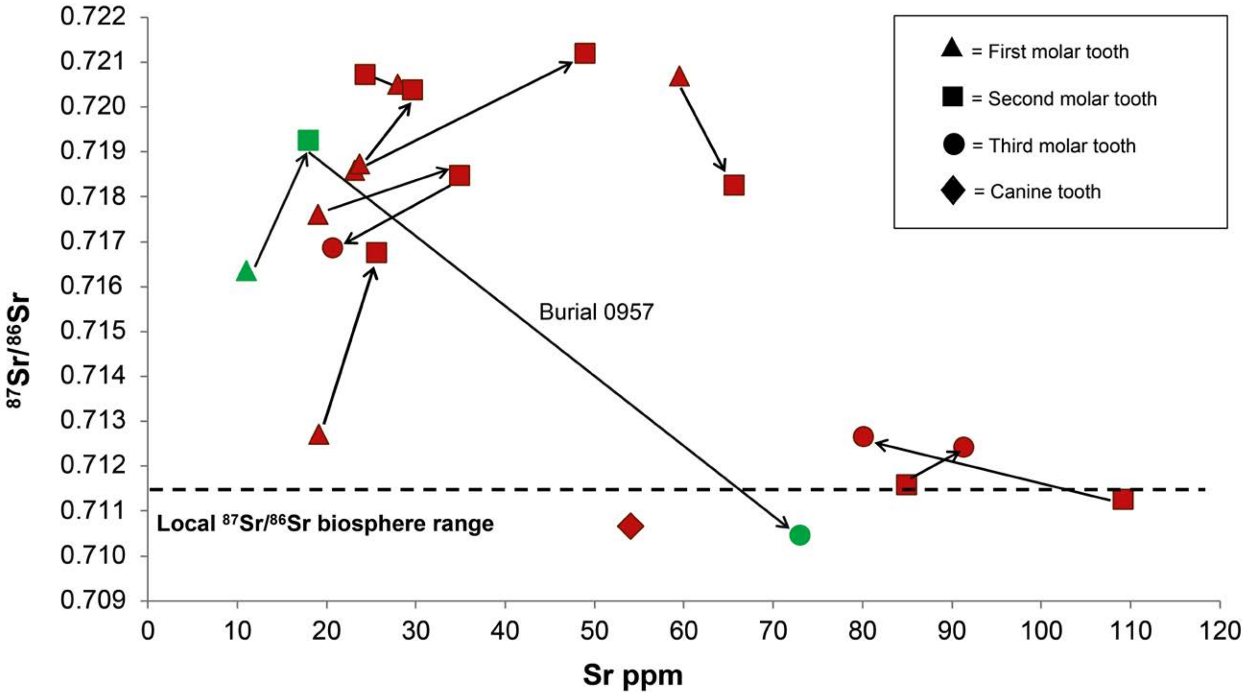

Figure 4. Strontium isotope ratios for tooth enamel from individuals buried at Whitwell, an Early Neolithic long mound in central England. Arrows link samples from teeth belonging to the same individual, denoting the direction of change in isotope ratio and concentration between earlier and later forming teeth. Individual 0957 appears to have moved to the Whitwell area during childhood (while the successive teeth were forming) (adapted from Neil *et al.* 2020).

of the 19th century concept of a 'megalithic people' or more recently Childe's 'megalithic missionaries' (Scarre 2018). Bayesian analysis of radiocarbon dates at the European scale has also suggested that megalithic tombs may have spread from northwest France along the sea routes of the Mediterranean and Atlantic coasts (Schulz Paulsson 2019). Whether this masks a greater complexity has still to be determined. For example, the chronology of standing stones in regions such as southern Iberia is currently unclear. Combining the chronometric evidence with ancient DNA and stable isotopes, however, highlights the contrasting histories of megalithic origins and development, region-by-region, at a more detailed level.

In Britain, the first monuments follow the Neolithic transition within a few centuries; the DNA evidence indicates the arrival of people presumably from northern France (Brace *et al.* 2019), who may have brought with them the concept of megalithic burial. Somewhat more speculatively, as we have seen, the stable isotope analysis at Whitwell and Penywyrlod tentatively identifies some of the specific individuals who may have been directly involved (Neil *et al.* 2017; 2020). The pattern in Iberia, however, is very different, with Early and early Middle Neolithic periods intervening before megalithic funerary monuments appear (Figure 5). Those first funerary monuments do not appear to be associated with a significant influx of outsiders who brought the megalithic tradition with them, but they may have been associated with an expansion of Neolithic lifeways across the interior of Iberia, and perhaps with new influences arriving from Brittany.

In Iberia as a whole, DNA analysis of Neolithic populations suggests a significant shift between the Early and Middle Neolithic. As one recent study puts it 'The first Neolithic migrants that arrived in Iberia had low levels of genetic diversity, potentially reflecting a small number of individuals; this diversity gradually increased over time from mixing with local hunter-gatherers and potential population expansion' (Valdiosera *et al.* 2018). The box plot from their study shows clearly the increased contribution of indigenous hunter-gatherer ancestry from Early Neolithic to Middle Neolithic to Late Neolithic/Chalcolithic, and this is borne out by other recent studies (Lipson *et al.* 2017; Olalde *et al.* 2019; Villalba Mouco *et al.* 2019).

DNA analysis has demonstrated the presence of population mixing between the initial Early Neolithic communities, established in enclaves around the coast, and indigenous Iberian hunter-gatherer communities. That may have varied from region-to-region, being lower in the east than in the southwest. Two individuals from the Gruta de Caldeirão in central Portugal had 27% and 43% of Iberian hunter-gatherer DNA respectively,

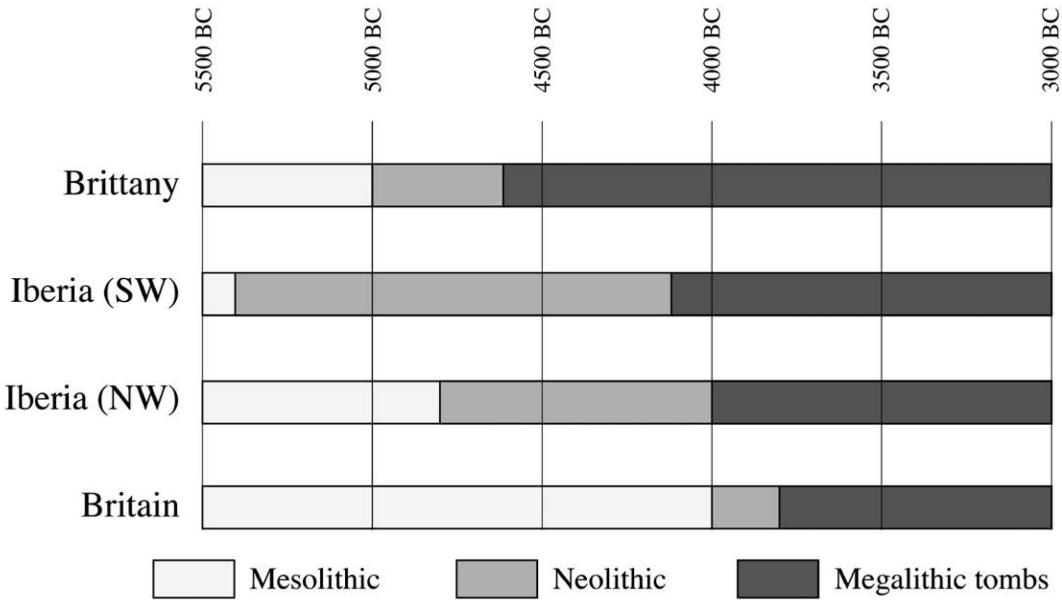

Figure 5. Schematic diagram illustrating relative timing of the Neolithic transition and the earliest megalithic tombs in selected regions of Atlantic Europe.

and Y-chromosomes belonging to the I2a haplogroup characteristic of pre-Neolithic populations (Allentoft *et al.* 2024a; Carvalho *et al.* 2023). At the transition to the Middle Neolithic, the contribution of maternal hunter-gatherer lineages rises to *c.* 30% in burial caves of central Portugal, and pre-Neolithic I2a Y-chromosomes continue to persist into the later Neolithic at levels of 40-60% (Carvalho *et al.* 2023).

The evidence from the Gruta de Caldeirão indicates that in western Iberia, the farming populations who spread from coastal enclaves into the interior in the Early and Middle Neolithic may have carried significant levels of local hunter-gatherer ancestry. At the same time, the nature of the archaeological evidence changes. Settlement sites become smaller and more ephemeral during the Middle Neolithic, while it is at this period that megalithic tombs make their appearance. Hence the construction of megalithic tombs may have been associated with a more mobile Middle Neolithic lifestyle, with more extensive use of the landscape. It has been suggested that part of the population buried in the Bom Santo cave in Portuguese Estremadura may have been involved in building the numerous megalithic tombs of the Alentejo uplands around the Sorraia valley, east of the Tagus. That is based on the evidence of strontium isotopes that indicated that 34% of the sampled individuals from Bom Santo were non-local, and it would imply significant levels of group mobility and interaction (Carvalho *et al.* 2019). Thus, some of the megalithic tombs may indeed have been built by mobile or partly mobile communities, moving between different regions of the landscape at certain times of the year. It calls to mind the comment by Pedro Bosch Gimpera almost a century ago, in which he speculated that the megalithic tombs of western Iberia, including the classic polygonal *antas* of Portugal, might have been created by pastoralist communities living within the stony landscapes of western Iberia (Bosch Gimpera 1932, 84).

The regional chronology of megalithic tomb construction in Iberia remains unclear, partly owing to the greater difficulty of obtaining reliable dates in regions where preservation of human remains is poor. One recent modelling exercise identified western Andalusia and Catalonia as the regions with the earliest dates (*c.* 4200-4000 cal BC), although these were from 'proto-megalithic' rather than fully megalithic structures (García Sanjuán *et al.* 2022). There is also however one early date for human remains from a fully megalithic tomb in northern Portugal (Dolmen de Areita 1: Gomes 1998; C14 5170±60 = 4226-3796 cal BC (OxCal v.4.4.4 Bronk Ramsey 2021), as well as early 4th millennium dates from samples of painted decoration from several megalithic tombs in northern Portugal and Galicia (Carrera Ramírez 2011). While it remains very possible that the earliest megalithic monuments in Iberia took the form of standing stones in the Algarve and Alentejo, in the late 6th millennium cal BC, the construction of megalithic tombs appears to have begun *c.* 4000 cal BC during the expansion of farming across the peninsula. That process that was accompanied by an enhanced contribution of hunter-gatherer ancestry, some 1500 years after the first establishment of farming colonies around the southern and south-western coast.

It is difficult to assign any specific role to the hunter-gatherer populations in the development of megalithic monumentality in Iberia. Long-established traditions that paid particular respect to rocks and outcrops may have played a part, but maritime connections with early centres of megalithic monumentality in western France, notably Brittany, have also been invoked as a key factor (Cassen *et al.* 2019). Whatever the impact of those external connections, however, it was clearly interactions within the Iberian Peninsula that underlay the specific development of megalithic funerary monumentality that ensued during the course of the 4th millennium cal BC.

Compare that now with Britain, where a very different picture emerges. Here the interval between the initial Neolithic transition and the construction of the first megalithic monuments appears to have been fairly short, albeit variable from region to region. In the southeast, where the Neolithic tradition has been modelled to *4315/3985 cal BC (95% probable*) (Whittle *et al.* 2011: 731) there are relatively few megalithic monuments, but among them is Coldrum, where Bayesian modelling has placed the first phase of burial activity at *3980-3800 cal BC (95% probability*) (Wysocki *et al.* 2013). In the southwest, the chambered tomb of Broadsands in Devon also has early dates (estimated construction *3840-3710 cal BC (95% probability*): Sheridan *et al.* 2008; Whittle *et al.* 2011, 520). These would place it close in time to the earliest Neolithic of south-western Britain according to the model that has been proposed (*3940-3735 cal BC (95% probability*): Whittle *et al.* 2011: 729).

It is hence possible that the earliest megalithic monuments in southern Britain were built within a very few generations of the initial establishment of farming communities, but the more generalised chambered tomb tradition represented by the Cotswold-Severn monument type appeared only in the 38th century cal BC. In South Wales, the earliest dated Cotswold-Severn long cairn is Penywyrlod, where recent modelling indicates the cairn was constructed in *3815-3680 cal BC (95% probability)* (Griffiths 2022: 83). Neolithic material culture and practices first appeared in this region in in *3880-3790 cal BC (95% probability)*, and both at Penywyrlod and neighbouring Gwernvale there is evidence of pre-monument activity that may represent the arrival of pioneer farmers a few generations earlier. At Penywyrlod, particular interest, as we have seen, attaches to one buried individual dated to 3770-3630 cal BC, who has strontium isotope values that exceed all currently recorded biosphere values in England and Wales. It is possible, though not certain, that this individual had been born in continental Europe (Neil *et al.* 2017; Neil 2022). The chronology would suggest this individual was not one of the first Neolithic settlers in south Wales, however, and may indicate the continued arrival of individuals or small groups from northern France two or three centuries after the initial Neolithic transition (Thomas 2022).

The overall pattern of dates now available to us suggests that the main period of construction of the classic Cotswold-Severn chambered long mounds falls within the period from the 38th to 36th centuries cal BC, so that many of these would post-date the Neolithic transition by two or more centuries. But that is still a considerably shorter internal than the 1500 years separating the Neolithic transition in southern Iberia from the proto-megalithic tombs of the Campo de Hockey.

The DNA evidence is also very different. Analysis of ancient DNA from Mesolithic and Neolithic individuals has demonstrated a very low level of indigenous Mesolithic ancestry in British Neolithic specimens (~74% Anatolian Neolithic Farmer ancestry, most of the remainder coming from Western Hunter Gatherer ancestry already incorporated in the Neolithic gene pool before those farmers migrated to Britain) (Brace *et al.* 2019; see also Brace and Booth 2023; Patterson *et al.* 2022). There appears to have been very little indigenous Mesolithic contribution to the British Neolithic gene pool, and in contrast to Iberia, in Britain there was no Middle Neolithic resurgence of Mesolithic ancestry. Some aspects of this model have been challenged (Thomas 2022). With the exception of western Scotland, however, where local Late Mesolithic populations may have made a larger contribution to the gene pool, Neolithic ancestries in Britain show little evidence of long-term Mesolithic admixture (Brace and Booth 2023: 133).

The Cotswold-Severn tradition of trapezoidal long mounds can be compared with the late 5th and early 4th millennium monument forms of northern France (Scarre 2015). The transepted megalithic burial chambers in some Cotswold-Severn tombs offer a close parallel with those of southern Brittany and the Loire estuary, a parallel which was noted long ago by British scholars and led Stuart Piggott in 1962 to propose a ‘Notgrove-Pornic’ group of tombs combining those of northwest France with those of southwest Britain (Piggott 1962; cf. Laporte and Tinévez 2004; Whittle *et al.* 2022: 270-71). Hence though the monument forms are not identical, an argument can be made that the concept of the chambered long mound was brought by colonist farmers from northern France. It may be compared with the movement of polished stone axes of Alpine greenstone, most of which reached Britain probably from the Paris basin and its northern margins, even if a few specific forms may have come direct from Brittany (Sheridan and Pailler 2012). Whether the megalithic tombs of western Britain, such as the portal dolmens and Clyde cairns, were inspired by a parallel set of connections across the western Channel and along the Irish Sea, as has been proposed, is still to be confirmed. It finds some support, however, in analysis of British Neolithic ceramic technology that indicates separate western and eastern streams in the transfer of Neolithic ceramic know-how to southern Britain (Pioffet 2017).

Hence in contrast to Iberia, where megalithic funerary monuments appeared within a secondary stage of the Neolithic, in Britain such monuments seem likely to have been introduced by the earliest farming communities from northern France within a few generations of their initial settlement of southern Britain. The cultural, social and demographic background stands in sharp contrast, the common factor in both cases being perhaps the consolidation of social control in newly or more intensively settled regions. The mechanisms underlying the introduction of megalithic tombs to these two regions of western Europe, however, can be argued to have been different. In Britain, the practice probably drew directly on continental monument traditions of the recent past; in Iberia, on the other hand, even if the concept of the megalithic tomb owed something to overseas contacts, the connection appears to have been less direct and the development of 4th millennium monument traditions may have incorporated an indigenous hunter-forager contribution.

In northern Europe, the pattern is different once again: with monuments (earthen long mounds, followed by megalithic dolmens) within a few centuries of the Neolithic transition. That Neolithic transition was once again associated with a movement of incoming farmers (Allentoft *et al.* 2024b), but those farmers came from a region without a strongly established tradition of megalithic monumentality. The megalithic connection, assuming there was one, could have been with other regions of megalithic architecture – again, western France is a possible contender (Klassen *et al.* 2011; Klassen 2014). The adoption of megalithic funerary monuments must, however, be set in the context of the developing social relations within and between agricultural communities as they grew in size and prosperity, triggering competition and the quest for social prestige (Müller 2019; Schülke 2015; Wunderlich 2017). Megalithic tombs may also have been a way in which communities marked their presence within the landscape, without that necessarily implying territoriality. The emphasis, once again, is on regional diversity.

Broader perspectives: other advances in megalithic studies

The insights offered by new analytical techniques and methodological advances have radically transformed our understanding of megalithic monuments. In favourable circumstances they allow us to construct precise chronologies almost down to the level of individual lifetimes. They enable us to reconstruct movements of people (both groups and individuals) and to understand what kinds of people had access to burial in megalithic tombs. They also enable us to review the European megalithic phenomenon against the increasingly detailed picture of genetics and population change in western Europe as a whole.

There are fundamental questions about megalithic monumentality, however, that must be addressed in other ways. The deployment of large, over-sized blocks for the creation of standing stones, stone circles and chambered tombs is one of the most obvious features of these monuments, and indeed constitutes the defining feature of the tradition as a whole. The significance of the 'megalithic' aspect has indeed attracted ongoing attention in recent decades. It has been enriched by a series of studies that have illustrated how detailed attention to the form and disposition of the blocks, their geology and place of origin, and their arrangement (sometimes following reutilisation) in the eventual megalithic monument can provide valuable insights. The 'twin stones' in Danish megalithic tombs provide one example: split halves of a single erratic boulder, they are often arranged in a highly intentional way in the megalithic burial chambers (Dehn and Hansen 2000). The sophisticated engineering and arrangement of megalithic blocks in the dolmen de Menga in Andalucia also illustrates the high levels of skill that were sometimes involved (Lozano Rodríguez *et al.* 2024).

The incorporation of special or unusual stones is an occasional but recurrent feature, as in the fossiliferous blocks used in megalithic tomb chambers in the Lisbon area (Cardoso and Boaventura 2011). In Brittany, the work of Dominique Sellier and Emmanuel Mens in connecting megalithic blocks in the Carnac stone rows to the outcrops from which they were sourced has been particularly illuminating (Mens 2008; Mens *et al.* 2022; Sellier 2023). Similar work has been carried out in Portugal, Spain and Britain, and to some extent also in northern Europe where glacial spreads of erratic boulders provided the main source of materials (Bekkema 2013). This draws attention to the fact that the landscapes in which these monuments were constructed were originally littered with rocks and outcrops, and that the creation of megalithic monuments sometimes involved a transformation of the natural into the cultural, or perhaps a merging of the two. That is seen particularly clearly in monuments that make use of natural outcrops to form a part of their structure. One of the most remarkable examples is Roh-Coh-Coët in the Morbihan, where a natural outcrop was split and formed one edge of an elongated tomb chamber completed by the addition of an orthostatic side wall and the placement of capstones (Gouézin 2022: 160, 348: Figure 6). The recycling of stone blocks from previous monuments was also a recurring and highly intentional process within megalithic monumentality in many regions.

Figure 6. Roh Coh Coët, a megalithic tomb in the Landes de Lanvaux, an upland region of the Morbihan department of southern Brittany, built up against a natural rock outcrop. Photo: Chris Scarre.

The significance of depositing bodies within a megalithic or stone built chamber above ground is also fundamental to this tradition. It is a feature shared with burial caves, which in several regions of western Europe become places of collective burial at the same period, in parallel with the construction and use of megalithic tombs. It may have been important to leave the bodies to decay, and perhaps even to be able to see that process in operation. It has recently been observed that through the process of decomposition, the corpses did in a sense merge with the structure of the tomb (Cummings and Richards 2021). It is widely documented, furthermore, that tomb chambers were revisited, and skeletal elements removed, to be deposited elsewhere or to circulate among the living. Hence megalithic tombs were often not sealed containers of the dead but porous recipients, allowing access to and manipulation of the remains, the introduction and removal of new elements, and direct observation of bodily decay.

Yet above all, it is their monumentality that is their most prominent feature. Megalithic monuments are places we encounter in a sensory way. They still have the power today to evoke in us feelings of wonder and fascination: they are not mute analytical concepts, but physical structures, built of large stone blocks taken directly from the landscapes in which they stand. New methods of analysis have been fundamental in opening up fresh avenues of research and understanding. More secure knowledge of chronology is essential if we are to understand the temporality of practices involved in the construction and use of individual monuments. It also shows how monuments were connected to each other, and how they were related to other aspects of social practice and material culture. Evidence bearing upon the ancestry and life-histories of those individuals who were buried in the tombs is revealing new detail about who those people were, and how they may have been selected for burial, whether their origins were local or more distant, and what kind of society they belonged to. All of these are critical insights. Yet at the same time, the widespread nature of the megalithic tradition, and the depositing of human remains within megalithic chambers, also connect directly with particular kinds of engagement with landscape and material forms, and indeed with the massive stone blocks themselves.

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Chapter 2
Towards a high-resolution chronology of major megalithic monuments: Menga and Montelirio (Andalusia, Spain)

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Abstract

For decades, establishing the temporality of major megalithic monuments was a significant methodological problem that hampered the interpretation of the roles they played among early complex societies as well as their changing social and cultural significance through time. In this paper, we discuss a high-resolution approach to two remarkable megaliths, the Menga dolmen (Antequera, Málaga) and the Montelirio tholos (Sevilla), for which, in the last ten years, a total of 122 chronometric ages (including radiocarbon, OSL and TL) have been obtained, including 79 for Menga and 43 for Montelirio. This body of evidence has allowed a completely new scientific understanding of their genesis and inception, time of use and biographies. Drawing from this experience, in this paper, we discuss the methodological problems and lessons implicit in the high-resolution dating of major megaliths, including choice of dating methods, sampling strategies, chronometric hygiene, and interpretation.

Establishing the chronology of prehistoric megaliths is a notoriously difficult archaeological problem. Very often, megalithic monuments display complex biographies involving substantial rearrangements of their architecture and deposits (including both human remains and grave goods - organic and inorganic), as well as multiple phases of use, abandonment and re-use over long periods of time, sometimes on the scale of hundreds, if not thousands, of years. The methodological problems involved in understanding the temporality of megaliths range from preservation issues (for example, decay and destruction of human and animal bone on account of soil acidity, or low collagen preservation), sampling strategies (deciding which samples best date which events or parts in the history of a given monument), costs involved in the application of dating techniques, inherent limitations of the available methods (for example, large standard deviations in OSL ages), or adequate analysis and interpretation of results via statistical modelling.

In Iberian Prehistory, the first radiocarbon date was published for the famed Copper Age settlement of Los Millares in the late 1950s (Almagro Gorbea 1959). The first luminescence age was established in the mid-1970s for Neolithic and Chalcolithic pottery from sites in Central Portugal (Whittle and Arnaud 1975). However, it took a long time for the systematic scientific dating of megalithic monuments to become widespread. Suffice it to say that the first AMS dates on human bone from the Los Millares megalithic graves were not published until barely four years ago (Molina González *et al.* 2020; Aranda Jiménez *et al.* 2020). The first OSL ages dating the erection of menhirs in southern Portugal had been published a few years earlier (Calado *et al.* 2004; 2013). Altogether, up until fairly recently, the numerical chronology available to understand the megalithic phenomenon in Iberia was rather thin and not of very good quality. According to a review published a decade ago, only 51 radiocarbon dates were available for the whole of the territory of Andalusia and Extremadura combined (129,233km^2, the size of England, and larger than Portugal). The small overall number of dates and their intrinsic limitations made specific diachronic analyses of single monuments completely impossible (García Sanjuán *et al.* 2011: 123).

In the intervening decade the quality of the chronometric base available to understand the megalithic phenomenon in Iberia has made significant progress. The IDEArq database (Uriarte González *et al.* 2017), which now offers online access to the records of thousands of Iberian radiocarbon dates, currently returns 349 radiocarbon dates for megalithic burials in Andalusia and Extremadura. Most of the newly published dates have been obtained through the AMS (Accelerator Mass Spectrometry) technique, and consequently are more precise and reliable, with standard deviations routinely below 30 years. On the other hand, after several years of trial (Calado *et al.* 2004; 2013; López-Romero 2011; Athanassas *et al.* 2016; 2017), OSL dating is increasingly assuming a key role in dating the construction and/or erection dates of megalithic monuments, in combination with radiocarbon dating, with satisfactory levels of precision (Burbidge *et al.* 2019; García Sanjuán *et al.* 2023; Bailiff *et al.* 2024).

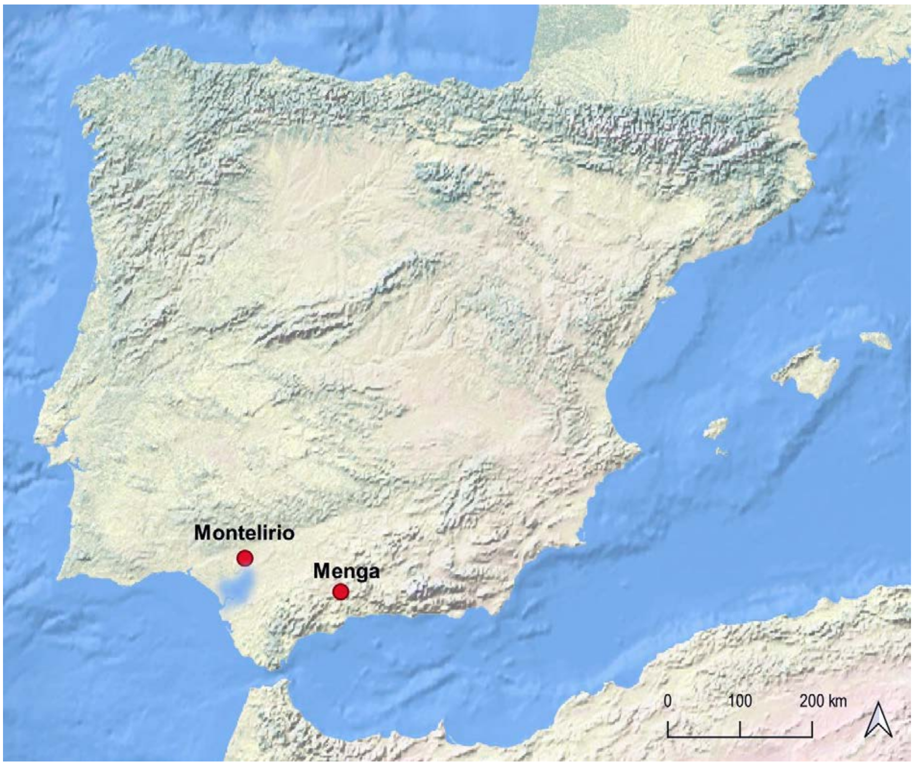

Figure 1. Location of Menga and Montelirio in the Iberian Peninsula. Design: Francisco Sánchez Díaz.

The quantitative expansion and qualitative enhancement of the chronometric base has led to significant advances in the understanding of the megalithic phenomenon across Iberia. Examples of this are the new approaches to the temporality of certain monument types, such as *tholoi* (Aranda Jiménez *et al.* 2021), or the supra-regional chrono-spatial spread of megalithic burials (García Sanjuán *et al.* 2022b). More relevant to the purpose of this paper is the fact that, thanks to the increase in the sheer number of available dates, more precise analyses of the temporality of specific monuments (and the wider settings they were part of, such as 'necropolises', 'sites', 'landscapes', etcetera.) are now becoming possible. Examples of this can be found in the southwest (Linares Catela and Vera-Rodríguez 2021), the southeast (Aranda Jiménez *et al.* 2017; 2021; 2022; Aranda Jiménez and Lozano Medina 2018; Milesi *et al.* 2023) or the northern Spanish Central Plateau (Santa Cruz *et al.* 2020; Santa Cruz 2024).

In this paper, we aim to contribute to this line of research by looking at two specific megalithic monuments, each of them remarkable in its own way, for which significant advances have been recently achieved. These are the Menga dolmen, part of the Antequera megalithic landscape (Málaga) and the Montelirio *tholos*, part of the Valencina de la Concepción-Castilleja de Guzmán (henceforth, Valencina) Copper Age mega-site (Sevilla) (Figure 1). In the last ten years, a total of 122 chronometric ages (including radiocarbon, OSL and TL dates) have been obtained for these two monuments: 79 for Menga and 43 for Montelirio. This new dataset has allowed completely new approaches to key problems such as the precedents, genesis and inception, time of use and biography of these two megaliths. Drawing from this experience, in this paper, we discuss the methodological problems and lessons implicit in the high-resolution dating of major megaliths, including choice of dating methods, sampling strategies, chronometric hygiene, and interpretation.

Case Studies

a. Menga

The Menga dolmen is part of the Antequera World Heritage Site, located in Málaga (Spain). First explored in the 1840s (Mitjana y Ardison 1847), soon after, and throughout the 19th century, it became an internationally-known reference for the study of the megalithic phenomenon (Sánchez-Cuenca 2011). Through most of the 20th century, however, research stalled. In the late 1980s and through the 1990s, the University of Málaga undertook excavations that, to this date, remain largely unpublished (Mora Molina and García Sanjuán 2020). New excavations carried out between 2005 and 2006 by a team of contract archaeologists and by the University of Granada were recently published as monographs (García Sanjuán and Mora Molina 2018; García Sanjuán 2022a), which, coupled with a series of papers (Lozano Rodríguez *et al.* 2014; 2023; 2024; García Sanjuán *et al.* 2023a), have provided valuable fresh evidence to understand the

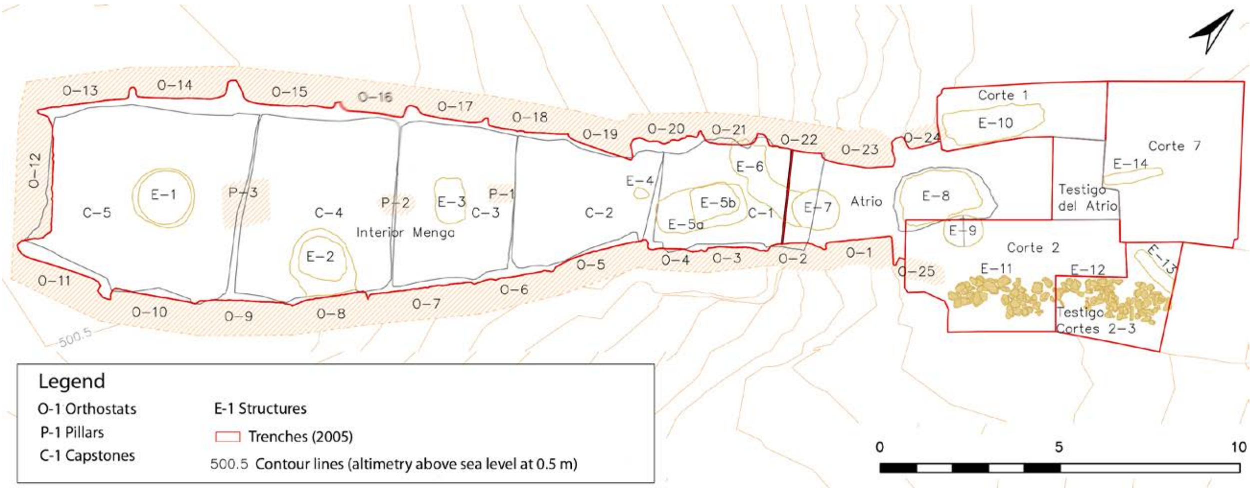

Figure 2. Plan of Menga showing the 2005 excavation trenches.
Design: Coronada Mora Molina.

genesis and temporality of this exceptional monument (Figure 2).

As a result of this recent impulse, a total of 79 numerical dates now exist for Menga (Tables 1, 2 and 3), including 70 radiocarbon ones, as well as 6 TL and 3 OSL ones. The first three radiocarbon determinations were obtained in 2006, but were not published until ten years later (García Sanjuán and Lozano Rodríguez 2016: 5). These dates, on samples of charred material retrieved from a pit located at the dolmen's atrium, provided the first Late Neolithic ages for Menga. Two more dates were then obtained on samples of human bone from the Early Medieval inhumations found in Menga's atrium (Díaz-Zorita and García Sanjuán 2012). A series of eight more radiocarbon dates were later obtained for the numerous Roman-period burials located around the great dolmen and on its mound (Aranda Jiménez *et al.* 2015: 274). Subsequently, another 14 radiocarbon determinations were obtained on samples of animal bone from the infill of the water well, all of which provided modern ages. From these dates, a chronometric model established the date of the formation of said fill in the 18th century AD (García Sanjuán *et al.* 2016). The latest batch of 32 new numerical dates was published recently (García Sanjuán *et al.* 2023a). This included 23 radiocarbon dates, which break down as follows: nine on animal bone and charred material from the mound, four on human bone from Trench 3 (located outside the dolmen, on the western slope of the Menga hill), and 10 on wood and leather from the infill of the well. In addition, this batch included also three OSL dates from samples obtained from the socket of Pillar #3 plus six TL dates on pottery fragments from the atrium area. Two more radiocarbon dates on samples of animal bone from Trench 3 (which had not been published earlier) yielded ages set in the 20th century. Finally, for the sake of completeness, 18 more radiocarbon dates not previously published (as they were not used in any of the chronometric models used to understand the chronology of the dolmen), are included in Table 1.

Several recently published numerical dates have also provided a solid base to understand Menga's territorial and landscape setting. Thus, 34 new radiocarbon determinations were published from three Late Neolithic sites located in the Antequera plain: Arroyo Saladillo (20 dates), Huerta del Ciprés (13) and El Comandante (1) (García Sanjuán *et al.* 2020). These dates provide a temporal framework to understand the settlement patterns and environmental transformations of the Antequera plain throughout the 4th millennium BCE, when Menga was built. In addition, two Th-U dates come from the painted schematic motifs of the Matacabras rock shelter, located at the northern sector of La Peña de los Enamorados (Rogerio-Candelera *et al.* 2018), a mountain with a strong bearing in the Antequera prehistoric landscape. Finally, eight radiocarbon dates on human bone from the hypogeum-megalithic burial located at its foot (García Sanjuán *et al.* 2023b), have provided a good basis to understand the remarkable visual and conceptual relationship Menga had with this mountain.

In summary, the number of published numerical dates available to understand the chronology of this unique monument has risen from zero to 123 in barely ten years, with 79 numerical dates from the Menga dolmen itself and 44 more from closely associated sites located in the Antequera plain.

b. Montelirio

The Montelirio tholos is part of the Valencina megasite, which, located in Sevilla (SW Spain), is one of the main references for the study of 3rd millennium BC Iberia. First discovered in 1998, Montelirio was subsequently

LAB CODE	SAMPLE CODE	SAMPLE MATERIAL	CONTEXT	DATE BP	DATE 2σ CAL BCE/AD	δ¹³C	REFERENCE
CNA-5040	A/DJ 14541-91-FIS	Charred material (*Phillyrea* sp.)	Mound (Trench 1)	5050 ± 30	3952–3776 BCE	–15.51	García Sanjuán *et al.* 2023a
CNA-5039	A/DJ 14541-90-QIC	Charred material (*Quercus ilex coccifera*)	Mound (Trench 1)	5000 ± 30	3938–3701 BCE	–19.82	García Sanjuán *et al.* 2023a
Ua-24582	Structure 9, Layer 3, Sample 1	Charred material (indeterminate)	Atrium (Structure 9, UE 3 (pit)	4935 ± 40	3790–3640 BCE	–27.10	García Sanjuán and Lozano Rodríguez 2016
CNA-5041	A/DJ 14541-95-QIC	Charred material (*Quercus ilex coccifera*)	Atrium (Structure 9, UE 1 (pit)	4880 ± 30	3707–3636 BCE	–23.45	García Sanjuán *et al.* 2023a
Ua-24583	Structure 9, Layer 3, Sample 2	Charred material (indeterminate)	Atrium (Structure 9, UE 3 (pit)	4865 ± 40	3760–3530 BCE	–28.50	García Sanjuán and Lozano Rodríguez 2016
Beta-526345	A/DJ 14541-203-3	Bone (deer, mandible)	Mound (Trench 1, Sector D, Layer 2)	4780 ± 30	3650–3510 BCE	–19.40	García Sanjuán *et al.* 2023a
Beta-526346	A/DJ 14541-73-1	Bone (cow, metacarpal)	Mound (Trench 1, Sector D, Layer 1)	4780 ± 30	3650–3510 BCE	–19.30	García Sanjuán *et al.* 2023a
CNA-5038	A/DJ 14541-90-ARU	Charred material (*Arbustus unedo*)	Mound (Trench 1)	4760 ± 30	3639–3384 BCE	–25.67	García Sanjuán *et al.* 2023a
Ua-36216	NA	Charred material (indeterminate)	Mound (lower infill)	4760 ± 30	3639–3384 BCE	–24.50	García Sanjuán and Lozano Rodríguez 2016
Beta-526337	A/DJ 14541-142-OLE	Charred material (*Olea europea*)	Exterior (Trench 2, Structure 31)	4750 ± 30	3640–3380 BCE	–25.60	García Sanjuán *et al.* 2023a
Beta-526344	A/DJ 14541-203-2	Bone (ovicaprine, upper tooth)	Mound (Trench 1, Sector D, Layer 2)	4750 ± 30	3640–3380 BCE	–18.50	García Sanjuán *et al.* 2023a
Beta-526347	A/DJ 14541-73-2	Bone (cow, first phalanx)	Mound (Trench 1, Sector E, Layer 1)	4580 ± 30	3500–3110 BCE	–19.40	García Sanjuán *et al.* 2023a
CNA-4319	A/DJ 14540.0112 (1)	Bone (femur, *Oryctolagus cuniculus*)	Atrium	2220 ± 30	374-202 BCE	-18.85	This paper
Beta-412999	A/DJ 14470/5	Human bone (right femur)	Exterior (Sample 1-C-14)	1790 ± 30	133-330 AD	-19.70	Aranda Jiménez *et al.* 2015
Beta-413001	A/DJ 14295/4	Human bone (skull)	Exterior (Sample 3-C-14)	1770 ± 30	138-345 AD	-18.90	Aranda Jiménez *et al.* 2015
Beta-413000	A/DJ 14470/5	Human bone (tooth)	Exterior (Sample 2-C-14)	1730 ± 30	243-386 AD	-19.10	Aranda Jiménez *et al.* 2015
Beta-413002	A/DJ 14295/4	Human bone (tooth)	Exterior (Sample 4-C-14)	1700 ± 30	253-406 AD	-17.70	Aranda Jiménez *et al.* 2015
CNA-5452	2020-02-05-047	Wood (unworked, *Nerium oleander*)	Well	1620 ± 25	386-536 AD	-24.52	García Sanjuán 2022
Beta-413004	A/DJ 14470/1	Bone (indeterminate, *Capra hircus/Ovis aries*)	Exterior (Sample 6-C-14, Trench 3/1988)	1540 ± 30	426-588 AD	-19.20	Aranda Jiménez *et al.* 2015
Beta-413006	A/DJ 14470/3	Bone (indeterminate, *Capra hircus/Ovis aries*)	Exterior (Sample 8-C-14, Trench 4/1988)	1520 ± 30	428-609 AD	-20.20	Aranda Jiménez *et al.* 2015
Beta-413003	A/DJ 14470/1	Bone (indeterminate, Capra hircus)	Exterior (Sample 5-C-14, Trench 3/1988)	1500 ± 30	432-639 AD	-19.00	Aranda Jiménez *et al.* 2015
Beta-413005	A/DJ 14470/4	Bone (indeterminate fauna, scapula)	Exterior (Sample 7-C-14, Trench 4/1988)	1490 ± 30	436-644 AD	-20.00	Aranda Jiménez *et al.* 2015
Beta-526350	ADJ14541-72-1	Human bone (adult femur)	Mound (Trench 3/2005-2006)	1300 ± 30	660-774 AD	18.70	García Sanjuán 2022
CNA-4324	A/DJ 14540.0100 (2)	Human bone (skull)	Atrium	1280 ± 30	667-770 AD	-16-59	This paper
Beta-526352	ADJ14541-76-1	Human bone (adult femur)	Mound (Trench 3/2005-2006)	1270 ± 30	664-827 AD	17.90	García Sanjuán 2022
Beta-526353	ADJ14541-324-1	Human bone (adult tibia)	Mound (Trench 3/2005-2006)	1270 ± 30	664-827 AD	18.50	García Sanjuán 2022
CNA-1174	NA	Human bone (adult upper limb)	Atrium (Individual #2, Grave #2)	1250 ± 35	676-871 AD	-21.52	Díaz-Zorita and García Sanjuán 2012
Beta-526351	ADJ14541-72-2	Human bone (adult femur)	Mound (Trench 3/2005-2006)	1200 ± 30	706-946 AD	19.00	García Sanjuán 2022
CNA-5457	2020-02-05-052	Wood (unworked, *Ulmus minor*)	Well	1150 ± 25	775-987 AD	-24.37	García Sanjuán 2022
CNA-1173	NA	Human bone (adult right femur)	Atrium (Individual #1, Grave #1)	1100 ± 45	783-1022 AD	-30.01	Díaz-Zorita and García Sanjuán 2012
CNA-4213	A/DJ 14540.0013	Charred material (indeterminate)	Atrium	579 ± 30	1301-1418 AD	-24.81	This paper
CNA-5456	2020-02-05-051	Wood (worked, *Pinus nigra*)	Well	410 ± 25	1437-1620 AD	-25.91	García Sanjuán 2022

Table 1. Summary data for all radiocarbon dates currently available for the Menga dolmen. (*): Probably out of range. NA: Not Available. All dates calibrated as reported in the cited publications or laboratory reports.

LAB CODE	SAMPLE CODE	SAMPLE MATERIAL	CONTEXT	DATE BP	DATE 2σ CAL BCE/AD	δ¹³C	REFERENCE
CNA-4210	A/DJ 14540.0088	Charred material (indeterminate)	Interior	405 ± 30	1434-1622 AD	-23.07	This paper
CNA-4211	A/DJ 14540.0086	Charred material (indeterminate)	Interior	399 ± 30	1437-1626 AD	-22.91	This paper
CNA-4323	A/DJ 14540.0101 (2)	Bone (humerus, *Canis lupus*)	Interior	390 ± 30	1439-1628 AD	-19.60	This paper
CNA-4317	A/DJ 14540.0117	Bone (metacarpal, *Sus scrofa*)	Interior	370 ± 30	1448-1633 AD	-19.73	This paper
CNA-4207	A/DJ 14540.0064 (2)	Charred material (indeterminate)	NA	364 ± 29	1449-1634 AD	-25.55	This paper
CNA-5455	2020-02-05-050	Wood (worked, *Pinus nigra*)	Well	350 ± 25	1467-1636 AD	-26.78	García Sanjuán 2022
CNA-4316	A/DJ 14540.0036	Bone (indeterminate)	Atrium	340 ± 30	1478-1638 AD	-20.40	This paper
CNA-4322	A/DJ 14540.0101 (1)	Bone (indeterminate)	Interior	340 ± 30	1478-1638 AD	-19.89	This paper
CNA-5460	2020-02-05-056	Leather (shoe sole)	Well	340 ± 30	1478-1638 AD	-24.46	García Sanjuán 2022
CNA-5453	2020-02-05-048	Wood (worked, *Pinus nigra*)	Well	340 ± 25	1474-1637 AD	-27.31	García Sanjuán 2022
CNA-5451	2020-02-05-046	Wood (worked, *Pinus nigra*)	Well	320 ± 25	1489-1645 AD	-27.68	García Sanjuán 2022
CNA-4206	A/DJ 14540.0064 (1)	Charred material (indeterminate)	NA	269 ± 29	1517-1949 AD*	-24.33	This paper
CNA-4209	A/DJ 14540.0092	Charred material (indeterminate)	Interior	255 ± 29	1521-1949 AD*	-23.42	This paper
CNA-4320	A/DJ 14540.0112 (2)	Bone (radius, *Sus scrofa*)	Interior	230 ± 30	1521-1949 AD*	-18.89	This paper
CNA-3366	Menga-05-8	Bone (indeterminate, Felis catus)	Well	211 ± 28	1644-1926 AD*	-19.82	García Sanjuán *et al.* 2016
CNA-5454	2020-02-05-049	Wood (unworked, *Populus sp*)	Well	200 ± 25	1651-1925 AD*	-26.82	García Sanjuán 2022
CNA-4318	A/DJ 14540.0108 (3)	Bone (rib, *Capra hircus/Ovis aries*)	NA	190 ± 30	1650-1949 AD*	-19.70	This paper
CNA-4208	A/DJ 14540.0091	Charred material (indeterminate)	Interior	184 ± 28	1652-1949 AD*	-26.40	This paper
CNA-3363	Menga-05-5	Bone (indeterminate, *Equus sp*)	Well	179 ± 28	1658-1915 AD*	-18.70	García Sanjuán *et al.* 2016
CNA-3365	Menga-05-7	Bone (indeterminate, *Canis lupus*)	Well	172 ± 28	1660-1910 AD*	-18.25	García Sanjuán *et al.* 2016
CNA-3370	Menga-05-12	Bone (indeterminate , *Lepus europaeus*)	Well	172 ± 28	1660-1910 AD*	-20.12	García Sanjuán *et al.* 2016
CNA-3362	Menga-05-4	Bone (tarsal, *Equus asinus*)	Well	164 ± 28	1662-1907 AD*	-21.41	García Sanjuán *et al.* 2016
CNA-3367	Menga-05-9	Bone (humerus, *Canis lupus*)	Well	163 ± 28	1663-1907 AD*	-18.80	García Sanjuán *et al.* 2016
CNA-4212	A/DJ 14540.0125	Charred material (indeterminate)	Interior	159 ± 30	1665-1949 AD*	-24.51	This paper
CNA-3368	Menga-05-10	Bone (tibia, *Canis lupus*)	Well	158 ± 28	1664-1906 AD*	-18.59	García Sanjuán *et al.* 2016
CNA-3360	Menga-05-2	Bone (femur, *Felis catus*)	Well	153 ± 28	1666-1905 AD*	-24.66	García Sanjuán *et al.* 2016
Beta-322312	NA	Bone (metacarpal, *Canis lupus*)	Well	150 ± 30	1667-1904 AD*	-19.10	García Sanjuán *et al.* 2016
CNA-3371	Menga-05-13	Bone (radius, *Canis lupus*)	Well	147 ± 28	1660-1950 AD*	-18.28	García Sanjuán *et al.* 2016
CNA-3359	Menga-05-1 D-5.185	Bone (NA)	Well	145 ± 28	1668-1945 AD*	-20.91	This paper
CNA-3361	Menga-05-3	Bone (ulna, *Canis lupus*)	Well	137 ± 28	1670-1950 AD*	-19.95	García Sanjuán *et al.* 2016
CNA-3369	Menga-05-11	Bone (femur, *Canis lupus*)	Well	134 ± 28	1670-1950 AD*	-19.30	García Sanjuán *et al.* 2016
CNA-5458	2020-02-05-053	Wood (unworked, *Sorbus aria*)	Well	130 ± 25	1677-1942 AD*	-24.61	García Sanjuán 2022
Beta-322311	NA	Bone (radius, *Bos taurus*)	Well	120 ± 30	1670-1940 AD*	-18.00	García Sanjuán *et al.* 2016
CNA-3364	Menga-05-6	Bone (indeterminate, *Equus sp*)	Well	118 ± 28	1680-1940 AD*	-20.03	García Sanjuán *et al.* 2016
CNA-4321	A/DJ 14540.0112 (3)	Bone (rib, *Bos taurus*)	Interior	110 ± 30	1681-1937 AD*	-17.88	This paper
CNA-5459	2020-02-05-054	Wood (unworked, *Nerium oleander*)	Well	110 ± 25	1648-1928 AD*	-21.99	García Sanjuán 2022
Beta-526349	NA	Bone (skull, *Sus scrofa*)	Exterior (Trench 3/2005-2006)	90 ± 30	1687-1926 AD*	-21.70	This paper
Beta-526348	NA	Bone (tibia, *Canis lupus*)	Exterior (Trench 3/2005-2006)	70 ± 30	1690-1924 AD*	-19.40	This paper

Table 1. Continued.

SAMPLE CODE	SAMPLE MATERIAL	CONTEXT	DOSE RATE (GY/KA)	EQUIVALENT DOSE (GY)	AGE (KA)	DATE BP	DATE BCE	BIBLIOGRAPHIC REFERENCE
MENGA2Socket	Infill	Socket of Pillar 3	1.03 ± 0.03	6.0 ± 0.3	5.8 ± 0.3	5719 ± 304	3769 ± 201	This paper
MENGA1Infill	Infill	Socket of Pillar 3	0.95 ± 0.09	5.2 ± 0.4	5.5 ± 0.4	5467 ± 365	3517 ± 325	This paper
MENGA1Contact	Infill	Socket of Pillar 3	1.00 ± 0.03	5.5 ± 0. 8	5.5 ± 0.8	5493 ± 790	3543 ± 510	This paper

Table 2. Optically stimulated luminescence (OSL) ages for Menga (after García Sanjuán *et al.* 2023a).

LAB CODE	CONTEXT	DOSE RATE (GY/KA)			EQUIVALENT DOSE (GY)			AGE (KA BEFORE 2016)			CALENDAR AGE
ANT-C-02	Atrium	2.64	±	0.18	2.20	±	0.03	0.83	±	0.06	1166 ± 60 AD
ANT-C-03	Atrium	2.23	±	0.21	4.50	±	0.09	2.02	±	0.19	4 ± 190 AD
ANT-C-04	Atrium	3.54	±	0.26	12.00	±	0.11	3.39	±	0.25	1374 ± 250 BCE
ANT-C-05	Atrium	3.48	±	0.29	4.14	±	0.07	1.19	±	0.10	826 ± 100 AD
ANT-C-06	Atrium	2.49	±	0.25	13.14	±	0.17	5.27	±	0.53	3254 ± 530 BCE
ANT-C-07	Atrium	2.98	±	0.35	5.93	±	0.09	1.99	±	0.24	26 ± 240 BCE

Table 3. Thermoluminescence (TL) ages for pottery shards from Menga (after García Sanjuán *et al.* 2023a).

excavated between 2007 and 2010. A full monograph (Fernández Flores *et al.* 2016) and several papers (García Sanjuán *et al.* 2018a; 2018b; 2025; Luciañez Triviño *et al.* 2022) have recently provided a detailed account of the human remains and material culture found in it (Figure 3). Montelirio is closely associated with the PP4-Montelirio sector, which spreads to the north over an area of *c.* 1 ha. Between 2007 and 2008, 164 features (mostly small megalithic graves and pits) were excavated here, approximately half of which contained human remains. A host of papers published in the last ten years have revealed the significance of the PP4-Montelirio sector as a 'formal disposal area' (*sensu* Chapman, 1981). Of particular note is Structure 10.042-10.049, a double-chambered *tholos*-type burial in which the remains of a remarkable young woman, subsequently nicknamed 'The Ivory Lady' on account of the collection of ivory artefacts that were deposited with her, were discovered. In barely a decade, both Montelirio and Structure 10.042-10.049 have become a paradigm of some of the main features associated with the Iberian Copper Age: economic intensification, emerging social complexity, supra-regional connectivity, sophisticated monumentality, lavish material culture and artistic exuberance.

For the Montelirio *tholos*, 43 radiocarbon dates have been published, including 19 on human bone, three on charred material (Bayliss *et al.* 2016; García Sanjuán *et al.* 2018a: 225-238) and 21 on shell beads from the attires worn by some of the women buried in its Large Chamber (García Sanjuán *et al.* 2025) (Table 4). For the PP4-Montelirio Sector, 66 further radiocarbon dates have been published, including 57 on human bone, 4 on shell beads and 5 on ivory (all of which were deemed invalid – see discussion below) García Sanjuán *et al.* 2013; 2018a; 2024).

Therefore, 109 radiocarbon dates are now available for the Montelirio tholos and PP4-Montelirio sector combined, compared to *none* existing barely 10 years ago. This significant leap in the breadth and depth of the chronometric base available to study these features is in keeping with that experienced by Valencina in general. From a meagre 10 dates published for the mega-site in 2011, the number has increased to over 300 in 2024 (most of them published in García Sanjuán *et al.* 2018a; 2024; Mederos Martín *et al.* 2023).

Discussion

The chronometric evidence described above, with a combined total of 232 numerical dates for Menga and Montelirio (and surrounding features and sites of immediate relevance), has allowed a much more detailed understanding of the temporality of two of the most prominent megalithic monuments in the Iberian Peninsula. These are very different monuments. Menga is a dolmen built with massive stones, whereas Montelirio is a *tholos*-type megalith, built with much smaller slabs and earthen domes (Figure 4). In addition, they are significantly apart chronologically: Menga was built between *c.* 3800 and 3600 BC, while Montelirio was used (and, most probably, built) between *c.* 2800 and 2700 BC. Menga represents well the Late Neolithic megalith-building phenomenon, with an emphasis on massive uprights and capstones, whereas Montelirio is a reflection of a later, 'second', megalithic tradition set in the Copper Age and based on the much-lighter architecture of the *tholoi*, with round chambers, long passages and corbelled or earthen domes. While Menga was designed as a grandiose temple devoted to the core concepts of the Neolithic worldview, Montelirio was probably the grave (albeit, perhaps, also sanctuary)

Figure 3. Plan of Montelirio as revealed by the 2010 excavation.
Design: Álvaro Fernández Flores.

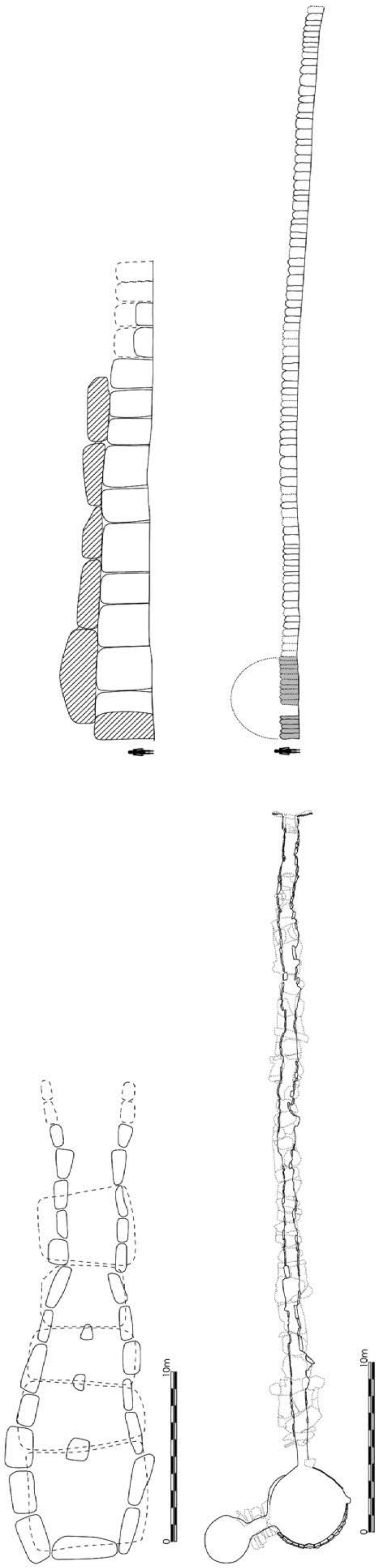

Figure 4. Comparison of Menga and Montelirio at scale in plan and section. Design: Ana García.

of a selected group of people (mostly women) who, in all probability, held high social positions as religious specialists and, perhaps, political leaders.

However, while rather different in morphology and, presumably, purpose, the newly available high-resolution dating of both megaliths provides new opportunities to reflect on the methodological problems and interpretative lessons implicit in the analysis of major prehistoric monuments.

Of course, sample preservation and sampling strategies are key issues. The failure to date 'The Ivory Lady' from Structure 10.049 at the PP4-Montelirio sector, a burial closely connected to the Montelirio *tholos*, is a good example of this. In total, 15 samples from this individual have been submitted for C14-dating over the years, all of which failed. This included five dates on ivory objects that were part of her grave goods, which were deemed invalid due to low levels of collagen (García Sanjuán *et al.* 2013: 625), seven samples of her bones and further ivory artefacts submitted later, which produced little or no collagen and failed the Oxford and SUERC quality-control procedures (García Sanjuán *et al.* 2018a: 231), as well as three more samples on human bone submitted to SUERC in 2022 (García Sanjuán *et al.* 2024).

Another example of the issues involved in dating major megalithic monuments is the lack of Neolithic materials in the interior of Menga. Given the intense, and (most probably) uninterrupted use of this dolmen as a temple, sanctuary or shrine over the last six thousand years (Figure 5), the material evidence of its earlier phases of use has been almost completely obliterated. Save for some exceptional finds (see for example Lozano Rodríguez *et al.* 2016), no evidence of Neolithic or Copper Age activity has ever been recorded inside Menga, either in the excavations undertaken by the University of Málaga between the late 1980s and mid-1990s, or the excavations carried out between 2005 and 2006 by a team of contract archaeologists and the University of Granada. Interestingly, the only solid record of Neolithic activity in Menga has been found either outside (i.e. around the dolmen), or within its mound. Of particular interest was the presence of large quantities of animal bone and charred material in the lower level of the mound, which was about 1.5m in depth and basically made up of a highly organic, dark sediment. The soil in this layer, which was collected on the Menga hill itself to be used as base level of the Menga mound, originally resulted from a long period of sustained activity at the site, before the dolmen was built, as various lines of evidence suggest (García Sanjuán 2022b).

Indeed, a second major result of the high-resolution dating of both Menga and Montelirio is the realisation

ID LAB	CONTEXT	MATERIAL	STRATIGRAPHIC UNIT	SU INDIVIDUAL	δ13C (‰)	BP	Cal BC 2σ (*)	SOURCE
OxA-X-2535-32	Mound	Human bone (right humerus)	UE273	UE273	−18.7 ± 0.2	5802 ± 34	4727-4547	Bayliss *et al.* 2016
OxA-41458	Large Chamber (MCG-INV6-31)	Shell (Pectinidae)	UE167	UE114	-4,1801	5058 ± 19	3555-3191	García Sanjuán *et al.* 2024a
OxA-41459	Large Chamber (MCG-INV1-90)	Shell (Cardiidae)	UE344	UE343	1,81452	4819 ± 18	3289-2901	García Sanjuán *et al.* 2024a
OxA-41319	Large Chamber (MCG-INV89-18)	Shell (Pectinidae)	UE94	UE102	0,711115	4787 ± 17	3258-2877	García Sanjuán *et al.* 2024a
OxA-41328	Large Chamber (MCG-INV6-91)	Shell (Cardiidae)	UE167	UE114	-3,70669	4686 ± 17	3100-2727	García Sanjuán *et al.* 2024a
OxA-41560	Large Chamber (MCG-INV1-60)	Shell (Pectinidae)	UE344	UE343	1,10319	4560 ± 19	2906-2574	García Sanjuán *et al.* 2024a
OxA-41460	Large Chamber (MCG-INV1-89)	Shell (Cardiidae)	UE344	UE343	-5,66563	4552 ± 18	2900-2567	García Sanjuán *et al.* 2024a
OxA-41323	Large Chamber (MCG-INV8-29)	Shell (Pectinidae)	UE95	UE108	-5,44029	4550 ± 17	2896-2566	García Sanjuán *et al.* 2024a
OxA-41326	Large Chamber (MCG-INV356-63)	Shell (Pectinidae)	UE357	UE356	-0,858594	4526 ± 17	2881-2542	García Sanjuán *et al.* 2024a
OxA-41327	Large Chamber (MCG-INV356-24)	Shell (Cardiidae)	UE357	UE356	1,15406	4501 ± 17	2862-2501	García Sanjuán *et al.* 2024a
OxA-41322	Large Chamber (MCG-INV8-93)	Shell (Pectinidae)	UE95	UE108	-5,06905	4486 ± 17	2851-2491	García Sanjuán *et al.* 2024a
OxA-41325	Large Chamber (MCG-INV1-61)	Shell (Pectinidae)	UE355	UE111	0,970057	4476 ± 17	2843-2476	García Sanjuán *et al.* 2024a
OxA-41320	Large Chamber (MCG-INV93-41)	Shell (Cardiidae)	UE94	UE102	-5,96386	4465 ± 17	2834-2469	García Sanjuán *et al.* 2024a
OxA-41314	Large Chamber (MCG-INV93-38)	Shell (Cardiidae)	UE94	UE102	1,19113	4457 ± 20	2832-2459	García Sanjuán *et al.* 2024a
OxA-41461	Large Chamber (MCG-INV1-70)	Shell (Cardiidae)	UE344	UE343	-3,43736	4455 ± 18	2833-2461	García Sanjuán *et al.* 2024a
OxA-41313	Large Chamber (MCG-INV89-21)	Shell (Cardiidae)	UE94	UE102	-5,8561	4450 ± 22	2830-2451	García Sanjuán *et al.* 2024a
OxA-41321	Large Chamber (MCG-INV93-41)	Shell (Cardiidae)	UE94	UE102	-6,6257	4455 ± 17	2834-2462	García Sanjuán *et al.* 2024a
OxA-42253	Large Chamber (MCG-INV24-85)	Shell (Bivalves)	UE175	Cloth	-6,407	4449 ± 19	2829-2452	García Sanjuán *et al.* 2024a
CNA-589	Large Chamber	Charred material (indeterminate)	UE166	--	−22.70 ± 0.70	4400 ± 60	3334-2901	Bayliss *et al.* 2016
OxA-42254	Large Chamber (MCG-INV24-27)	Shell (Pectinidae)	UE175	Cloth	-6,02412	4437 ± 19	2821-2438	García Sanjuán *et al.* 2024a
OxA-42252	Large Chamber (MCG-INV16-01)	Shell (Pectinidae)	UE163	UE103	-5,49186	4432 ± 19	2821-2427	García Sanjuán *et al.* 2024a
OxA-41324	Large Chamber (MCG-INV1-58)	Shell (Pectinidae)	UE355	UE111	-3,24053	4410 ± 17	2771-2384	García Sanjuán *et al.* 2024a
OxA-28245	Large Chamber	Human bone (right femur)	UE103	UE103	−20.2 ± 0.2	4279 ± 29	3002-2873	Bayliss *et al.* 2016
CNA-585	Large Chamber	Human bone (left radius)	UE102	UE102	−20.6 ± 1.0	4250 ± 35	2923-2698	Bayliss *et al.* 2016
SUERC-60405	Large Chamber	Human bone (tooth)	UE103	UE103	9.8 ± 0.3	4203 ± 28	2619-2472	Bayliss *et al.* 2016
Ua-40801	Small Chamber	Human bone (indeterminate)	UE80	UE88	−19.9	4180 ± 30	2890-2660	Bayliss *et al.* 2016
OxA-32304	Large Chamber	Human bone (tooth)	UE103	UE103	−18.6 ± 0.2	4179 ± 29	2885-2666	Bayliss *et al.* 2016
SUERC-47686	Large Chamber	Human bone (right femur)	UE116	UE116	−19.1 ± 0.2	4168 ± 33	2883-2633	Bayliss *et al.* 2016
OxA-32303	Large Chamber	Human bone (tooth)	UE105	UE105	−19.1 ± 0.2	4164 ± 36	2881-2631	Bayliss *et al.* 2016
OxA-32301	Large Chamber	Human bone (right ulna)	UE343	UE343	−19.1 ± 0.2	4168 ± 30	2881-2635	Bayliss *et al.* 2016
Ua-40803	Large Chamber	Human bone (left femur)	UE102	UE102	−20.4	4165 ± 30	2880-2630	Bayliss *et al.* 2016
CNA-586	Large Chamber	Human bone (tooth)	UE102	UE102	−20.31 ± 0.86	4140 ± 50	2880-2575	Bayliss *et al.* 2016
OxA-30385	Main Corridor	Human bone (tooth)	UE232	UE232	−18.9 ± 0.2	4151 ± 30	2876-2630	Bayliss *et al.* 2016
OxA-32302	Large Chamber	Human bone (tooth)	UE113	UE113	−18.4 ± 0.2	4145 ± 29	2875-2625	Bayliss *et al.* 2016
SUERC-47682	Large Chamber	Human bone (left femur)	UE110	Ue110	−19.0 ± 0.2	4129 ± 33	2872-2581	Bayliss *et al.* 2016
OxA-30439	Main Corridor	Human bone (tooth)	UE229	UE229	−18.8 ± 0.2	4125 ± 30	2867-2581	Bayliss *et al.* 2016
Ua-40805	Large Chamber	Charred material (indeterminate)	UE166	--	−25.5	4086 ± 35	2862-2494	Bayliss *et al.* 2016
CNA-588	Large Chamber	Human bone (tooth)	UE113	UE113	−21.38 ± 0.62	4060 ± 40	2851-2476	Bayliss *et al.* 2016
Ua-40802	Small Chamber	Human bone (indeterminate)	UE88	UE88	−21.4	4002 ± 31	2580-2460	Bayliss *et al.* 2016
CNA-587	Large Chamber	Human bone (right radius)	UE113	UE113	−21.74 ± 0.74	3950 ± 70	2622-2206	Bayliss *et al.* 2016
Ua-40804	Large Chamber	Human bone (right radius)	UE113	UE113	−22.6	3862 ± 30	2470-2200	Bayliss *et al.* 2016
OxA-32200	Main Corridor	Charred material (indeterminate)	UE76	UE76	−24.0 ± 0.2	2569 ± 29	809-564	Bayliss *et al.* 2016

Table 4. Summary data for the radiocarbon dates available for the Montelirio *tholos*.
All calibrations as published in the references cited.

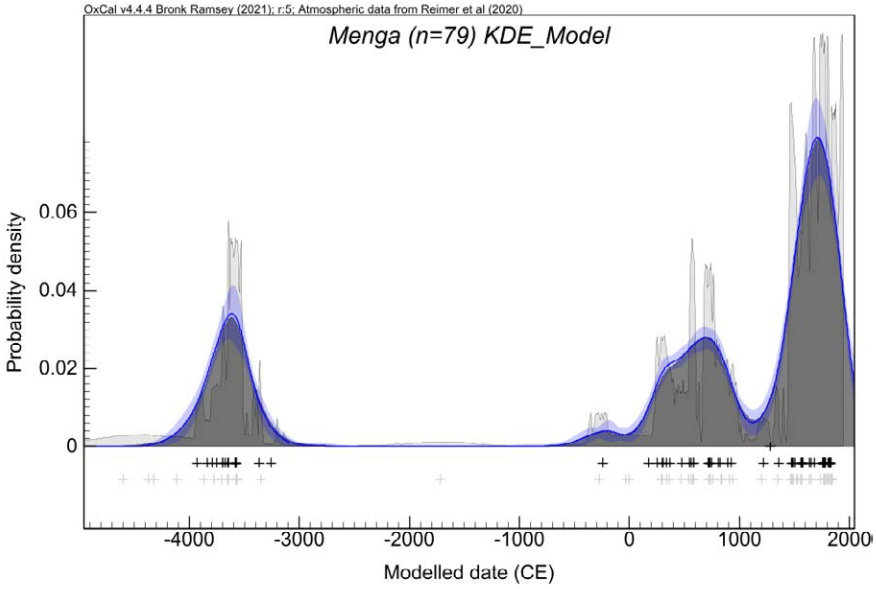

Figure 5. Kernel density estimate (KDE) for all radiocarbon dates from Menga. Design: Francisco Sánchez Díaz.

that the sites where these monuments were built already had a history prior to their construction. This suggests that the choice of the precise locations where these two exceptional megaliths were to be built was far from random, and was determined, at least partly, by the ancestral significance already conveyed by the sites themselves. Needless to say, this is perfectly understandable: major monuments are normally built in locations that are already loaded with social and ideological meaning. In the case of Menga, this is slightly paradoxical: while the empirical record of the great dolmen is not of much help when it comes to understand its use immediately after it was built, it provides useful information regarding the background and precedents of the site prior to its construction. The large quantities of knapped flint, highly fragmented (and rounded) pottery and faunal remains retrieved from the base layer of the Menga mound point to a regular and intense frequentation of the hill before Menga was built. It has been suggested that some of Menga's very stones might have been used as menhirs or stelae, perhaps erected on the Menga hill, and then re-used as uprights and capstones upon the construction of the dolmen (Bueno Ramírez *et al.* 2009: 191). While this is not consistent with the geological evidence (Lozano Rodríguez *et al.* 2024), various pits and blocks of stone recorded behind Menga (i.e. on the southwestern edge of its mound) open the possibility that structures made of wood (posts, fences) or stone (menhirs or stelae) existed there before the dolmen was built (García Sanjuán 2022: 470), and then disappeared. Similar evidence has been documented at other southern Iberian megalithic monuments such as Llano de la Belleza (Aroche, Huelva, Spain) (García Sanjuán *et al.* 2006: 185-186), Soto (Trigueros, Huelva, Spain) (Linares Catela and Mora Molina 2015: 105; 2018: 104-105) or Alcalar 7 (Mexilhoeira Grande, Faro, Portugal) (Díaz-Guardamino 2004).

The case of Montelirio is also quite interesting, if different from Menga. While the radiocarbon chronology of all the individuals recorded inside Montelirio, based on 21 dates on samples of human bone, is quite consistent, suggesting that the *tholos* was first used (perhaps built) in 2875-2700 2σ cal BC and continued to be used until 2805-2635 2σ cal BC, being in use for a period of 1-200 years (95% probability) or 1-100 years (68% probability) (Bayliss *et al.* 2016), the date OxA-X-2535-32 (human bone), which dated an individual buried outside the main passage, yielded an age of 5802 ± 34 (4727-4547 2σ cal BC), which obviously falls long before Montelirio was built. What this date means is that there was burial activity at the hill of Montelirio very long (almost two thousand years) before the *tholos* was built. Since nothing is known about the frequentation or occupancy of the Valencina mega-site at this period, in the Early Neolithic, it is difficult to assess the significance of this burial as a precedent to the intense occupation the site experienced between *c.* 3200 and 2300 cal BC. What is beyond doubt, however, is that, like Menga, Montelirio was built on a hill that was already imbued with ancestral significance.

A third valuable element of interpretation is that the high-resolution dating of major megalithic monuments may lead to new interpretations regarding remarkable short-term events and episodes of use. The Montelirio chronometric models are compatible with both the burials in the Large Chamber occurring as a single event and spanning a period of a few decades (García

Sanjuán *et al.* 2018a: 237). The implications of these two hypotheses in terms of the social background of these burial practices are quite different, but judgement must be postponed until further evidence is available. What is clear, however, is that, in the Copper Age, this grandiose monument was used over a relatively short period of time (a few decades at most), which suggests a background of social dynamism and intense ritual practice. Indeed, the results of the combined statistical modelling of the 24 recently obtained dates on shell beads and the existing 21 on human bone (Figures 6 and 7), which are largely overlapping (Figures 8 and 9), reveals intense activity invested in the preparation of this complex ritual setting (Garcia Sanjuán *et al.* 2024a). Both models of dates from shell beads and human bone are consistent, while the joint modelling of dates on shell beads and human bone from individuals UE 102 and UE343 clearly indicates that the time elapsed between the collection of the shells, the making of the beads and the death of these two women, was rather short. This is consistent with the solid evidence suggesting that the 29th and 28th centuries BC were the 'peak' period (a true 'prime time') of the Valencina mega-site as a whole, with a remarkable increase of social complexity, specialized craftsmanship, and long-distance exchange of rare and exotic materials (García Sanjuán *et al.* 2024b).

It is also important to note that the newly available chronometric data (García Sanjuán *et al.* 2024b), coupled with a fine-detail analysis of the material culture, has revealed the close connection between the Montelirio *tholos* and Structure 10.042-10.049 (burial of 'The Ivory Lady'), located barely 100m to the north. The builders and/or users of Montelirio paid tribute to 'The Ivory Lady', a prominent leader who had lived less than a century earlier, by depositing, on a newly created floor made with slate slabs on top of her burial chamber (Structure 10.049), and at the entrance of Structure 10.042, sophisticated artefacts that had not been part of her original set of grave goods. These included a finely knapped ultra-thin and long-barbed mylonite arrowhead, a small number of discoidal shell beads and a rock crystal dagger (García Sanjuán *et al.* 2018b). The quality of the 'second' funeral afforded to 'The Ivory Lady', which took place at the time Montelirio was being used, bears witness to the powerful social, cultural and ideological impact this woman had upon successive generations after her death. Within the context of Iberian Late Prehistory, this is a rare opportunity to understand the importance of issues that are often mentioned in association with the megalithic phenomenon, but for which good-quality data are usually few and far between, such as leadership (in this case, *female* leadership), memory-keeping and ancestor worship.

Menga also provides some good examples of how major megalithic monuments witnessed relatively short-lived social phenomena. A particularly intriguing one is the backfilling of the dolmen's water well. A chronometric model based on 14 radiocarbon dates obtained from samples of animal bone provided a start age for the formation of the infill inside the Menga well in 1700-1770 cal AD (79.5% probability) and an end date for its end in 1730-1830 cal AD (87.5%) (García Sanjuán *et al.* 2016: 2019). Some years later, the detailed study of the decoration of some buttons, also found forming part of the well's infill, suggested they were manufactured between *c.* 1808 and 1873 AD (García Sanjuán *et al.* 2022c: 380). Given that, from his own personal account, Rafael Mitjana y Ardison (1847) started his excavations at Menga in *c.* 1840 AD, a point in time by which the Menga well was already fully backfilled, combining the results of the radiocarbon model and the stylistic analysis of the buttons leads to the conclusion that the Menga water well was backfilled between *c.* 1808 and 1830 AD, that is to say, only a few years before the Málaga architect started his explorations at the great dolmen. The implications of this 'recent', and probably very rapid, backfilling of the water well are multiple, not least because there is plenty of evidence (in the form of pottery, wooden furniture and coins) for the frequentation of the dolmen between the 15th and 18th centuries AD. The rather abrupt and radical termination of the use of the well could be connected with the long-standing use of its water on account of its supposed healing or sacred powers – see discussion in García Sanjuán *et al.* 2021.

In opposition to the 'short term' episodes illustrated by the examples just mentioned, the high-resolution dating of both Menga and Montelirio has also led to completely new insights regarding their long-term biographies, which spanned several millennia.

In the case of Menga, the numerical dating now available has provided a firm chronological framework to understand the extraordinary persistence of this monument through time. Upon its construction in the first half of the 4th millennium BC, Menga became a major focus of social activity in the Antequera region, and from that moment on, it never ceased to play that role. Menga was used in the Copper and Bronze Ages, as suggested by TL dates on pottery; it was also used in the Iron Age, as reflected in several pottery finds; it was used as a burial space, and perhaps also as a sanctuary, in Roman times and the Middle Ages, as attested by several radiocarbon-dated burials and multiple elements of material culture. Menga was also intensely frequented between the 15th and late 18th centuries, as shown by several radiocarbon dates and a large quantity of finds, including pottery, coins

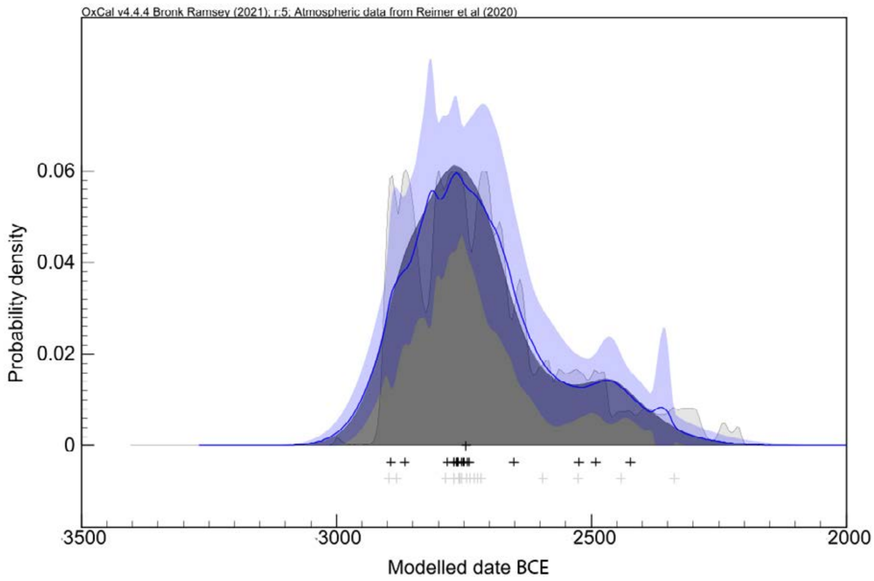

Figure 6. Kernel density estimate (KDE) for all radiocarbon dates on human bone from Montelirio. Design: Francisco Sánchez Díaz.

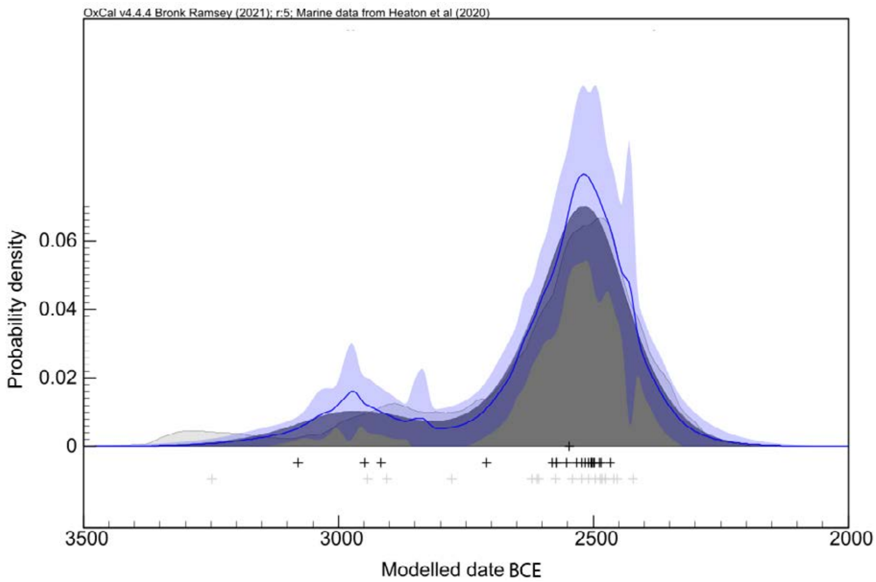

Figure 7. Kernel density estimate (KDE) for all radiocarbon dates on shell beads from Montelirio. Design: Francisco Sánchez Díaz.

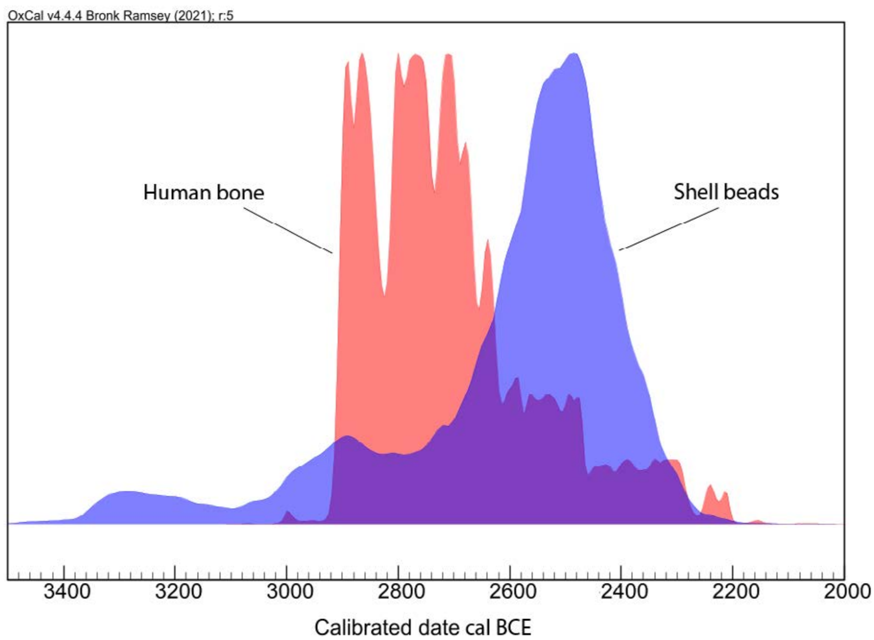

Figure 8. Summed distributions for all radiocarbon dates on human bone and shell beads from Montelirio (raw data). Design: Francisco Sánchez Díaz.

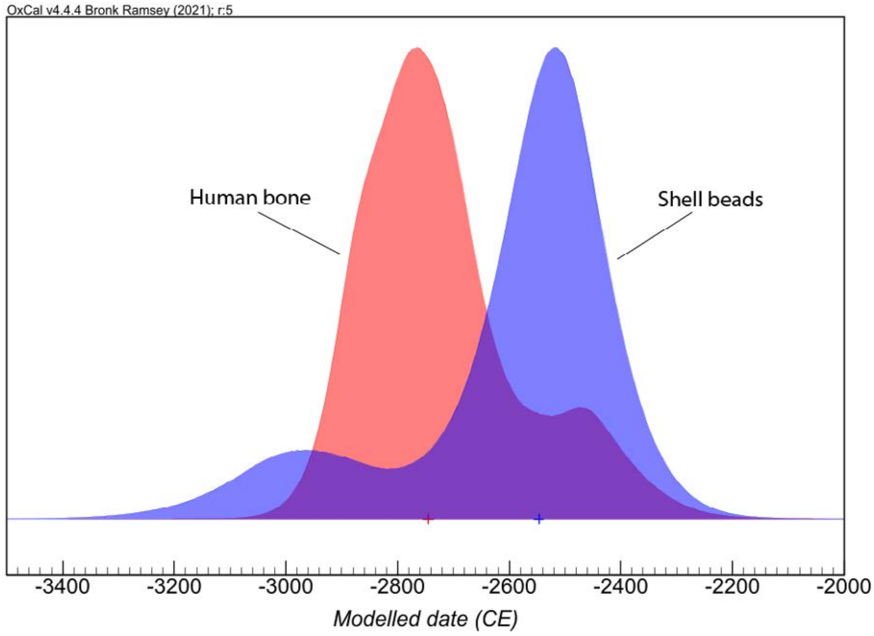

Figure 9. Summed distributions for all radiocarbon dates on human bone and shell beads from Montelirio (modelled data). Design: Francisco Sánchez Díaz.

issued by the Spanish crown, and wooden remains. There are very few megalithic monuments world-wide with the kind of 'outstanding' biography Menga has. It seems plausible that the only (short) period of time in which Menga was (forcibly) consigned to oblivion, between the late 18th and early 19th centuries BC, resulted from a 'cultural war' of sorts, as suggested by the numerous references preserved in official documents of the Spanish Catholic church in which Menga is presented and described as a sanctuary for 'gentiles' or 'heathens' (García Sanjuán and Lozano Rodriguez 2016).

It has been proposed that it was upon orders of the Catholic church that the water well (and perhaps the whole inner space of the dolmen), was filled with earth, debris, dead animals and rocks in order to radically 'terminate' it as a sacred space (García Sanjuán *et al.* 2021). While the dolmen appears to have attracted intense 'popular' interest in the early modern period, most probably because of its water well, it also drew the ire of the Catholic church. But the attempt at 'killing' Menga would not succeed. By the mid-1840s, Rafael Mitjana y Ardison started his 'scientific' explorations of the great dolmen and immediately after the publication of his 1847 booklet, in which (with far more insight than his late-20th century counterparts) he interpreted the monument as a 'temple' rather than a 'sepulchre', Menga quickly gained back the fame that, presumably, had made it such a persistent monument since its construction and through the ages.

While the abundant presence of material culture has been of great value to outline the long and complex biography of Menga, it is only thanks to the solid scaffolding of numerical dates now available that such biography can be properly understood.

The case of Montelirio is different, its biography less persistent and shorter than that of Menga. And yet, there are also fascinating elements to it. Unlike Menga, Montelirio was not conceived to last and to be known through the ages. Montelirio appears to have been created for a narrower temporal endeavour: to provide the resting place for a group of exceptional people (possibly all women), who lived at a time in which the Valencina mega-site was experiencing an intense flourishing, and who held very high social positions. After its closure, probably in the 28th century cal BC, Montelirio was not used in the following centuries of the Copper Age, even though other sectors of Valencina were very much active until *c.* 2300-2200 cal BC. Montelirio was not used in the Bronze Age either, mirroring the lack of activity at Valencina through that long period. There may have been some kind of frequentation of the great *tholos* in the Iron Age, as suggested by date OxA-32200 (2569 ± 29 BP, 809-564 cal 2σ BC), which was obtained from a discrete deposit of burnt botanical material found in the main corridor, near Individual 232, and the deposit of two ceramic vessels which have been interpreted as altars. It is unclear exactly what kind of episode, event or visit this particular date represents.

The use of Montelirio in Roman times was far more intense and complex, involving the digging of a shaft through the mound, the almost complete destruction of the Small Chamber (the slate slabs lining its walls were all ripped off) and the construction of a wall made of sun-dried bricks across the northeastern section of the Large Chamber, part of which was also damaged. Remarkably, the mortar used to make this wall included small fragments of ivory (presumably from the Small Chamber, where all the pre-existing ivory objects were shredded to bits), some discoidal beads like those used for the beaded attires worn by the women buried in the Large Chamber, as well as some fragments of chalcolithic pottery. All this evidence suggests that the sun-dried brick wall was manufactured on the spot, using the very soil available inside both the chambers of Montelirio. While the chronology of this remarkable 'intervention' in Montelirio is not firmly established through radiocarbon dating, barely 100m further to the north of Montelirio 10 burials were dated by five still unpublished radiocarbon dates to between the 4th and 6th centuries AD. Unlike Menga, there are no traces of re-use or manipulations dating to the Middle Ages or Modern period in Montelirio.

Conclusion

With a combined total of 122 age determinations, including OSL, TL and radiocarbon dates, Menga and Montelirio are currently the two best-dated megalithic monuments in Iberia. This is coupled with a further 110 dates for associated monuments, sites, or site sectors located in their immediate vicinity. In total, 232 numerical dates exist now to understand these two monuments and their respective contexts. But that was not the case barely ten years ago, when none of this information was yet available. The review offered above illustrates the great potential that numerical dating has to understand the temporality of major megalithic monuments with complex biographies, as is the case for Menga and Montelirio.

The process through which these two major monuments have been subjected to a systematic dating program has led to important lessons regarding problems such as sample preservation and sampling strategies, chronometric hygiene, statistical modelling or interpretation. Despite the problems, enormous advances have been achieved in understanding the temporality of these two great megaliths, including their genesis (history of their respective sites prior to their construction), the existence of remarkable short-term events and episodes of use, and the general background of their long biographies, which spanned several millennia.

Although material culture, stratigraphy and taphonomy are of great value to outline the temporality of complex megalithic monuments, it is only through scientific dating that such temporalities can be understood in all their profound nuances. In particular, OSL is set to become an important method to understand the dates of original construction and major architectural transformations, problems for which radiocarbon dating is often ill-suited.

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Chapter 3
Dissolving and contrasting. The secondary deposition of human cremains at Perdigões enclosure (3rd millennium BC, South Portugal)

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Abstract

The paper explores the deposition of human cremains at the Perdigões ditched enclosure in South Portugal, specifically delving into the unique funerary contexts within the central area, an aspect with distinctive characteristics not observed elsewhere in Iberia. The comprehensive analysis includes a detailed description of these contexts, the associated votive assemblages, and a thorough examination of the radiocarbon chronology. The study not only elucidates the nuances of the depositions but also delves into the meanings and social roles they hold, with a particular emphasis on the central area.

Furthermore, the research considers the potential significance of these funerary practices within the broader framework of identity management. It explores the role of these practices as potential strategies of social resistance to counteract the growing social inequality of the time. The paper posits that understanding the motivations behind these unique funerary rituals can offer valuable insights into the socio-cultural dynamics of the community at Perdigões.

The study also highlights the necessity for adopting more relational approaches to funeral practices, emphasising the interconnectedness of these rituals with broader social, cultural, and economic contexts. By doing so, it seeks to contribute to a more holistic understanding of the Perdigões community's cultural practices, shedding light on the multifaceted roles that funerary activities played in shaping and expressing social identity during this historical period.

Keywords: Funerary Practices, Cremation, Iberian Chalcolithic, Social Relations, Perdigões enclosure

Introduction

In Neolithic and Chalcolithic Iberia, the funerary practices were mainly characterised by primary and secondary burials within a variety of structures: megalithic monuments, tholoi, hypogea, caves, and pits. However, in many of these contexts, burned human remains have also been identified, indicating that cremation and rituals involving fire were part of those practices. Mostly, they correspond to parts of bodies or partially burnt bones, generally at low temperatures, mixed in contexts with unburned bones, and that may correspond to diversified circumstances, frequently unclear and difficult to determine: hygienic practices, anthropophagy, dehydration of the body, intentional cremation, burning of the funerary monuments, or even accidental burning (Agustí and Farjas 2002; Delibes de Castro and Etxeberria Gabilondo 2002; Pascual Benito 2002; Reverte 1984-85; Rojo Guerra *et al.* 2002; Sáez *et al.* 2002; Sanchez-Abellán *et al.* 2021; Silva *et al.* 2014; Weiss-Krejci 2005, 2011). The number of individuals totally or partially burned is usually low. The higher numbers reach between ten to 25 in places such the Abrigo de Escurrupenia, the Blanquizares de Lébor cave (Pascual Benito 2002; Weiss-Krejci 2005), the satellite Tholos B of the Dolmen 2 of Olival da Pega (Silva *et al.* 2008), or the dolmen of El Pendón (Tejedor-Rodríguez *et al.* 2023) with a possible pyre associated to human cremains.

In the majority of observed contexts, *in situ* cremations are prevalent, exhibiting varying degrees of fire exposure. Secondary depositions of cremains, on the other hand, occur less frequently. However, secondary accumulations have been suggested for some cave contexts based in the presence of cremains without ashes, such as Cueva de la Mostela, Cueva Sadurní and Cueva de la Guia (Agustí and Farjas, 2002), and were recently identified in the necropolis of Los Milanes (Almeria), where cremains were deposited in Tomb 8 also without associated ashes and charcoals (Becerra Fuello *et al.* 2025).

However, it is within the central area of Perdigões that we encounter the most extensive and intricate instance of secondary deposition of cremains. This context not only represents a larger number of individuals but also lacks a parallel in the broader Iberian context.

Still not fully excavated and studied, this context has been already partially addressed in some publications

(Godinho *et al.* 2019; Pereira, 2014; Silva *et al.* 2014; Valera *et al.* 2014; Valera 2020), and several studies of specific material assemblages have been published: the charcoals (Coradeschi *et al.* 2023; Gebreselassie 2023), the anthropomorphic figurines (Valera, 2015, 2021; Valera and Evangelista 2014), the ivory items (Valera *et al.* 2015), the stone idols (Dias *et al.* 2017), the beads (Dias *et al.* 2018), the faunal remains (Almeida and Valera 2022), or a tool made out a human bone (Cunha *et al.* 2016). Its importance for the research of cremation in the 3rd millennium BC in Iberia and for the understanding of this practice in Perdigões is unequivocal, justifying, together with other features that also revealed some burned bones, the summary of the available data and a discussion of the procedures, meanings, and social roles involved.

Perdigões ditched enclosure: a brief description

Perdigões is a large set of roughly concentric ditched enclosures (with at least 16 ditches), with an area of 16ha and a long chronology between the late Middle Neolithic and the Early Bronze Age (3500-2000 BC), located in the inner Alentejo region, South Portugal (Figure 1A). With substantial investments in monumentality (Valera 2019, 2023), it has been providing evidence of strong mobility of people and animals, underlining its aggregating role (Valera *et al.* 2020; Zalaite *et al.* 2018),

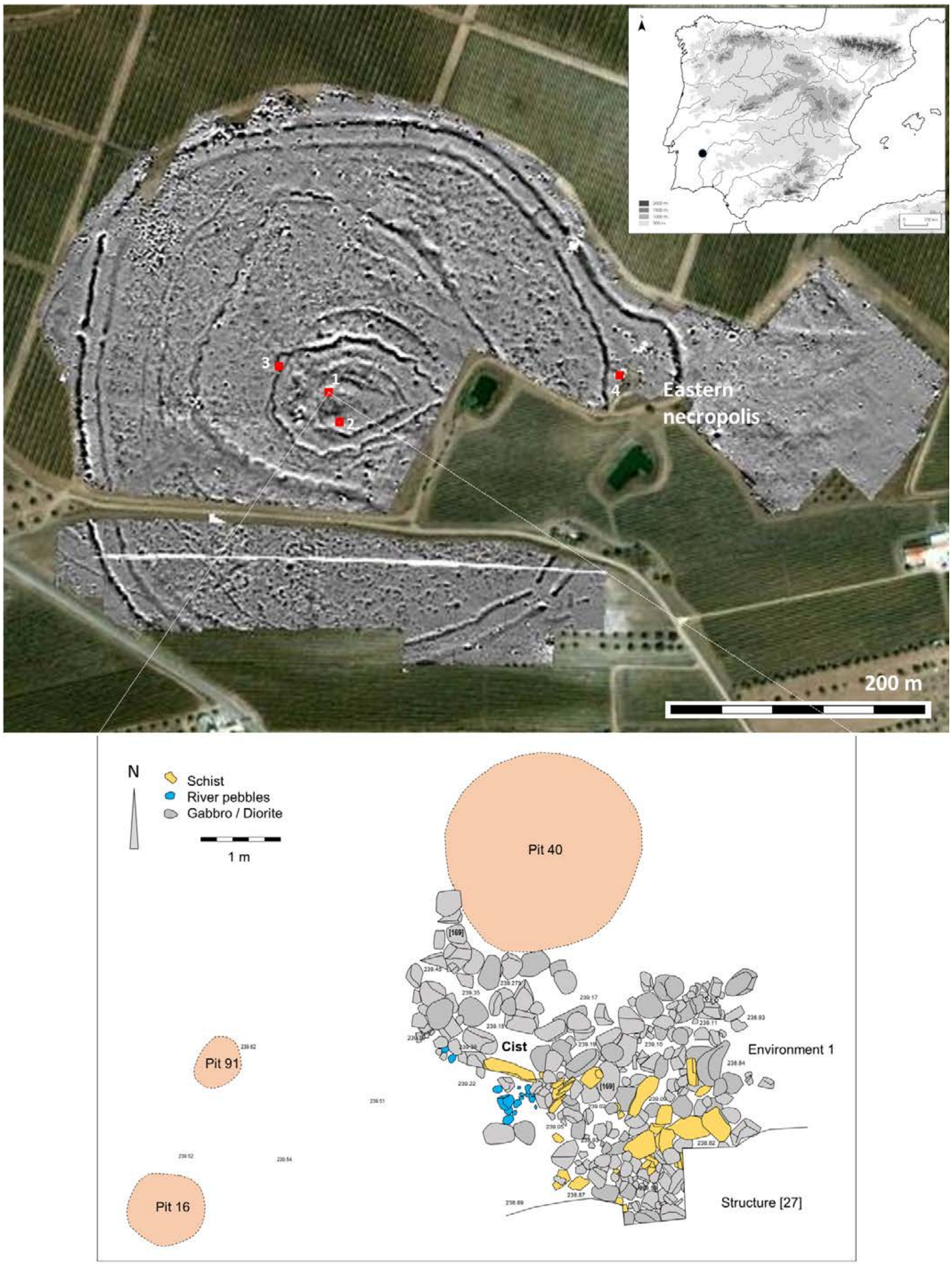

Figure 1. A. Location of Perdigões in Iberia and magnetogram with indication of the contexts with human cremated remains: 1. Pits 16, 40, 91 and Environment 1; 2. Ditch 5; 3. Ditch 7; 4. Tomb 1. B. Plans of the features with cremains in the central area.

its integration in large-scale interaction networks (Valera 2017), and of architectures and scenarios for diversified ceremonial practices, among which are several funerary contexts (Evangelista 2019; Valera, 2020; Valera *et al.* 2014) and settings with manipulation of human remains (Evangelista and Valera 2019). With a long list of publications and academic thesis (see https://perdigoes.org/en/bibliografia/), the site is classified as a National Monument and boasts a longstanding research program, spearheaded by ERA Arqueologia, which has been in continuous operation since 1997.

The contexts with deposition of cremains

The main context of depositions of human cremated remains is in the central area of the Perdigões enclosures and comprises three pits (Pits 16, 40 and 91) and a cist surrounded by an agglomeration of stones (Environment 1), dating from the Chalcolithic (Figure 1B). These structures overlap and cut through the sediments that covered a ceremonial structure of the 'timber circle' type (about 20m in diameter – Valera 2023), except for Pit 91, which was opened at the top of the filling of an older ditch, dated to the last third of the 4th millennium BC.

Pit 16 (P16) has a base with a 1.5m diameter, 0.92m at the top and a depth of 0.90m (Figure 3A). After the bottom was filled with two thin deposits, human cremated remains of a minimum number of nine individuals were deposited inside, forming a conical accumulation with at least two moments of deposition that brought together burned human remains, burned fauna, charcoals, solid cremation scum, and equally burned votive archaeological materials (Table 1). The top of the pit was later filled with deposits containing unburned ceramic fragments and fauna, without human remains.

Approximately 5m to the NE Pit 40 (P40) was identified. Circular in plan, it had a diameter of 2.5m and a depth of 0.80m, with two central post holes, which reveal that it had a roof. Unlike Pit 16, the stratigraphic sequence showed a phased and recurrent use with the deposition of thousands of human cremated bones, mixed with charcoals and solid cremation scum, and few unburned partial anatomical connections, which in total correspond to a minimum number of 240 individuals. These remains were accompanied by many equally burned and fragmented archaeological materials (Table 1), including a large container fragmented *in situ* that was used to transport cremated remains in one of the depositions (Figure 2). Although charcoals and solid cremation scum are present, there is no signs of local firing, namely in the earth walls of the pit, in scattered stones inside it, or in the fragments of the pottery used for transportation, which, together with the existence of several small depressions for depositions of individualised cremains along the stratigraphy, indicated secondary depositions.

Pit 91 (P91), 72cm wide and 40cm deep, is located one meter north of P16 and was excavated on top of the sediments that filled Late Neolithic Ditch 12. Inside, piled fragments of two large containers used to transport cremains were deposited (Figure 3B). In the sediments that contained this deposition, there were few burned human bones and some burned materials (Table 2). This pit was opened specifically to receive these containers used to transport the cremated human remains. After the depositions, probably in one (or both) of the other two pits, these pots were fragmented, and the fragments piled and deposited there. The presence of scarce cremated human remains, some ashes, small charcoals, solid cremation scum and burnt materials may have inadvertently accompanied the process of deposition of the fragments. While not strictly classified as a conventional funerary setting, it exhibits a purposeful deposition within the context of distinct funerary rituals. This phenomenon is intricately woven into the fabric of the structures where these rituals unfolded, emphasising a meaningful integration with the broader area of their execution.

Finally, on the south side of P40, there was a cist surrounded by a ramped agglomeration of stones (local gabbro and diorite, and some exogenous schist slabs) that continues under a later stone structure not yet removed (which is why this context has not yet been fully excavated). A great amount of human cremated remains (with a minimum number of 86 individuals in the osteological material already studied) were collected in several deposits over these stones and in the cist (Figure 4), indicating several episodes of open-air secondary depositions. This open-air context, designated by Environment 1 (E1), also provided abundant votive materials (Table 1). It covered previous depositions of non-cremated human long bones in stratigraphic units (SU) 672 and 733/737 (Figure 5A).

Located in the central area of Perdigões, these features are surrounded by several contexts with Bell Beaker materials (decorated and undecorated vessels, copper tools such as tongued daggers, a Palmela point, a halberd, several awls, ivory buttons with 'v' shaped perforations, and a gold fragment) deposited in pits and in open air at East and South of the cremations (Figure 8) (Valera *et al.* 2020), but not directly mixing with them (with the exception of copper awls). In the same area there are also hundreds of material records related to copper metallurgy (crucibles, slags, copper ores).

Apart from these contexts of the central area of Perdigões, some cremated human bones were also

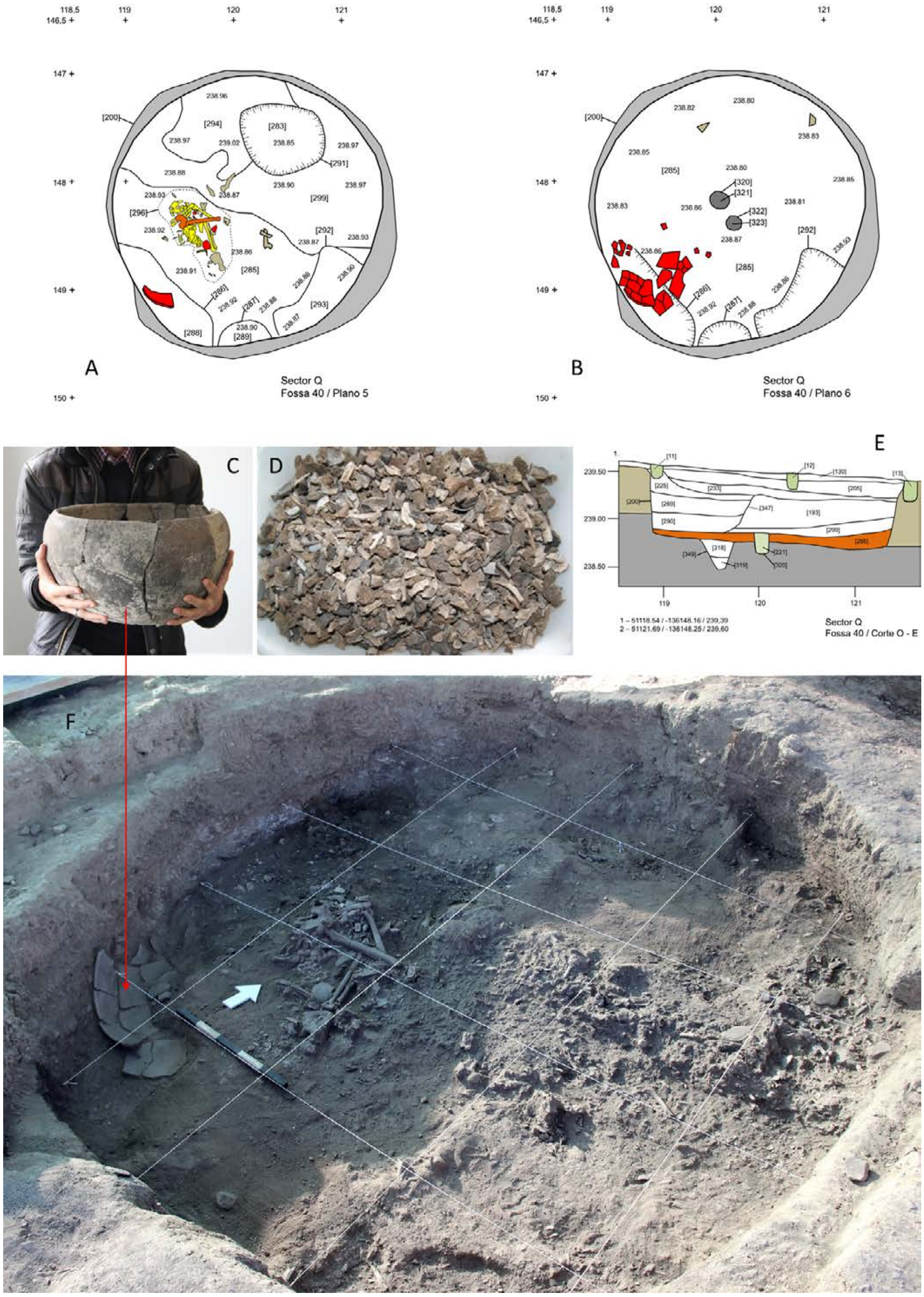

Figure 2. Pit 40. A. Intermediate plan; B. Bottom plan; C. Large vessel used in the transportation of cremains; D. Aspect of some cremains; E. Profile of Pit 40; F. Aspect of the context during excavation with some unburned partial anatomical connections.

deposit in one Late Neolithic ditch (Ditch 5), in one Chalcolithic ditch (Ditch 7) and in Tomb 1 (Figure 1A), here commingled with mostly unburned bones.

Within all these contexts, the cremains consistently constitute secondary depositions, complicating our understanding as the original provenance of the human remains and the locations of cremation remain unknown. For the main context of the central area, the presence of small and larger bone fragments (even the smallest phalanx are abundant), charcoals, ashes, fragments of solid cremation scum (possibly from cork), and small fragments of burned votive materials indicate a collection of the mass of the cremation remains (or parts of them) without selection, but with careful attention to the smallest elements (almost as if the cremation context had been swept or in some cases sieved before transportation).

Regarding the charcoals from the combustible material used in the cremations, two anthracological studies were developed using samples from P16 (Coradeschi *et al.* 2023) and from P40 (Gebreselassie 2023). They show a similar variety of taxa, composed by *Olea europaea,*

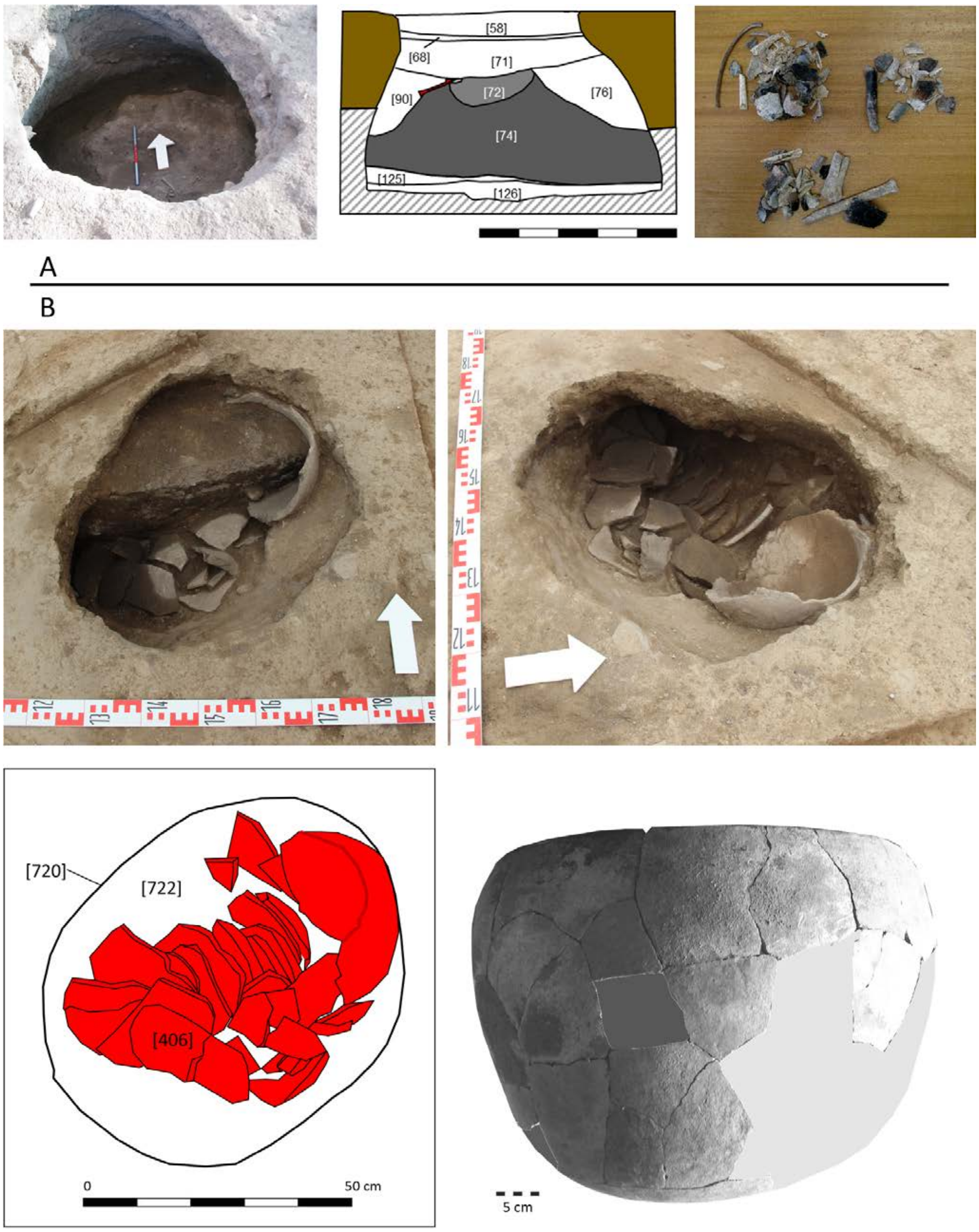

Figure 3. A. Pit 16, its profile and aspect of some cremains. B. Pit 91, with the piles of fragments of transportation vessels and reconstitution of one of those vessels.

Quercus sp. (evergreen), *Pinus pinaster,* Fabaceae, *Arbustus unedo,* and Angiosperm. The most abundant is *Olea europaea*, followed by *Quercus* sp. (evergreen) and *Pinus pinaster*, but, in P16, the inverted preponderance of *Olea* and *Pinus* and differences in temperature inferred from the charcoals between layers suggest the deposition of remains from two different cremations. The study also shows that parts of trees were used shortly after being cut, suggesting wood collected specifically for the cremations.

Chronology of the cremains at Perdigões

There are twenty-one radiocarbon dates for the contexts of the central area of Perdigões: fifteen for P40, one for P16, four for E1 and one for the SU672 (Table 1). The Bayesian modelling of these dates provides support for the precedence of the unburned long bones from SU672, dating back to the first third of the 3rd millennium BC. This chronological evidence indicates that these unburned long bones predate the deposition of cremated remains, which occurred in the middle of the 3rd millennium BC, specifically around 2600-2400 BC. (Figure 6).

Within the cremation themselves, although there is no significant differentiation between the dated contexts, a slight anteriority of P40 regarding P16 and E1 is suggested, with the former starting a bit earlier (around 2600 BC) than the later (closer to 2500 BC) (Figure 7).

Two other chronological comparative analyses are important for the interpretation of these contexts

Figure 4. Environment 1. A. deposit of cremains; B. and C. aspects of the cists; D. aspect of the cairn of stones and layer with cremains going underneath posterior deposit and stone structure.

of cremated remains of the central area. First the relation with the surrounding depositions of bell beaker materials and secondly the relation with the tombs located 200m away, in the eastern limits of the enclosure (Figure 1A).

Regarding the Bell Beaker contexts, ten dates (Table 2) put them within the middle/third quarter of the 3rd millennium BC, overlapping the time span of the cremains (Figure 8), associating these funerary rituals with other ritualised depositions involving beaker materials. The absence of Beaker pottery within the secondary depositions of cremains indicates its absence in the contexts of provenance (most of the material is also burned and came with the cremains), following the pattern of Alentejo, where, contrasting with other Iberian regions, decorated beakers are rare in funerary contexts (Valera *et al.* 2019).

As to the eastern necropolis, four tombs of collective use (three *tholoi* type monuments and a hybrid structure), manly for secondary depositions, were already excavated (Evangelista 2019; Silva *et al.* 2017; Valera 2020; Valera *et al.* 2014). The Bayesian modelling (for radiocarbon dates see Valera 2020) indicates Tomb 3 to be older than the deposition of cremations and Tomb 4 to be more recent. But Tomb1 (the one that also has some burnt bones) and especially Tomb

Figure 5. A. Human unburned bones underneath the depositions of cremains; B. ivory anthropomorphic figurine deposited in Environment 1 with a broken leg completed with a cremated human bone; C. fragments of burned ivory anthropomorphic figurines from Environment 1 and Pit 40; D. fragments of ivory tusks from Pit 40.

2, although built previously, were still in use during the time span obtained for the cremains of the central area (Figure 9).

Finally, the deposition of cremated human bones in Ditch 7 is dated from 2581-2468 BC (ICA-15T/1023, 4010±30BP). Notably, in Neolithic Ditch 5, the older presence of cremations in the site extends back to the end of the 4th millennium BC, representing the earliest evidence of such practices at the location thus far. Note that the date for the human bones in Ditch 7 overlaps the chronological span of the cremations in the central area, and the section of the ditch where they were deposited is just 40m West (Figure 1).

Material assemblages in the cremains of the central area of Perdigões

The materials associated with the depositions of cremains in the central area of Perdigões encompass all items retrieved from Pit 40 and Pit 91, those integrated within the levels featuring cremains in Pit 16, and selected artefact categories from Environment 1. (Table 2). Because this last context corresponds to open air depositions, where other materials were also accumulated, it is harder to discriminate what was directly linked to the funerary rituals. So, at this stage, the option was to consider ideo-technic items, ivory items, arrow heads, copper, and adornment items.

Context	SU	Sample	Lab Ref.	Date BP	
Central area					
Context 672	UE672	Human left femur	FTMC-ML56_14	4248	±30
Pit 40	UE298	Human bone left petrosal	SANU-51725	3980	±35
Pit 40	UE193	Human bone left petrosal	SANU-51726	4015	±30
Pit 40	UE193	Human bone left petrosal	SANU-53733	3952	±25
Pit 40	UE193	Human bone left petrosal	SANU-53730	3788	±28
Pit 40	UE193	Human bone left petrosal	SANU-53731	4044	±27
Pit 40	UE193	Human bone left petrosal	SANU-53732	3976	±26
Pit 40	UE193	Human bone left petrosal	SANU-53729	4076	±26
Pit 40	UE193	Human bone left petrosal	SANU-53727	4070	±25
Pit 40	UE193	Human bone left petrosal	SANU-53726	3931	±25
Pit 40	UE193	Human bone left petrosal	SANU-53725	4016	±26
Pit 40	UE193	Human bone left petrosal	SANU-53724	3867	±25
Pit 40	UE193	Human bone left petrosal	SANU-53723	4021	±25
Pit 40	UE193	Human bone left petrosal	SANU-53721	4107	±27
Pit 40	UE193	Charcoal Salix sp.	UBA-50791	3976	±29
Pit 40	UE193	Charcoal Arbustus wnedo	UBA-50793	4013	±29
Pit 16	UE74	Human bone (Axis Dens)	Beta-289262	3990	±40
Environment 1	UE177	Human bone	Beta-308785	3970	±30
Environment 1	UE109	Human bone	Beta-308784	3900	±30
Environment 1	UE128	Human bone	Beta-313720	3850	±30
Environment 1	UE263	Human bone	Beta-313721	4000	±40
Eastern necropolis					
Tomb 3	UE532	Human Tíbia	ICA-17B/1141	4200	±30
Tomb 3	UE531	Human Fémur	ICA-17B/1142	4190	±30
Tomb 1 Chamber	UE173	Human bone	Beta-327750	4030	±40
Tomb 1 Chamber	UE93	Human bone	Beta-327748	4060	±30
Tomb 1 Chamber	UE84	Human bone	Beta-327747	4130	±30
Tomb 1 Chamber	UE145	Human bone	Beta-311480	3990	±30
Tomb 2 Chamber	UE458	Human bone	Beta-308791	4090	±30
Tomb 2 Chamber	UE429	Human bone	Beta-308792	3890	±30
Tomb 2 atrium	UE231	Human bone	Beta-308793	3970	±30
Tomb 2 atrium	UE232	Human bone	Beta-308789	3840	±30
Tomb 4	UE636	Human rib	ICA-18B/0539	3780	±40
Tomb 4	UE643	Human umerus	ICA-18B/0541	3870	±30
Tomb 4	UE658	Human (16714) Left tibia	BETA-514884	3830	±30
Tomb 4	UE640	Human (16542) Left umerus	BETA-514883	3810	±30
Tomb 4	UE642	Human (16138) Left tibia	BETA-514881	3860	±30
Tomb 4	UE644	Human (16131) Left tibia	BETA-514880	3840	±30
Tomb 4	UE647	Human (16149) Fibula	BETA-517339	3930	±30
Tomb 4	UE644	Human (16140B) right femur	BETA-517338	3820	±30
Bell Beaker contexts in central area					
Pit 87	UE593	Fruit	Beta-474677	3850	±30
Pit 45	UE279	Canis familiaris	ICA-15R/1253	3820	±30
Deposit	UE767	Fruit	FTMC-TK72-1	3931	±28
Pit 92	UE909	Cervus elaphus	FTMC-TK72-2	3896	±28
Pit 93	UE797	Cervus elaphus	Beta-535489	3900	±30
Pit 93	UE819	Cervus elaphus	Beta-542213	3800	±30
Deposit	UE361	Sus sp. scapula	Beta-535486	3860	±30
Pit 96	UE1247	Human skull	FTMC-IQ60-1	3898	±31
Pit 96	UE1154	Sus metacarpo	FTMC-ML56_5	3855	±27
Pit96	UE1156	Axis humano	KIA-57262	4150	±35

Table 1. Radiocarbon dates.

These materials share equivalent presence within the pits, with a significant portion of them also exhibiting signs of burning. Abundant pottery shards and some loom weights were not accounted for.

So, cremains were predominantly accompanied by objects and fragments of objects of an ideographic nature: naturalistic or stylised anthropomorphic figures (occulated and with facial tattoos and hairlike engravings) mostly made of ivory, but also bone, bethyls (some occulated and with facial tattoos and hair) and stone vases, and phalanx idols and scallop shells. Arrowheads and beads follow, the latter almost exclusively made of shells (*Trivia monacha* and

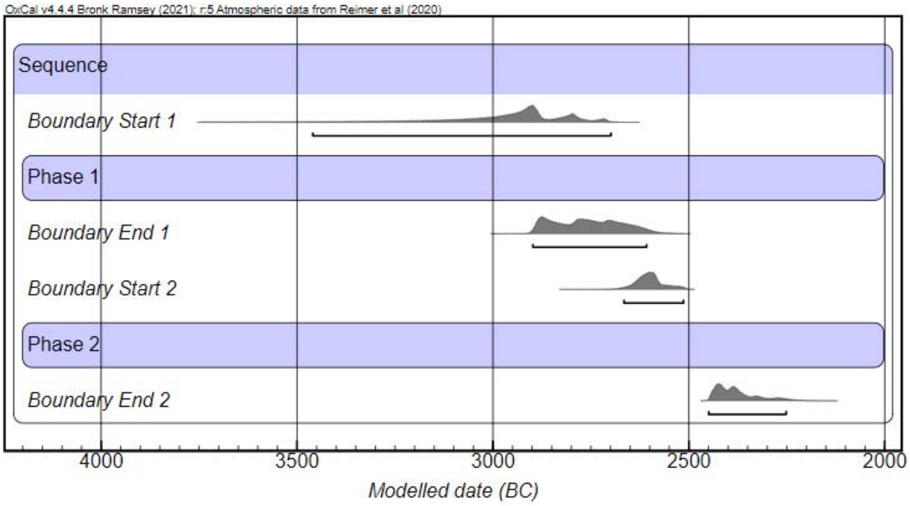

Figure 6. Model of a sequence of two phases, being Phase 1 the deposit 672 of the unburned bones and Phase 2 the depositions of cremations (P40, P16, and E1) (Amodel=65.9).

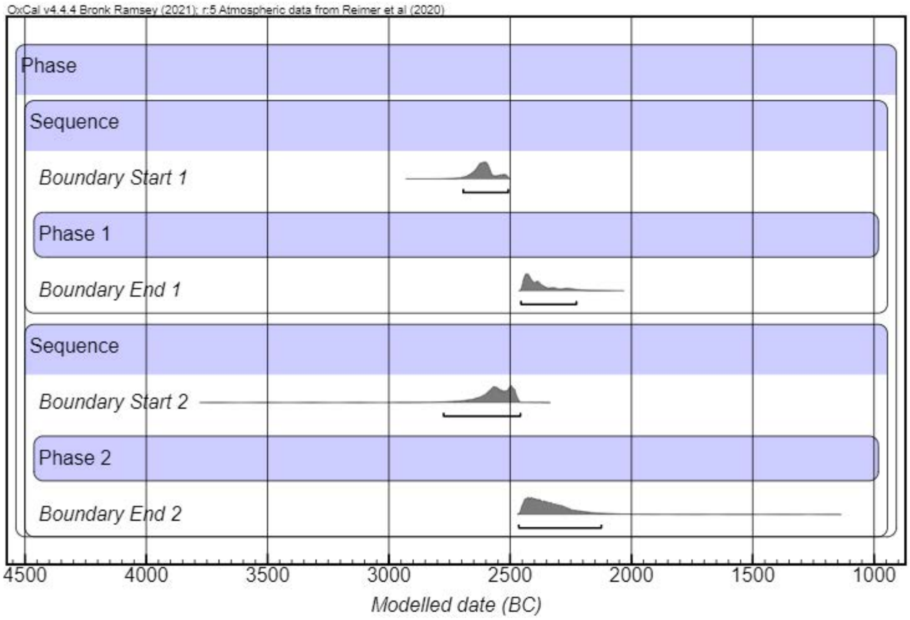

Figure 7. Model of two overlapping phases, being Phase 1 P40 and Phase 2 P16 and E1 (Amodel=68.1).

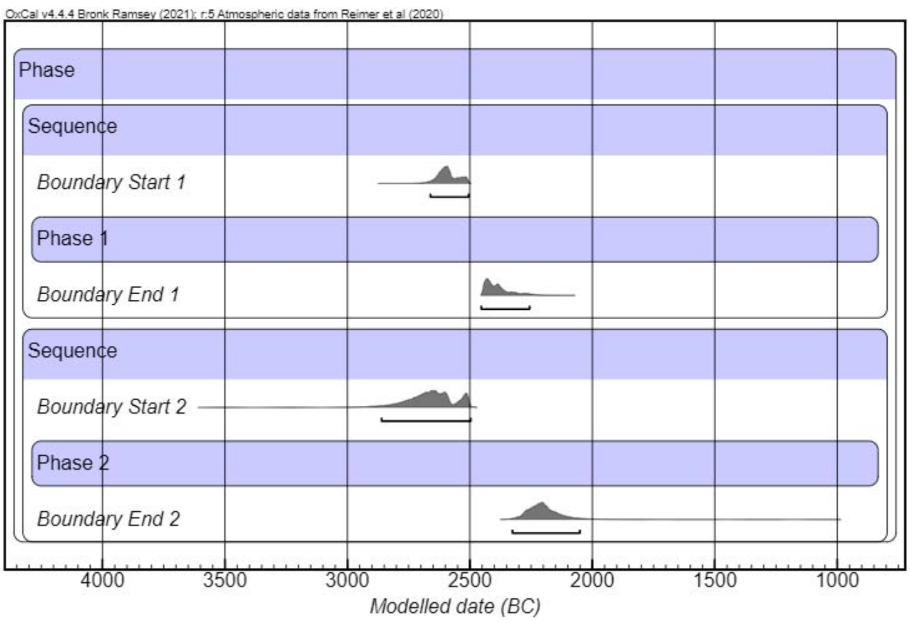

Figure 8. Model of two overlapping phases for the cremations (Phase 1) and deposits and pits with beaker materials (Phase 2) (Amodel=62.3).

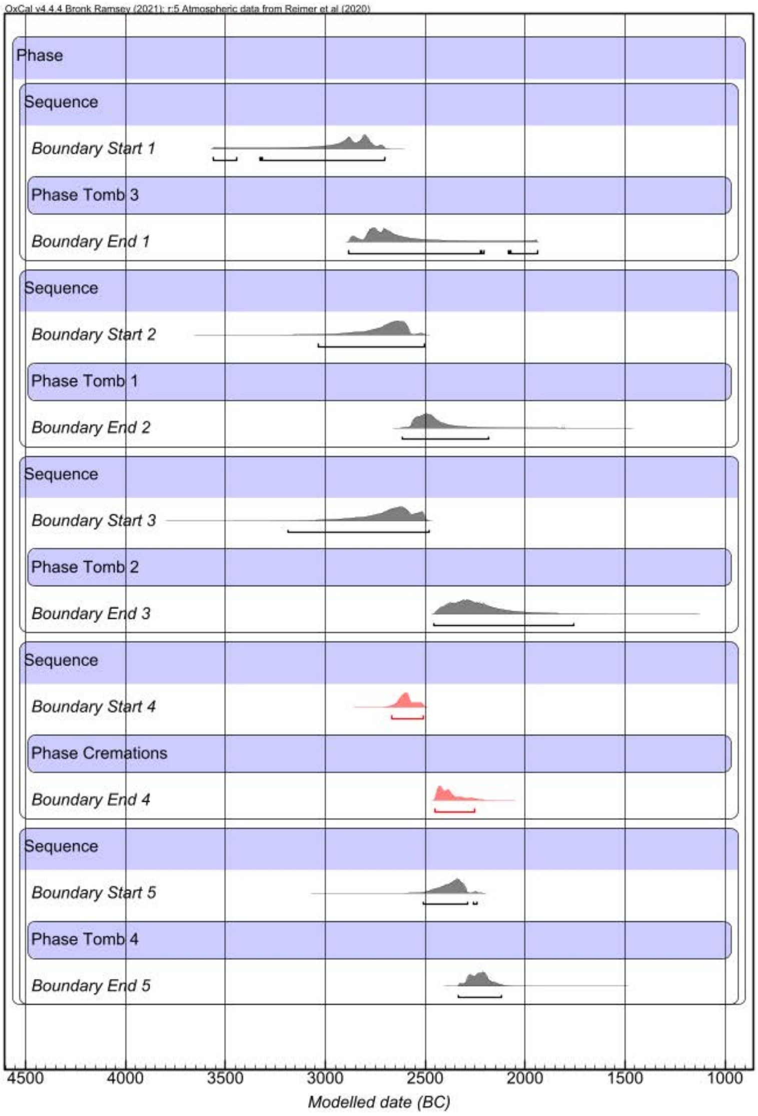

Figure 9. Model of five overlapping phases, considering the cremations and the four tombs of the eastern area (Amodel=68.5).

indetermined). Ceramics, with the exception of the large containers used to transport cremated remains, always appear in the form of small fragments, many of them unburned. With a less expressive presence are copper tools (just awls) and some metallurgical remains, as well as some knapped stone elements (flakes, blade, and lamella fragments) and a stone axe. It is noteworthy to mention the presence of two tools, specifically awls, crafted from human bone. One of these tools has already been published, (Cunha *et al.* 2016).

Most of the materials are burnt, indicating that they were part of the contexts where cremations took place. However, the addition of unburned materials also occurs, namely some quartz utensils and ceramic fragments. Particularly significant, though, is the deposition of an ivory anthropomorphic figure next to the cist that was part of Environment 1. Remarkably, it is the sole unburnt anthropomorphic figure found in the assemblage. One of its legs was fractured at the end, a break that was mended with a small calcined human bone (Figure 5B). If the countless anthropomorphic figures are all burnt and very fragmented, in a state of dilution of the body comparable to that of human cremations, this deposition expresses a contradiction, through a discourse of completeness and unity of the body, highlighting the ambiguities and complexities that these practices can involve. Most materials, however, are fragmented as a result of being subjected to fire, particularly ivory objects, which gave rise to several hundred small burnt fragments.

Fauna was also incorporated in these depositions of human cremains. The study conducted for Pits 16 and 40 (Almeida and Valera 2022), documented the presence of bones from various animals, including swine, caprine, leporids, and, to a lesser extent, bovine, equine, and cervids. Similarities have been detected between the pits, with a clear predominance of pig remains and a general tendency for the prevalence of appendicular bones. But some differences have also been noted. In Pit 16, where 35% of the fauna was burnt, the remains were highly altered reaching calcination degrees, while in Pit 40, with the burning range is between 18% and 50% in different phases of deposition, the burning effects were lower with less abundant signs of calcination.

The presence of these burned faunal remains may be related to human funerary contexts previous to cremations (animal bones are also present at Tombs 1, 2, 3, and 4), but it is also possible that some were introduced during the cremation ceremonial practices.

In both features, the percentages of unburned faunal remains are notably high, suggesting the inclusion of these animals in the deposits without undergoing fire-induced changes. This phenomenon is likely associated with the consumption of animals during other stages of the ritual processes following cremations, possibly during the final deposition of the cremains in the pits (Table 2).

Figure 10. A. Anthropomorphic figurines and occulated plaques;
B. Stone bethyls and pots.

Figure 11. Arrow heads, beads, copper awls and a Equus phalanx with attached beads.

Structure	Pit 16		Pit 91		Pit 40		Environment 1	
Contexts	[72] [74]		All		All		Partial	
Material categories	**Total**	**Burned**	**Total**	**Burned**	**Total**	**Burned**	**Total**	**Burned**
Large transportation pots	_	_	2	_	1	_	_	_
Rim shard	37	16	12	_	121	**	*	_
Decorated rim	2	1	_	_	1	**	*	_
Decorated shard	_	_	_	_	3	**	*	_
Arrow heads	55	52	3	2	44	37	18	8
Blade frag.	2	2	_	_	2	1	*	_
Lamellae	1	_	1	_	1	_	*	_
Flakes	4	_	7	2	2	_	*	_
Microlith	_	_	_	_	2	_	*	_
Flint frag.	1	1	_	_	3	3	*	_
Quartz frag.	_	_	2	_	8	_	*	_
Stone ax	_	_	1	_	_	_	_	_
Schist/Jasper frag.	_	_	1	_	4	2	*	_
Anthropomorphic figurines frag.	_	_	_	_	43	43	19	18
Thin plaque oculated idols (frags.)	6	5	_	_	17	17	7	6
Ivory frag.	6	6	_	_	580	228	234	234
Stone idols (betyls)	_	_	_	_	8	8	6	4
Stone pots	_	_	_	_	1	1	1	_
Beads	_	_	_	_	130	129	14	13
Bracelet	_	_	_	_	6	6	_	_
Pin	_	_	_	_	3	3	_	_
Pending	_	_	_	_	1	1	_	_
Phalanx idol	1	1	_	_	7	5	_	_
Loom weights frag.	3	_	_	_	25	**	*	_
Copper awl	1	**	_	_	3	**	2	**
Copper frag. / slag	_	_	_	_	8	**	19	_
Pecten maximus	_	_	_	_	1	1	1	_
Bone tool	_	_	_	_	_	_	3	_
River pebble	2	_	1	_	_	_	*	_

* Not considered ** Indeterminate

Table 2. Archaeological materials from the contexts with cremains in the central area.

Bioanthropological data

The Perdigões enclosure presents a great variety of mortuary practices and body treatments happening in different architectures with different artefactual sets. These different funerary practices, all come together in the same physical space, built and rebuilt throughout approximately 1400 years and it must be considered that each of these realities must have played a part in the construction of meaning and the embodiment of beliefs for the communities that used that space for the deposition of human remains. Cremains occur in both a formalised and non-formalised way. The latter include remains, identified as 'outliers' inside formal architectural structures or integrated in the filling strata of some of the ditches.

The paleo-demographic study of these bones was severely hindered by the state of fragmentation of this collection and the employed methodologies were adapted to this circumstance. The method proposed by Herrmann (Herrmann *et al.* 1990) was used to calculate the NMI, and the estimations for age-at-death were established based on bone maturation levels defined by Ferembach (Ferembach *et al.* 1980) and dental development and calcification as proposed by Ubelaker (1984) and Alqahtani (Alqahtani *et al.* 2010). Sexual diagnosis considered the features described by Ferembach (Ferembach *et al.* 1980) and Bruzek (2002).

The oldest examples of cremated human bones at Perdigões were recovered from the Late Neolithic Ditch 5, in the section excavated in Survey 2 of Sector Q (Valera 2018; Evangelista and Valera 2019). They comprise a group of non-identifiable fragments of long bones, a fragment of cranium, an MC 4 and the sternal extremity of a clavicle fragment whose incomplete degree of fusion indicates belonging to an individual under 30 years of age. No sex diagnosis was possible. The minimum number of individuals (MNI) is one. All the fragments reveal signs of exposure to fire. The white coloured was the most frequently found followed by those with grey / whitish tone. This data reflects that most of the material was exposed to temperatures above 645º degrees Celsius, with various examples of calcined fragments reaching this state when exposed to temperatures above 940º (Shipman *et al.* 1984) (but see Reidsma *et al.* (2019) and Walker *et al.* (2008) about the limitations of estimation of precise burning temperatures based on bone colour).

The type of fractures observed are mainly longitudinal cracks, with the presence of some transversal cracks. Curved fractures, which are often associated with the shrinkage of the periosteum as a reaction to soft tissue rupture (like muscles and tendons) due to heat (Symes *et al.* 2007), were identified in one fragment of this sample.

Human bone fragments with evidence of exposure to fire were also identified integrated into a continuous horizontal deposition [SU91] and [SU92] in Ditch 7 (Sector P). A frontal bone fragment (from SU 91) and a mandible were found very close to each other and towards the South of the section. Several other cranial fragments (left and right parietal, and occipital) were about 1.20 m to the North. The latter fragments showed evidence of exposure to fire in the internal and external surfaces (Evangelista and Valera 2019). None of the bone fragments identified overlap anatomically. They all belong to a non-adult individual and are metric and morphologically compatible and therefore the possibility of them belonging to a single individual (≥ 2 years old) cannot be ruled out.

Harder to explain is the small group of cremated bones identified in SU 175 (Phase 2B) from Tomb I, a tholos type structure identified in the eastern side of the site, amongst the thousands of secondary depositions of human remains (Evangelista 2019). It comprised a small number of fragments of long bones altered by fire and several teeth fragments (FDI 14,33 and 46). They were classified as adult remains and the assemblage corresponds to a MNI of one. They showed signs of fragmentation, shrinking, thumbnails fractures and changes in colour, compatible with fire at different temperatures.

To gain a more nuanced understanding of the incorporation of this small group of bones amid the thousands of secondary unburnt remains in Tomb I and the occurrence of cremated bones in the filling of ditches, it becomes imperative to comprehend the conditions surrounding these cremations. Without a clear criterion for such circumstances, various hypotheses emerge regarding their presence in these structures. These hypotheses span from intentional gestures and purposeful movements to the possibility that they are residual outcomes of accidental or sanitising burnings, ultimately culminating in their inadvertent inclusion in the observed deposits.

While the inclusion of groups of cremated human bones is occasionally part of the filling of ditches and tombs, a form of highly ritualised deposition of cremains in specific structures and open-air environments is very much part of the known funerary register in Perdigões, occurring side by side with other funerary practices of totally secondary, collective nature described for the Eastern part of the enclosure throughout the 3rd millennium BC (Table 1).

Pit 16 has a full anthropological study (Silva *et al.* 2015b). The stratigraphy also showed evidence that the cremation took place elsewhere and that the remains were carefully collected, transported and deposited in the structure. The fragmented human bones recovered showed no selection of body parts, since all were represented and corresponded to a minimal number of 9 individuals: 6 adults and 3 sub-adults. No sex diagnosis was possible.

Regarding Pit 40 the osteological and archaeological material is still under study. In total, 152.4kg of bones were processed. Of these, 13.7kg corresponds to 5324 individualised bones/ bone fragments, and the remaining 138.7kg to non-individualised bones. The minimum number of individuals (NMI) is 240, estimated through the left petrous pyramid. No bone selection was identified as all parts of the skeleton of adult (both sexes) and non-adult individuals were identified amongst the fragments analysed. All non-adult ages are present from 30 weeks prenatal to adolescents (but age estimation should be regarded with caution due to heat-induced bone shrinkage, which inevitably underestimates age at death in osteometric-based approaches). Mixed with the cremains some partial anatomical connections were identified corresponding to an adult male, most of which showed no signs of being thermally altered.

As with Pit 16, no evidence of fire was identified in loco. The careful recovery of all body parts from the original cremation place is attested by the presence of very many fragments of human bone like phalanges (including non-adult), teeth, or unfused epiphyses and artefacts.

A small collection of what are probably remains intended for Pit 40 were found adhered to the internal walls of two large containers found in situ in Pit 91. Approximately 95 bone fragments were studied, of which at least four belonged to non-adult individuals: three skull fragments and one distal phalanx of the foot. Elements from all areas of the skeleton were recovered, including the skull, scapula, ribs, vertebrae, ilium, bones from the upper and lower limbs (including hand and foot). Dental elements were not recovered. Minimum number of individuals is two (one adult and one non-adult). No sex diagnosis was possible.

After Pit 40 was filled with sequential depositions of human remains, these continued to happen on top and around a stone structure and a small cist, a context designated by Environment 1.

This open-air context is also still under study since part of it has not been excavated as it extends underneath the large stone cairn at the centre of the enclosure. Of the excavated remains some large portions have been anthropological analysed. In a 2014 study, the presence of at least 77 individuals was estimated for Environment 1 and the area inside the cist (Pereira 2014). This number is based on the presence of that number of right pars petrosa. Because this anatomical feature is not suitable for age at death distinction it can only be used to provide total minimum of individuals, However, this value necessarily includes non-adult individuals as analysis of tooth eruption and calcification revealed the presence of at least 18 individuals between one year and 15 years of age in Environment 1 and 3 in the cist. Bones belonging to individuals from both sexes were identified. Work on these contexts continues during 2018 and 2019 and the large amounts of cremated remains were sample studied, considering that the remaining hundreds of cremated elements await a comprehensive anthropological study. Until now these deposits yielded a minimum number of more 9 individuals. Additionally, the presence in this group of at least two non-adult individual of different undetermined ages were identified. Regarding the sexual diagnosis, it was not possible to gather metric or morphological information on this demographic parameter due to the high fragmentation of the sample. Similarly, due to the same reason, no pathologies were identified in the analysed sample.

Based on the analysed sample, the presence of all anatomical regions is noticeable, with a predominance of long bone fragments. It seems possible to exclude a potential pattern of selection of elements for later deposition at the site. However, the excavation of the area where this was deposited is not yet complete, and future campaigns may alter the data. In the analysis of thermal alterations on the osteological material, a predominance of colours ranging from bluish grey to white is observed. All types of fractures were present, both characteristic of fresh bone (curved transverse fractures, patina, laminations, dendritic features) and dry bone (longitudinal fractures and surface fissures) (Gonçalves 2012; Silva 2005; Walker *et al.* 2008).

These cremated remains from Environment 1 were identified surrounding and covering older assemblages of human depositions with no sign of alteration by fire. Several small independent assemblages were identified (SU, 169, 631a, 733, 734, 737 and 751) close to a large group of also non-cremated bones, SU 672. They comprise mostly long bones, but all skeletal parts were identified.

Despite a relative degree of fragmentation, it was possible to identify the entire assemblage, not subject to changes by fire. It is mainly composed of long bones from adults (two diaphysis of right tibiae, two fragments of right femurs - one proximal end and one diaphysis fragment, a hyoid bone, and two fragments of a left rib). Bone fragments belonging to non-adult individuals were also identified: a diaphysis of the left femur and one of the left tibiae. A fragment of *os coxae* presented male anatomical features. The MNI for this set of bones is three: two adult individuals of undetermined sex, and at least one non-adult individual of an age below 14/16 years of age. Anatomical parts necessary for metric or morphological sexual diagnosis of adult individuals were not available. No pathological changes were observed in the examined bones. The presence of a hyoid bone should be highlighted). If it is a secondary burial, the presence of this bone element once again reveals care in the transportation of the bones from the previous deposition site to this one.

Structure	**Weight**	**MNI**	**Non-Adults**
Pit 16	4845.18g	9	3
Pit 40	152400.0g	240*	
Pit 91	151.1g	2	1
Environment 1 (2014)	36742.64g	72*	18
Environment 1 (2018/19)	>5992g	9*	2
Cist 1	1856.76g	5	3
Total	201987.68g	337	27

* Partial numbers

Table 3. Summary of cremated remains found at the central area at Perdigões.

Summarising the current findings in the study of human cremated remains at Perdigões emphasises the secondary and collective nature of these burials. Partial anatomically connected remains were identified in Pit 40, with no apparent subjection to fire. However, this information will be confirmed in the near future through specific analysis. Human bones are found side by side with animal cremains, repeating what was observed in the collective toms of the Eastern side of the site.

These very fragmented human bones showed no selection of body parts, since all were represented, carefully collected, transported and deposited in the structures. There is also no evidence of selection based on age or sex, a practice that mirrors what is already known for the other Chalcolithic funerary structures at the site.

Processes of cremation

Intentional cremation is unequivocal at Perdigões and, so, many resulting questions arise about the funerary rite which culminated with the deposition of the human remains in the funerary contexts described above. How many individuals were cremated? At what temperatures were the bodies/bones cremated? Was there cremation of cadavers, of skeletonised remains or both. If cremation of skeletonised remains took place, then does this suggest complex multi-stage funerary rites? Conclusive answers to such questions are, unfortunately, often not possible. Yet, the use of several supplementary bioanthropological methods to examine the remains deposited in those structures may provide some tentative interpretations. Thus, previous studies have examined heat-induced changes (colour changes, fractures and warping), the proportional mass of different anatomical regions and bone frequency to provide some insights about the cremation processes at Perdigões (Godinho, Gonçalves and Valera 2019; Pereira 2014; Silva *et al.* 2014). Thorough descriptions of how heat exposure induces colour and morphological bone/teeth changes, and how archaeo-thanatological methods provide insights about the cremation process may be found in previous studies (Godinho, Gonçalves and Valera 2019; Godinho *et al.* 2019; Gonçalves *et al.* 2016; Gonçalves and Pires 2017). Notwithstanding, we provide a very brief description of why such approaches were used before summarising some of the results and discussion of the studies focusing on these cremation contexts.

Heat-exposure induces colour changes of bones that depend on the temperature to which bones were subjected, duration of exposure and oxygen availability during burning. Exposure to heat also causes fractures and morphological deformations (i.e., warping) of bones. Transverse curved fractures (also commonly known as thumbnail fractures) and warping are more frequent in cadavers or in bones that were buried for shorter periods than in fully skeletonised remains that were buried for longer periods. Moreover, the representativeness of different anatomical regions in the assemblages provides information about the completeness of the bodies, and so it may be used to assess if individuals were more likely to have been cremated as corpses or as skeletonised remains that necessarily had to be recovered and deposited in the cremation structure. Thus, more complete assemblages with balanced representativeness or different anatomical regions suggest cremation of whole bodies, whereas unbalanced representativeness suggests cremation of skeletonised disarticulated remains.

Representativeness is commonly assessed by quantification of frequency of different bones and then examining if there are meaningful differences across bones/anatomical regions. However, cremated bones are typically very fragmented and distorted, and so this approach is not feasible, especially in very large samples such as the case of Pit 40 (in which 152kg and tens of thousands of bones/bone fragments were examined, and this does not represent the full assemblage). Alternatively, bones/bone fragments may be identified according to anatomical regions and weighed. The proportional mass of those anatomical regions is then compared to reference studies to assess if representativeness of different anatomical regions deviates from the reference studies or not.

The studies of Pits 16 and 40, Environment 1 and Cist consistently suggest intentional cremation processes and subsequent secondary deposition of the remains in collective contexts. The latter is shown by the stratigraphic record, the absence of any burning of the structure, the paucity of charcoal (see above), and Minimum Numbers of Individuals (MNI) ranging from nine (Pit 16) to 240 (Pit 40). Intentional cremation is clear because almost all human bones present in those structures show evidence of heat exposure. Bones are frequently black, grey and/or white due to heat-induced colour changes, which is suggestive of exposure to very high temperatures. Notwithstanding, evidence of exposure to lower temperatures is also recorded via the presence of bones that have tanned and/or brownish colours.

In a study using chemometric analyses of charcoal recovered from Pit 16, Coradeschi *et al.* (2023) estimate wood burning temperatures of around 500ºC. Estimation of precise burning temperatures based on heat-induced colour changes is difficult because such colour changes are impacted not only by temperature, but also by the magnitude of oxygen availability during cremation and duration of heat exposure (Reidsma *et al.* 2016; Walker *et al.* 2008). Notwithstanding, the estimations provided by Coradeschi *et al.* (2023) are within the wider range of (and so are generally consistent with) the temperatures suggested by bone colour.

Analysis of representativeness of different anatomical regions (as assessed via bone frequencies and the proportional mass of different anatomical regions) shows little deviation from what is found in primary contexts and/or full bodies/skeletons. This is a strong indicator of cremation of full/complete bodies, most likely cadavers. This, in turn, is a consistent with the presence of few anatomical connections within Pit 40, which are possible due to the presence of soft tissues when deposition took place. Although most of those anatomical connections show little to no macroscopic evidence of cremation, there is one case of a right temporal bone that preserved the mandibular condyle in the glenoid fossa. Both are fully blackened due to heat-exposure. This reflects burning with soft tissues. Notwithstanding, there is also some evidence of cremation of dry bones (although much less frequent). Specifically, in Pit 40 there were cases in which the internal surface of the bone (e.g., internal table of bones from the cranial vault) displayed evidence of burning at higher temperatures than the external surfaces. This strongly suggests that the bones were already fragmented when cremated. Further, almost all bones showed no evidence of weathering and/or other taphonomically induced surface changes (except for those induced by heat). Yet, there were a few bones that did show surface erosion, suggesting that they were deposited/buried previously to cremation. The frequency from heat-induced curved fractures and warping is also apparently lower than that found in bones from cremated cadavers, but the implications of this evidence are unclear. Specifically, frequencies from full body cadaver cremations, or experimental heat exposure of complete bones, are calculated per individual or per complete bone. In contrast, those from the archaeological contexts from Perdigões are inevitably quantified per fragment. Thus, the results from Perdigões surely underestimate frequencies per bone and/or individual and should be viewed cautiously as indicators of burning of cadavers vs. skeletonised dry bones.

In summary, the evidence from Perdigões clearly shows that large numbers of individuals were being cremated (overall, at least 360 individuals in the central area based on the current evidence; the MNI is based on different bones in different contexts and so this number assumes individuals were not scattered across different structures). Moreover, although cremation of full bodies appears to have been most common, there is also evidence for cremation of skeletonised remains in some cases. Thus, this appears to reflect some degree of variability in the cremation funerary behaviour, with coexistence of contrasting pre-burning conditions of the human remains. While the cremation of cadavers does not imply complex multistage funerary rituals (but does not exclude them either), cremation of skeletonised human remains appears to suggest that there may have been a first moment that promoted skeletonization which was then followed by a cremation event. Regardless of if this two-stage processing did indeed occur, the archaeological evidence suggests that the primary cremation site was elsewhere, and the cremated remains were then transported to the contexts from which they were retrieved. Unfortunately, we are unable to assess how long it took between these two moments and so about the ritual funerary implications.

Interpreting cremations at Perdigões

The funerary archaeology in Iberia has been documenting a great variety of practices involving the treatment of the dead during the 3rd millennium BC, progressively changing a setting traditionally dominated by primary inhumations (mainly collective). Evidence of commingled mortuary contexts resulting from clear secondary depositions (and not just resulting from the management of collective primary ones), of segmentation of bodies, and of intense manipulation and deposition of human remains outside the formal funerary structures has proliferated in the archaeological record, revealing complex and interconnected practices harder to reconstitute and interpret.

Recognised as a marginal procedure within the spectrum of funerary behaviours in the Late Prehistory of Iberia, the utilisation of fire for transforming human bodies and/or funerary containers (such as burning tombs) is progressively gaining documentation. This adds layers of complexity and diversity to an already intricate scenario, not only in terms of the processes involved but also regarding beliefs, ontologies, worldviews, and the social roles associated with attitudes toward death.

Cremation is a powerful process of transformation. It does not eliminate the material evidence of the body, but might fragment it into small pieces, as seen in Perdigões. The fragmentation of the body resulting from these practices becomes part of a broader social context during the 3rd millennium BC. This period appears characterised by a tendency to subject various elements to segmentation, extending from objects to architectural features (e.g., ditched enclosures) and even to entire communities. In a more porous processes of categorisation, unity responds to complex relations part/whole, and processes and agents of transformation (as fragmentation and fire) gain protagonism in a more permeable organisation of the world. Therefore, as a transformation process, cremation introduces significant differences regarding inhumation. Differences that should not be seen as a clear dichotomous opposition, as the processes involved in cremation and inhumation may share similar characteristics or stages (Sørensen and Rebay 2007). For instance, the secondary depositions of cremains and secondary depositions with the formation of ossuaries show some proximity. In both cases, and despite the possible recognition of bone types, the corporeal unit and any individuality that might have been associated to it are fragmented and dissolved into a mass of bones and bone fragments. From this perspective, the effect observed in the graves in the East of Perdigões is not very different from that provided by cremations in the central area in terms of individual anonymity. However, the cremation process introduces an important and significant difference: the submission to fire, which is simultaneously a technical, social, and cosmological process (Oestigaard 1999, 2013; Williams *et al.* 2017). The interpretation of cremation cannot be detached from the meanings and attributes of fire in each society, such as transformation (transubstantiation), purification or regeneration (Rebay 2010; Williams *et al.* 2017). In addition, we must also consider more sensitive and practical aspects of cremation, such as the effects of the choreography it provides (scenarios, smell, sounds, heat), the investments in the process (ex. wood acquisition) or the level of transformation it operates, which also facilitates transportation and mixing (Williams *et al.* 2017).

Looking at Perdigões, all the contexts where cremains occur correspond to secondary depositions, meaning they were transported from the contexts where the human remains were submitted to fire.

Regarding these contexts, our knowledge remains limited, and only certain aspects of the procedures can be inferred through an examination of the bone conditions, archaeological materials, and charcoal residues. Individual or collective cremation in open air pyres, burning of collective depositions within tombs, mixtures before or post cremation, burning of dry bones or bodies and parts of bodies with soft tissues, the burning of previous associated votive assemblages or the burning of added materials in the act of cremation (pyre-goods), all are none exclusive possibilities allowed by the data. About what might have happened between the cremations and the final deposition of the cremains there is a total lack of information. We can only attest for a careful collection of the cremated remains.

Regarding their final depositions, there are significant differences at Perdigões. Two contexts correspond to depositions in ditches, one in the Neolithic phase (Ditch 5) and other during the Chalcolithic (Ditch 7). A third context is Tomb 1, in the eastern area of the enclosure, where in a mass of unburned bones some show changes induced by fire. In these cases, submission to fire seems to have been a marginal procedure. The situation in the central area is, though, totally different. Here the cremains, with different levels of fire induced changes, are clearly predominant, although some few unburned bones, namely a couple of partial anatomical connection, occur mixed with them (an inverted situation regarding Tomb 1). The cremains were transported with large pots and deposited in pits. One, Pit 16, showed one event of deposition (but possibly of two different cremations), and the other, Pit 40, presented evidence of some sort of roof and of several moments of deposition. These depositions were carried on outside, in an open-air scenario around the pit and over a stone agglomeration involving a small cist. Some of the transportation pots were deposited inside Pit 40 and others were broken, the fragments pilled, and deposited in another pit (Pit 91), as part of the ritual. During the process (or previously to it), some unburned materials (grave goods) and unburned human and animal bones were added to the cremains.

These cremations involved not only the transformation of bodies, bones and objects (the ones that were also burned), but also the transformation of a space (the central area of Perdigões already used for ceremonial purposes). By adding these contexts of funerary depositions (and all associated rituals and commemorations), meaningful relations with other practices performed in that area were established, originating a process of transformative placemaking (Goldstein 2017), where the bell beaker depositions and the copper metallurgy were also actively engaged.

In face of the number of depositions of Bell Beaker material in open-air and pits surrounding the cremations (Figure 12A), their absence within these funerary deposits generates a relation of exclusion where both, Beakers and cremains, participate as part of a discourse. On the other hand, cremation, as a technology, should be considered in relation with other technologies using transformation by fire (Williams *et al.* 2017), like metallurgy. This central area has been providing huge amounts of evidence of copper metallurgy (crucibles, slags, copper ores, together it finished objects), with a spatial distribution that involves and partially overlaps the area of the deposition of cremains (Figure 12B). In this context, it is interesting to note that the objects (palettes) in the hands of two ivory anthropomorphic figures, usually seen as some sort of symbols of power or ritual items (assumed for one of these pieces found in Tomb 4 – Valera, 2020), were recently interpreted as possible tools used in metallurgical work (Armenta *et al.* 2024). What could be considered unusual, and even strange under a more dichotomic perspective (two different activities, one of a craft nature and the other of funerary type, sharing a same space that was already invested of ceremonial meaning) gains meaning if we adopt a relational approach. In fact, these two activities share a common trait: the transformation by fire. Technologies, in premodern world views, incorporate believes (Goldhahn and Oestigaard 2008). It is well known that primitive metallurgy was involved by mystery and magic (Eliade 1956), related to enigmatic existence of fire and its transformative capacity. If the technical skills were being progressively acquired, the full comprehension of the processes remained within the scope of the transcendental. Cremation and metallurgy would not just be linked by the technological use of fire (Goldstein 2017), with shared expertise, but also by its magical power of transubstantiation. The gathering of cremains, copper metallurgy, and beaker depositions in this central area of Perdigões enclosure, creates relations and generates meanings that might help to explain the uniqueness of this funerary context and enlightening its social roles. And within this relational scope, another interaction must be stressed and analysed: the one with the eastern tombs.

Being 200m apart, both areas show evidence of ceremonial structures and practices before the funerary contexts. In the eastern side, the tombs were built just next to a Neolithic cromlech, remodelled during the Chalcolithic, while the structures with the cremains in the central area were built over deposits with evidence of feasting (concentrations of thousands of animals remains and pottery shards) that were covering a ceremonial timber circle. However, using areas with

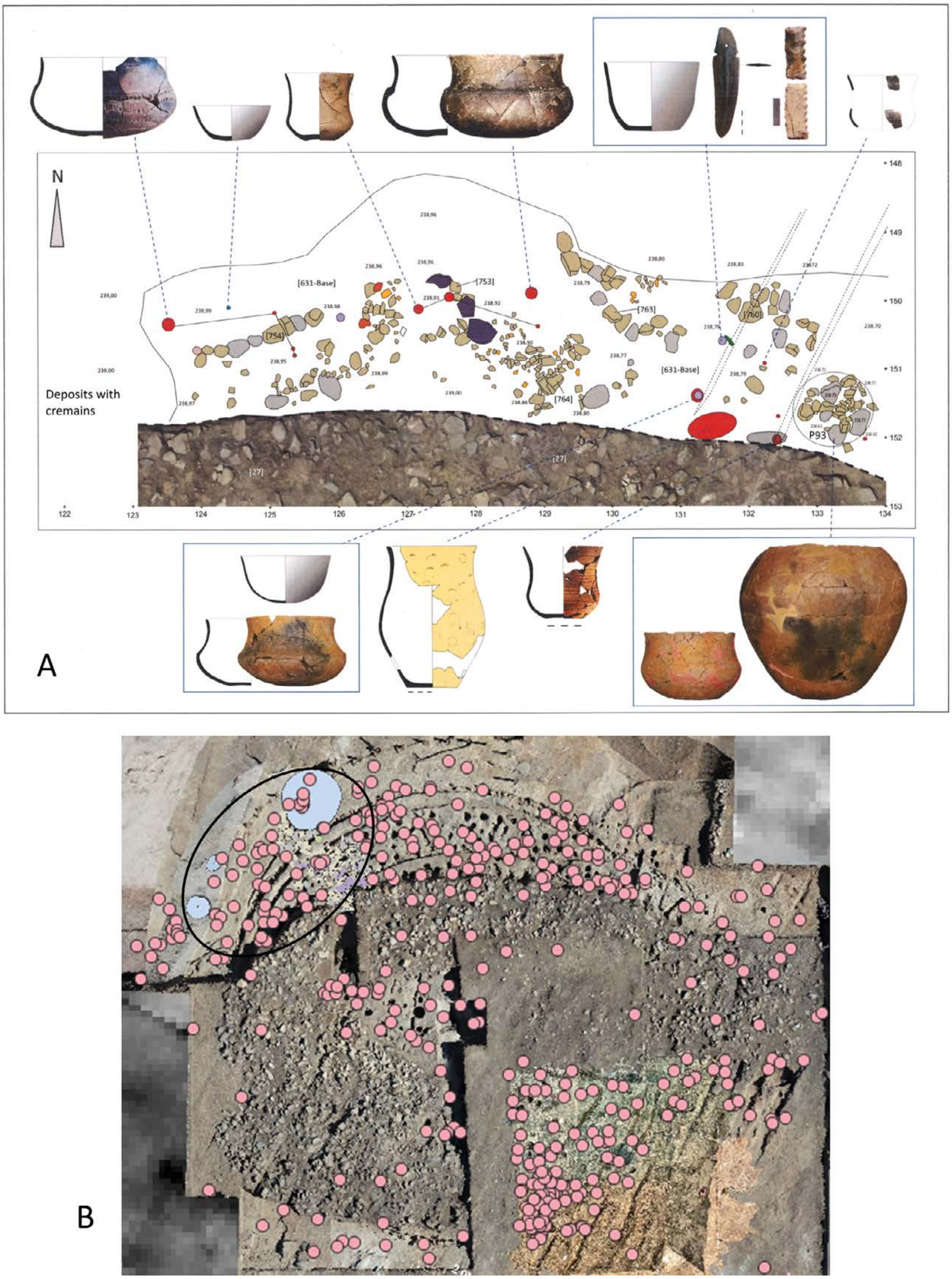

Figure 12. A. Some of the beaker materials deposited at east of the deposits with cremains of Environment 1.
B. Copper metallurgical records (dots) in relation to the area of deposition of cremains (ellipse).

previous ritual status, the funerary contexts present significant differences regarding architectures (pits and open-air deposits versus tholoi type and hybrid tombs), body treatment (mostly secondary depositions of cremains versus secondary depositions of mostly unburned bones and some anatomical connections) and votive materials (differences in categories, styles, and raw materials). Are these two scenarios reflecting independent and contrasting mortuary practices or are they somehow related within a chained process?

The predominant secondary status of the different funerary contexts in Perdigões implies practices of intense manipulation of human remains and their circulation between contexts. This circulation could occur within the enclosure itself using other tombs as preliminary burial places, although we lack the unequivocally primary ones during the 3rd millennium BC.

However, secondary contexts, like the tombs on the eastern side, might be part of larger chains involving cremations. The coexistence of cremations of dry bones and of bones with soft tissue, the identification of sequences of depositions, and the variation in the dates within Pit 40 suggests that the cremains at Perdigões may mix remains from different burnings and that these burnings could have been carried out on remains in different states of decomposition, and from different structures.

A succession that could also involve outer contexts. The mobility studies show that most analysed individuals at Perdigões were exogenous to the local settlement network, with several being compatible with peripheral geologies while others had a more distant origin (Valera *et al.* 2020). As ceremonial centre, it is likely that Perdigões would attract not just the living but also remains of the dead, originating from monuments spread across the Álamo Valley, its outskirts, and even more distant territories. Adopting a chain perspective necessitates considering both a more confined scope within the site itself and a broader one that extends to the valley and beyond. Note the presence of a cremation level inside tholos B of Anta 2 of Olival da Pega (OP2B), approximately 12km from Perdigões. Regardless the interpretation given to this type of situation (in the case of OP2B understood as hygiene fire – Gonçalves 1999), the cleaning of similar contexts could constitute one of the origins of at least some of the cremated remains present in Perdigões.

An argument against a link between the contexts with cremains and the other known funerary monuments in Perdigões, or others spread in the Álamo valley, are the associated materials. Most of the materials from the deposits with human cremations were also burned, indicating that they were burned and collected with the cremains. They show a significant contrast with the materials of the eastern area of the site. In both areas numerous exogenous raw materials are present, but with a reduced typological variety in the cremains and a greater diversity in Tombs 1, 2 and 3. In the cremains, ivory is abundant, but used essentially in anthropomorphic and occulated figurines, in boxes and bracelets, contrasting with the typological variety of equally abundant ivory artefacts from Tombs 1 and 2 (zoomorphic figurines, combs, staff, decorated plaques and cups, pins), where those human figurines are absent (Valera 2021; Valera *et al.* 2015). The bethyls and stone pots are made of marble, a raw material from 30/40k distance, while in Tombs 1 and 2 they are made of limestone related to the Estremadura region, more than 200km away (Dias *et al.* 2017), and the proportion between stone idols and pots is the inverse. The arrowheads have essentially a straight or concave base, with the developed fins so common in Tombs 1 and 2 being practically absent. The blades are very rare and always in the form of small segments, being abundant and appearing complete in Tombs 1, 2 and 3. Phalanx idols are equally numerous in these tombs, while residual in the cremains. Ceramics, except for large transport containers, always appear in the form of small fragments in cremains (many not burned), but small entire pots are abundant in the eastern tombs. Finally, the beads recovered from the cremains are predominantly crafted from shell, (Dias *et al.* 2018). In contrast, the eastern tombs showcase a diverse array of raw materials, with a particular emphasis on variscite, schist, and Sicilian amber. The material assemblages from both areas are very distinctive, too distinctive to be an unintended circumstance. In addition to this contrast, noteworthy distinctions include the varied locations within the site, diverse architectural features (notably, a significantly higher architectural investment with the incorporation of imported schist slabs in the eastern tombs), and differing approaches to the treatment of human remains. This contrast cannot be diachronically explained since there is a contemporaneity of the funerary use of both areas. And they do not show significant social differences based in quantity and quality of associated exotic and prestigious materials.

The observed distinctions are primarily stylistic in nature and are discernible at the level of tombs. Not at the level of individuals, but at the level of groups of individuals, completely dissolved in the masses of bones with no concerns in expressing individuality. A situation of social emulation between groups in the contexts of identity management and negotiation of social tensions, with the amortization of valuables, and where the funerary manipulation of human remains acquired central relevance, could be a scenario more compatible with the archaeological record.

This is particularly interesting in face of the 'Beaker chronology' of these depositions of cremains and of the contexts with beakers that surround them. The individuation of graves and of votive assemblages are a trend of the funerary practices associated to beaker contexts all over Europe and in most parts of Iberia. Yet, at Perdigões, both in the disposition of cremains in the central area and in the tombs of the eastern side, the funerary discourse is totally collective, as if the management of the dead was also used as an expression of resistance to a trajectory of increasing social inequality. In fact, by the middle / third quarter of the 3rd millennium BC Perdigões is, somehow, a contradictory stage, where exotic and prestigious goods circulate and are amortised, but in ways that privilege the collective statement over the individual one. Here, the funerary practices seem to be, together with investments in feasting and in monumental public projects (it is at this same moment – middle of the 3rd millennium BC – that the two monumental outer ditches were built), one more strategy of prevention of accumulation and of political control that inhibit the development of strong unequal social relations (Díaz-del-Río 2021; Rich 2018; Valera in press).

Final remarks

The growing evidence of cremation in the Neolithic and Chalcolithic Iberian funerary practices has been changing the contours of our understanding of the attitudes towards death in these periods. This growing elaboration of the funerary accompanied, simultaneously reflecting and inducing, the general trajectory of social complexification observed between the middle of the fourth and the late 3rd millennium BC. Perhaps more than ever before, the dead and the ways in which the living deal with their remains became central in the arenas of social and political relations, explaining their intense presence within ditched enclosures, namely in the large ones. Without losing their bond with the cosmological and ontological organisations of the world, with conceptions of time and ancestry, funerary practices became more and more active in the practical management of identities, in ceremonial negotiations, as means of status differentiation or as mechanisms to control it. In the south of Portugal, as in many other Iberian regions, the dead are everywhere and in many diversified ways.

The middle of the 3rd millennium BC constitutes the peak of a social trajectory that resorts to more and more exuberant forms of ideological display as means of negotiation of increasing internal contradictions. It is a period of fragmentations and mixtures, of diversification and complication (in the sense of Strum and Latour 1987) of social practices. In this background, the agency of the funerary and of the manipulation of human remains extracts protagonism from the relations established with other practices and places, integrating networks of activities and scenarios more complex and diversified.

The cremations within the Perdigões enclosure, along with the contextual relations they established with other funerary contexts and activities, can be comprehended within the broader context of an escalating social activation of the deceased and their remains. There are still many unanswered questions regarding the unique context of the central area, many of which are unlikely to ever be answered. Almost all the previous stages through which the human remains went through are, and probably will always be, inaccessible. So, we must basically focus on what was created in a particular meaningful place, within a particular meaningful site, by the deposition of these remains. Whatever it was, it looks quite holistic, responding simultaneously to social, ideological, cosmological, ontological, and practical issues.

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Chapter 4
Para-megalithism: alternative routes to understanding big stones

Jessica Smyth

Abstract

'Passage Tomb People' is a research project investigating the social drivers of passage tomb construction along the Atlantic Façade, focussing on the archaeology of three key zones – Ireland, North Wales and Orkney. The connectedness of passage tombs (in terms of iconography, building methods, and material culture) has long been recognised, but to date there has been no targeted research on the societies that built them. Erected after the arrival of farming in each of the three regions, these monuments may be responses to economic stress or, equally, the result of surplus and increasing social competition. PTP probed the connections between monument construction and changes in farming practice, diet/health and environment, testing whether similar factors - cultural, technological, or both - triggered similar behaviours in each area. This was achieved through large-scale programmes of bio-molecular and isotopic analyses tailored to the taphonomic conditions of each region, crucial in successfully scrutinising these otherwise challenging archaeological horizons and materials, as well as in-depth osteological analysis on key human and animal assemblages and targeted radiocarbon dating. As results emerge, the complexity and sophistication of these later Neolithic communities is being revealed.

Keywords: Neolithic, Passage tombs, Ireland, Orkney, Wales, Irish Sea, prehistoric farming, biomolecular archaeology

Introduction

In Europe, the varied routes to farming continue to be intensively studied and are now known to encompass a wide range of scenarios and human-environment interactions. However, within this diversity certain common phenomena can be seen to emerge, most notably the construction of megalithic monuments across large areas of western Europe. A recent project – Passage Tomb People (PTP) – targeted a specific manifestation of this broader megalithic phenomenon: passage tombs of the Irish Sea zone, dating to the 4th and early 3rd millennium BC. Monuments within this cluster are recognised as representing some of the greatest achievements of human engineering and creative expression, involving the transport and erection of substantial stone blocks, elaborate sequences of stone carving, and in some cases precise astronomical alignments. They form part of two UNESCO World Heritage Sites: the 'Archaeological Ensemble of the Bend of the Boyne' and the 'Heart of Neolithic Orkney'. Despite this international recognition, relatively little is known about the nature and structure of the prehistoric communities that raised them. The overall aim of PTP was thus to investigate the social drivers of passage tomb construction, attempting to answer some foundational questions: who were these builders, what worlds were they part of, and what types of resources underpinned these feats of engineering? The project focused on three zones - Ireland, Orkney and North Wales: regions that appear closely connected culturally but are also similar in terms of climate and environmental affordances. This was in order to better focus on mechanisms, drilling down into contemporary archaeological horizons in an integrated and systematic manner to further contextualise passage tomb construction.

A failure of farming?

The significant achievement represented by passage tombs, both in their extent and in the scale of individual monuments, is suggestive of a sophisticated, even specialised, resource base. Passage tomb people were certainly farmers, with monuments erected after the arrival of agriculture in each region and the most elaborate examples constructed several centuries later. However, the agricultural resources that supported passage tomb communities have to date been under-analysed. This is partly due to the fact that attention has previously been focused on exploring the arrival of farming to the islands of Ireland and Britain, and in examining the Mesolithic-Neolithic transition *c.* 4000 BC (e.g. Whittle and Cummings 2007; Thomas 2013; Whitehouse *et al.* 2014). It is also partly due to shifts in the nature and visibility of the archaeological record *c.* 3600 BC, particularly settlement evidence (e.g. Smyth 2013, 2014; Worley *et al.* 2019) which makes piecing together daily life in the centuries after the arrival of farming in Ireland and Britain particularly challenging.

Recent radiocarbon and climate proxy data from parts of western temperate Europe appear to show an initial population boom after the introduction of farming followed by a decline—viewed by some as a population crash, by others as a failure of the farming experiment that only becomes properly established in the Bronze Age (Shennan *et al.* 2013; Stevens and Fuller 2012; Whitehouse *et al.* 2014). However, such 'boom-bust' scenarios have been critiqued for being insufficiently nuanced (e.g. Bishop 2015) relying heavily on datasets skewed towards characterising early Neolithic horizons and the transition to farming, as well as glossing over regional variability. Passage tomb activity certainly seems at odds with a 'boom-bust' reading of the evidence, with sizeable monuments constructed exactly at the point when human labour and economic surplus are argued to be at a low ebb.

Central to this debate are questions about the nature of farming, and the interplay of arable and pastoral modes of production from the early Neolithic onwards (cf Ebersbach 2010). Land and resources have long featured in discussions about megalithic monuments, argued by some to have been erected by farming groups seeking to legitimise ancestral claims to crucial resource-rich areas (e.g. Renfrew 1976) which is often taken to mean land best suited to tillage. While in certain areas the distribution of megalithic monuments and fertile soils does seem to overlap (e.g. Cooney and Grogan 1994) the well-documented importance of cattle husbandry and dairying in late 5th - 4th millennium BC western Europe (e.g. Balasse *et al.* 2021) as well as evidence of cattle symbolism from passage tombs themselves (Le Quellec 2006; Eogan and Cleary 2017) reminds us that the association between monuments and land use is not straightforward.

New social networks and the rise of élites?

There is long-held and widespread recognition of the long-distance links between Atlantic passage tomb regions, evidenced by striking similarities in grave goods and other portable objects, tomb art and architecture, and a new concern with marking the sun cycle (e.g. Piggott 1954; Sheridan 1985; Callaghan and Scarre 2017; Bradley 2024). Recent ancient DNA analysis has supported this picture of long-distance connections, identifying genetic affinity among some individuals deposited in passage tombs and passage tomb-associated contexts across the island of Ireland (Cassidy *et al.* 2020) although the social mechanisms and the timings behind such movement are as yet imperfectly understood. In Ireland, the siting of passage tombs in prominent, upland locations and a growing concern with intervisibility of tombs has been taken to indicate expanding spheres of interaction in the later 4th millennium BC, with monuments drawing in an increasing number of ritual participants from wider networks (Cooney 2000; Hensey 2015). The reasons for these widening networks are unclear but they may have emerged within a developed phase of agriculture with more extensive subsistence strategies that increased the range of farming groups and reconfigured existing social relationships (Carlin *et al.* 2025; Smyth *et al.* 2025).

Another approach views these long distance connections as the result of the competitive behaviour of Neolithic élites, who acquired and introduced exotic materials and ideas to enhance their local power, as well as driving increasingly ambitious programmes of passage tomb construction (Sheridan 1985, 2014; Schulting *et al.* 2010). The argument for élites as drivers is in part based on the restricted (i.e. exclusive) internal spaces of passage tombs and the scale of some monuments, representing a substantial investment of labour. Though often unstated, it has been assumed that such labour required a coercive or at least centralised force to harness and direct it (e.g. Sheridan 1985; Eogan and Roche 1997; Eogan 1999). Bearing in mind that the social structures or organisation required in passage tomb construction may have been transient or conditional (e.g. Thomas 1996; Brück 2001) testing an 'élites' hypothesis requires robust and multistranded methods of inquiry into, for example, economic strategies, patterns of mobility and territoriality, and settlement organisation. Certainly, the human bone deposits from passage tombs likely reflect a selection of the living population and those that were valued in society (e.g. Bradbury and Scarre 2017). However, the commingled, disarticulated and often fragmented human bone assemblages recovered from passage tombs (e.g. O'Sullivan 2005; Lawrence 2012; Crozier 2016; Geber *et al.* 2017a; Buckley *et al.* 2017) suggests that maintaining and remembering specific individuals after death was not part of the passage tomb tradition, although variable recording of burial deposits across sites and regions currently provide little standardised data (e.g. Smyth *et al.* 2025).

Underpinning the above issues are questions around the temporal connectedness of passage tomb regions. There has been a steady increase in programmes of radiocarbon dating, and accompanying Bayesian modelling, as the excavation archives of larger monuments are revisited and reanalysed (e.g. Bergh and Hensey 2013; Kador *et al.* 2018; Schulting *et al.* 2010; 2017a). However, gaps remain in our understanding of the sequence and development of passage tombs across the islands of Ireland and Britain, and how such forms of cultural transmission align with other developments in the middle Neolithic (Hensey 2015; Griffiths 2016).

In attempting a deeper understanding of the passage tomb phenomenon in this part of Atlantic northwest Europe, the Passage Tomb People research questions

Sustainability		Connectedness	
Investigating economic conditions under which passage tombs were constructed		Probing the extent and timing of later Neolithic social networks	
RQ1	Are regional programmes of monument building the result of subsistence regimes with similar affordances of time and labour to enable large-scale megalithic construction?	RQ4	Is passage tomb construction embedded in more expansive farming regimes that extend over larger territories and connect into larger social networks?
RQ2	Are subsistence regimes grounded in locally different responses, e.g. tailored to climate and geography?	RQ5	How similar are behaviours observed in passage tomb contexts across regions? Does practice travel with materials and motifs?
RQ3	Does resource exploitation contemporary with passage tombs represent a continuing investment in agriculture or is there a drop in intensification?	RQ6	How closely related in time are those passage tomb regions with the most overlap in architecture and material culture?

Table 1. Passage Tomb People research questions.

thus encompassed two broad themes - sustainability and connectedness (Table 1). Overall, PTP sought to shed light on a poorly understood and critically important process: the extended impact of farming practices on prehistoric societies, i.e., beyond the initial phase of agriculture. Building on existing archaeobotanical datasets for these areas (e.g. Colledge *et al.* 2016; McClatchie *et al.* 2016; Bishop *et al.* 2009; Treasure *et al.* 2019) the aim was to provide a more integrated picture of the resource bases underlying passage tomb construction and the extent to which regions aligned and diverged. Interwoven with this were questions designed to tease apart how social relationships may have been reconfigured in this period, identifying ways of probing and accounting for the intensified and more expansive cultural interaction indicated in the archaeological record.

Sampling strategies and methods

PTP focused solely on already excavated material rather than any new fieldwork, and as with any history of research spanning multiple decades and different jurisdictions, had to engage with a variety of site records, artefacts and ecofacts. Understandably, research interest has tended to focus on the monuments themselves, frequently the most imposing examples, generating large excavation archives and sometimes taking several decades to process and publish (e.g. Eogan and Cleary 2017). This has resulted in datasets for the period that are at once expansive (indeed, sometimes overwhelming) and narrow. While biomolecular archaeology and archaeogenetics have certainly reinvigorated passage tomb research in recent years, providing important new insight into the lifeways of people deposited in monuments, there has been less progress in connecting these individuals to their wider social and economic worlds. Reasons for this are two-fold: the nature of the archaeological materials to be analysed and the scale of the analysis required. Specific obstacles include disturbed and/or depleted passage tomb deposits and a sparse and often ephemeral contemporary settlement record, alongside the numbers and variety of analyses needed to resolve inter-regional level research questions on differentially preserved samples. The visibility of settlement evidence from this time period is particularly challenging, with an apparent shift (in some regions at least) of architectural practice resulting in a lighter footprint (e.g. Smyth 2014). A range of taphonomic factors, from environmental (e.g. soil acidity) to cultural (e.g. cremation rites dominating in some regions) mean that material from which information about diet and subsistence is normally extracted - human and animal bone – is frequently decayed and/or fragmented and unidentifiable to species. Combined with the effects of differential resourcing and research infrastructure, there can be considerable unevenness of coverage in terms of an accessible archaeological record.

Conscious of these gaps and biases, PTP in the first instance adopted an overarching methodological approach that sought to identify units of information common to each area, enabling systematic largescale programmes of analyses that could be easily integrated (Table 2). Biomolecular and biochemical multi-proxy approaches in particular are especially powerful in 'levelling the playing field', as increasingly targeted mass spectrometric and isotopic analyses and greater instrumental precision are allowing us to probe extremely small quantities of biomolecules in degraded materials, such as bone fragments or pottery sherds, making more of the excavated archive available for scrutiny. For example, collagen fingerprinting can elicit species information from bone fragments <1 mg up to ~25 mg in size, whilst analysis of absorbed residues in pottery can characterise lipid extracts as small as ~10 µg (Buckley *et al.* 2009; Roffet-Salque *et al.* 2017). Recent methodological advances have also enabled high throughput of archaeological samples and a 'scaling-up' of analysis to interrogate large multi-region datasets. At the same time, different results and success rates were expected from the different study areas, e.g. poor bone preservation, or low-visibility domestic architecture,

Analytical technique	Question answered	Theme
Strontium ($^{87}Sr/^{86}Sr$) isotope analyses of animal/human tooth enamel	How far did animals and humans move?	Connectedness
Stable carbon ($\delta^{13}C$) and oxygen ($\delta^{18}O$) isotope analyses of animal tooth enamel	Seasonal changes in grazing? Manipulation of birth season?	Sustainability
Stable carbon ($\delta^{13}C$) and nitrogen ($\delta^{15}N$) isotope analyses of animal bone collagen	What were animals feeding on? Baseline values for human diet?	Sustainability
Stable carbon ($\delta^{13}C$) and nitrogen ($\delta^{15}N$) isotope analyses of human dentine and collagen	Dominant dietary protein source in childhood and over life average?	Sustainability
Molecular and stable carbon ($\delta^{13}C$) isotope analyses of pottery lipids	How are vessels used? Strength of dairying signal?	Sustainability
14C dating of pottery lipids	How old is vessel and context vessel is found in?	Connectedness
14C dating of bone collagen and apatite	How old is sample and context sample is found in?	Connectedness
Peptide fingerprinting of unburnt bone and tooth enamel	Species and sex of animal/human	Sustainability/Connectedness

Table 2. Passage Tomb People analytical techniques.

and analyses were thus bundled into regionally tailored and taphonomically sensitive ‘toolkits’ to maximise the informative potential of challenging archaeological horizons and materials. Another key principle was to examine a wide range of contemporary site types – a passage tomb ‘horizon’ – that would hopefully counteract any selection bias coming from any one sphere of activity, e.g. the funerary context (see ‘Sites and Materials’, and Table 3 below).

Multi-isotope analyses on bone, tooth enamel and dentine

Multi-isotope analyses have become standard practice on archaeological bone and teeth, as a means of providing as wide a window as possible on ancient lifeways as well as ensuring resulting interpretations are robust, with each strand of analysis offering complementary (or possibly contradictory) information.

Strontium ($^{87}Sr/^{86}Sr$) and carbon ($\delta^{13}C$) isotope analyses of faunal remains bring into focus the spatial aspects of Neolithic animal management practices, e.g. by tracking movement on and off specific geologies or between dense canopy and open grazing environments. Values obtained from analyses of domesticates from both funerary and habitation contexts in Ireland and Orkney are enabling us to assess the likely ranges of animal management strategies in the later 4th to 3rd millennium BC, indicating how extensively passage tomb people moved with their animals and how likely they were to come into contact with other communities. For example, a significant number of strontium values outside the local range of the sampled site may indicate farming practices involving a high degree of organisation and extensive use of the landscape. Strontium isotope values from humans deposited in monuments will also inform on the extent of routine (or perhaps exceptional) mobility within these communities. Early farmers have sometimes been uncritically assumed to be relatively sedentary and local in their worldviews, something increasingly challenged by isotope studies (e.g. Brandt *et al.* 2014; Neil *et al.* 2016). It is hoped that more detail on the ratio of local: non-local signatures within burial deposits can inform us on the spatial dynamics of kin groups, which may also have a gendered aspect (e.g. Bentley *et al.* 2012). Overall, these analyses will provide new insight into later Neolithic connectedness, testing the link between tomb construction and growing relations of interdependence with larger, more widespread groups of people. Comparisons will be made within and between regions, with results also compared with observations on the distances travelled to acquire the stone for passage tombs (e.g. Cooney 2000, 136-7) and with the extraordinary long-range mobility recorded in faunal assemblages from southern Britain at *c.* 3000 BC (e.g. Viner *et al.* 2010; Madgwick *et al.* 2019).

In several parts of northern and western Europe, $\delta^{13}C$ and $\delta^{15}N$ values of adult human bone collagen have indicated consumption of less than 10-15% aquatic protein in the early Neolithic, interpreted as a deliberate ‘shunning’ of marine resources with the uptake of farming (e.g. Richards *et al.* 2003; Schulting *et al.* 2004; Schulting 2013). However, adult human bulk bone collagen provides an average of many years’ diet and has relatively poor temporal focus; utilising high-precision dentine collagen increments can provide much higher temporal resolution (Beaumont *et al.* 2013) with the resulting $\delta^{13}C$ and $\delta^{15}N$ measurements allowing identification of dietary patterns over very short periods of an individual’s early life (e.g. Montgomery *et al.* 2013). From the perspective of sustainability and more deeply interrogating the ‘boom to bust’ narrative for the early-middle Neolithic, PTP was interested in obtaining more detailed insight into marine resource consumption across different passage tomb communities, potentially highlighting periods of unusual consumption due to stress or resource shortages. $\delta^{13}C$ and $\delta^{15}N$ values from dentine are being compared with those from bulk bone collagen sampled from the same site and from additional individuals from further sites, providing information on an averaged diet over a longer period. Together, both bulk and incremental values should allow greater scrutiny of the relative proportions of dietary protein from terrestrial/aquatic and animal/plant sources consumed by different groups. For the above approach to be of maximum value, $\delta^{13}C$ and $\delta^{15}N$ values of both fauna and humans from a given site were measured where possible, so that relative trophic levels for a given set of environmental conditions could be established, improving isotopic baselines for consumption practices among different passage tomb communities. The $\delta^{13}C$ and $\delta^{15}N$ isotope values from domesticates can provide useful information on foraging behaviour and how these animals may have been managed (e.g. Schulting *et al.* 2017b).

While not part of the original PTP project design, the opportunity also arose to undertake incremental multi-isotope analyses ($\delta^{13}C$, $\delta^{18}O$, $^{87}Sr/^{86}Sr$) on a large number of cattle molars from a single Irish site (see section below). Sequential $\delta^{18}O$ analysis along the tooth growth axis allows the reconstruction of a seasonal cycle, reflecting seasonal variation in drink water values. This can be compared to $\delta^{13}C$ and $^{87}Sr/^{86}Sr$ values along the same growth axis, potentially identifying a range of seasonal activities such as animal/herd mobility, temporary shifts in diet and calving. Time-resolved isotopic records for Neolithic domesticates have been generated for several parts of Europe, including Orkney (e.g. Balasse *et al.* 2012; Balasse *et al.* 2019; Berthon *et al.* 2018) and this suite of multi-isotope analyses from a contemporary Irish site provides an important addition to the wider dataset, shedding more light on the nature of specialised animal management strategies among passage tomb communities.

Molecular and isotopic characterisation of absorbed lipid residues in pottery

Where bone and teeth are absent, or collagen is too poorly preserved, organic residue analysis (ORA) of absorbed lipids in pottery vessels provides a powerful proxy for resource exploitation and subsistence regimes. Molecular and stable isotopic techniques can distinguish the fats of the major classes of domesticated animals (ruminants or non-ruminants) between adipose and milk fats, and the fats of some hunted terrestrial species (e.g. Copley *et al.* 2003; Evershed *et al.* 2002; Outram *et al.* 2009). ORA has already shown dairying to be a well-established practice in Neolithic Ireland and Orkney (Smyth and Evershed 2015, 2016; Cramp *et al.* 2014) but there was no comparable data for north Wales. PTP fills in this picture as well as conducting more in-depth analysis on any shift in dairying practice from the earlier to later Neolithic. With the identification of marker compounds that allow the processing of fish and other aquatic resources to be detected in pottery at high sensitivity (Hansel *et al.* 2004; Hansel and Evershed 2009). ORA can also provide information on types of subsistence strategies. In northern Britain in the Neolithic, lipid residue data indicates that communities did not process aquatic resources in pots (Cramp *et al.* 2014) and a further goal of PTP was to establish the relative importance of aquatic/maritime resources in Ireland and in Wales, complementing the $\delta^{13}C$ and $\delta^{15}N$ isotope analyses of human dentine outlined above. Finally, programmes of ORA on pottery assemblages from a variety of later Neolithic contexts were intended to compare the use of vessels across mortuary and domestic spheres.

Radiocarbon dating and compound-specific radiocarbon analysis (CSRA)

The targeted radiocarbon dating and chronological modelling of passage tomb assemblages has steadily increased in recent years as older excavation archives are revisited (e.g. Burrow 2010; Bayliss and O'Sullivan 2013; Schulting *et al.* 2017c). This has occurred alongside projects collating large datasets of radiocarbon dates from Orkney and Ireland (e.g. Bayliss *et al.* 2017; Griffiths 2016; Cooney *et al.* 2011; McLaughlin *et al.* 2016). The aim of PTP was to complement these datasets, targeting sites and phases not extensively sampled. Previous research had also shown megalithic monuments to be dynamic, multi-phase environments (e.g. Schulting *et al.* 2012) so a large programme of direct dating (*c.* 100 measurements) was needed to provide chronological constraint for isotope analyses of human and animal samples from passage tombs. For those contexts where bone was not anticipated to survive or not to be present, a parallel programme of compound-specific radiocarbon analysis (CSRA) of pottery lipids (*c.* 50 measurements) was planned. Fatty acids absorbed into pottery offer a unique source of short-lived ^{14}C, derived directly from the commodities processed in the vessels, and CSRA has been a significant leap forward in resolving particularly challenging archaeological horizons (Casanova 2020). Together, these 100 'bulk' measurements on animal/human bone collagen and apatite and 50 compound-specific measurements on pottery lipids aimed to target key gaps in passage tomb chronologies, furthering our knowledge of how different sites and regions interacted with one another.

Proteomics

Alongside ORA, protein analysis – peptide fingerprinting of both collagen and enamel – was explored as an additional way to overcome the limitations of poor sample preservation in the study areas. For fragments of unburnt bone, unable to be characterised morphologically, collagen peptide fingerprinting (or ZooMS) could potentially elucidate species (e.g. Buckley and Kansa 2011). Previous collagen peptide fingerprinting of indeterminate bone fragments from the eastern chamber of the main Knowth passage tomb successfully identified *c.* 60% of samples and—crucial for mortuary contexts—could distinguish between fragments of animal and human bone (Smyth *et al.* 2017). Other forms of peptide analysis, specifically targeting the protein amelogenin in tooth enamel, has been shown to aid sex determination in humans (Stewart *et al.* 2017) and this was also explored as part of the PTP project for both animal and human samples as a means to extrapolate further on animal husbandry systems and mortuary practice.

Sites and materials

In total, PTP sampled pottery sherds and human and animal bone and teeth from the archives of nearly 40 sites across Ireland, Orkney and North Wales (Table 3). In doing so, the project aimed to directly address existing sampling biases in the Neolithic archaeological record, which were previously focused on the earlier Neolithic transition to agriculture, and to systematically examine the relationship between passage tomb construction and the character of contemporary farming practice and resource exploitation. The generation of comparable datasets was prioritised – in some cases undertaking new parallel analyses across the three study regions, in other cases filling in gaps in particular areas to match existing datasets in other areas. This was especially the case for Ireland, where multi-isotope studies of later Neolithic humans and animals have been more limited in scope (e.g. Kador 2015). From the outset it was anticipated that unfavourable soil conditions in some areas would not produce suitable samples for all types of analysis and in these cases a multi-proxy approach was crucial, e.g. the dearth of suitable unburnt bone from North Wales/Anglesey meant that archaeological lipids from pottery assemblages became the main source of information on the nature of farming practices and chronology. Furthermore, it was recognised that with only a proportion of the dead of any community deposited in passage tombs, it was important to attempt to access as many aspects of later Neolithic society as possible and to sample from a range of contexts and site-types across both mortuary and settlement spheres. In Ireland, for example, the relationship between passage tombs and the contemporary Linkardstown-type mounds with

Site name	Site type	Pottery sherds	Tooth enamel (human)	Tooth enamel (animal)	Bone (human)	Bone (animal)	Dentine (human)
IRELAND							
Drimnagh	Funerary (Linkardstown tomb)	---	---	1	1(F)	3+1(F)	---
Ashleypark	Funerary (Linkardstown tomb)	---	2	1	2	7	2
Ardcrony	Funerary (Linkardstown tomb)	---	2	---	2	---	2
Baunogenasraid	Funerary (Linkardstown tomb)	---	1	---	1	---	1
Ballintruer More	Funerary (Linkardstown tomb)	---	1	---	1	---	1
Jerpoint West	Funerary (Linkardstown tomb)	---	1	---	1	---	1
Norrismount	Funerary (Linkardstown tomb)	---	1	---	---	---	1
Newgrange Site Z	Funerary (Passage tomb)	---	3	---	1	---	3
Dowth Hall	Funerary (Passage tomb)	---	3	---	2	---	2
Poulnabrone	Funerary (Portal tomb)	---	---	7	---	3	---
Knowth	Habitation/funerary (Passage tomb)	30	1	---	2	---	1
Townleyhall II	Habitation/funerary (Passage tomb)	30	---	---	---	---	---
Knockroe†	Funerary (Passage tomb)	---	---	---	---	---	---
Fourknocks†	Funerary (Passage tomb)	---	---	---	---	---	---

Table 3. Sites and number of samples analysed for the Passage Tomb People project.
(F) indicates failed sample. † indicates assemblage where new osteological analysis was undertaken;
* indicates previously analysed pottery re-sampled for compound-specific radiocarbon dating.

Site name	Site type	Pottery sherds	Tooth enamel (human)	Tooth enamel (animal)	Bone (human)	Bone (animal)	Dentine (human)
Kilshane†	Ceremonial (Enclosure)	---	---	34	---	5	---
Rathlin Island	Habitation	50	---	---	---	---	---
Lambay Island	Habitation	20	---	---	---	---	---
Haynestown	Habitation (Enclosure)	12	---	---	---	---	---
Balregan*	Ceremonial (Enclosure)	1	---	---	---	---	---
Tullahedy*	Habitation	2	---	---	---	---	---
Lowpark*	Habitation	2	---	---	---	---	---
Region total		***147***	***15***	***43***	***13***	***19***	***14***
NORTH WALES							
Llanfaethlu	Habitation	45	---	---	---	---	---
Parc Cybi	Habitation	23	---	---	---	---	---
Parc Bryn Cegin	Habitation	30	---	---	---	---	---
Penmynydd	Habitation	4	---	---	---	---	---
Clynnog	Habitation	7	---	---	---	---	---
Region total		***109***	**---**	**---**	**---**	**---**	**---**
ORKNEY ISLANDS							
Unstan	Funerary (Orkney-Cromarty-type tomb)	20	2	2	5	7	3
Isbister	Funerary (Maeshowe /Orkney-Cromarty hybrid)	---	12	3	6	10	12
Quanterness	Funerary (Maeshowe-type tomb)	12	18	9	4	7+1(F)	20
Cuween	Funerary (Maeshowe-type tomb)	---	---	2	1+1(F)	1	---
Quoyness	Funerary (Maeshowe-type tomb)	---	---	1	4	3	---
Banks	Funerary (Maeshowe-type tomb)	---	6	1	5	5	3
Skara Brae	Habitation	16	---	42	---	12	---
Pool	Habitation	27	---	5	---	10	---
Stonehall	Habitation	---	---	7	---	---	---
Wideford Hill	Habitation	30	---	---	---	---	---
Crossiecrown	Habitation	31	---	---	---	---	---
Rinyo	Habitation	24	---	---	---	---	---
Barnhouse	Habitation	50	---	---	---	5	---
Region total		***210***	***38***	***72***	***26***	***61***	***36***
Total samples		**466**	**53**	**115**	**39**	**80**	**50**

Table 3: Continued.

their central inhumations of mainly adult males (e.g. Cooney 2023) remained under-explored.

In addition to the biomolecular and biogeochemical approaches described above, opportunities to pursue complementary in-depth osteological analyses presented themselves in 2020. These initially arose due to the Covid pandemic and the closure of museums and other institutions where sampling was due to take place. With research limited to the home institution and material already stored there, it was decided to undertake further work including bone pathology analysis on a large assemblage of cattle bone recovered from the ditch of an enclosure excavated along the M2 motorway at Kilshane, Co. Dublin (see below) as well as full osteological analysis of the cremated human bone assemblage from Knockroe passage tomb, Co. Kilkenny, excavated in the early 1990s in a research context (O'Sullivan 1993; 1995). With this latter site, the human bone had not been subject to modern osteoarchaeological analysis and completing same was a condition of permission being granted by the National Museum of Ireland for future destructive analyses such as radiocarbon dating and strontium isotope analysis. The value quickly realised in properly quantifying and characterising the Knockroe burial deposits led to another unstudied human bone assemblage from Fourknocks passage tomb, Co. Meath being added as a final PTP site. Some of the emerging benefits of these unplanned twin approaches - micro/macro and broad/focused – are detailed below.

FILLING OUT and DIGGING DOWN – some emerging results

In terms of the value of aligning and integrating datasets, parallel programmes of organic residue analysis of pottery assemblages from all three study areas is providing important nuances to the subsistence strategies and food cultures of Neolithic Ireland and Britain. For example, in Wales, where few sites had been investigated previously via ORA, the emerging pattern of vessel use seems to be more closely related to the signal observed for Ireland than other parts of Britain, with a particularly strong dairying component (Olet *et al.* 2023). From the late 4th millennium BC onwards, when some of the largest passage tombs from the study areas were being constructed, the increase in processing animal carcass products in pots noted in several regions of Britain does not seem to occur to the same extent in Wales. A trend away from dairy products was only statistically significant at one of the sites analysed (Parc Bryn Cegin) while at another site (Parc Cybi) there appears to be specialised use of Grooved Ware for dairy products. Notedly, the association between pork and Grooved Ware that is so characteristic of southern Britain is not visible in north Wales and speaks to locally (perhaps culturally) contingent animal husbandry practices and culinary traditions that may have connected communities across the Irish Sea. At the same time, there seems to be more variety in vessel use in Neolithic north Wales compared to Ireland, a trend that is mirrored in the greater variety of vessel types, including Fengate Ware, which has no parallels in Ireland. As well as bringing into clearer focus regional traditions of livestock exploitation, ORA is providing glimpses of other later Neolithic resources. This includes the first recorded instance of beeswax in Wales, at Llanfaethlu, previously only recorded in southern Britain (Roffet-Salque *et al.* 2015) as well as increasing evidence for use of aquatic and/or marine resources previously thought to be virtually absent in Neolithic Britain (Cramp *et al.* 2014). A number of pottery assemblages in both Ireland and Wales have now yielded evidence for aquatic biomarkers, albeit at low levels, potentially reanimating debates about the perceived cultural importance of marine foods in the Neolithic in this part of Europe (e.g. Richards *et al.* 2003; Milner *et al.* 2004). These results will also provide valuable comparative data for the results of incremental isotope analysis of human dentine from Orkney and Ireland.

The value of in-depth single site analyses is becoming clear in PTP's work on the mid-4th millennium BC enclosure at Kilshane in north Dublin, approximately 25 km south of the *Brú na Bóinne* passage tomb complex. Kilshane was excavated along the route of the M2 motorway in 2004, the site revealing remains of approximately 60 cattle deposited along the base of a segmented enclosure ditch, interpreted as the remains of one or more feasting events closely connected in time (Pigière *et al.* 2022). This cattle bone 'layer' was dated by a spread of diagnostic Middle Neolithic Impressed Ware pottery sherds and charcoal dating to *c.* 3600-3500 cal. BC lying above it in the ditch. Crucially, the assemblage contained a high number of cattle metapodials and phalanges, on which an analysis of pathologies related to traction could be undertaken (Pigière and Smyth 2023). This work revealed that a large number of the Kilshane phalanges displayed a level of pathological changes with higher incidence than prehistoric aurochsen and cattle from Neolithic Scandinavia, similar to modern draught cattle but with less severe pathology. Metacarpal and metatarsal bones displayed bone remodelling consistent with traction, with five examples reaching or exceeding the pathological index threshold. Higher pathological indices recorded for metatarsals than for metacarpals were also in keeping with studies of modern draught cattle who display more severe pathologies on their hindlimbs than on their forelimbs. When metacarpal widths were plotted against the greatest metapodial lengths, to give an indication of bone slenderness relative to the height of an animal, the Kilshane cattle fell into three groups: likely females, likely males and a third small group with relatively slender bones but of above average height. These last measurements can be an indicator of castrated males and are cautiously interpreted as the earliest evidence for oxen in Ireland (Pigière and Smyth 2023). Interpretation of the results of incremental multi-isotope analyses (C, O, Sr) on third molars from 17 cattle from Kilshane is ongoing and will bring important context to these animals' worlds, hopefully elucidating aspects of seasonal activities such as movement/herding, grazing/foddering and calving. The working hypothesis, based on studies of traditional agro-pastoralist societies from temperate climates (Ebersbach 2010, 2013) is that these approximately 60 individuals belong to a number of different households or communities, but the extent to which they form part of the same husbandry systems is to be explored.

A final example of work emerging from the PTP project relates to the passage tomb people themselves, i.e., the remains of human individuals selected for deposition in these monuments. Once again, this has been a process of assessing current gaps and deciding on new systematic approaches to even out and standardise the evidence base. In Ireland, of the approximately 230 extant passage tombs (Prendergast 2021) less than 10% have been investigated (Eogan and Cleary 2017, table 10.1) with most excavation undertaken at a time when there was limited interest in human bone, especially cremated human bone (O'Donnabhain and Murphy 2014). In many cases, it is unclear how much of this human bone was collected at the time of excavation, and how much of the original depositional activity each assemblage represents (e.g. Geber *et al.* 2017a; 2017b). With the exception of Knowth (Buckley *et al.* 2017) passage tomb human bone deposits have been analysed by anatomists and the - often speculative and non-scientific - reported results are still frequently referenced in archaeological literature. Compounding this is considerable variation in approach. For example, standard recording methods (i.e. of bone fragmentation and taphonomy, as well as how exactly MNI was calculated) were not used during analysis of the human bone assemblages from Newgrange, Knowth and Mound of the Hostages passage tombs (Eogan and Cleary 2017; O'Kelly 1982; O'Sullivan 2005) making integrated analysis of data from these important monuments very difficult.

The decision to properly quantify the human bone assemblage from Knockroe passage tomb, and subsequently Fourknocks, was prompted by a successful recent reassessment of the surviving osteological material from the Carrowkeel complex of passage tombs in Co. Sligo, excavated in 1911 and rediscovered at the Duckworth Laboratory in Cambridge (Hensey *et al.* 2014). Despite the loss of accompanying spatial and contextual information, it was possible to revise the original MNI, reconstruct contextual patterns relating to sex and age, as well as reveal new evidence for mortuary practice and processing of the dead (Geber *et al.* 2017a; 2017b; Kador *et al.* 2018). By analysing the Knockroe and Fourknocks human bone assemblages using the same standardised methods undertaken at Carrowkeel, it was hoped to provide a new baseline for Neolithic Ireland, reflecting mortuary practice at three locations on the island from west to east, which in turn would enable comparative analysis with tomb assemblages from key Orkney sites, e.g. Rousay and Quanterness. What has become apparent is that Knockroe and Fourknocks currently represent the only Irish passage tombs where we can be sure that the surviving burial deposits were fully sampled during excavation, providing a unique opportunity to analyse what may come close to a complete sequence of prehistoric mortuary activity (Smyth *et al.* in press b). Quantification is now complete for both assemblages, which represent some of the very largest assemblages of cremated human remains recorded from a megalithic monument anywhere, and provide a glimpse of what may originally have been deposited at other sites. At Knockroe, the size of the assemblage amounts to 217.5kg of cremated human bone, and just 300g of unburnt bone, while at Fourknocks I and II combined (a passage tomb and associated cremation site) the total stands at 87.5kg of cremated bone and 10.3kg of unburnt bone. Final quantification of individuals awaits analysis of archaeological contexts and phasing of the assemblages, but the preliminary minimum number of individuals from Knockroe is 92 and from Fourknocks I and II combined is 87 and includes a range of ages from neonates up to adults, and both females and males.

Routes into analysing big stones

Much like the aphorism 'the dead don't bury themselves', so too megaliths and megalithic monuments don't erect themselves. Understanding why they appear in the landscape when they do involves trying to understand, among other things, the social structures and subsistence modes underpinning everyday life. The Passage Tomb People project emerged out of the conviction that more could be made of current narratives of society in the centuries following farming in Ireland and Britain. In particular, there was more clarity and new data that could be brought to bear on models of social structure and power, and the roles of different human and non-human actors. The various PTP datasets are still being interpreted and integrated but below are some preliminary observations on what it might have meant to be part of communities of passage tomb builders along the Irish Sea in the later fourth millennium BC.

At a broad level, information from lipid biomarkers in pots and stable isotope values from enamel and dentine indicates that communities across the study areas were tapping into similar terrestrial, and milk-heavy, resource bases. Overlapping patterns between regions – e.g. Ireland-Wales, Ireland-Orkney – suggests at least some of this resource use is culturally embedded and socially reproduced, especially when viewed alongside existing archaeological evidence for shared cultural expression, e.g. pottery types. However, there are sufficient site-by-site differences to indicate that such resource use was not rigidly prescribed and may reflect specific site trajectories and/or particular environmental affordances. The low-level detection of aquatic resources, present in a few pottery assemblages, is intriguing and reasserts (or reinserts) the deeper value of seaways and waterways for these communities, echoed in the location of passage tombs around the Boyne valley and Irish east coast and on Anglesey at Barclodiad y Gawres. Are these foodways that reemerge during this period, or has to date their earlier presence been masked by bulk collagen stable isotope data showing a shift to mostly terrestrial food sources?

The land of course remains important and results from Kilshane, the earliest conclusive evidence of cattle traction from Britain or Ireland, provide a glimpse of how involved and extensive interactions with the land may have been by the mid-4th millennium BC. While the enclosure at Kilshane is not a settlement context and it is difficult to tell how prevalent animal traction was, the presence of even these few working animals points to the existence of systems of farming that required, for example, the regular transport of manure or other heavy loads on one hand and the ongoing provision of fodder or pasture on the other hand (Isaakidou 2011). As discussed elsewhere (Pigière and Smyth 2023) it may also be significant that this evidence for traction appears at the same time as the earliest dated passage tomb architecture in Ireland, often in upland locations and requiring increasing labour inputs. Sequential strontium isotope data from the Kilshane cattle molars are showing a very large range in strontium isotope ratios indicating seasonal long range movement was being undertaken by at least some animals (C. Snoeck, pers. comm.) movement which was presumably shaped by and shaped human social networks, perhaps now extending further than before. While being cautious of circular reasoning, exploring how farming practice might create and sustain particular forms of sociality, and need particular forms of social moderation, can potentially provide better ways of explaining the passage tomb phenomenon than assuming the a priori existence of 'elites'.

Similarly, analysis of the burial deposits from passage tombs themselves is beginning to highlight the shakiness of the foundations of our models of social structure for this period. Of those few sites where, skeletal assemblages can be shown, or reasonably argued, to represent relatively intact sequences of deposition, the individuals selected for interment come from all age groups and both sexes. This demographic diversity is also reflected in the diversity of mortuary practice observed across sites, including instances of dismemberment and varying proportions of cremated to unburnt bone. Such diversity likely represents site- and community-specific histories, local unfolding of events, that will need to be properly placed within existing overarching models of 'passage tomb culture' and weighed against current arguments for late 4th millennium BC dynasties (e.g. Cassidy *et al.* 2020; cf Carlin *et al.* 2025; Smyth *et al.* 2025).

As with many projects, PTP has generated as many questions (if not more) as it has answered; results continue to be interpreted and project outputs will continue to appear over the coming months. They will hopefully provide some useful new directions, and useful new data, in tackling the complexity of this period and the entanglement of communities across the Irish Sea.

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Chapter 5
Funnel Beaker Culture megaliths in northern Germany. A comparison of architectural elements between three regions

Anja Behrens

Abstract

The megalithic graves of the Funnel Beaker Culture, erected in the 4th millennium BC, have a prominent place in the history of archaeological research. Beyond the large-scale inventories compiled by Ernst Sprockhoff in the 1930s, many regional research projects have investigated local sites and regional interconnections between sites. The focus, however, was primarily on the monuments as they appear in modern times and on the grave goods found inside the chambers. Within the past decade excavations have revealed much more complex structures and a greater diversity of megaliths at a local scale. In some cases, sets of specific constructional elements define a group of graves, while in contrast, there are also heterogeneous groups that have only single distinctive elements in common. These detailed insights allow us to draw conclusions about local burial traditions, while new 14C data and reconstructed biographies of such monuments are giving insights into their development through time. Within this contribution these aspects will be illuminated for the regions of the Elbe-Weser Triangle in western Germany as well as Western Mecklenburg and the island of Rügen in eastern Germany. Further intensive inquiry on the location of megaliths in these regions, including documents, historical maps, surveys, and LiDAR data, have led to more precise distribution maps. On this basis regional analyses of grave types and chronological correlations were carried out, demonstrating possible social interactions on a wide geographical scale.

Zusammenfassung

Die eindrucksvollen Monumentalgräber der Trichterbecherkultur aus dem 4. Jahrtausend v. Chr. nehmen in der Geschichte der archäologischen Forschung eine herausragende Stellung ein. Neben der großen Bestandsaufnahme von Ernst Sprockhoff wurden in vielen kleineren Forschungsprojekten lokale Standorte und regionale Zusammenhänge untersucht. Dabei ging es meist um eher oberflächliche Betrachtungen der Denkmäler, wie sie sich in der Neuzeit darstellen, und der Grabbeigaben in den Kammern. In den letzten zehn Jahren haben Ausgrabungen wesentlich komplexere Strukturen und eine große Vielfalt in der Architektur von Megalithgräbern auf lokaler Ebene zutage gefördert. Grabgruppen, die sich durch eine einheitliche Architektur auszeichnen, stehen im Kontrast zu heterogenen Gräberfeldern, welche teilweise nur durch einzelne architektonische Elemente miteinander verbunden sind. Diese detaillierten Einblicke erlauben Rückschlüsse auf die lokalen Bestattungstraditionen. Neue 14C Datierungen und der Nachweis von Nutzungsabläufen an Großsteingräbern erlauben zudem die zeitliche Entwicklung der TBK-Bestattungslandschaft nachzuvollziehen. Im Rahmen dieses Beitrags werden diese Aspekte für die Regionen des Elbe-Weser-Dreiecks in Westdeutschland sowie Mecklenburg und die Insel Rügen in Ostdeutschland beleuchtet. Weitere intensive Recherchen zur Lage der Megalithen in diesen Regionen unter Einbeziehung von Literatur, historischen Karten, Surveys und Lidar-Daten führten zu genaueren Verbreitungskarten. Auf dieser Grundlage wurden regionale Analysen von Grabtypen und deren zeitliche Entwicklung durchgeführt, die mögliche soziale Interaktionen in einem größeren Maßstab aufzeigen.

Keywords: Funnel Beaker Culture, megalithic grave, architecture, spatial distribution, social meaning

The megalithic graves located in northern Germany are attributed to the Funnel Beaker Culture (TRB, 4000-2800 cal BC) and most were built between 3600 and 3200 cal BC (Furholt and Mischka 2019). A development in architecture becomes perceptible, starting with non-megalithic long barrows around 3700 cal BC; approximately 100 years later, the first dolmens (*Urdolmen* and extended dolmens) emerged (ibid.). The small closed chambers had most likely been used for single or double burials (Midgley 2008). Still within the Early Neolithic (EN) phase II, the size of dolmens increased and the structures transitioned towards the open-chambered dolmen (*Großdolmen* – great dolmen), a shift accompanied by a change in the burial tradition towards collective practices. After a *hiatus* of at least 50 years the most elaborate monuments were constructed in the form of passage graves (Furholt and Mischka 2019). The main distribution of megalithic monuments in Germany lies within the modern states of Lower Saxony, Schleswig-Holstein and Mecklenburg-Western Pomerania (Müller and Sjögren 2022: figure 1), which represent the northernmost areas of the country. Through intensive research in the past decade, records of more than 11,000 preserved megalithic and non-megalithic graves have been collected, although an even higher number can be expected (Müller

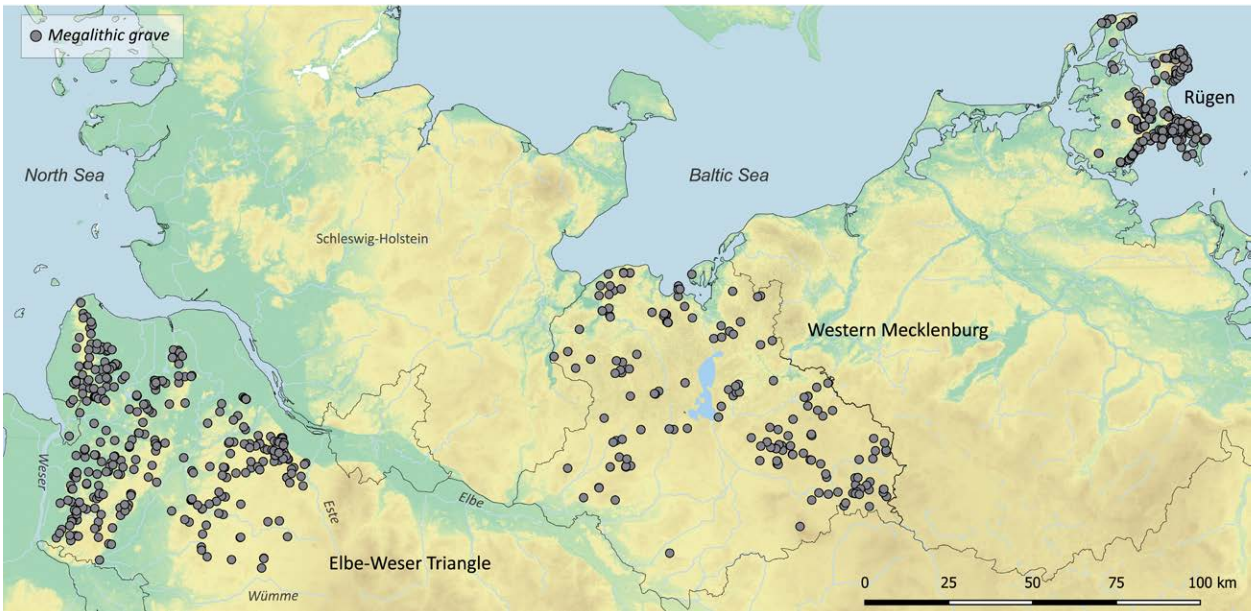

Figure 1. Map of northern Germany including the study case areas of the paper with its recorded megalithic graves.

2019: 34). This impressive number reflects intensive settlement activities and landscape shaping by the TRB over a very wide area. Analysing the architectural style and construction techniques of these megalithic monuments can play a key role in understanding how the people of the TRB were organised and anchored in social networks. This could complement already existing artefact studies (e.g. Brandt 1967; Laux 1991; Lorenz 2018), that have been further characterised through investigations of flat graves (Kossian 2005), settlements (e.g. Brozio 2016; Mennenga 2017) or enclosures (Klatt 2009; Hage 2016). So far, the focus of megalithic studies in northern Germany has been mainly set on single investigations at local and regional levels (e.g. Brozio 2016; Hage 2016; Menne 2018). Wider datasets, e.g. those presented by Laux (1991) and Schuldt (1972), lack analytical evaluation of the architectural descriptions and data is incomplete.

The present contribution represents a first attempt at a comparative study of the megalithic architecture of the Elbe-Weser Triangle (Lower Saxony), and Western Mecklenburg and Rügen (both Mecklenburg-Western Pomerania; Figure 1). By concentrating on the chronological development of megalithic structures and activities at the sites, as well as on differences and similarities in constructional elements, it is possible to discern local, regional and supra-regional traditions and variations that can be attributed to social factors, aspects of which will be presented in this paper.

Research history

A good overview of megalithic studies, especially the architecture of the monuments, was given by Midgley (2008), acknowledging however that Sprockhoff's typology (1938) of megalithic grave types, based mainly on datasets acquired in the 1930s, is still valuable in modern research. Sprockhoff's atlases (1966, 1967 and 1975) provide the foundations of megalith distribution and monument construction that have been used widely since then. But more recently, excavations at sites in northern Germany have led to new insights, especially in relation to architecture (Laux 1991; Rassmann and Schafferer 2012), revealing much more complex constructional sequences than had been recognised before. In Mecklenburg-Western Pomerania a large-scale investigation of 104 megaliths was conducted by E. Schuldt (1972) in the 1960s, who noticed different distribution patterns for individual grave types. Schuldt also described the variation of individual chamber constructional elements and retrieved a collection of artefactual material which is the basis of numerous more recent typo-chronological studies (e.g. Nilius 1971, Lorenz 2018). His input was enormous and gave the impulse to further studies in surrounding areas. In the 1960s to 1980s investigations followed in Lower Saxony (Schirnig 1975) and Schleswig-Holstein (e.g. Hingst 1985). But unlike in Mecklenburg-Western Pomerania, the excavations in Lower Saxony had not been undertaken within the framework of research projects and were carried out under different field archaeological conditions. Therefore, the dataset is much smaller and includes heterogeneous descriptions at a relatively individual level. Nevertheless, relying on this data Laux (1991) identified community and network patterns on a regional scale for this area, while Schuldt did not draw any further conclusions – leaving aside social aspects. Within the past decade a new project, led by Johannes Müller and Friedrich Lüth and funded by the German Research Foundation, has aimed to update TRB studies (Müller 2012). The priority program (SPP 1400) 'Early monumentality and social differentiation' included excavations of megalithic sites in the different areas of northern Germany, integrating various scientific methods. The result is the identification and reconstruction of complex biographies of megaliths at different sites (e.g. Behrens 2014, Brozio 2016, Dibbern 2016, Hage 2016). In Lower Saxony, settlement investigations were an important focus of attention (Mennenga 2017), closely linked to the evaluation of earlier excavations in the western region (Menne 2018). New insights into the construction and phasing of megaliths were gained within a separate project initiated by Moritz Mennenga and conducted by the Lower Saxony Institute of Coastal Historical Research (NIhK) in the years 2019-2022. Here three megalithic sites located in the bog of Ahlen-Falkenberg, dist. Cuxhaven, were partially excavated, revealing almost undisturbed features and well preserved original architecture (e.g. Behrens *et al.* 2022, 2024). Overall, the level of data available for the north German TRB has increased considerably, allowing preliminary conclusions on the role of social interactions and social structure over a period of more than 1000 years (Müller 2019). Throughout, megalithic monuments play an important role as, due to their prominence, these features are accessible for archaeological investigation. Within the SPP 1400, data on the distribution, architecture and artefactual material were collected and integrated in the database 'Megaform' with the aim of correlating different elements and characteristics of megaliths at the same level (Rassmann and Schafferer 2012). Unfortunately, the results have not yet been fully published (Rassmann and Schafferer 2012; Schafferer 2014).

Case studies: Elbe-Weser Triangle, Western Mecklenburg, and Rügen

The landscape of northern Germany is characterised by Pleistocene and Holocene processes, shaping a slightly hilly relief interspersed with wetlands as well as alluvial valleys with high paludification rates. Especially in the 5th and 4th millennium cal BC, there was massive bog growth in the western area of northern Germany (Behre 2008). Here also the North Sea coastline was well seaward of its present line creating a larger coastal litorral that had great influence on the shores and the people living there. By contrast, the Baltic Sea shore was characterised by stable or slowly rising water levels (Hartz *et al.* 2014).

The *Elbe-Weser Triangle* is edged by the rivers Elbe and Weser and represents the north-eastern part of Lower Saxony (see Figure 1). To the south the rivers Wümme and Este form a natural border, encompassing an area of approx. 7000km². The region corresponds to the modern districts of Cuxhaven (CUX), Osterholz (OHZ) and Stade (STD), and part of Rothenburg/Wümme (ROT). Today the area is characterised by *geest* (i.e. sandy elevations), peat and marsh. Most of the 400 known megalithic graves are located on the geest; only a small proportion (2%) can be found in wetland locations.

The area of *Western Mecklenburg* (approx. 7000km²) is enclosed by waterways and moraine ridges (Behrens and Darvill 2021: 131). To the north the Baltic Sea forms a natural boundary, to the south the river Elbe and smaller creeks form the border with Brandenburg. To the west the waters of the Ratzeburger, Mechower and Lassahner lakes mark the line of the state of Schleswig-Holstein, while the eastern boundary is defined by the network of rivers and creeks of Mildenitz, Radebach and Teppnitzbach. It encompasses the modern districts of Nordwestmecklenburg (NWM), Wismar (HWI), Schwerin (SN) and Ludwigslust-Parchim (LUP). In contrast to the Elbe-Weser Triangle the soil variation is much more diverse, as here the last glacial period brought fresh soil deposits, while the ice did not extend as far as to Lower Saxony. In common, though, is the high frequency of damaged and destroyed megalithic monuments, with records of altogether 238 sites being found so far (Behrens and Darvill 2021).

Last but not least, the *island of Rügen* represents the final case study in this paper, and differs from the other regions in many ways. Part of the district Vorpommern-Rügen (VR), Rügen is an island within the Baltic Sea and has been separated from the adjacent mainland since the Littorina transgression (Lampe *et al.* 2007). While its eastern part is characterized by moraine ridges and tectonically uplifted chalk plates, the west is levelled by fluvial sand. The whole island is rich in water holes and creeks, with a concentration of boggy areas in the centre. On this island of almost 1000km² more than 400 megaliths are known.

Data collection and analyses

The distribution of recorded megalithic monuments presented in this paper is based on the different databases assembled by the various state-based heritage offices (denkmalGIS Heritage Department Mecklenburg-Western Pomerania and ADABweb of the Heritage Department Lower Saxony). Here, the records have been compared and cross checked with documentary descriptions and historical maps in order to increase comparability. In the case of Rügen, LiDAR data were also checked, and field inspections carried out. Geomagnetic surveys complemented this evidence for south-east Rügen and the necropolis of Wanna, dist. CUX (Behrens *et al.* 2022). Altogether 1051 recorded megalithic monuments could be identified (Table 1), representing the most precise and elaborate dataset of TRB megaliths from any of the three case study areas

type/region	EWT	EWT (unsure)	WM	WM (unsure)	RÜG	RÜG (unsure)	
Urdolmen	-	-	15	7	1	6	**29**
extended/poly-gonal dolmen	7	3/3	10/2	4/2	8	3	**42**
great dolmen	-	1	5	7	210	10	**233**
passage grave	67	21	12	5	1	-	**106**
chamberless long barrow	-	-	18	-	-	1	**19**
undef.	215	53	103	23	120	48	**562**
necropolis	6	-	5	-	-	-	**11 × 5**
	319	**81 (20%)**	**195**	**48 (20%)**	**340**	**68 (17%)**	**1051**

Table 1. Megalithic types of the case study areas in numbers
(EWD – Elbe-Weser Triangle, WM- Western Mecklenburg, RÜG – Rügen).

available to date. In sum, the percentage of uncertain types is relatively equal between the three areas, which allows a high comparability between the different data sets. They comprise all the types of megaliths defined by Sprockhoff (1938), although distributional differences become obvious when looking closely at the numbers. The types used in this study include: non-megalithic long barrows, *Urdolmen*, extended dolmens (including polygonal dolmens), great dolmens, and passage graves. Local sites with destroyed groups of megaliths are listed as a necropolis. As the number, where given, varies between two and eight, an average of five monuments is used in the calculations presented below (see Behrens and Darvill 2021: 132). Thus, by calculating the number of monuments divided by the size of the research area the density of recorded sites for Rügen is much higher (0,4/km²) than for the other two regions (0,06/km²), which might reflect different archaeological data sources rather than true differences in the construction activities of the TRB megalith builders. Thanks to Friedrich von Hagenow (1829) and his 'Special Charte' a map of Rügen including a great number of archaeological sites is available, giving an idea of the original density of megaliths and a base for calculations of the original numbers of megaliths in the TRB area as a whole (Müller and Sjögren 2022). It also shows the enormous level of destruction and violation of the sites over the past 200 years, which was done, amongst other things, in order to clear space for agricultural activities or to extract materials for construction work in fast-developing communities (Behrens and Hüser 2021). Today, within the research area, over 50% of the known TRB megalithic graves are destroyed or at least not visible above ground any more. Further, most of the still visible sites show disturbance, limiting the description of constructional elements and the reliability of their classification (see Table 1). Here the Elbe-Weser Triangle shows the greatest impact of destruction. Excavations and reports have been carried out only on a small scale (e.g. Rügen 12%; Schafferer 2014: 92, figure 1) and mostly on already disturbed monuments. Investigated sites with original, preserved architecture are limited to single sites such as Wanna, dist. CUX (Behrens *et al.* 2024).

Accordingly, the dataset acquired for this paper is mostly limited to location, but this allows important conclusions on the distribution and size of necropoleis, which can be made visible by simple mapping. Further descriptions of the construction types are available for almost half the sites, giving information on the necropoleis' composition and regional chronological development. Where more detailed components had been described, architectural elements were recorded separately in order to ensure an objective perspective for comparison and statistical analysis.

The analytical focus in this paper lies on the one hand on spatial distributions. For this, maps have been created in QGIS, to allow density illustration heatmaps to be generated. On the other hand, constructional elements were compared at regional and local scales using boxplot charts and scatterplots calculated in R (version 4.4.0; Wickham 2016).

Spatial and chronological distribution - a skip through time

Examining the distribution of megalithic graves in the three study areas, several aspects become apparent. First, a varying density of megaliths within the regions is apparent (Figure 2). While some areas show high numbers of megalithic graves others are less distinct or show a complete lack. An explanation for this could be seen in the natural environment, which excludes less accessible areas such as bogs, and regions with difficult-to-reach building material, like the fluviatile and sand covered areas of southwestern Mecklenburg or western Rügen. Second, a different emphasis of megalithic types becomes visible (see Table 1). Schuldt (1972) already pointed this out, as he noted the dominance of great dolmens on Rügen (Figure 3), while in Western Mecklenburg (Figure 4) local clusters of certain types are recognisable as well as mixed areas (see also Rassmann and Schafferer 2012). For the Elbe-Weser Triangle (Figure 5) passage graves are most frequent with an absence of very early types (non-megalithic long barrows and *Urdolmen*; Laux 1979). This suggests a differential development of megalithic traditions

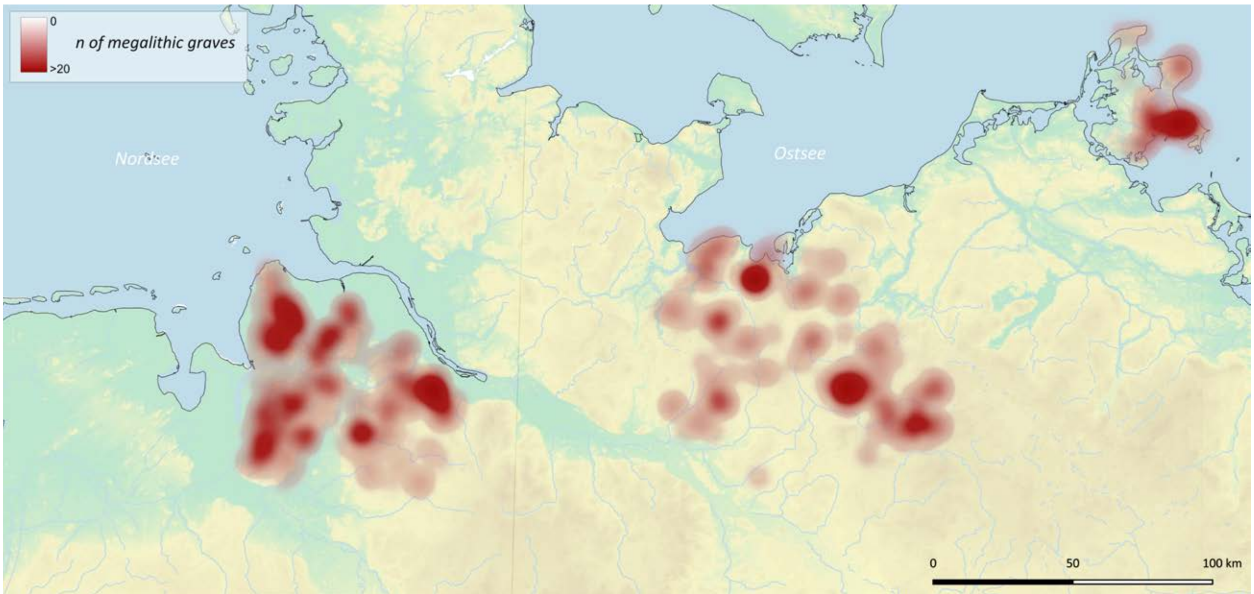

Figure 2. Heatmap on the density of megalithic grave distribution within the study case areas (heatmap by QGIS, radius 5km).

across the north German TRB area – a possibility that is further explored in the following analyses.

Building of non-megalithic and megalithic graves, ongoing activities

The typo-chronological studies of TRB megalithic types by Furholt and Mischka (2019) allow a simple mapping of monuments linked to different time-spans. The time slices chosen are based on the chronology of megalithic types classified by Furholt and Mischka, on dated features, and on artefacts connected to the sites, thereby creating three categories (absolute dates from Müller *et al.* 2010):

A – EN Ib 3800-3600 cal BC
- Types erected : non-megalithic long barrows (green in Figure 6)

B – EN Ib/EN II 3600-3400 cal BC
- Types erected: *Urdolmen*, extended, polygonal and great dolmens (red in Figure 6)

C – EN II/MN I/II 3350-3200 cal BC
- Types erected: passage graves (blue in Figure 6)

Continued activities at great dolmen sites according to evidence of features and artefactual material (orange in Figure 6)

Only typologically classified graves are included in the analyses (see Table 1), reducing the number of sites to approximately 50% of all known megalithic graves. Especially for the region of Western Mecklenburg the database is stretched to the limit and conclusions should be considered highly provisional. Still, some insights into the chronological development of burial sites and regions can be obtained (Figure 6: 1-3).

The ***first evidence*** of TRB-monumental graves in the study areas come from the region of Ludwigslust, Western Mecklenburg, where a number of non-megalithic long barrows have been recorded (Behrens and Darvill 2021; Figure 6, Category A). Due to the lack of datable material – most sites had been destroyed in the 19th century – a confirmed dating is missing. But according to Furholt and Mischka (2019: 928, figure 8) construction within the Early Neolithic (EN) phase Ib can be assumed. This correlates with the only securely dated non-megalithic long barrow known from Rügen at Pastitz/Forst 53. Its mound was dated to approximately 3700 cal BC (Behrens 2020).

With the ***transition to the EN phase II*** increased building activities can be seen in the number of dolmens (see Table 1; Figure 6, Category B). In Western Mecklenburg and Rügen most megaliths were built in this period (WM – 48%, Rügen – 99%). In contrast to this, only 7% of the classified megaliths in the Elbe-Weser Triangle are identified as dolmens. While in most areas only single or double burial sites are present, two concentrations are visible in this region. At Stintstedt seven dolmens have been described, although today all but one is destroyed and investigations have not been carried out so far (Laux 1970). The site of Bliedersdorf is extraordinary for this region, in that it includes four extended dolmens in close proximity to one-another (Deichmüller 1972). In Western Mecklenburg, the largest megalithic grave cluster is located in the Everstorfer Forst (Schuldt 1970), where seven *Urdolmen* and three extended dolmens

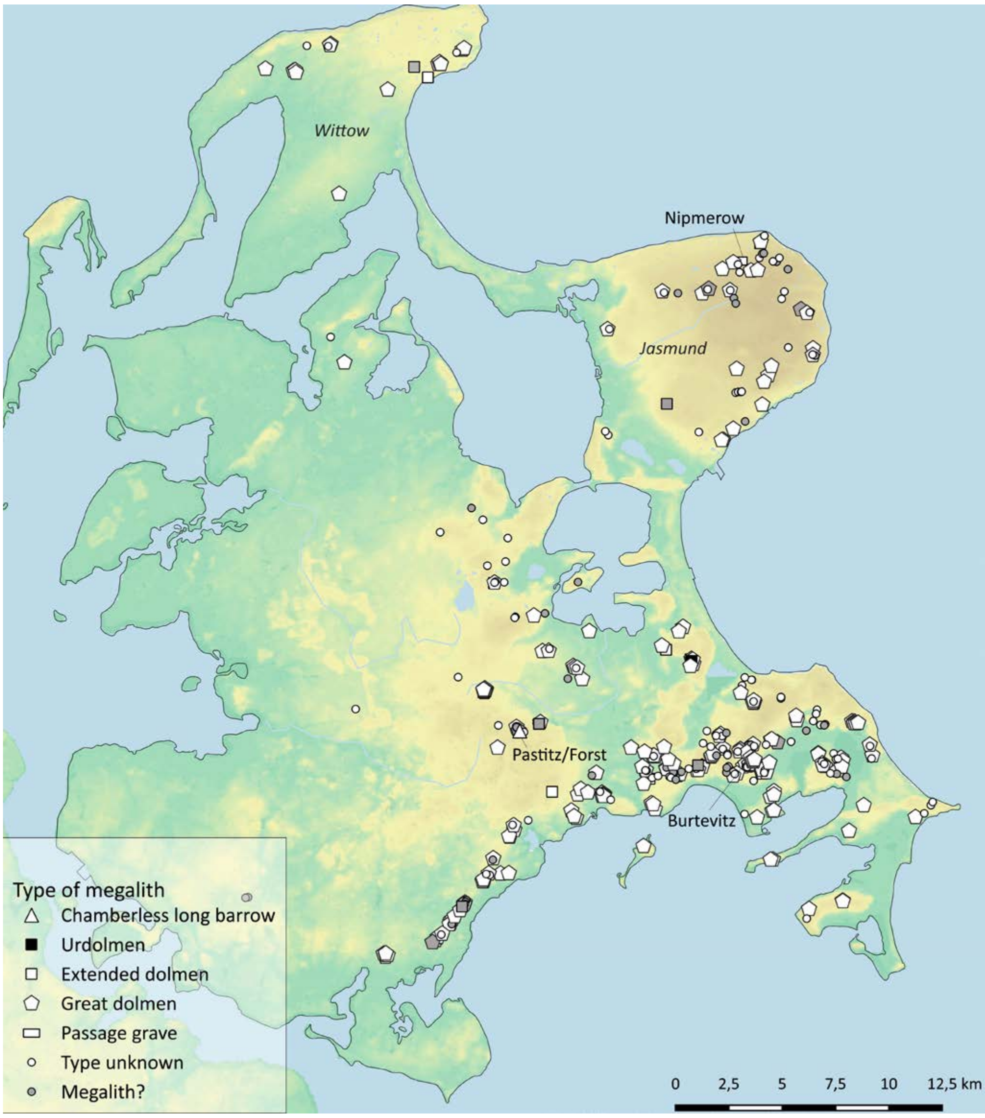

Figure 3. Distribution of megalithic grave types in the case study area of Rügen with sites mentioned in the paper (data from: denkmalGIS Heritage Department Mecklenburg-Western Pomerania, literature, prospections and historical maps).

form a relatively consistent burial landscape within a range of 1km (Behrens and Darvill 2021, 137). Just two kilometres to the south a second group (Naschendorf) was created including at least one of each of the three dolmen types (Behrens and Darvill 2021). The other dolmen sites are spread over the region in lesser numbers and constitute more diverse burial areas in regard to their types. Overall building activities can be assessed for the north, middle and east of the study region. To the south and southeast on the other hand no secure megalithic burial practices attributable to EN phase II have been so far identified. At the site Wittenburg/Klein Wolde 15 a megalithic chamber within a long barrow was described in 1839 (Ritter 1839), implying persistence of building traditions also in this region. By contrast, building activities are continuous on Rügen. Close to the site of Pastitz/Forst 53 several dolmens were built (see Figure 3). Furthermore, thanks to the database created by von Hagenow (1829) a boom in megalithic building activity is recognizable on the island of Rügen. Most dolmens concentrate in the south of the region; further north their number significantly declines. As mentioned above, the majority of the megalithic grave types on Rügen are great dolmens.

From the ***start of the Middle Neolithic (MN) phase***, dolmens were no longer built; passage graves were instead introduced (Figure 6, Category C – blue). Nonetheless, burial traditions continued at dolmens (Figure 6, Category C – orange). This is evident, for example, from the many pottery vessels found within and around the dolmen chambers, particularly those associated with the great dolmens, which are linked to MN phases I-V (Lorenz 2018). Further, external structures such as round and long barrows can be related to ongoing building activities. On Rügen the mound of the great dolmen Burtevitz 1 consisted of at least three layers, the upper two dating to the MN III-V (Behrens 2014). As for the long barrows, a chronological classification might be difficult as at least some of them fall within the initial megalithic period of the TRB (see Furholt and Mischka 2019), whereas others were

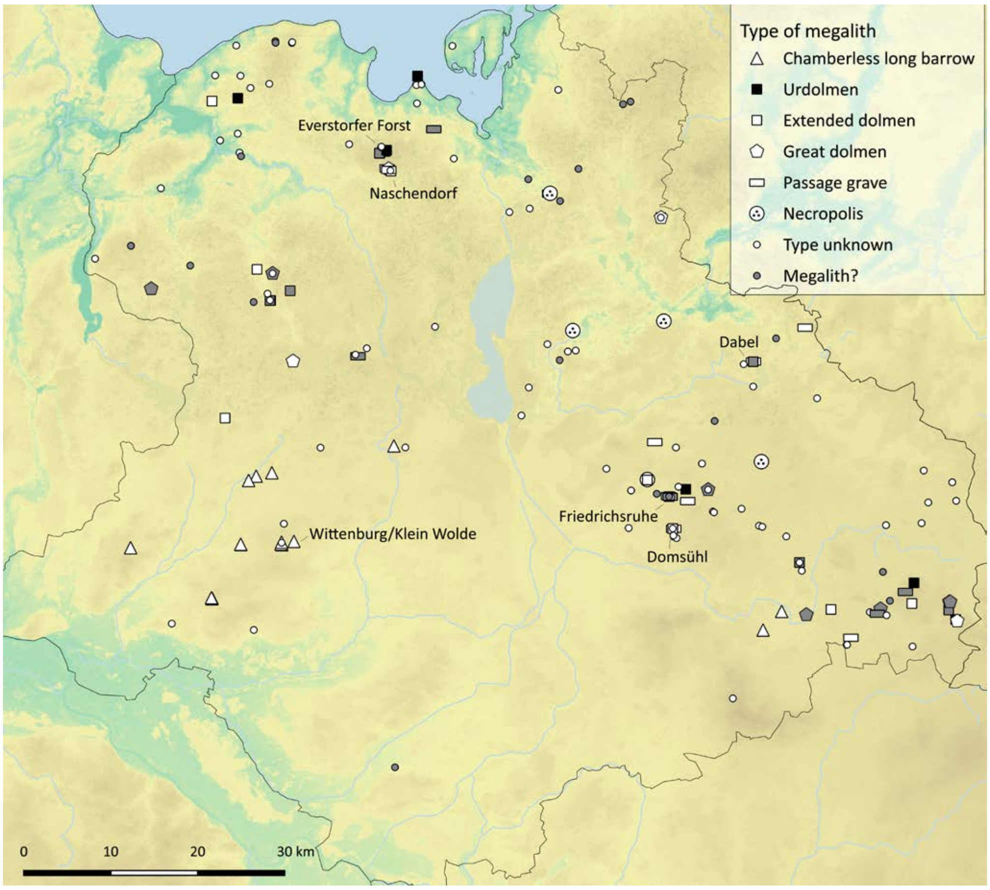

Figure 4. Distribution of megalithic grave types in the case study area of Western Mecklenburg with sites mentioned in the paper (after Behrens and Darvill 2021: Fig. 8).

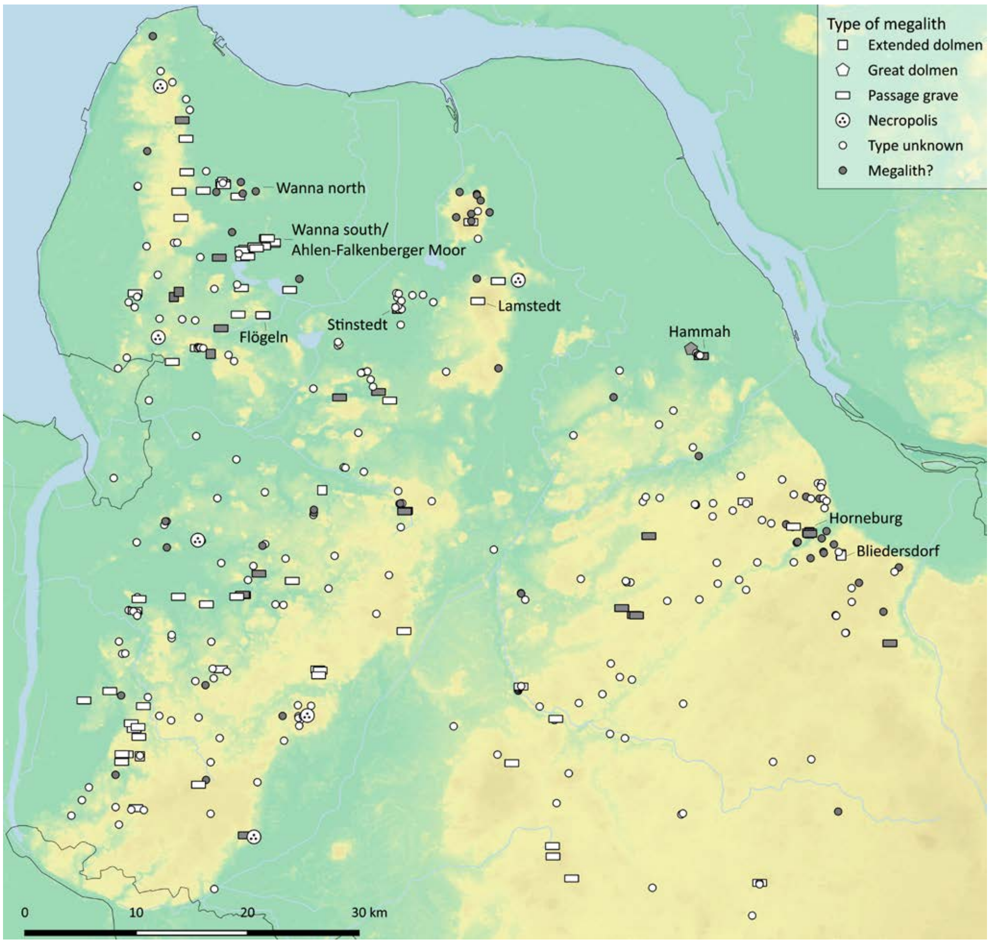

Figure 5. Distribution of megalithic grave types in the case study area of the Elbe-Weser Triangle with sites mentioned in the paper (data from: ADABweb, Heritage Department Lower-Saxony, literature, prospections and historical maps).

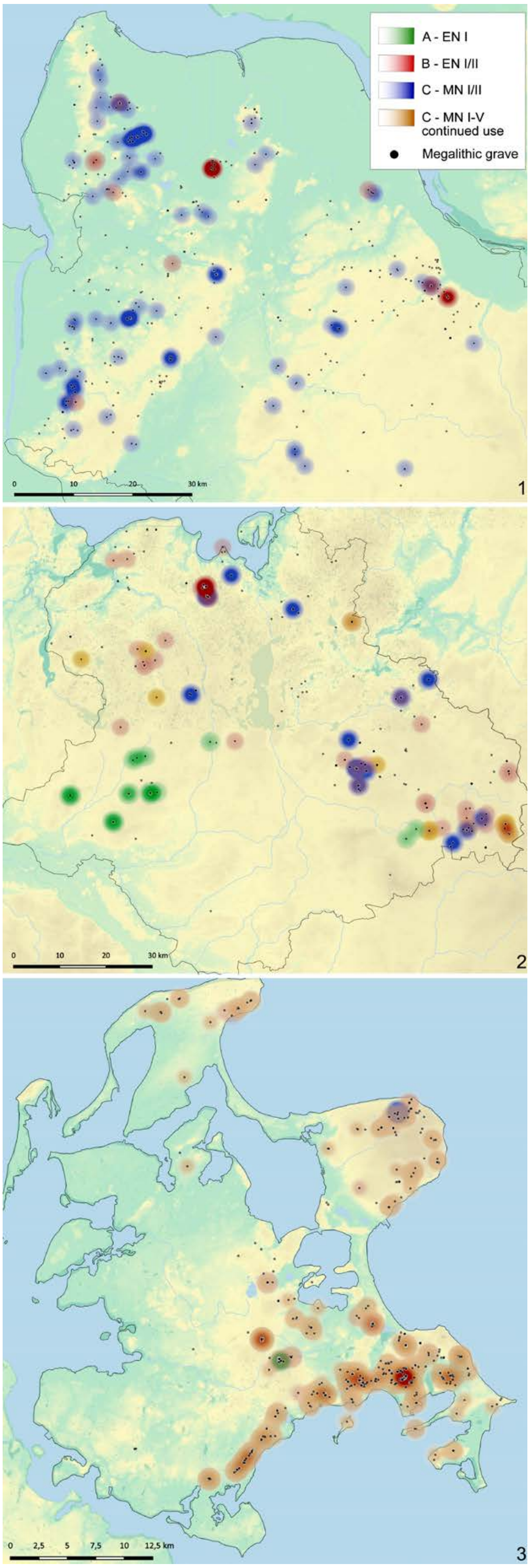

Figure 6. Heatmap of the chronological categories A-C described in the text. 1 – Elbe-Weser Triangle, 2 – Western Mecklenburg, 3 – Rügen (heatmap by QGIS).

newly constructed or at least rebuilt after the chamber erection (e.g. Brozio 2016: 159; cf. Mischka 2022: 233). In the Elbe-Weser Triangle, round barrows would seem to be closely linked to passage grave construction (Laux 1991). Within the bog-covered landscape of Ahlen-Falkenberg (Wanna south) all passage graves are free of external structures, which is rather an exception for this area. This may be due to the abandonment of the nearby settlement site around 3000 cal BC (Behrens *et al.* 2024), indicating that external structures had been built sometime after the megalithic chambers. Direct evidence of ongoing activities at *Urdolmen* or extended dolmens is missing. So far, no finds or dated features are present to allow any conclusion on that point. The only clue comes with the construction itself as at least some extended dolmens are re-accessible and might have been used multiple times (Behrens and Darvill 2021). As this has not been proven so far, however, only great dolmens will be included in category C to represent continuing burial practices at these sites.

Turning now to the distribution of MN activities at megalithic burial sites, a differentiated picture of burial traditions is visible: In the Elbe-Weser Triangle a boom in megalithic construction is recognisable with 88 recorded passage graves (93% of total classified sites). Laux (1991) suggested a single burial phase for all megalithic graves in this region. However, recent excavations in Wanna demonstrate multiple burial phases at passage graves (Behrens *et al.* 2024). Nonetheless, continuous burial activities at the dolmens have not been proven so far, as both investigations and material culture are missing. In sum, only the distribution of passage graves provides some evidence for megalithic burial traditions during this period. On the map, numerous passage graves are visible in the north and southwest as well as in the southeast. Groups of up to 12 passage graves (Wanna south) can be located, some of them integrating dolmens like the groups at Wanna north, Hammah or Horneburg. On the other hand, a clear spatial separation of dolmen and passage grave sites becomes apparent.

A similar picture can be drawn for Western Mecklenburg. While in the southeast no clear evidence of megalithic burial activities is visible, the areas north of Ludwigslust show separation between existing and newly established burial sites. The only exception can be found in the Everstorfer Forst, where within the grave group of Naschendorf at least two passage graves had been included (Behrens and Darvill 2021: 138). Such an extension of megalithic grave sites seems to be typical for the southwestern region of Western Mecklenburg. Here, the implementation of new burial traditions is visible at sites like Domsühl (Hollnagel 1965), Friedrichsruhe (Schuldt 1973) or Dabel (Sommer 1967), where passage graves had been erected. On the other hand, practices continued at already established places if we assume that the great dolmens here had been used multiple times.

Lastly a completely different picture becomes apparent for Rügen. Here the erection of new megalithic graves is of less importance as only one passage grave (Nipmerow – Rennebach 1986) is known so far. It is rather the continuity of burial use at established sites that seems to play the key role. In addition to repeated deposition of vessels and other artefacts inside the chamber, the building of external structures has been identified (see above).

Diverse architectural styles in three regions of northern Germany

Overall, during the hundreds of years of activities at megalithic grave sites, different intensities and traditions are recognisable within and between the three case study areas.

On the one hand the distribution of megalithic types varies considerably within the study areas, but on the other hand the types themselves impress by uniform construction techniques and reflect a widespread TRB network. Was there a general blueprint passing between groups in the TRB region? Are there regional and or even local varieties that allow some conclusions about social networks and entities that are just as visible as those in the pottery decoration styles? By taking a closer look at some detailed constructional elements it is possible to test whether interactions become more visible and to what extent individuality was expressed. For this, different constructional elements will be analysed and compared in order to investigate the relation to local, regional, or supra-regional impact.

Regional and supra-regional patterns

Common to all areas are ***protective external structures***. On Rügen, the site of Burtevitz displays a compact clay packing directly on the top of the boulders, that are again covered by a further stone layer (Behrens 2014). At the site of Friedrichsruhe in Western Mecklenburg a compact stone layer was found surrounding the chamber of an extended dolmen (Behrens 2018). Similar construction, but more elaborate, is found at the passage graves of Wanna south (Behrens 2024). Midgley (2008) considered this element a standard component of TRB megalithic construction, as similar observations are known from Denmark (e.g. Dehn 2019) and Schleswig-Holstein (e.g. Wunderlich 2014). In sum, the presence of protective external structures itself is supra-regional, while the execution would seem to depend on local material and tradition. A similar observation was made by Rassmann and Schafferer (2012) regarding the design of ***chamber floors***. While on Rügen materials such as clay, red sandstone slabs, and flint played a major role, in Mecklenburg floors made of pebbles as well as flint and clay dominated (Rassmann and Schafferer 2012: 118, figure 7). In the Elbe-Weser Triangle, cobbled floors are recorded in the majority of chambers while in only a few cases crushed granite or flat slabs were used (Figure 7). For the chamber shape itself a rectangular ***groundplan*** is dominant in all case study areas regardless of the megalithic grave type (Table 2). Trapezoidal groundplans are rather rare and

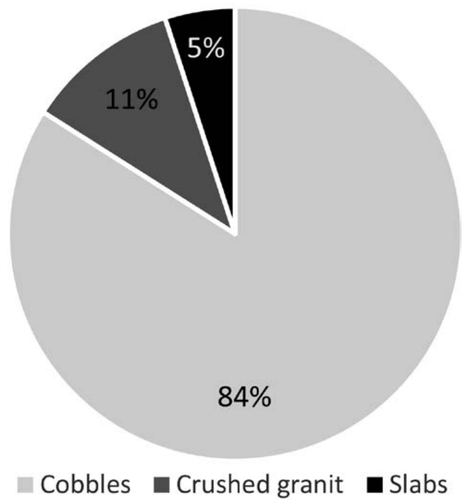

Figure 7. Chamber floor material used in megalithic graves in the Elbe-Weser Triangle.

construction parameter/region	*EWD*	*WM*	*RÜG*
outside construction	yes	yes	yes
chamber floor	stone, crushed granite	stone, burnt flint, clay	red sandstone, clay, flint
chamber shape (rectangular/trapezoid)	77/7	36/6	43/6
preferred chamber orientation of collective graves (great dolmen & passage graves)	E-W (62%)	homogeneous	N-S and E-W (each 31%)
quaters in collective graves (great dolmen & passage graves)	yes (rare)	yes (frequent)	yes (frequent)
max. chamber size (length in m) collective graves (great dolmen & passage graves)	14.1 (passage grave)	8.2 (passage grave)	7.0 (great dolmen)

Table 2. Overview on megalithic construction elements with the case study areas Elbe-Weser Triangle (EWD), Western Mecklenburg (WM) and Rügen (RÜG).

are only associated with collective burial monuments. Furthermore, the grave chambers of great dolmens and passage graves on Rügen and in Western Mecklenburg were segmented by upright standing slabs, creating separate compartments (Schuldt 1972). So far, this architectural element appears rare in the region of the Elbe-Weser Triangle (e.g. Flögeln; Sprockhoff 1975: 5).

The ***orientation*** of the different megalithic types shows a diverse picture (Figure 8). For the non-megalithic long barrows of Western Mecklenburg an east-west-orientation is dominant, and this preference returns with the collective burial types. In the Elbe-Weser Triangle, in particular, 62% of the passage graves share this same orientation. On Rügen the number of E-W oriented great dolmens and passage graves equals those oriented N-S (both 31%). Furthermore, N-S as well as NW-SE and NE-SW seem to be the preferred orientations applied to *Urdolmen* and extended dolmens in all regions. Just as for the Elbe-Weser Triangle and Rügen, clear preferences are also visible in the orientation of megalithic chambers in Western Mecklenburg which show a wide variety in the different types at a regional scale.

Chamber length also seems to have been a decisive element of distinction among *collective grave types* (great dolmens and passage graves). Chamber lengths are available for 48 great dolmens and 64 passage graves. Starting with great dolmens, a very similar level of variation (median 4.0m) is visible for Rügen and Western Mecklenburg (Figure 9a). With the passage graves an increase in size becomes apparent as for Western Mecklenburg the median is 7.0m (Figure 9b). In the Elbe-Weser Triangle smaller passage grave chambers were erected on average (median 6.0) but show a much wider range in comparison to Western Mecklenburg. And the only recorded passage grave from Rügen correlates in size with those of the great dolmens. By contrast, the chamber length of the different grave types in Western Mecklenburg shows almost no overlap but instead a clear distinction (Figure 10).

Taken as a whole, some architectural elements such as external protective structures or chamber groundplans are clearly of supra-regional importance, but others such as chamber floor material or chamber sizes show regional patterns. In order to distinguish regional characteristics from micro-regional variations the focus will now be set to a more local scale (in terms of local region not local sites).

Local variation of chamber lengths of collective megalithic graves

When it comes to comparison at a local scale, the size of the dataset increases steadily. In order to make a reliable analysis representing the local regions the

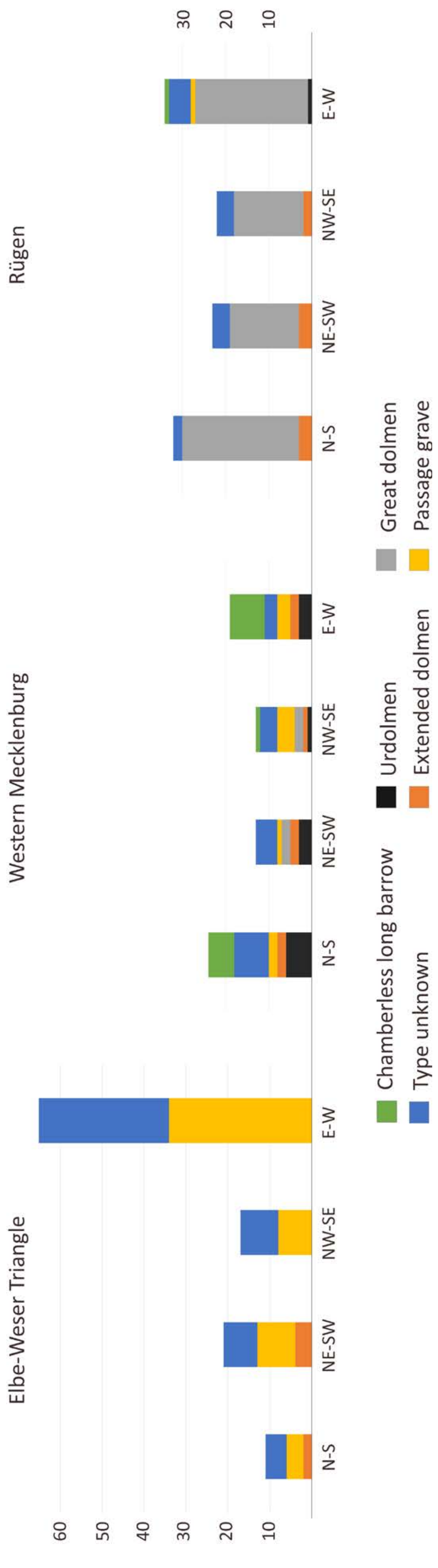

Figure 8. Chamber orientation of the different megalithic types according to the three study case areas.

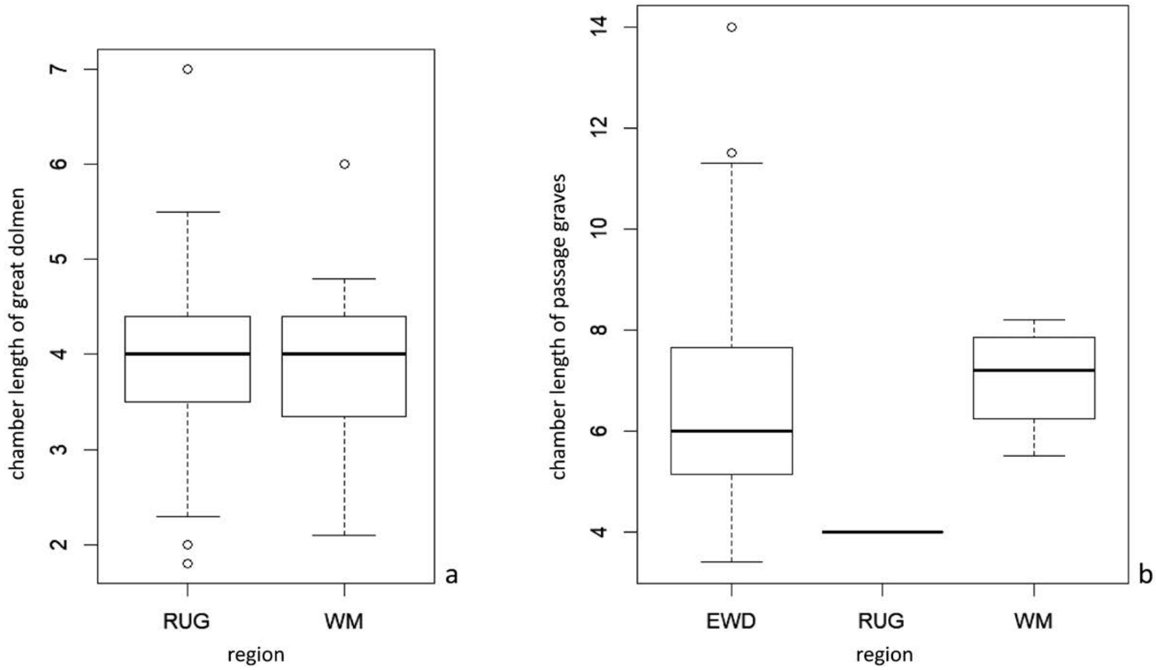

Figure 9. Statistical analyses on the chamber length of collective burial TRB graves. a – great dolmen, b – passage grave, RUG – Rügen, WM – Western Mecklenburg, EWD – Elbe-Weser Triangle (analysis by RStudio).

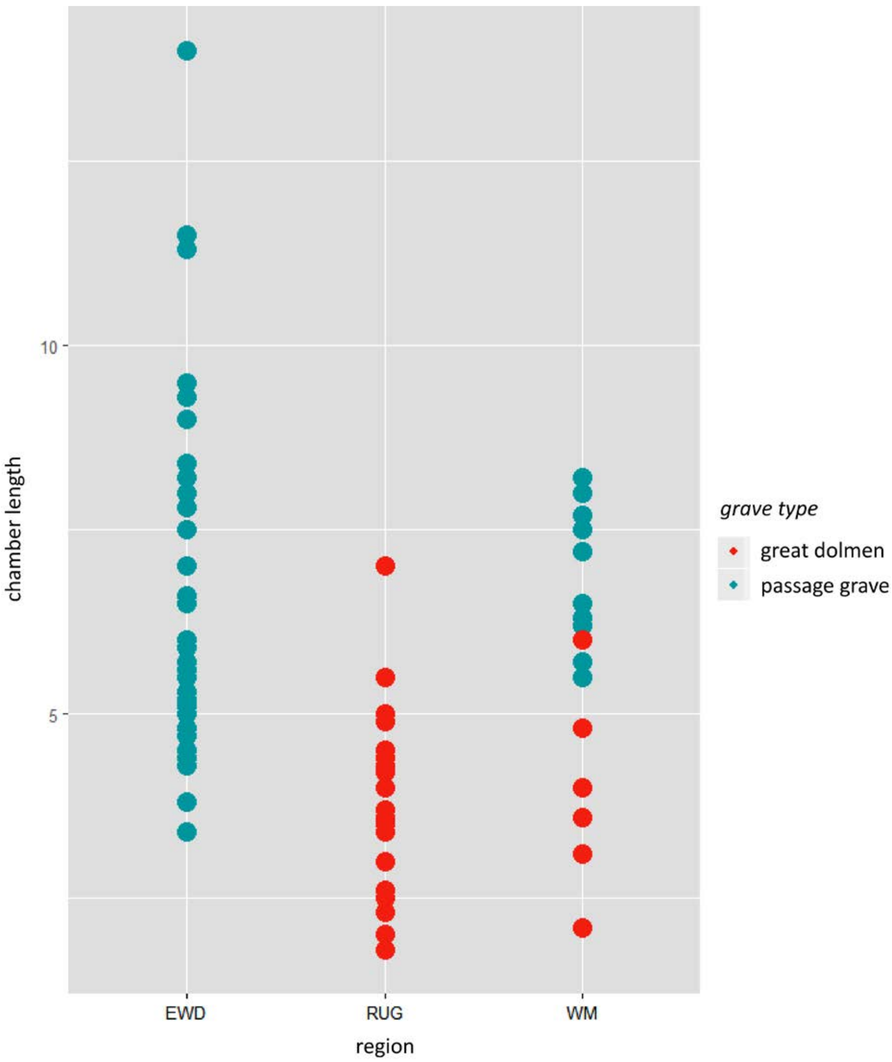

Figure 10. Distribution of chamber length of collective burial TRB graves within the three study case areas (for abbreviation see Figure 9, analysis by RStudio - ggplot).

chamber length of collective graves provides a good starting point. Altogether, from each local area at least 7 sites are recorded.

Elbe-Weser Triangle

Chamber lengths have been recorded for 51 sites in this region (Figure 11 A1). The sites are located on three different geest ridges, which have been used to identify three separate local regions in these analyses: the North-West group (NW) comprising 17 sites, the South-East group (SE) with 7 sites and the South-West (SW) group with 26 sites. The boxplots suggest that while the NW and SE groups encompass rather small chambers with a similar range between 4.5-6.0m (median 5.3/5.5) the number of longer chambers is much higher for the SW group (up to 14m, median 7.3; Figure 11 A2). This observation confirms that local differences subsist between micro-regional groups. The site of Lamstedt, which is located on a fourth geest ridge in the NE of the Elbe-Weser Triangle, represents an outlier as its chamber length of 4.5m would allow for an attribution to both the NW and SE groups.

Western Mecklenburg

Records for this region provide chamber lengths of only 19 sites in total (great dolmens = 8; passage graves = 11). Their geographical distribution furthermore is patchy, hindering a clear distinction between local clusters (Figure 11 B1). For the sake of comparison, at least on a minimal scale, a horizontal line was drawn across the middle of the region, creating a coast-related North (n = 9) and South group (n = 10). The results (Figures 11 B2 and B3) suggest that people in the northern group built longer chambers, regardless of the general grave type, while people in the southern area built great dolmens of equal and passage graves of diverse chamber lengths.

Rügen

For Rügen the small number of known chamber lengths again hinders the clear distinction of smaller regional groups (Figure 11 C1). In the north, the Jasmund area comprises six great dolmens and one passage grave, forming a natural enclave. Further south, monuments are scattered along the coast with some exceptions in the centre of the island. This time, a vertical line was drawn following the eastern foothill of the Granitz range, forming a South-West group (SWR, n = 21) and a South-East group (SER, n = 13). The graphs displaying the statistical distribution of chamber lengths (Figure 11 C2) suggest nearly equal measurements for great dolmens in the micro-regions of Jasmund (median 4.1m) and South-East Rügen (median 4.0m). Further west, these size-values would seem to decrease (median 3.6m).

Overall, the analyses of chamber lengths at a micro-regional level indicates differences in the pattern of megalithic grave construction. For some local regions these are very clearly visible.

Discussion and conclusion

This article has focused on the chronological development and the regional diversity of megalithic grave construction. Starting with the **chronological aspect**, different developments are perceptible across the three case-study areas. While in Western Mecklenburg and Rügen, the first building activities began as early as EN phase I, in the Elbe-Weser Triangle, megalithic traditions were introduced only in EN phase II. This is not surprising, as the earliest evidence of the TRB West group is considered to fall around 3500 cal BC, roughly 500 years later than the North group (Mennenga 2017). During the period when dolmen types with inaccessible or only partially accessible chambers were constructed (*Urdolmen* and extended dolmens) a high activity level is noticeable in northern Western Mecklenburg. In contrast, only sporadic evidence is recorded in southern Western Mecklenburg, on Rügen, and in the Elbe-Weser Triangle. With the shift in burial traditions from single to collective burials, the situation changes again. A boom in the megalithic construction of great dolmens is evident on Rügen, where most of the monuments were erected during this period. In Western Mecklenburg, this new burial type was integrated into existing grave groups, continuing traditions at the same sites. In the Elbe-Weser Triangle, however, no secure evidence of great dolmens has been found so far, suggesting that the transition to collective burials here first occurred with the construction of passage graves. These were built extensively in this region, likely shaping the landscape for the first time. In Western Mecklenburg the construction of passage graves was continuous, whereas only one monument of this type has been recorded on Rügen. Nonetheless, burial activities at great dolmen sites persisted.

In summary, Rügen and the Elbe-Weser Triangle show a slower start in megalithic grave building activities associated with single burials. However, with the shift to collective burial traditions, hundreds of monuments were constructed, focusing on one specific type that was continuously used until the end of the TRB. In Western Mecklenburg the situation is different, with consistent activities over time, although the centre of these activities shifted within the region.

When considering more ***detailed construction patterns,*** both differences and similarities between the three case study areas become apparent. Each region shows distinct preferences in the design of chamber floors, yet there are overlaps between regions in certain floor

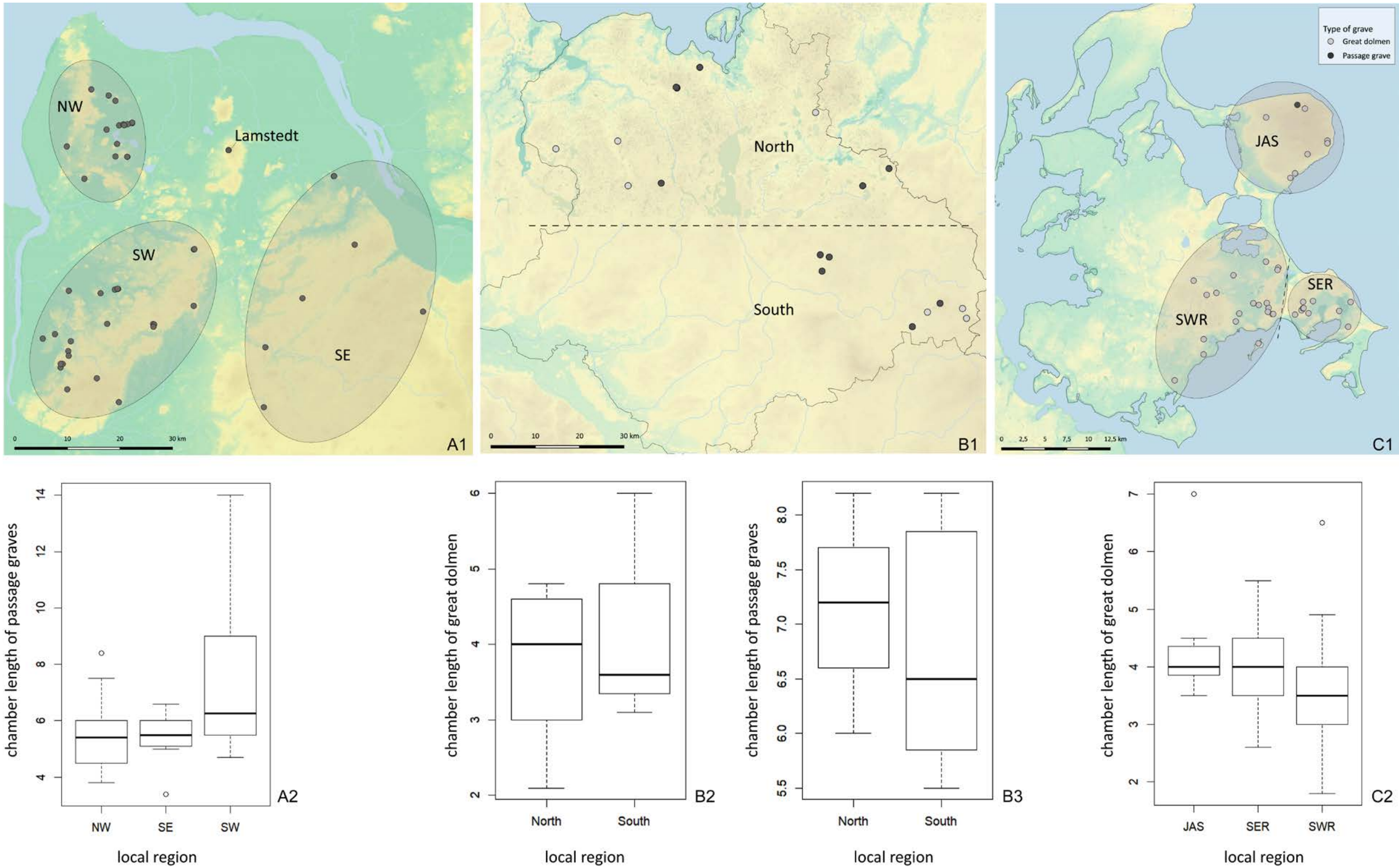

Figure 11. Overview and analyses of chamber length from collective graves in the three study case areas. A – Elbe-Weser Triangle, B – Western Mecklenburg, C – Rügen, 1 – distribution maps of collective graves with recorded chamber length, 2-3 – box plots of chamber length distribution according to local regions marked on maps above (analysis by RStudio).

constructions. A similar pattern emerges in chamber orientation. Some elements, such as protective structures and rectangular chamber groundplans, exhibit supra-regional consistency, while variations in architectural styles such as chamber length are evident at a more local level.

TRB-networks

TRB communities clearly developed ***widespread connections*** over time. Burial traditions emerged simultaneously in the North group and spread to the West group by the end of EN phase II. The widespread grave types suggest a shared framework for construction techniques, including protective external structures and consistent preferences for specific chamber shapes. Still later, with the introduction of passage graves, new trends – like the inclusion of internal compartments (quarters) – spread widely, at least within the North group (Midgley 2008). Megalithic building traditions appear to have followed a sort of blueprint, comparable to the funnel beaker vessel shapes and *tiefstich* decoration. For such detailed information to be transmitted through time, a constant network of communication would have been essential.

At the same time, ***regional developments and construction patterns*** reveal distinct networks. The three study areas exhibit significant differences in both chronology and architectural characteristics. After an initial phase, communities on Rügen and in the Elbe-Weser Triangle experienced a surge of activity, constructing their burial landscapes within a relatively short period. By contrast, Western Mecklenburg shows evidence of ongoing change, adopting and adapting a wide array of ideas. As a central area in the TRB distribution zone, Western Mecklenburg may have functioned as a melting pot of TRB interactions.

Zooming in further, each case study area can be divided into smaller ***local regions*** each with their own specific traditions. This is particularly evident in the variation of chamber length in collective graves, and in Western Mecklenburg, the distribution of grave types also highlights these localised networks.

In conclusion, TRB networks can be glimpsed in the construction and use of megalithic tombs. Within this system of exchange, general ideas and techniques were passed from group to group but were adopted differently in each region over time. The variations likely reflect the individuality of the people, as well as economic and ecological factors, that shaped the development of different social groups (Terberger *et al.* 2018). Additionally, regional patterning in details of megalithic construction provide insight into both regional and local networks. To further explore these dynamics, more studies across a range of themes are required. A comprehensive analysis of other burial traditions and associated finds would offer valuable insights into these complex systems.

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Chapter 6
Sardinian megalithic and rock-cut tombs in the context of the prehistoric western Mediterranean

Maria Grazia Melis

Abstract

The earliest megalithic monuments in the Western Mediterranean appear during the 5th millennium cal BC, with particularly significant manifestations in Corsica and Sardinia, in the form of *coffres* burials enclosed by stone circles and associated with small standing stones. The similarity between the Sardinian and Corsican monuments and those of Catalonia and the French Midi are evidence of the dissemination of the proto-megalithic tomb model along the circulation routes of Sardinian obsidian. In Sardinia this cultural phenomenon evolves and acquires distinctive attributes during the course of the Neolithic and the Copper Age.

This paper will examine those monuments with mixed characteristics, specifically, rock-cut tombs with megalithic elements. Particular attention will be given to comparisons with Sicily; as is well known, Tusa and other authors have, for some time, drawn attention to some similarities between these monuments in the two islands and their possible relationships with the Bell Beaker phenomenon.

Résumé

Les premiers monuments mégalithiques apparaissent en Méditerranée occidentale au cours du Ve millénaire cal J.-C., avec des manifestations particulièrement significatives en Corse et en Sardaigne, sous forme de coffres funéraires entourés de cercles de pierres et associés à de petites pierres dressées. La similitude entre les monuments sardes et corses et ceux de Catalogne et du Midi français témoigne de la diffusion du modèle de tombe proto-mégalithique le long des voies de circulation de l'obsidienne sarde. En Sardaigne, ce phénomène culturel évolue et acquiert des attributs distinctifs au cours du Néolithique et de l'Âge du Cuivre. Cet article examinera des monuments aux caractéristiques mixtes, en particulier des tombes creusées dans la roche comportant des éléments mégalithiques. Une attention particulière sera portée aux comparaisons avec la Sicile ; comme on le sait, Tusa et d'autres auteurs ont depuis longtemps signalé certaines similitudes entre ces monuments des deux îles et leurs possibles relations avec le phénomène du vase Campaniforme.

Riassunto

I primi monumenti megalitici compaiono nel Mediterraneo occidentale durante il V millennio cal B.C., con manifestazioni particolarmente significative in Corsica e in Sardegna, sotto forma di sepolture a *coffres* circondate da circoli di pietre e associate a piccoli menhir. La somiglianza tra i monumenti sardi e corsi e quelli della Catalogna e del Midi francese testimoniano la diffusione del modello di tomba proto-megalitica lungo le vie di circolazione dell'ossidiana sarda. In Sardegna questo fenomeno culturale evolve e acquisisce attributi distintivi nel corso del Neolitico e dell'Età del Rame. Questo articolo esaminerà i monumenti con caratteristiche miste, in particolare le tombe scavate nella roccia con elementi megalitici. Particolare attenzione sarà data ai confronti con la Sicilia; come è noto, Tusa e altri autori hanno, da tempo, segnalato alcune somiglianze tra questi monumenti nelle due isole e le loro possibili relazioni con il fenomeno del vaso Campaniforme.

Keywords: Megaliths, Rock-cut tombs, Sardinia, Western Mediterranean, Neolithic, Eneolithic, Bronze Age

Introduction

Rock-cut tombs (also called 'hypogean tombs' or simply 'hypogea') represent the most frequent funerary monument in Sardinian prehistory. It is estimated that there could be around 3000/3500. Megalithic tombs are well attested although in smaller numbers (about 270). However, the Sardinian megalithic landscape is complemented by other monuments such as stone circles without tombs, 1180 standing stones and 253 menhir statues. Caves and natural shelters were also used for funerary purposes, particularly in the 3rd millennium BC (about 85). Other funerary types (pit tombs, dolium tombs, tombs under huts) are sporadically attested.

This paper will examine those monuments with mixed characteristics, specifically, rock-cut tombs with megalithic elements. The analysis will be preceded by an update of the chronological framework of the

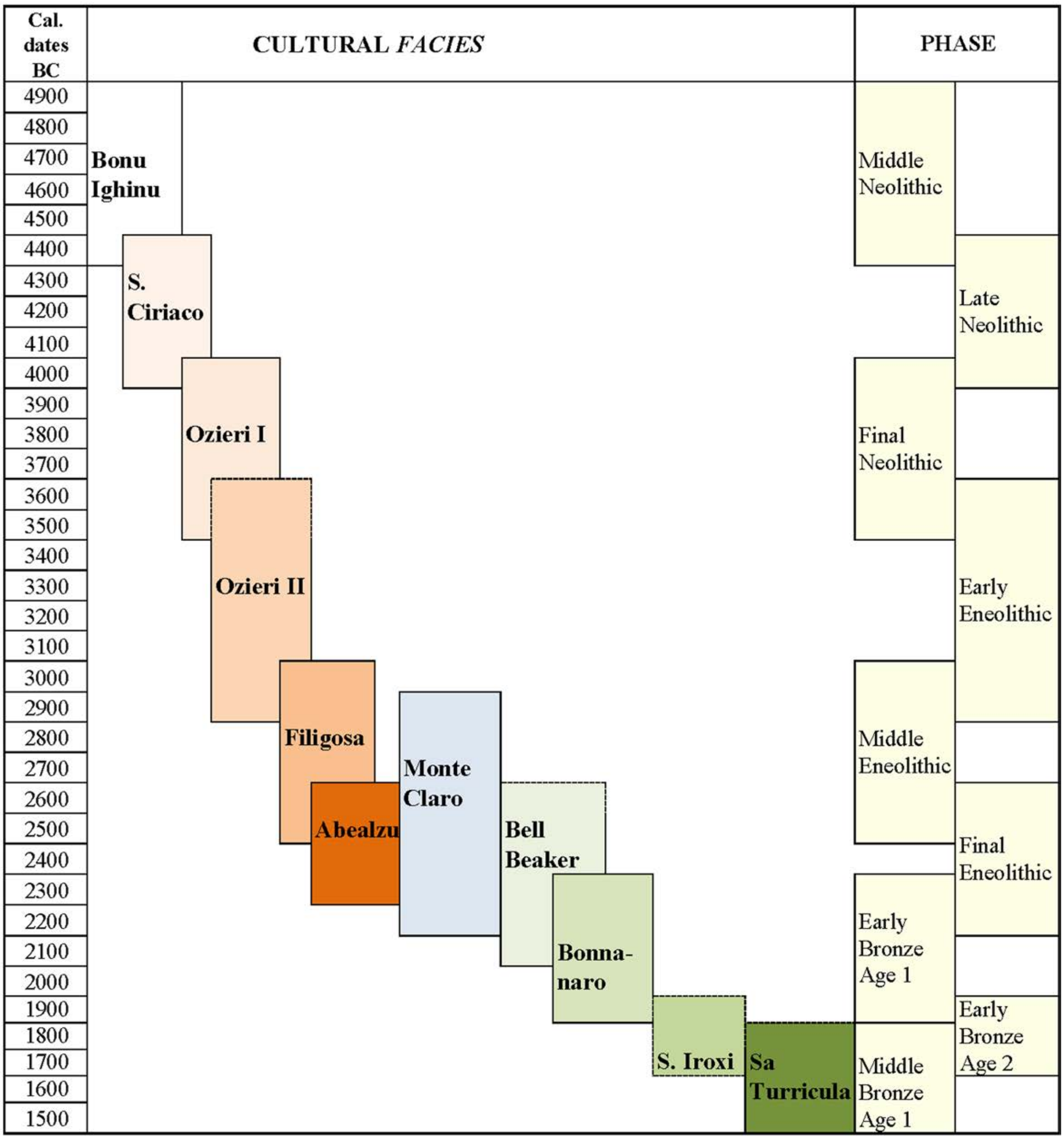


Figure 1. Chronological framework (processing M.G. Melis).

megalithic and hypogean monuments of Sardinia from the origins to the final manifestations of the Bronze Age (Figure 1). Particular attention will be given to comparisons with Sicily; as is well known, Tusa and other authors have, for some time, drawn attention to some similarities between these monuments in the two islands and their possible relationships with the Bell Beaker phenomenon (Tusa 2014, 2020). The earliest megalithic monuments in the Western Mediterranean appear during the second half of 5th millennium cal BC (Schulz Paulsson 2019), including particularly significant manifestations in Corsica and Sardinia; from the Early Neolithic the two islands were part of a network of exchange related to the circulation of Sardinian obsidian. Absent in Corsica, the earliest rock-cut tombs appear in Sardinia during the second half of the 5th millennium cal BC., reaching their greatest diffusion in the first half of the 4th millennium cal BC, and continue to be newly excavated and/or re-used up until the Bronze Age and beyond.

Chronology of the megalithic monuments

The 5th millennium cal BC

Analysing the phenomenon through a Sardinian-Corsican perspective, and considering the close relationship that existed between the two islands stretching back to the early Neolithic in the ambit of the exchange of raw materials, it can be seen that in Corsica the earliest elements of megalithism appear during a later period of the local Middle Neolithic I. These comprised of small monoliths erected at the sites

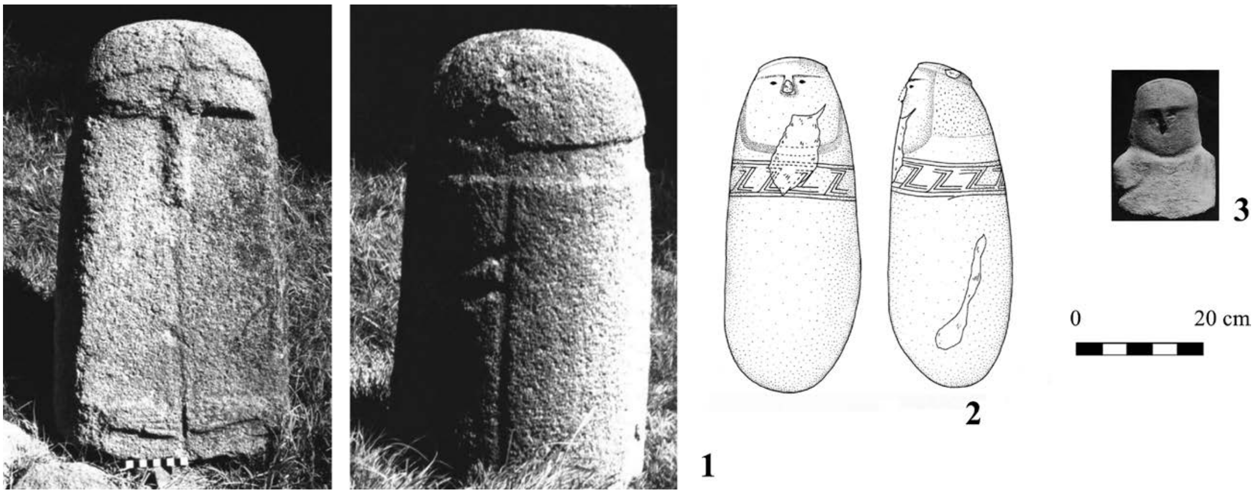


Figure 2. Menhir-statue from San Pietro (1). Baetylus and stelae from Sa Mandara (2-3) (1 from Atzeni 2012; 2-3 from Atzeni 1973-1974).

of Renaghju and I Stantari, dating to between 4600 and 4300 cal BC (D'Anna *et al.* 2012).

The data concerning the first Sardinian megalithism, while attributable to the 5th millennium, perhaps suggests, although without concrete evidence, initiation during the first half of the millennium. Several artefacts discovered out of context (Figure 2), which for their general characteristics are unique, may be referable to the first half of the 5th millennium cal BC due to some similarities to the figurines of the Bonu Ighinu cultural *facies*. However, in the exemplar from San Pietro (Figure 2.1; Atzeni 2012) the representation of the hands also brings to mind the figurines of the later cultural *facies* of San Ciriaco; a chronology of the last centuries of the 5th millennium cal BC, could furthermore be confirmed through comparisons with the stelae of Ta Trapna (Zebbug, Malta; Malone *et al.* 2009). Of the two artefacts from Sa Mandara, that for their dimensions are closer to the class of stelae than to that of figurines, the first (Figure 2.2; Atzeni 1973-74) captures the soft forms of the Bonu Ighinu figurines, while the second (Figure 2.3) recalls, in the representation of hair, the figurines of the Middle and Recent Neolithic, though the flatness of the torso appears closer to the group of the Recent Neolithic. The chronology of the aniconic stelae discovered in the well-known cave at Sa Ucca de su Tintirriolu (Loria and Trump 1978), that are possibly contextual with the earliest known use of the cave (first half of the 5th millennium cal BC), remains however, uncertain. In fact, it cannot be excluded that they were erected during one of the following phases of frequentation of the Recent or Final Neolithic, or indeed the Early or Middle Eneolithic.

The attribution to the Recent Neolithic of the stone cist burials of Li Muri and the menhirs associated with them, on the other hand, is certain (Figure 3.1); the Corsican chronological data (Gilabert *et al.* 2011) and the cultural background of the two islands confirm the diffusion of burials in *coffres* (surrounded by stone circles and occasionally associated with small menhirs), during the second half of the 5th millennium cal BC in the Sardinian-Corsican sphere. The similarity between the Sardinian and Corsican monuments and those of Catalonia and the French Midi (Guilaine 1996) are evidence of the diffusion of the proto-megalithic tomb model along the circulation routes of Sardinian obsidian.

The 4th millennium cal BC

In Sardinia the cultural phenomenon evolves and acquires distinctive attributes during the final Neolithic and the Copper Age. Tombs surrounded by stone circles undergo a transformation at Pranu Mutteddu (Atzeni Cocco 1989), where cist burials are replaced by small dry-stone walled chambers, and, in one case, by a small rock-cut tomb (Figures 3.2; 5.8; 6.3); the other elements inherited from the preceding phase, the circle or concentric circles surrounding the tumulus and the presence of menhir, persist.

Standing stones can be found in numerous sites across Sardinia, both in an aniconic and 'proto-anthropomorphic' form, which, according to Atzeni (1994) indicates an evolutionary path towards anthropomorphisation, that culminates in the menhir-statues of the 3rd millennium cal BC. The chronological-cultural positioning of the engraved boulders of central and eastern Sardinia, characterised by the presence of cup-marks, *cuvettes*, spirals and concentric circles, appears more complex. These types of motif are present in the decoration of the pottery of the first half of the 4th millennium. However, they are also occasionally associated with linear elements, that develop outwards from the centre of the motif, and this type of depiction is represented in later periods. As for the *cuvettes*, comparisons with Corsica suggest a chronological horizon somewhere between the mid-4th millennium and the 3rd millennium cal BC. The symbolic landscape of the 4th millennium cal BC was further enriched by other elements, particularly evident in the territory of Laconi, where, during the first half of the millennium, cromlechs and the *temenos* of Cirquittus can be found.

The earliest dolmens make their appearance in the funerary sphere of this period. This class of monument is represented by roughly 240 exemplars, mainly in central and northern Sardinia, for the most part without chronological-cultural references. However, the stratigraphical data of the dolmen of Alzoledda and Ciuledda (D'Arragon 1999) show that they were erected during Ozieri I. The 'corridor' dolmen at Motorra (Ferrarese Ceruti 1980) is also probably pertinent to the same cultural horizon, perhaps in an early phase, as is perhaps indicated by a carenated cup found in the access corridor, that recalls the traditions of the preceding Neolithic phases (Figure 3.4).

The most ancient example of *allée couverte*, found in the area close to the eastern group of rock-cut tombs at Montessu (Atzeni 1987), can be attributed to the second half of the 4th millennium (Early Eneolithic, Ozieri II cultural *facies*). This area is characterised by megalithic structures, some of which were sometimes built against the hypogeum tombs, while others delimited the spaces around them. Their chronology, excluding the obvious alteration of the entrances through the addition of exedra during the Middle Bronze Age, is not easily identifiable and could fall between the Eneolithic and the Early Bronze Age. The double-ringed megalithic structure formed around the entrance to Tomb IX probably constitutes an exception (Figure 6.1); the similarity with the stone circles of Li Muri and the archaic structure of the vertical access hypogeum, of Middle Neolithic tradition, suggest a more ancient chronology, probably to the second half of the 5th millennium cal BC.

The well-known sanctuary of Monte d'Accoddi (Melis 2023), with its ramp and platform structure, can be well and truly classed in the phenomenon of megalithism. This is demonstrated by the presence of the two standing stones and the boulder with cup-marks found to the east of the building, and the menhir placed to the west of the ramp. These, together with the monoliths and the dolmen at Frades Muros, delineate the megalithic landscape around Monte d'Accoddi. The head of an anthropomorphic stele that, while

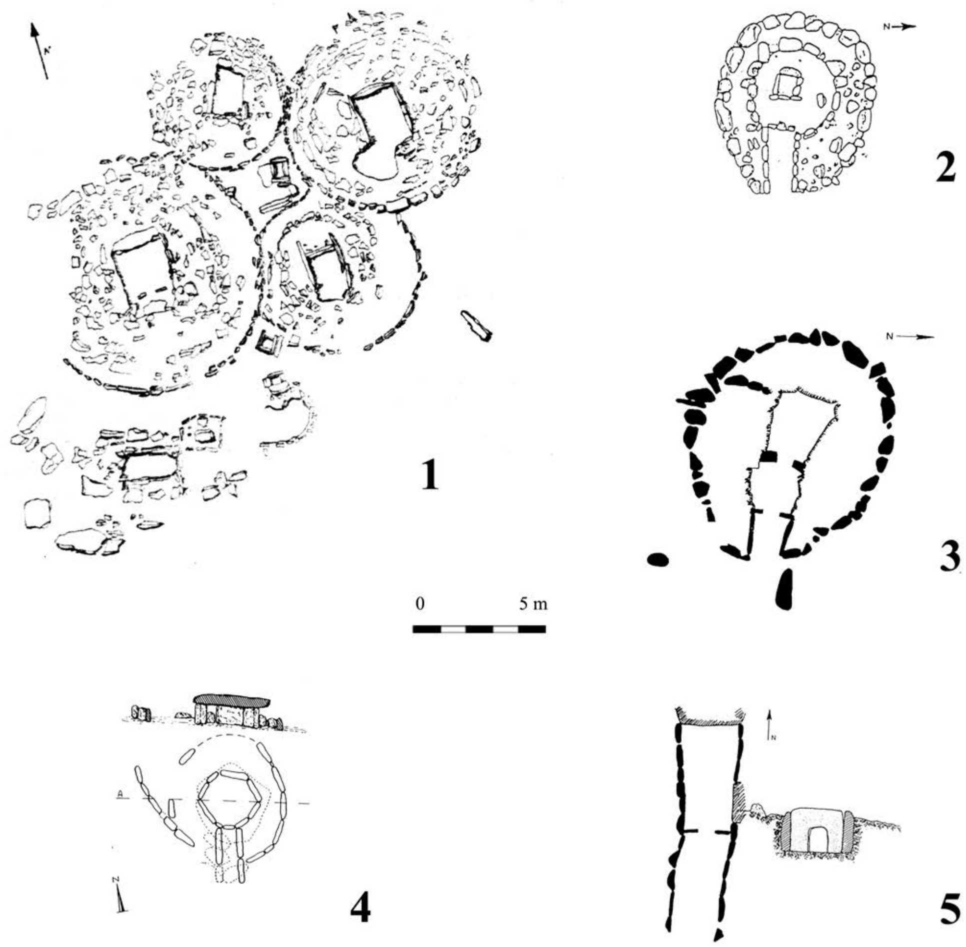


Figure 3. Sardinian tombs with stone circles by Li Muri (1), Pranu Mutteddu (2) and Masone Perdu (3). Dolmen of Motorra (4). Allée couverte of Corte Noa (5) (1 from Atzeni 1981; 2 from Atzeni and Cocco 1989; 3,5 from Atzeni 1988; 4 from Ferrarese Ceruti 1980).

constituting an *unicum*, recalls the spiral theme of the pottery decorations of Ozieri I, could also be attributable to the first half of the 4th millennium. A second stele, found close to the west corner of the monument, could also belong to the Early or Middle Eneolithic due to its filiform representation of a human figure, present in Sardinia from Ozieri II onwards. Furthermore, the terraced building itself recalls in its architectonic detail, the characteristics of megalithic monuments. Both the stepped structural form and the containing walls of the building itself are, indeed, evident in the megalithism of western Europe (Giot 1987; Laporte *et al.* 2002). An ulterior confirmation of Monte d'Accoddi's association with the megalithic world of western Europe is offered by the find of a sperm whale tooth (Melis and Zedda 2021). The connection between this cetacean and the megalithism of western Europe is attested through both symbolic depictions and the finds of fauna remains and tools. Were the tooth not originally recovered from the nearby beach at Platamona, it may have arrived at Monte d'Accoddi through contact with the western coast of the Mediterranean along obsidian trade routes.

The 3rd millennium cal BC.

In some European regions, the 3rd millennium corresponds to a certain stasis in the megalithic phenomenon (Schulz Paulsson 2019), which can also be partially seen in Corsica. Here an apparent absence of *pierres dressées i*s notable, however the dolmen of Cardiccia and Fontanaccia could be referable to the Eneolithic *facies* of Terrinien (D'Anna 2015).

The situation in Sardinia, on the other hand, demonstrates a continuity with the preceding phase and simultaneously, the introduction of innovative elements. The circular tombs undergo a further evolution, as represented by the burials at Masone Perdu (Figure 3.3), that are part of the extraordinary megalithic landscape at Laconi (Atzeni 1988), marked, furthermore, by menhirs, menhir-statues and by the allée couverte of Corte Noa (Figure 3.5). The process of the anthropomorphisation of menhirs continues to develop, reaching the stage of menhir-statues, chiefly concentrated in central Sardinia. Simultaneously, there is good evidence of both aniconic menhirs and cromlech in the ambit of the Monte Claro *facies*. At Biriai (central-eastern Sardinia) a possible cromlech was identified, together with isolated menhirs, while other menhirs were integrated within a terraced building of uncertain interpretation.

The 2nd millennium cal BC. A Nuragic megalithism?

The concept of megalithism in Sardinia has sometimes been mistakenly associated with the entirety of Nuragic monuments, which lack the distinctive architectonic and functional characteristics of true megalithic monuments. A notable exception is a monumental class which typifies the first Nuragic phase, the 'Giants' tomb' with a dolmen-like chamber and a facade including round-topped stelae and vertical stone slabs. The derivation of this model from that of the *allée couverte* can possibly be seen in the tomb at Li Lolghi (Castaldi 1969), in which the Nuragic monument integrates with a pre-existent *allée* (Figure 4.1). This sign of continuity between the Pre-Nuragic and the Nuragic worlds is counterbalanced through the destruction and the reuse of the menhir-statues (Atzeni 1980). If, as in some cases (e.g. the Orrubiu nuraghe) the simple

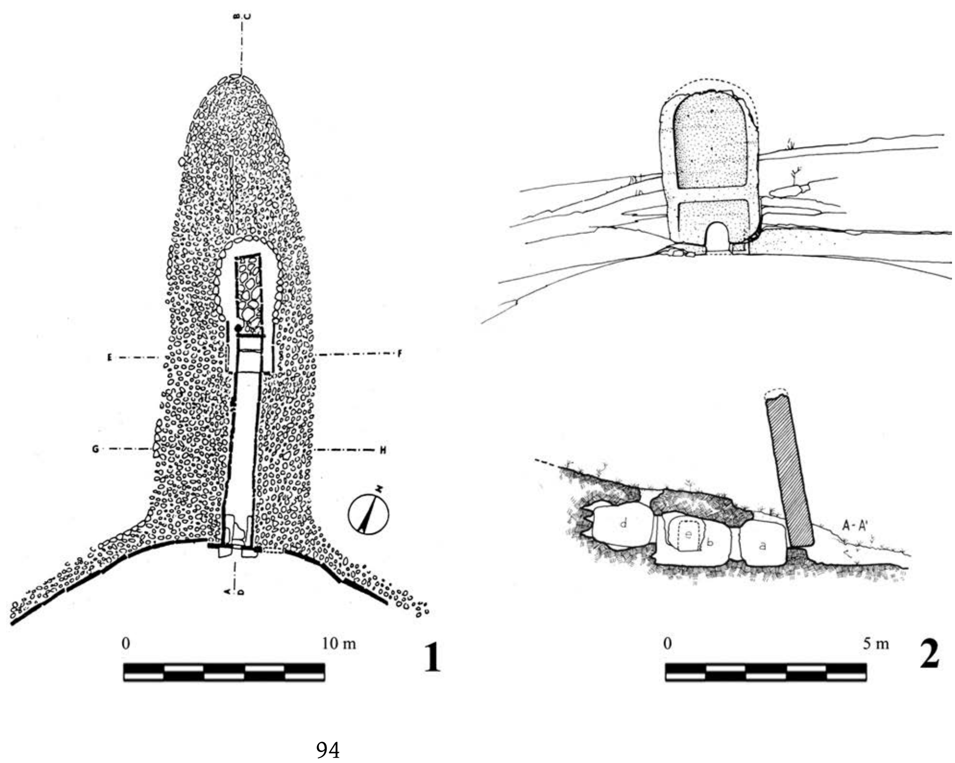


Figure 4. Giants' tomb of Li Lolghi (1) and Domus de janas with architectural facade from Tana de Lu Mazzoni (2) (1 from Castaldi 1969; 2 from Castaldi 1975).

reuse as building material appears obvious, in others (such as the Giants' tomb at Aiodda) the position and the visibility of a menhir-statue at the corridor of the Nuragic monument make it impossible to exclude that the symbolic significance of Pre-Nuragic monoliths was in some way conserved or reinterpreted.

The chronology of rock-cut tombs

Neolithic and Eneolithic (5th-3rd millennia cal BC)

Artificial caves, as is well known, form the most diffuse category of funerary architecture in prehistoric Sardinia. The tombs of Cuccuru s'Arriu, with vertical access and room with convex ceiling, are evidence of the earliest phase of the phenomenon during the first half of the 5th millennium cal BC, (Middle Neolithic, Bonu Ighinu *facies*). Three radiocarbon dates (Table 1.1-3) obtained from the human remains of tombs 385 and 386 from the necropolis at Cuccuru s'Arriu were from roughly between 4800 and 4400 cal BC 2σ (Lugliè and Santoni 2021).

The passage from individual burials in these tombs to collective burials in tombs locally named *domus de janas* took place during the second half of the 5th millennium (the San Ciriaco *facies*) and probably reflects an evolution of ritual underlining of family ties and genealogy. The connection between the beginning of the phenomenon of the *domus de janas* and the San Ciriaco *facies* was initially attested solely through diagnostic finds recovered from the archaeological deposits of some hypogea. Currently, however, radiocarbon dates are also available (Marcus *et al.* 2020*)*, including those sampled from the *domus de janas* at Noeddale and S'Isterridolzu (Table 1.4-6).

N.	Site	Lab. n.	Date BP	Date cal. BC (95.4%)	Bibliography	Phase
1	Cuccuru s'Arriu t. 385	AA-75636	5828 ± 61	4837 (95.4%) 4539	Lugliè and Santoni 2021	Middle Neolithic
2	Cuccuru s'Arriu t. 385	AA-75637	5784 ± 61	4786 (95.4%) 4494	Lugliè and Santoni 2021	Middle Neolithic
3	Cuccuru s'Arriu t. 386/a	AA-75635	5703 ± 60	4706 (91.6%) 4442 4421 (2.7%) 4396 4384 (1.2%) 4370	Lugliè and Santoni 2021	Middle Neolithic
4	Noeddale	MAMS-39527	5352 ± 32	4325 (13.3%) 4288, 4264 (48.1%) 4156, 4138 (34.0%) 4052	Marcus *et al.* 2020	Late Neolithic
5	Noeddale	MAMS-39526	5307 ± 32	4246 (94.5%) 4045, 4009 (1.0%) 4001	Marcus *et al.* 2020	Late Neolithic
6	S'Isterridolzu	MAMS-39532	5316 ± 31	4310 (0.7%) 4305, 4249 (94.8%) 4047	Marcus *et al.* 2020	Late Neolithic
7	San Benedetto	AA78327	5078 ± 58	3982 (95.4%) 3710	Lai 2009	Final Neolithic
8	San Benedetto	AA78328	5044 ± 58	3963 (93.5%) 3706 3672 (1.9%) 3658	Lai 2009	Final Neolithic
9	San Benedetto	AA78330	4984 ± 52	3946 (22.4%) 3856 3845 (1.2%) 3834 3819 (71.8%) 3647	Lai 2009	Final Neolithic
10	San Benedetto	AA78329	4969 ± 52	3943 (16.2%) 3862 3814 (79.3%) 3642	Lai 2009	Final Neolithic
11	San Benedetto	Beta-72233	4920 ± 70	3945 (10.5%) 3857 3818 (80.0%) 3622 3582 (5.0%) 3530	Floris 2001	Final Neolithic
12	Filigosa t. I	MAMS-38276	4472 ± 25	3338 (53.7%) 3209, 3195 (34.7%) 3082, 3060 (7.0%) 3029	Marcus *et al.* 2020	Early Eneolithic
13	Bau Su Matutzu	LTL4197A	4121 ± 45	2875-2573	Manunza 2010	Middle Eneolithic
14	Gannì	OxA-25343	Not published	2469-2293	Manunza 2013	Late Eneolithic
15	Bingia 'e Monti	MAMS-26891	3984 ± 29	2578-2456	Marcus *et al.* 2020	Late Eneolithic
16	Mereu I	MAMS-38277	3794 ± 25	2297 (95.4%) 2139	Marcus *et al.* 2020	Early Bronze Age 1

Table 1. Radiocarbon dates from the tombs cited in the text. The data was calibrated in OxCal v.4.4.4 using the IntCal20 atmospheric curve (Reimer *et alii*. 2020; Bronk Ramsey 2021).

The lack of human remains and of most of the grave goods relating to the first use of the *domus* rules out any further reflection. It must be underlined that this transition from vertical access hypogea to *domus de janas* happened in conjunction with another important innovation, namely the introduction of the first megalithism of *coffres* and stone circles in Sardinia and Corsica.

The large development of the *domus de janas* took place during the first half of the 4th millennium cal BC, in the sphere of the Ozieri I *facies* (Final Neolithic); they were notable for their numerosity, plan complexity and for the presence in many of the rock-cut tombs of carved, incised or painted symbolic and/or artistic imagery. On a chronological plane, among the main points of reference is Tomb II at San Benedetto di Iglesias, which returned a series of dates (Table 1.7-11) in the ambit of the first half of the 4th millennium cal BC (Atzeni 2001; Lai 2009).

A continuity in the excavation and use of *domus de janas* during the second half of the 4th millennium is confirmed by past and present radiocarbon results gathered from the tombs at Cannas di Sotto (Lai 2009) and Filigosa (Marcus *et al.* 2020). Of particular interest is the dating of Tomb I at Filigosa (Table 1.12), which backdates the original excavation and first use of the tomb to Ozieri II. The typological study and the statistical-combinatorial analysis of the typological data (Melis 2000, tav. 102), performed on ceramic artefacts demonstrated their association to the Eneolithic phases of the 3rd millennium; however, some of the ceramics, also present in contexts belonging to Ozieri II and at the time considered as typologies of extended duration, with the support of the ^{14}C dates can now be reinterpreted as documentation of a first phase of frequentation during Ozieri II.

In the light of this, the dating of the tomb at Santa Caterina di Pittinuri (Lai 2009), which initially seemed anomalous with respect to the published contextual data (Melis 2013) that attested to frequentation during the 3rd millennium cal BC in the ambit of the Filigosa and Abealzu cultural *facies*, could be readjusted to the second half of the 4th millennium cal BC. The dating of the tomb, which followed a longitudinal plan similar to that of Tomb I of Filigosa, re-enters fully within the range of Ozieri II, testifying to\ an occupation phase in this earliest period of the Sardinian Eneolithic; any archaeological finds relating to it may have been removed during later reuses, or, if existing, are yet to be published.

The frequentation of the *domus de janas* during the first half of the 3rd millennium (Filigosa and early phase of Monte Claro cultural *facies*) is attested through the contextual data and confirmed by radiocarbon dates (Lai 2009; Marcus et *al.* 2020). The Monte Claro groups, beyond reusing the *domus de janas*, created new and particular hypogeic tombs. The radiocarbon dates attest that the initial excavation of these tombs is referable both to the ancient phase of the *facies* (Table 1.13), as well as to the more recent phase (Table 1.14). Between the final years of the Eneolithic and the Early Bronze Age, the *domus de janas* continue to be used by the Bell-Beaker and Bonnanaro groups, as is well attested by archaeological and radiocarbon evidence.

The Bronze Age. Observations on the origins of Nuragic funerary architecture

A new important phase of Sardinian funerary hypogeism evolved during the Bronze Age. This consisted of a well noted phenomenon (Contu 1978), attested mainly in north-western Sardinia and is considered to be the beginning of the Nuragic culture. It was characterised by the digging of new hypogea and the modification of Neolithic *domus de janas*, that outwardly recall the architectonic structures of the 'Giant's tomb' (Figure 4). The criteria that distinguish the Bronze Age hypogea from the Neolithic hypogea are essentially two:

– the relief representation of the facade of the giants' tomb (*prospetto architettonico*);
– the simplified plan; the tombs typically had one large circular, elliptical or rectangular chamber, sometimes including niches.

Available literature presents diverse classifications that illustrate the variability of architectonic models. In synthesis, that which is of interest is the principal distinction between renovated prehistoric rock-cut tombs and those realised during the Bronze Age itself. From a terminological point of view, it appears correct to use the term '*domus de janas* (or in a briefer form, *domus*) with *prospetto architettonico*' only for those Neolithic tombs modified during the Bronze Age; the hypogea wholly realised during the Bronze Age form a distinct monumental class from the *domus de janas* and are more appropriately defined as 'hypogea with *prospetto architettonico*' (Melis 2016). The modification of the *domus de janas* sometimes necessitated the demolition of chamber walls in order to create a larger internal space, as, for example, in Tomb VI at Mesu 'e Montes (Derudas 2000), often accompanied by the presence of a step or counter at the base of the wall. The most diffuse model possesses a facade with the relief reproduction of the facade of the most ancient version of Giants' tomb, with round-top stelae in correspondence to the entrance, and, often but not always, an exedra, a space dedicated to funerary practises such as the deposition of offerings (e.g. Molafà; Castaldi 1975). Another detail sometimes present in Giants' tombs and hypogea with architectural facade are three holes close to the summit of the stelae for the insertion of small elongated stones (baetils). An alternative, less common, solution, had the facade built from courses of stone blocks that imitate a more recent model of the Giants' tomb. The holes for the insertion of sacred stones are to be found both in the Giants' tombs with stelae, near the upper edges of the slabs, as well as in the teeth-like stone blocks found at the summit of the stone course facade (Bittichesu 1989).

The presence of finds belonging to the cultural *facies* of Sa Turricula in the archaeological deposits of the hypogea with a facade and of the Giants' tombs with stelae, has made it possible to identify the contemporaneous development of the two phenomena in the ambit of Middle Bronze Age I. This *facies* is generally attributed to this period, although radiocarbon dating seems to suggest that it began in the final phases of the Early Bronze Age (Rubinos and Ruiz-Galvez 2003). It is interesting to note how it is possible to glimpse, in the later phases of Sardinian prehistory, the architectonic premise of proto-historic hypogeism: the tomb at Padru Jossu a Sanluri (Ugas 1998) was originally excavated by Monte Claro groups of the 3rd millennium cal BC, with a simplified rectangular plan, which anticipated the characteristics of the Bronze Age hypogea. In this context the recently acquired date of Early Bronze Age I (Table 1.16), collected from the hypogeum with architectonic facade I of Mereu a Usini, which intercepts an occupation phase earlier than that placeable between Middle Bronze Age I and the Final Bronze Age, previously identified on the basis of architectonic, archaeological and radiocarbon data, assumes enormous importance. The 'high' date given as Mereu I, first and foremost makes it possible to reconstruct the link between prehistoric and proto-historic hypogeism, along a probably gradual evolutionary process, that from the advanced Eneolithic (Padru Jossu) arrived at the Middle Bronze Age, with an intermediate stage during the Early Bronze Age. Furthermore, this Early Bronze Age date poses various questions. Was this just a simple single-chamber hypogeum, dug during the Early Bronze Age, that was then given an external carved architectonic facade during the Middle Bronze Age? Alternatively, were the tomb and its facade built contextually during Early Bronze Age? This second hypothesis could reopen the long-standing debate on the origins of the architectonic model: the hypothesis that the hypogeic model was derived from the megalithic Giants' tombs has for some time been accepted by scholars on the basis of various arguments, among which the most convincing is the presence, on top of some of the hypogea, of a reproduction of a tumulus, that could have no purpose except to evoke the analogous structure present in the Giants' tombs. Nonetheless, the dating to the Early Bronze Age of Mereu I cannot be ignored and forces a reflection on the origin and chronology of both the hypogeic and epigeic models, therefore on a possible beginning during the Early Bronze Age of one or the other or of both.

Monuments with mixed characteristics

The Pre-Nuragic phase

The current state of research numbers 50 funerary monuments of mixed characteristics in Sardinia (Figure 5), that share both hypogeic and megalithic components. With respect to previously published studies (Cicilloni 2015, *ivi* bibliography) the collection presented here adds a further 14 monuments to the corpus. This class of monument represents a marginal component in Sardinian hypogeism (roughly 1.7%), that includes of over 3000 rock-cut tombs.

The most common model (94%) is the *domus de janas* incorporating megalithic elements (orthostatic stone blocks and slabs) positioned externally, usually around the entrance. They were generally simple in plan, with two (47%), one (40%), or, less often, multiple chambers (11%), while in one case the number is unknown. The megalithic elements in the majority of cases (70%) form corridors, and less commonly surround circular, semicircular (Figures 5.5; 6.2) or quadrangular spaces. Occasionally the megalithic elements are found inside the tombs, such as orthostatic stones for dividing internal spaces or as cists. In one case, Tomb IX at Montessu (Figures 5.16; 6.1), the hypogeic architectonic model (similar to the archaic example at Cuccuru s'Arriu) had vertical access and a convex-ceilinged chamber; the entrance opens on to the centre of an area surrounded by two concentric circles of orthostatic slabs, that partially survive.

Tomb 2 of Pranu Mutteddu (Figures 5.12; 6.3) is a unique example and represents the fusion of the *domus de janas* model with that of the megalithic stone circle and tumulus burial (Atzeni, Cocco 1989). It forms part of a necropolis otherwise comprising cist tombs or megalithic chamber burials surrounded by one or more stone circles and covered with a tumulus. The anomaly is provided by the substitution of the cist or of the central room with a large stone block, into which a small two-cell *domu de janas* has been cut. This was placed at the centre of a circular structure, surrounded by three concentric circular walls divided into four sectors by two walls and two orthostatic slabs; one of the two slabs had a quadrangular door at its centre, communicating the two adjacent sectors. In a second block a small antechamber had been cut. The two large stones were not extracted from on-site rock, but were transported from another location. The hypogeic-megalithic landscape of the site is completed through the presence of several enclosures, numerous menhirs and an *allée couverte*. The close proximity of a necropolis of rock-

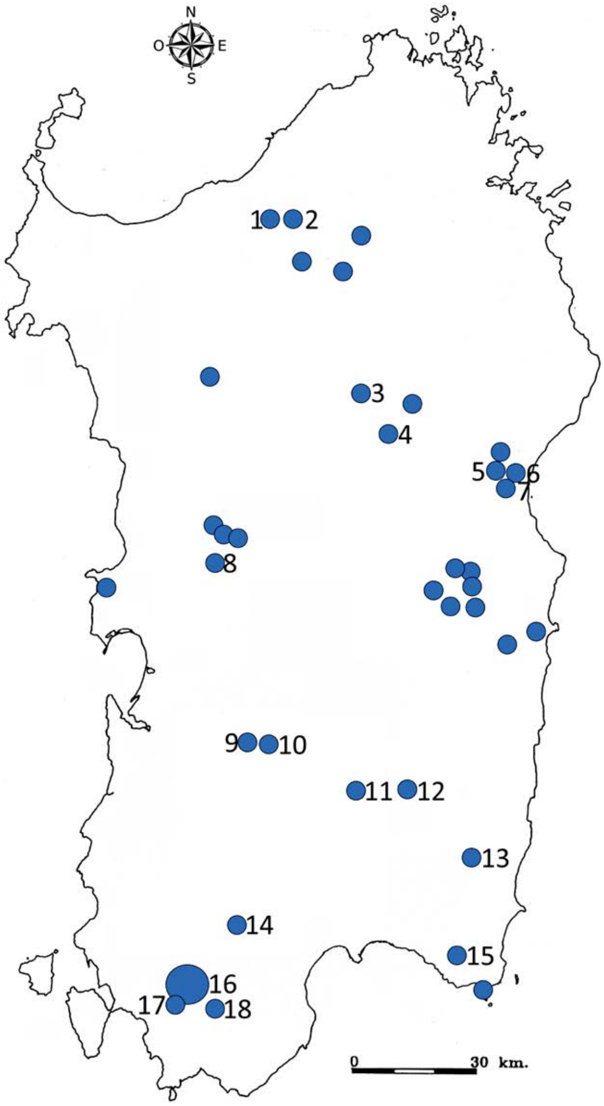


Figure 5. Distribution map of Prenuragic hypogeic-megalithic tombs. The numbers relate to the monuments cited in the text and/or reproduced in the figures: 1 Lu Cannigioni, 2 Domus dell'Ariete, 3 Maone, 4 Janna Ventosa, 5 Campu Marinu I, 6 Canudedda, 7 Mariughia, 8 Su Tiriarzu A, 9 Bingia 'e Monti, 10 Scaba 'e Arriu, 11 Pranu Siara, 12 Pranu Mutteddu, 13 Pranu Narbonis II, 14 Sa Serra Masì, 15 Cuccuru Craboni, 16 Montessu, 17 Marchiana I, 18 Pani Loriga I (processing by M.G. Melis).

cut tombs is evidence of the coexistence of diverse funerary practices and a distinct social role of tumulus graves in comparison to rock-cut tombs. The lack of radiocarbon data or evidence of the burial practices make it impossible to formulate a hypothesis about the social organisation of the human group of Pranu Mutteddu. If tumulus tombs, ostensibly containing single or double burials, suggest the necessity to underline the social importance of individuals, rock-cut tombs, which contained multiple burials, show the necessity to highlight family ties. This apparent evidence of social inequality is in contrast with other factors that appear to indicate a cohesive community. Firstly, there are no signs of separation between the megalithic and hypogeic structures. Furthermore, the architecture of Tomb 2 entails collective involvement in its construction. Its subdivision into four sectors around the two hypogeic rooms recalls the centripetal plan of numerous *domus de janas*, with a central chamber surrounded by peripheral rooms. The function of these sectors, were it funerary, may involve the rituals of multiple burials.

Concerning the tombs with corridor entrances (Figure 7), they were chiefly built from orthostatic slabs (65%), and with lesser frequency polygonal stone blocks. The latter were employed exclusively (5.9%) in association with orthostatic slabs (8.8) or in sections of the corridor that were cut into rock (14.7%). There are also sporadic examples of corridors created with dry-stone walls (5.9%).

One of the most representative sites exhibiting the association between megalithic and hypogeic features is the necropolis of rock-cut tombs of Montessu (Figure 5.16), in which at least 14 tombs are associated with megalithic elements (Melis 1997-1999). Here we find the hypogeic tomb surrounded by a stone circle (T. IX), that, for the archaic aspect of the hypogeic section, and the close similarity of its circle of orthostatic slabs to those of the monuments at Li Muri, may possibly have been built during the second half of the 5th millennium. Another vertical access chamber tomb (T. XXXIV; Figure 8.1) with concave roof is decorated with a horn motif in relief; this stylistic choice is typical of the first half of the 4th millennium cal BC. This tomb is associated with a poorly preserved megalithic structure, that perhaps originally included a corridor made from polygonal blocks. Seven tombs have megalithic corridors. In other cases, couples of tombs appear in wide quadrangular (T. VII and T. VIII) or semicircular (T. XXXII and T. XXXIII) megalithic enclosures.

In Tomb II the walls are richly decorated with spirals, triangles and other elements, which points to a chronology of the first half of the 4th millennium cal BC, on the basis of stylistic comparisons with the decorative repertoire of the pottery. Material of the 3rd millennium (Filigosa and Monte Claro cultural *facies*), found during excavations, is probably relative to phases of reuse. The megalithic corridor with which it is associated contained an orthostatic slab of considerable size, which helps to confer a certain importance to the tomb. Remains of a megalithic structure and a menhir can be found in front of the entrance to T. XXV. An *allée couverte,* datable to the second half of the 4th millennium cal BC on the basis of the finds recovered, is placed close to the eastern group of rock-cut tombs. Lastly, some megalithic corridors appear to trace ritual pathways in the areas in front of the hypogea. With the exception of the chronological references provided,

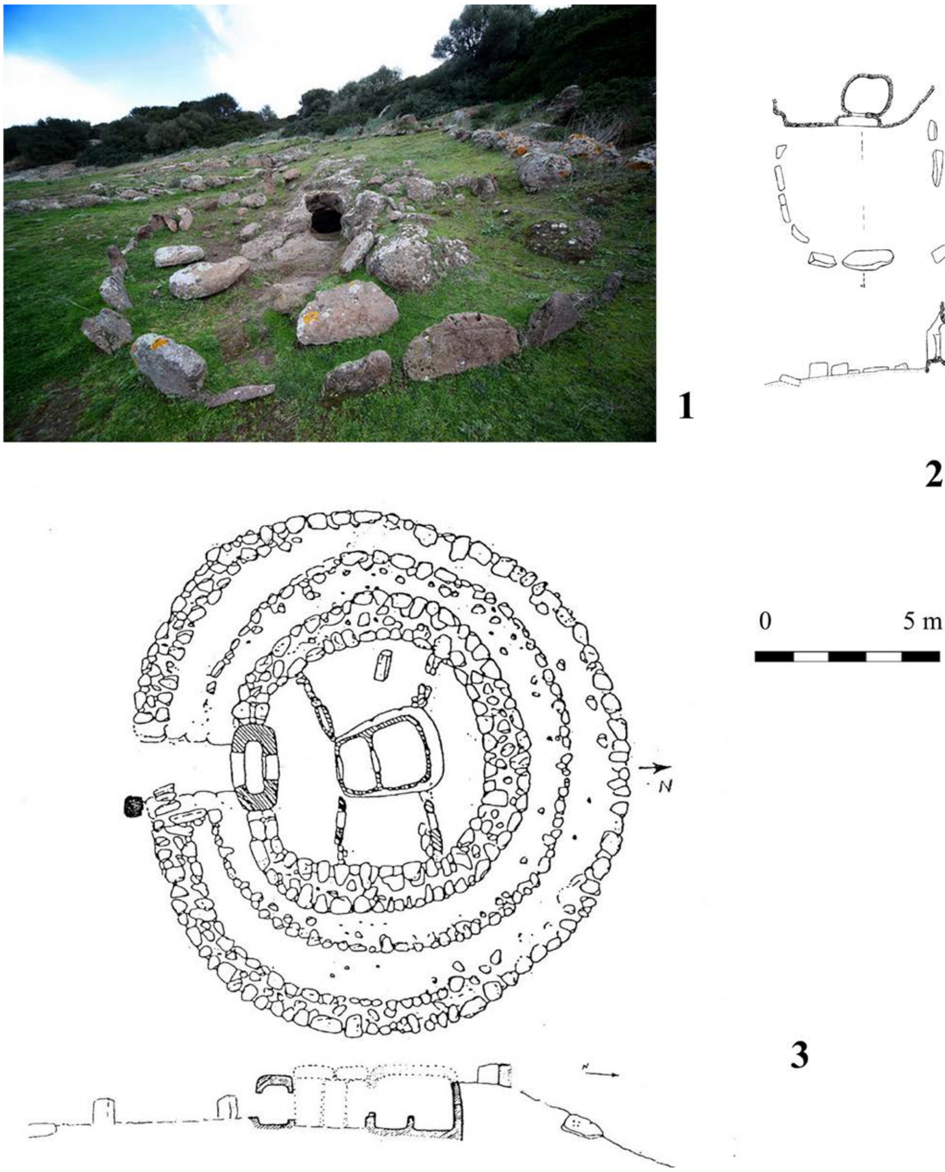
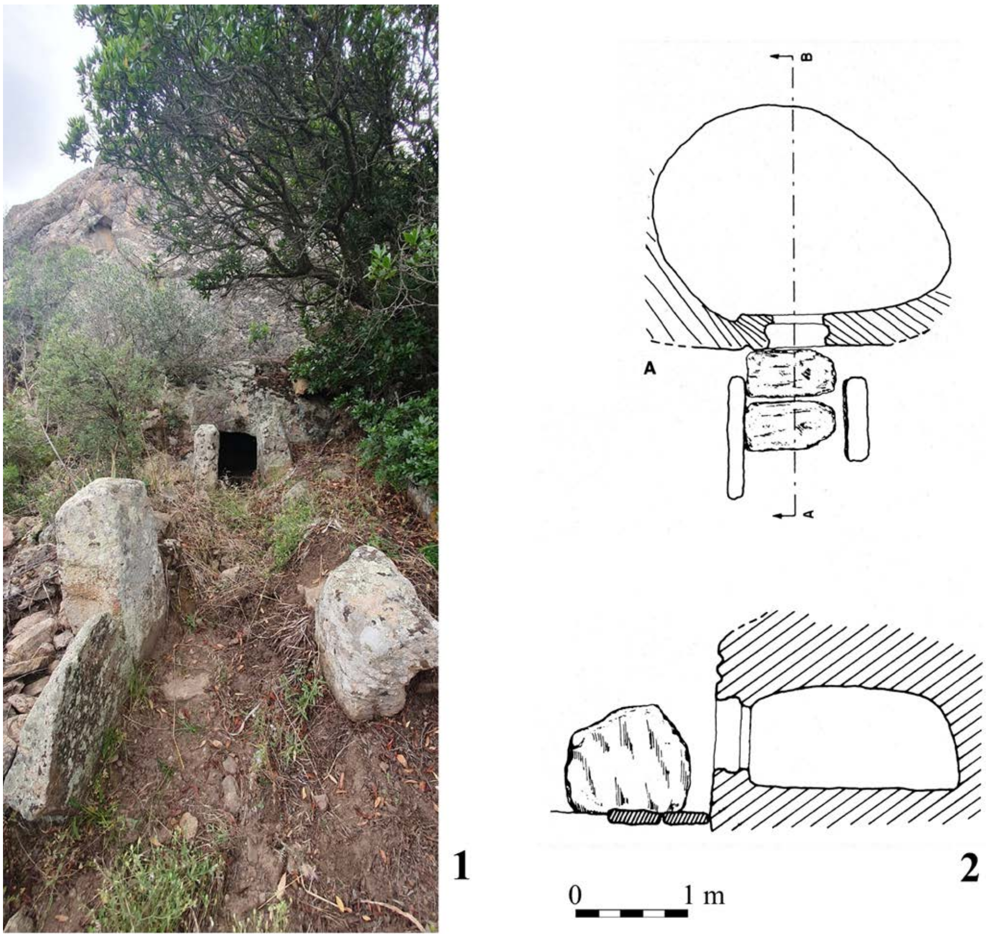


Figure 6. Hypogeic-megalithic tombs of Montessu IX (1), Campu Marinu I (2) and Pranu Mutteddu 2 (3) (1 photo by F. Serchisu; 2 from Manunza 1995; 3 from Atzeni and Cocco 1989).

dates for the megalithic structures at Montessu are not easily established at. The rock-cut tombs were likely excavated in the 4th millennium cal BC and then reused during the 3rd and 2nd millennia. If the architecture of Tomb IX offers some evidence of a possible construction during the second half of the 5th millennium cal BC., the data from the few studied and published finds from the necropolis, often found out of stratigraphic context, do not attest to frequentation earlier than the first half of the 4th millennium cal BC. Nevertheless, it must be underlined that the earliest frequentation of the settlement at S'Arriorgiu, situated 2 km to the south of Montessu on the plain overseen by the necropolis (Figure 8.3-6) took place during the second half of the 5th millennium cal BC. A few brief notes (Forresu 2015) offer indications about the frequentation of Tombs VI and VIII. Tomb VI, on a two room plan, had a corridor that was one part excavated and one part built of orthostatic blocks (Figure 8.2). Some of the finds show frequentation in the 3rd millennium cal BC (Monte Claro cultural *facies*). Tomb VIII, another two-room plan, faces Tomb VII within a quadrangular megalithic enclosure. This provided pottery fragments of the 3rd millennium cal BC (Filigosa and Monte Claro cultural *facies*).

Three monuments, Maone, Bingia 'e Monti and Pranu Siara, are distinct from model of the tomb formed by the association of megalithic characteristics with those of the *domus de janas* (Figure 9). In these, the hypogeic component is not a *domus de janas* but is formed by a single 'hypogeic-megalithic' structure. The tomb at Maone (Melis 1992) had a rectangular chamber that was partially cut into the rock against which a dolmen-like structure was placed (Figure 5.3). The walls were not formed of orthostatic slabs, but of irregular courses of different sized stones. In the tomb at Bingia 'e Monti (Atzeni 1998) the rear portion of the chamber is cut

Figure 7. Hypogeic-megalithic tombs of Lu Carragioni (1) and Canudedda (2) (1 photo by Vittoria Pilo; 2 from Ferrarese Ceruti 1980).



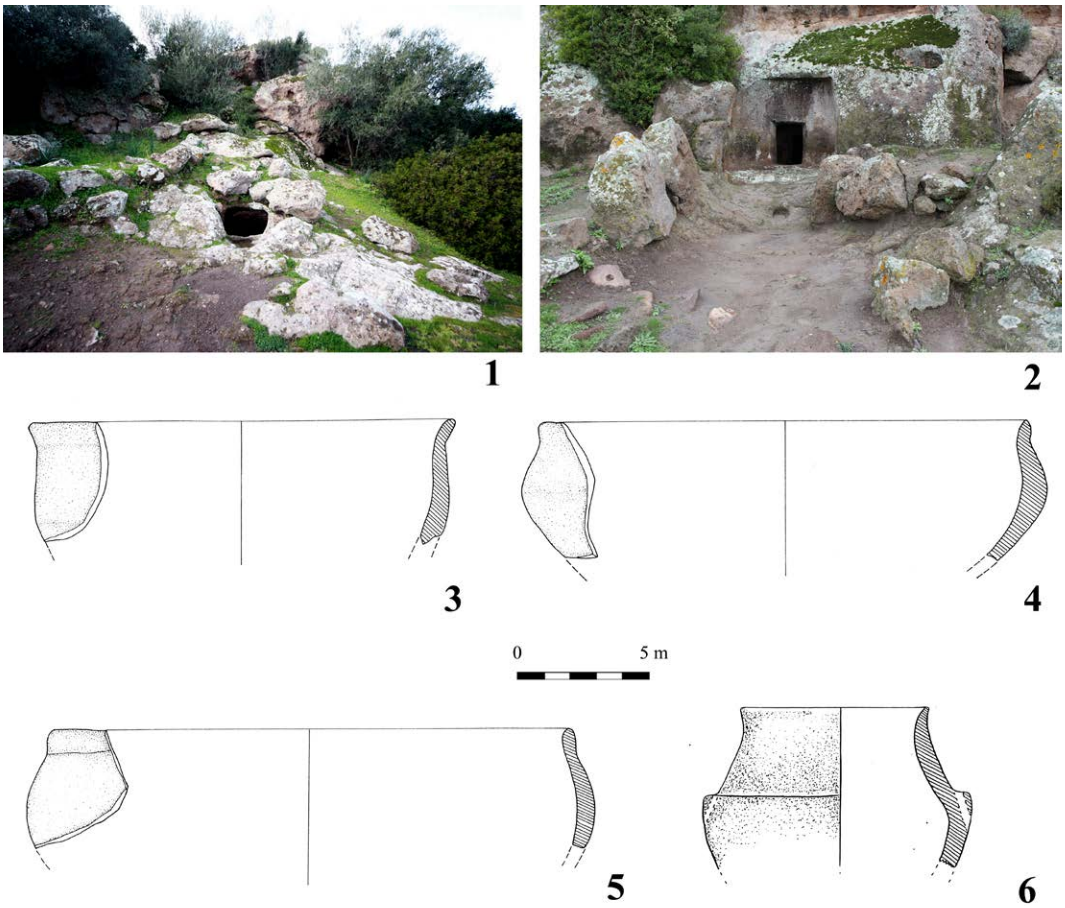


Figure 8. Hypogeic-megalithic tombs XXXIV (1) and VI (2) at Montessu. Unpublished Late Neolithic ceramics from the S'Arriorgiu settlement (3-6) (1-2 photos by F. Serchisu; 3-6 drawings by E. Atzeni).

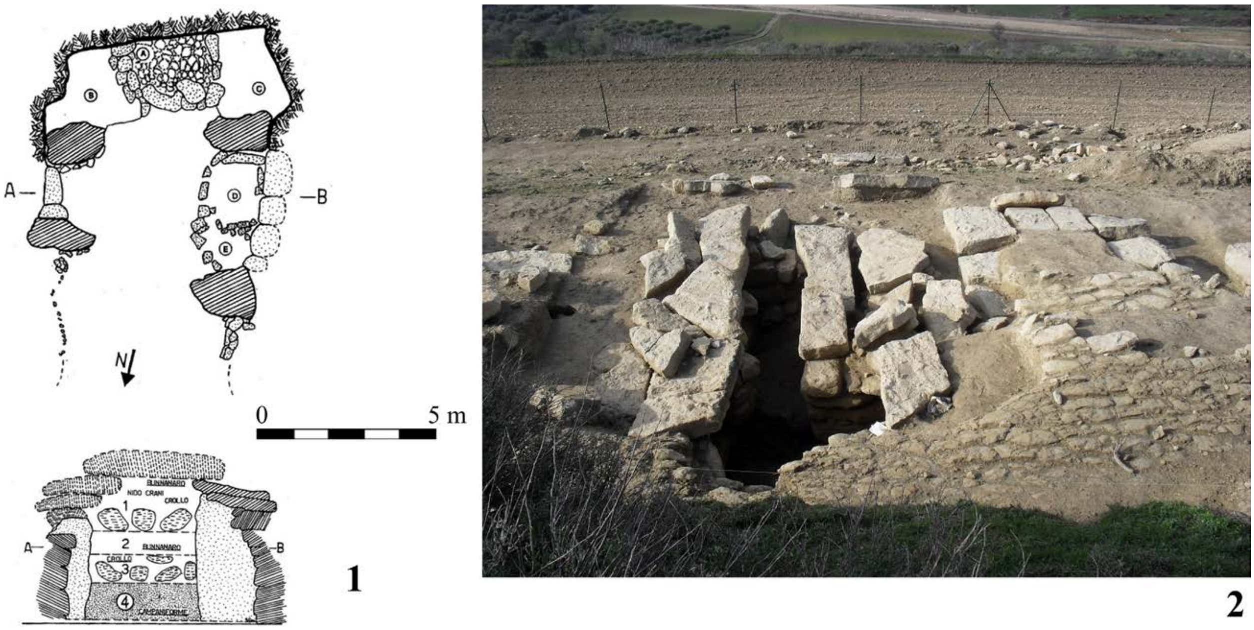


Figure 9. Hypogeic-megalithic tombs of Bingia 'e Monti and Pranu Siara (1 from Atzeni 1998; 2 from https://upload.wikimedia.org/wikipedia/commons/c/ce/Pranu_Siara.jpg).

into bedrock, while the front half, missing its entrance wall, was built of orthostatic blocks alternated with dry stone walls in an *en encorbellement* profile (Figures 5.9; 9.1). The finds put the construction of the monument to the Middle-Late Eneolithic (Monte Claro cultural *facies*), a period also given by the earliest radiocarbon date (Table 1.15), unless this was not referable to an older phase of later Bell Beaker frequentation, well documented in the tomb. The burial at Pranu Siara (Nieddu, Cocco 2014) constitutes a *unicum* and probably represents the most sophisticated Sardinian example of a megalithic tomb (Figures 5.11; 9.2). The hypogeic element is formed by a large trench dug along the edge of a plateau. A megalithic structure was built inside the trench, which was composed of a longitudinal corridor, from both sides of which there was access to three pairs of overlying niches. It was built from courses of horizontal slabs that formed the walls. The roof was made of large slabs that were laid at natural ground level. This tomb was also built in the ambit of the Monte Claro cultural *facies* and successively occupied during the Bell Beaker phase. It has been compared to two hypogeic chamber tombs from the same cultural horizon (Nerbonis and Santu Luxori), in which the walls were formed of small polygonal stones.

Observations on the chronological and cultural data concerning the the Pre-Nuragic monuments with mixed characters

With the exception of the few monuments whose architectonic characteristics unequivocally attest to the contemporaneousness between hypogeic and megalithic elements, for the remainder the principal problem is the dating of the megalithic additions; these may have been part of the original design or, alternatively, been added in a following phase. The available chronological-cultural data is limited, either because the monuments were found without a surviving archaeological context or because they have not been archaeologically excavated; in other cases the results of excavations are yet to be published. This lack of information regards 57% of the tombs. However, some considerations may be drawn from the available data, including the finds, the wall decoration and the architectonic characteristics (Table 2).

The d*omus de janas* generally date to the Final Neolithic, and in two cases perhaps to the Late Neolithic: Tomb IX at Montessu for its architectonic characteristics and the *Domus dell'Ariete*, for the presence of finds referable to the San Ciriaco cultural *facies* (Lo Schiavo and Pitzalis 1982, fig. 7). The megalithic components of some of the hypogea are contextual (such as at Pranu Mutteddu), while in others they may be later. For the tomb at Cuccuru Craboni (Figure 5.15), Atzeni (1973-1974) hypothesised the excavation of the rock-cut tomb on the Monte Claro chronological horizon, and the construction of the megalithic corridor during Early Bronze Age 1.

As for the monuments in which the hypogeic component is not a *domus de janas* and is integrated with a megalithic element as part of a unitary architectonic project (Maone, Bingia 'e Monti and Pranu Siara) in two cases out of three the earliest finds belong to the Monte Claro *facies*, which overlaps a Bell Beaker occupation phase.

Occupation phases with megalithic integrations relating to Monte Claro have also been identified in ten *domus*

Cultural *facies*	S. Ciriaco	Ozieri I	Ozieri II	Filigosa	Monte Claro	Bell Beaker		Bonna-naro	S. Iroxi	Sa Turricula (Early Nuragic)	Middle Nuragic	Late Nuragic	Final Nuragic
Age	LN	FN	EE	ME	ME-FE	FE	E	EB1	EB2	MB1	LB	FB	I
Sites													
Bingia ‘e Monti					X	X		X	X				
Canudedda		X											
Cuccuru Craboni					X			X					
Domus dell’Ariete	X?							X		X			
Janna Ventosa		X			X	X							
Marchiana I		?		X	X	X		X					
Mariughia		?						X					
Montessu II		X		X	X								
Montessu VI		X			X								
Montessu VII		X					X						
Montessu VIII		?		X	X						X		
Montessu IX	X?												
Montessu X		X			X			X	X	X			
Montessu XXV		?								X			
Montessu XXVII		X					X						
Montessu XXXIII		?								X			
Montessu XXXIV		X											
Pani Loriga I		?			X	X							
Pranu Mutteddu		X											
Pranu Narbonis II		X	X			X		X			X		X
Pranu Siara					X	X							
Sa Serra Masì		X	X			X							
Scaba ‘e Arriu		X		X	X								
Su Tiriarzu A		X			X	X		X					

Table 2. Chronological data based on the finds, rock art and architectural features.

de janas. In the tomb at Scaba ‘e Arriu (Figure 5.10) the excavation record shows that the megalithic elements are attributable to the Monte Claro phase (Usai and Ragucci 1999). The megalithic structure realised inside the *domus de janas* at Sa Serra Masì (Figure 5.14) is attributable to Bell Beaker (Usai 2001) as well as the cist inside the tomb at Bingia ‘e Monti. This information suggests that the Bell Beaker groups preferred to re-utilise hypogeic-megalithic monuments and only occasionally introduced megalithic elements inside the funerary chambers.

The problem with the chronology of megalithic additions remains open: the complete absence of data for the majority of the monuments compromises any statistical elaboration; furthermore, in the cases where there is data, it is necessary to take into account that repeated reuse has compromised the integrity of the archaeological deposits. Even with these limitations, a probable role emerges -in some cases with certainty- of the Monte Claro groups in the building of the megalithic structures. However, it is not possible to totally exclude the idea of building phases relating to Filigosa, Bell Beaker and the Early Bronze Age.

The first hypogeic-megalithic monuments of the Balearic islands appear during the Early Bronze Age, recalled by some scholars for their similarities to the Sardinian monuments, while those of Catalonia are older (Final Neolithic and Eneolithic) (Guerrero Ayuso and Calvo Trias 2001). The monuments of the French *Midi*, in particular the hypogea of the area around Arles, have also often been cited for comparison with Sardinian monuments. At Fontvieille, (Guilaine 2015; Porqueddu *et al.* 2021) the tombs were typified by a long hypogeic chamber with a roof formed of megalithic slabs, covered by a tumulus (Figure 10). These are, it must be said, substantially different monuments, datable, according to Guilaine, to the last centuries of the 4th millennium cal BC.

Looking east, towards southern Italy, regarding Puglia, where both the phenomena of hypogeism and megalithism are attested, several monuments of mixed type of uncertain chronology are known, that have a dolmen structure built against a hypogeic chamber (Franco 1998). The phenomenon also touches Basilicata, where, during the Bronze Age, a vertical access tomb with hypogeic chamber

1 2

Figure 10. Hypogeic-megalithic tombs of Fontvieille: Castellet (1) and Bounias (2) (photos by M.G. Melis).

surrounded by stone circles is attested (Matarese 2018).

In Sicily several rock-cut tombs with megalithic corridors can be found in the western part of the island (Figure 11); these have been studied by various authors and compared to the Sardinian phenomenon. Tusa (2014, 2020), on the basis of these comparisons together with the chronological-cultural considerations, believes that this architectonic model and Bell Beaker arrived simultaneously in Sicily from Sardinia. The tombs show very clearly the characteristics of this monumental class, although in Sicily as in Sardinia, they played a marginal role compared to those of the rock-cut tombs. As in Sardinia, alongside the common general structure of hypogeic chamber and megalithic corridor, there is a variability in the characteristics of the external structure, built from orthostatic blocks or a *telaio* structure, with stone courses alternated with orthostatic blocks. From Tomb 2 at Pergole come three dates referable to Bell Beaker frequentation, comprising the period between 2500 and 1900 BC (Olalde *et al.* 2018). The structure built between the Late and the Final Eneolithic in front of the entrance to the rock-cut tomb at Calaforno (Puglisi *et al.* 2021) is more complex and further from the Sardinian models, with even the characteristics of the hypogeum dissimilar to Sardinian monuments, and should be considered a local re-elaboration of Maltese influx from groups belonging to the Malpasso cultural *facies*. The architectonic elements engraved on the facades of some Sicilian rock-cut tombs (Lanteri 2012) also recall the Maltese hypogeic and megalithic model.

Reassuming, the hypogeic-megalithic model appears in Sardinia earlier than in Sicily. The Sardinian chronological-cultural data invites us to reconsider the idea of the simultaneous introduction in Sicily of the hypogeic-megalithic architectonic model and Bell Beaker, while being unable to exclude an earlier contact between the two islands in the cultural ambit of Monte Claro. This *facies* does not, however, appear to share further analogous elements with the Sicilian Eneolithic *facies*; an examination of the material culture shows substantially different production from technological and morphological-typological points of view, except for some similarities with Malpasso and Sant'Ippolito finds; building styles of housing offer generic comparisons in the ambit of apsed huts (Melis 2019). Regarding Bell Beaker, as demonstrated by Guilaine (2009, 2021) the international style, little represented in Sardinia, is more frequent in Sicily. This aspect is coherent with the possibility of a first Sicilian Bell Beaker phase of direct derivation from the Iberian

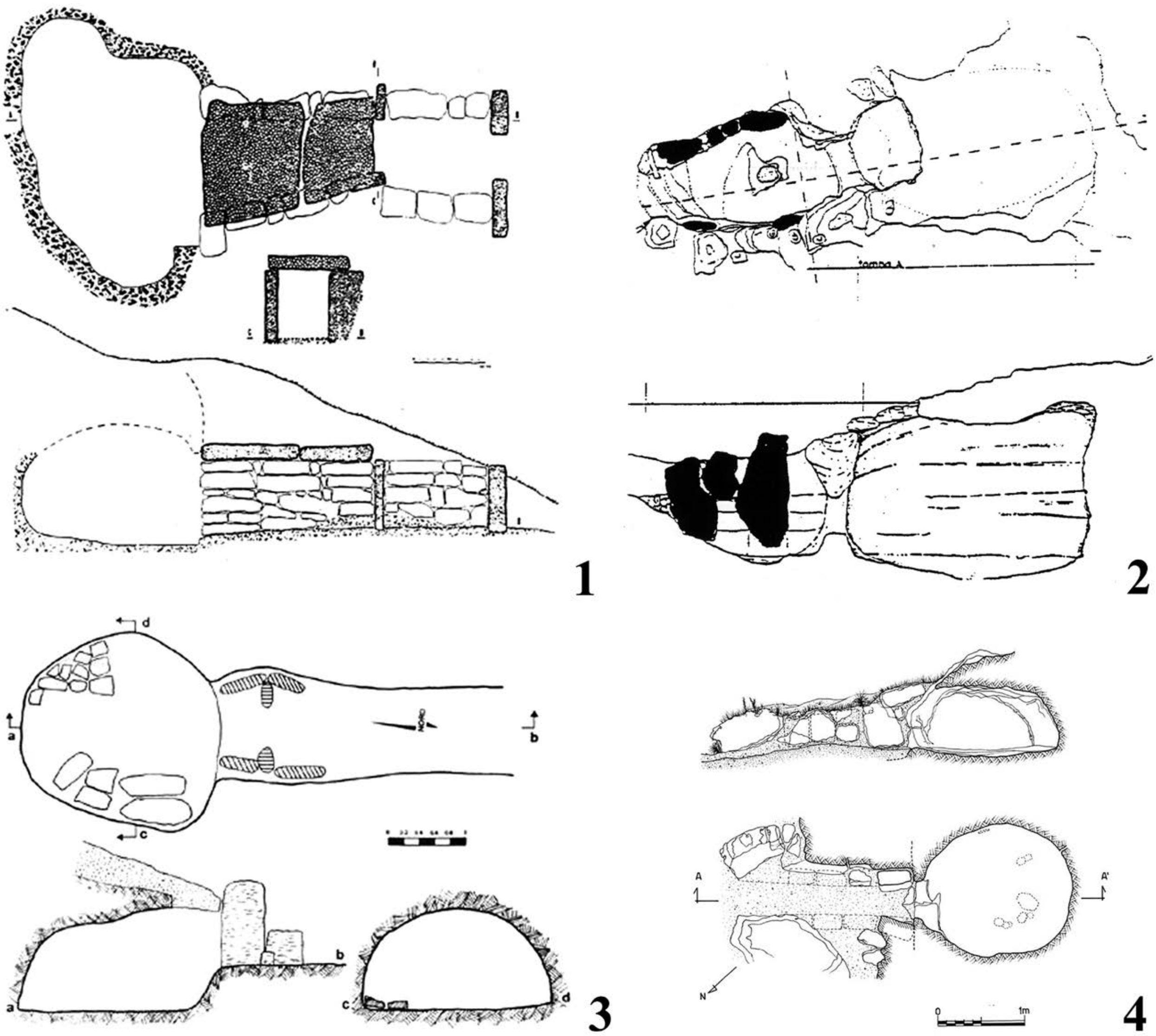


Figure 11. Hypogeic-megalithic tombs of Sicily: Contrada Pergole (1) Marcita (2), Torre Donzelle (3), Castelluccio di Noto (4) (1 from Mannino 1971; 2 from Tusa 2014; 3 from Tusa 2020, 4 from Barucco *et al.* 2021-2022).

Peninsula and of a second contribution from Sardinia. Guilaine excludes, however, that this following phase could have originated in Sardinia, favouring the hypothesis of an autochthon evolution. The similarities between Sardinian and Sicilian Bell Beaker production have been well documented by various authors in the field of ceramics. Less common are the comparisons relative to the elements of the Bell Beaker 'package'; firstly, compared to the rich representativeness on the Sardinian side, there is a more sporadic presence of some elements on the Sicilian front, which brings Guilaine (2021) to the definition of *assemblage opportuniste*, occasionally included in grave offerings to highlight some quality of the defunct. Notable, furthermore, is the scarcity of data on Sicilian metallurgy compared to the numerous Sardinian finds, probably due to the different level of availability of raw materials. It must be noted, however, that less common artefacts bear similarities, such as the gold and silver collar found in the Bell Beaker levels at Bingia 'e Monti and the example from Villagrazia (Battaglia, Mannino 2015), both of which recall exemplars known in the European and eastern Mediterranean ambits between the end of the 3rd and the start of the 2nd millennia cal BC (Melis 2019; De Marinis 2022).

In the Early Bronze Age transition phase and the initial Early Bronze Age, manifestations appear of the phenomena of hybridisation and of the acquisition of regional characteristics in the two islands. For the Early Bronze Age, that in Sardinia and Sicily is closely connected to the final phases of the Eneolithic, the presence in Sicilian contexts of vases with elbow-handles, perhaps recall the productions of Sardinian Bonnanaro. The tetrapod cup at the Pepoli Museum fuses diverse elements; indeed, Sardinian tronco-conical cups generally had three long stands; those vases with more than three stands rested on multiple short bases. The same Museum of Trapani also contains tronco-conical bowls, with foot and without, (Filippi 2014) that, for their shape recall Sardinian models.

The Nuragic phase

The addition of megalithic-orthostatic architectonic elements or of courses of stone blocks is documented in Sardinia in 17 hypogea either created or restructured in the Middle Bronze Age. In three of these (Montessu X, XXV and XXXIII) a Pre-Nuragic megalithic phase can also be identified. In the majority of cases (76%) these are *domus de janas*, that have been altered on the facade with the addition of an architectonic prospect typical of Nuragic burials, the Giants' tomb. The internal spaces of single, double or multiple cell rock-cut tombs, when formed of more than one chamber, were sometimes transformed into one large internal space. It is interesting to note how the megalithic integrations are associated with restructured *domus de janas* but not the hypogea dug *ex novo* during the Middle Bronze Age. The tomb at Oridda provides an exception. Excluding the cases in which a megalithic integration can be hypothesised, but is no longer conserved (T. VI of Sa Figu and T. IX of S'Adde Asile; Melis P. 2014) and those where it is not possible to say whether the facade was built of orthostatic blocks or dry stone courses (T. IV of S'Elighe Entosu; Melis 2023b) only in seven of the hypogea the integration is 'megalithic', namely, formed of orthostatic slabs, with a stele with a curved top at its centre. In some cases a tumulus also covers the hypogeic chamber. These are all grouped in north-western Sardinia, excluding those of Montessu, to be found in the south-western part of the island.

Here follows a description of the general characteristics of the monuments. Calarighe (Castaldi 1975) is a multiple cell *domus de janas*, with modified internal spaces; fragments of the stele were found outside in a secondary deposit. In the necropolis of Montessu (Melis 2016) Tomb X is also a multiple cell *domus de janas*, that in the Pre-Nuragic period is linked to a corridor, partly dug into the rock and partly outlined by polygonal blocks; the megalithic facade, made from orthostatic blocks and slabs, belongs to the Middle Bronze Age. The frequentation of the tomb during the Middle Bronze Age is confirmed through finds and a radiocarbon date (1730-1440 cal BC 2σ; Lai 2009). In *domu de janas* XXXIII of the same necropolis, apart from Pre-Nuragic megalithic elements there is a megalithic facade, constructed during the Bronze Age, which is built against a wall made from roughly-squared stone blocks. The latter has been interpreted as an ancient restructuring (Cicilloni 2009), that substituted the original entrance wall of the first room. However, the fabric and the thickness of the wall do not seem compatible with Pre-Nuragic building techniques. Oridda-Sennori (Castaldi 1975), is a hypogeum with a rectangular chamber; inside, walls made from files of polygonal blocks are built against the chamber side. The facade is formed of courses of polygonal blocks; in front of the entrance is the lower slab of the central stele, which was originally formed of two slabs one on top of the other. At the necropolis of Sa Figu (Castaldi 1975) Tombs II and III are multiple cell *domus de janas*, with modified internal spaces; in Tomb II the facade is formed of orthostatic slabs and a central stele, of which several fragments were recovered. An apsed tumulus, surrounded by orthostatic slabs, covered the funerary chamber. In Tomb III the facade was made from orthostatic slabs and a central stele, found in fragments in a secondary deposit. The re-examination of the photographic record of the initial stages of excavation undertaken during 1959 and 1960 by Ercole Contu in Tomb I at Santu Pedru (Contu 1964) made it possible to add it to the class of restructured neolithic hypogea during the Middle Bronze Age; clearly visible in the upper levels of the corridor are several of orthostatic slabs, three of which remain *in situ*. The presence of finds from the Middle Bronze Age in the archaeological deposit, confirm the frequentation of the hypogeum and strengthen the hypothesis of restructuring and of the realisation of an architectonic facade with an exedra formed by orthostatic slabs, but apparently without stele. Lastly, the tomb at Tana di Lu Mazzoni (Figure 4.2) is a multi-cell *domus de janas*, where a stele with a residual height of 3.60m is placed against the entrance of the tomb (Castaldi 1975).

Final considerations

The data presented here demonstrates that the phenomena of hybridisation (a unitary architectonic project) and of contamination (successive additions) between hypogeic and megalithic monuments are fairly marginal in prehistoric Sardinia. The low number of mixed monuments compared to rock-cut tombs and megalithic monuments, the wide chronological arc of reference, the architectonic variety and the different shapes of internal and external ritual spaces make it impossible to extend to Sardinia the 4th and 3rd millennium concept of 'standardised symbolism' hypothesised for other regions, such as the Southern Iberian Peninsula (Aguado Molina 2010). The chronological and regional variability surely suggests different significances and function, relating to social dynamics in continuous transformation. The almost constant association of megalithic elements to the one or two cell *domus de janas* is much closer to the parameters of megalithic tombs compared to rock-cut tombs, that could be formed of dozens of chambers. Nevertheless, the distribution map of the monuments (Figure 5) shows their presence both in correspondence to the areas where dolmens are most concentrated

(Cicilloni 2015, fig. VIII.1.B), as well as outside it, in the southern part of Sardinia. This distribution, on the contrary, seems closer to that of rock-cut tombs and standing stones, of which circa 1450 exemplars are currently known in Sardinia; indeed, to the 1353 recorded by F. Soula (2015) must be added the roughly one hundred standing stones found at Cuccu de Lai (Perra 2017). These have been studied using a systemic-analytic approach (Soula 2015), which made it possible to demonstrate the existence in some regions of central Sardinia of territorial subsystems, in which standing stones play a socio-territorial role in relation to habitation and funerary areas (rock-cut tombs and/or megalithic tombs).

In mixed monuments, beyond any possible plurality of functions in relation to their chronology, emerges the intent to externalise ritual, which moves from the internal spaces of the hypogea to the open air, reaching monumental forms in the spacious enclosures at Goni, Cirquittus and Montessu. This externalisation is not however manifested in opposition to the internal funerary practises of the rock-cut tombs; at Goni, the same community expresses itself through the languages of both hypogeism and megalithism. It would appear, rather, to respond to local requirements.

During the Bronze Age the phenomena of hybridisation crystallise in the reproduction of the forms of funerary architecture of the earliest Nuragic phase, the Giants' tombs made with orthostatic slabs. It seems likely that it is not coincidental that these are predominantly present in the area of the greatest diffusion of dolmen, in central Sardinia. The hypogea with architectonic facade, the archaic Giants' tombs and hypogeic-megalithic burials constitute the final events of the two long-lasting traditions of hypogeism and megalithism in Sardinia.

The cultural framework remains incomplete in relation to the Pre-Nuragic phase, above all for the scarcity of chronological data, which makes it impossible to fully understand the cultural significance of the analogies observed over different geographical areas, and in particular between Sardinia and Sicily. The two islands, profoundly diverse for geographical position and character, undergo differing cultural developments, conditioned by different networks of relationships that, in the case of Sardinia, appear to include only the western Mediterranean. Different general characteristics mark the manifestations of megalithism and in particular the chronology of hypogeic-megalithic monuments, that in Sardinia began during the Neolithic. Diverse, also, is the role of raw materials and in particular, of metal (Melis 2020), that in Sardinia acquires a growing symbolic significance, confirmed from the beginning of the 3rd millennium by growth in production and by its role in the composition of grave goods.

In Sicily, the introduction to the local cultural substrate of new elements with references to Sardinia, such as hypogeic-megalithic monuments and Bell Beaker cultural components, happens in an advanced phase of the Copper Age. The evidence presented here suggests a hypothesis of possible contacts that preceded the introduction of Bell Beaker, that may have involved the Monte Claro groups. The many questions raised may only be answered through further research and the acquisition of radiocarbon dates.

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Chapter 7
Megaliths: the singularity of each element. Appropriation of distinct entities *versus* geometric constructions

Luc Laporte[1]

Abstract

The development of new approaches to the study of megalithic monuments, and of those who built them, partly relies on technological innovations, but also on the way in which the object of study is conceived, both by us and our peers. From this point of view, the singularity of each of those very large blocks seems so obvious that it has not always been sufficiently emphasised. This singularity can be opposed to the geometric contours of larger structures often built with different raw materials and of which these large blocks form the ruins. The mobilization of very large stones is mainly construed in terms of social implications, exacerbated by rather limited technical knowledge and by the efficient use of resources revealing the ingenuity of their builders. But little thought has been given to the real nature of this choice, apart from comparing such ruins at times with natural features standing in the same landscape. We will argue here that this choice, rather than an economy of means, is above all the result of two distinct modes of human action; one consisting in transforming raw materials to obtain standardized products whose form can only be conceived by a human mind, the other consisting in reclaiming some (non-human) entity whose individualized material envelope already existed in nature, preserving all of its diversity.

Neolithic megaliths in Europe, and elsewhere

In Europe, the term megalith generally refers to very large stones used in the construction of prehistoric structures, which for all intents and purposes require cooperation within the human group to move or position them within a monument. No tangible measurement has been put forward to define what a large stone is (Barrientos and García Sanjuan 2021), despite some attempts to do so (e.g. Boulestin 2016), other than the fact that they can hardly be handled by a single individual. The transport, or raising, of the stone block is thus considered as an indication of each society's ability to coordinate the physical efforts of many individuals for a task that is not strictly necessary for their biological survival (Gallay 2006). The weight or size of the block of stone, and the number of people involved, gives the measure, rather like a snapshot. Dealing with such prehistoric societies generated an assumption of 'primitivism', deeply rooted in the history of research on the subject, assuming that they used limited technical means, whether the slabs were left in their natural form, or in contrast, carefully shaped (Figure 1).

Most of the world's megaliths, however, date from protohistory, most often from before the adoption of writing and the emergence of the state. Their layout is sometimes reminiscent of a chaos of natural blocks. The coarse surface of these very large blocks of stone, erected during the Metal Ages, cannot be attributed to the absence of tools adapted to more advanced shaping (Laporte 2022a). For the earliest periods, the possibility of using force multipliers is almost never investigated, as these latter implements were made of perishable materials for which we have no remains. Such technical advances are more closely associated with historical periods, particularly in Europe (Adam 1977). As for animal traction, unknown on other continents for a long time, the oldest material evidence from Northern Europe is just a few centuries later than the construction of numerous megaliths (Laporte 2019). Megaliths must therefore be primitive architecture, perhaps also because they are supposed to reflect the ingenuity of the human being, capable of assembling such large stones using necessarily rudimentary technical means.

Megaliths are the oldest stone monuments in Western Europe, built in the Neolithic period in a quest for durability that still marks the landscape of our countryside today. Some of these very large stones form a recurrently used burial chamber, sometimes for several millennia (Joussaume 1985). It is the ruins of these monuments that were first described as megaliths, before the term was extended to the whole architectural and landscaping system built using other materials, some of which more labile (Laporte 2022b). The fact that sometimes, and elsewhere in the world, the direct heirs of other megalith builders transport barely shaped enormous stones in dumper trucks, to erect structures that are, all in all, fairly similar to those

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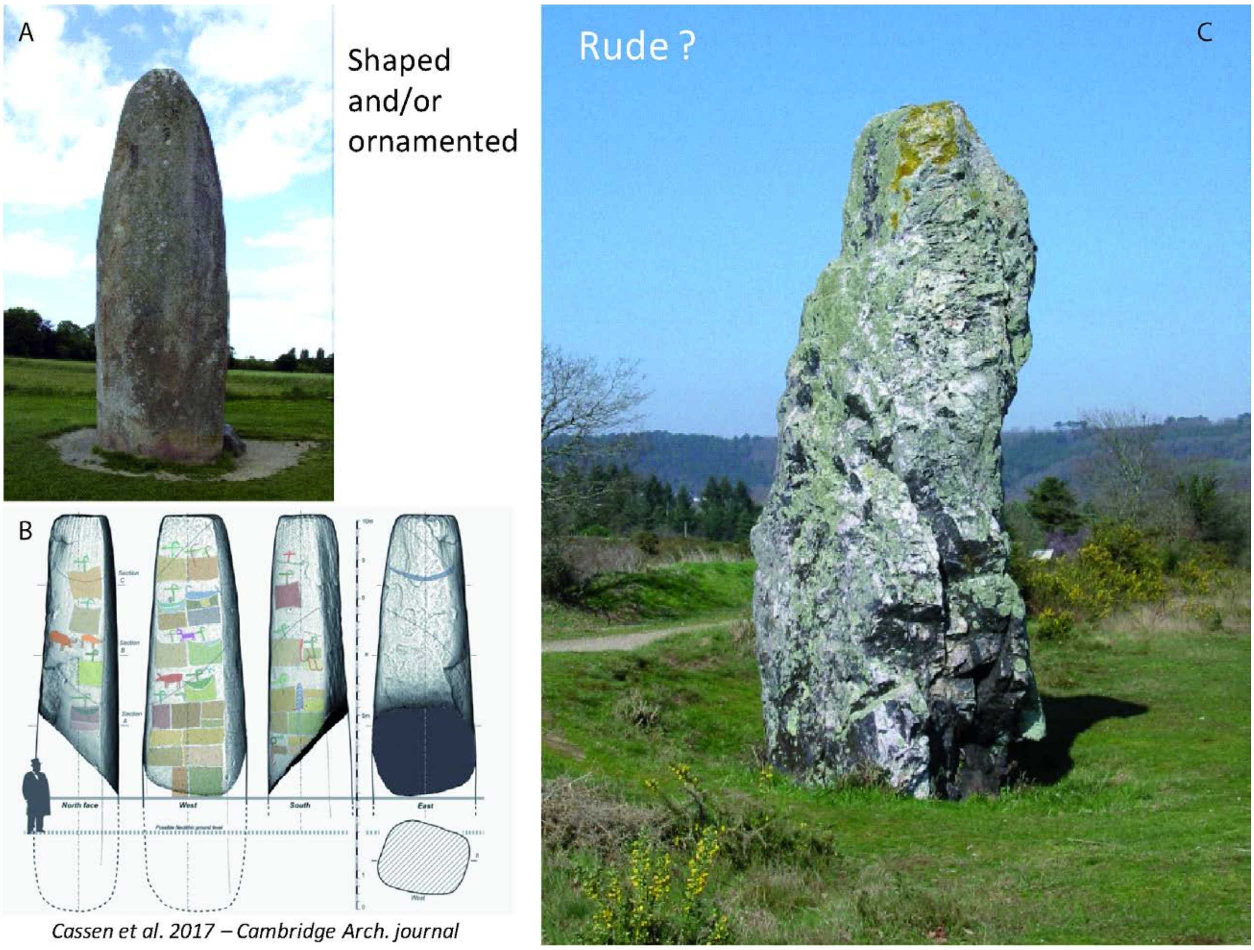

Figure 1. “Rude stone monuments” (Fergusson 1872): Some of the standing stones in northern Brittany, such as the Dol-de-Bretagne stele (A), have a completely worked surface, and others, such as the Saint-Samson stele (B), are even completely decorated. Other standing stones, such as at Sel-de-Bretagne (C), seem to have been left as they appeared in the outcrop, or were roughly hewn. (A and C: photo L. Laporte; B: Cassen *et al.* 2017.)

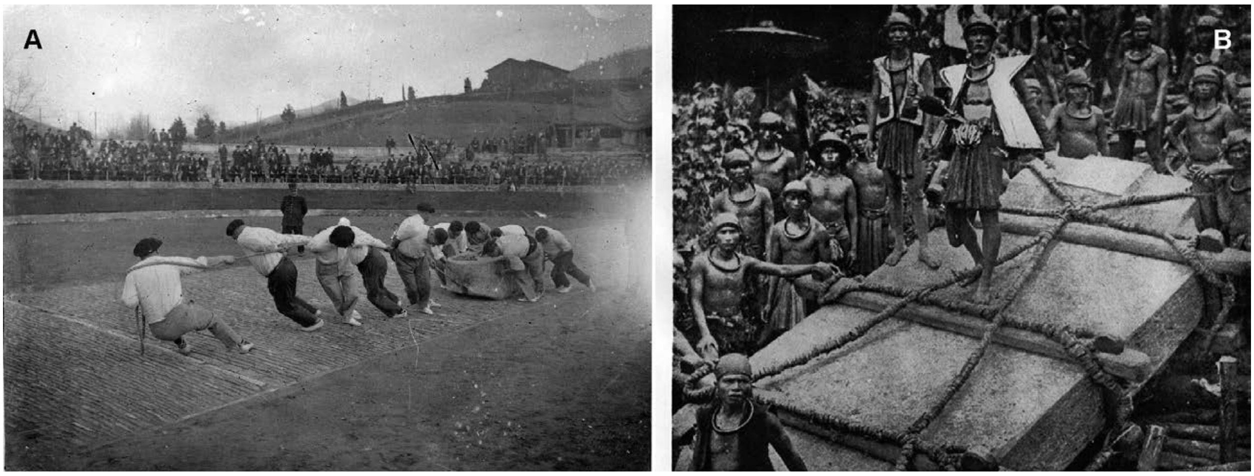

Figure 2. Transporting a large block of stone on a surface prepared with river pebbles, during traditional games in the Spanish Basque Country (A) and (B) transporting a megalith on the island of Nias, around 1910 (A: photo I. Ojanguren, taken in Eibar in 1940; B: after Schöder 1917).

of their predecessors, does not raise many questions, and is considered as an example of anachronistic modernity. The scientific literature on Neolithic megaliths in Europe is strewn with photographic images from the early twentieth century, which are all the more popular for their depiction of scantily-clad humanity (Figure 2).

Faced with remains found on almost every continent, built at different times by populations that often did not know each other, and for which some similarities were identified very early on, it was first necessary to avoid the pitfalls of hasty comparativism (Galles 1869), then those of unbridled diffusionism, by means of regional studies, some of which still require further substantiation (Joussaume 2003). However, through successive extensions and a history of research specific to each academic tradition, the term 'megalith' has come to cover sometimes very disparate realities, depending on the region of the world concerned. Considering megaliths as one form of monumentality, among many others, thus appeared to be the only way of circumventing such obstacles (Gronenborn 2006; Müller 2019; Gallay 2022). Once the real subject of study shifted towards the social organisation of the corresponding human groups, any interest in clarifying what so many objects of study might have had in common began to fade.

The fact is that we now have a fairly complete overview of the diversity of what we have become accustomed to calling megaliths, almost everywhere on different continents for nearly two centuries. This, in turn, kindles our awareness of many possibilities that have been somewhat overlooked or, on the contrary, of some particularly tenacious presuppositions, in the study of megaliths erected during the Neolithic period in Western Europe.

Stones erected vertically or moved horizontally

In Europe, megaliths composed of standing stones in the open air are often contrasted with those where an assemblage of very large blocks creates a covered space, sometimes sealed beneath a tumulus. Their distribution in time and space sometimes overlaps, but does not totally coincide. Only the latter are thought to have a funerary dimension, due to the recurrent discovery of associated human bones, while the former are considered to have a ceremonial purpose (Joussaume *et al.* 2006). Throughout the world, however, there are a few examples of stones systematically erected for funerals, but with no burials beneath them (Adams and Robin 2022). Conversely, in Northern Europe and the British Isles, the initial sepulchral character of a megalithic chamber built in the Neolithic period has sometimes been called into question (Scarre 2016).

This categorisation of architectural structures is globally relevant in Europe, but cannot always be applied to other continents in the same way (Cros and Laporte 2022). This may also be because, even in Europe, there is a tendency to associate too closely the whole of a megalithic structure with each of its constituent elements. There are cases where the two merge, as in the case of a single standing stone in the midst of its terrestrial and celestial landscape, more commonly referred to as a 'menhir'. As the number of stones increases, however, it is no longer clear whether the same term is used to designate the whole structure or each individual standing stone (Laporte 2015a). There are other cases where the same stone, placed vertically or on its side, forms part of the wall of a megalithic chamber, within a 'dolmen'. In such cases, the stone is referred to as an orthostat, because of its supposed or actual function as a support. Pointing out that an orthostat is nevertheless in a quite similar position to that of many standing stones in the open air might seem unfounded, unless we envisage that these are reused 'menhirs' (Laporte *et al.* 2017).

Attempting to access the intentions of the builders of such a distant past, by examining how they conceived each architectural project, is always a very delicate exercise (Laporte *et al.* 2018). We can at least demonstrate that the support function implicitly allocated to each vertically arranged stone slab in a megalithic chamber is not systematically proven, contrary to what the term orthostat suggests. In many cases, orthostats are simply inserted into a dry-stone wall, with no real support function, and are sometimes far too fragile not to break when the ruin of the monumental masses causes them to bear the full load of the capstone. In western France, this is illustrated by the example of the limestone orthostats of many dolmens from the *Angoumois* region (Laporte and Bueno Ramirez 2022), and Neolithic builders even had to underpin one of the megalithic chambers at Petit Mont, in Arzon, Morbihan (Laporte 2010). In fact, comparing the layout and specific characteristics of each of the stones erected in the open air, within the same structure, with those erected in a megalithic chamber or along its access corridor, can sometimes prove highly instructive (Gouézin 2020). It is the only way of highlighting a similar rhetoric with regard to the layout of the stone slabs inserted in the walls of chamber A and its corridor, in the large Barnenez cairn (Plouézoc'h, Finistère), as well as those erected on its western façade, where they were displayed for all to see (Figure 3).

Similarly, and in keeping with the idealized image of the 'dolmen', all capstones seem to be inseparable from the pillars supporting them. However, this is only one of the cases where a very large horizontal stone is used to cover a burial, and its often very real architectural function may not always suffice to explain the nature of the structure. Such staging, carried out for funerals, occurs in the case of boulder graves, such as those in the Paris Basin in the middle of the fifth millennium BC or in Ireland two millennia later (Laporte *et al.* 2011). From a broader perspective, we can see that this is sometimes even the most frequent situation, as in Korea and Japan during much more recent periods. The contours of the stone block concerned are always singular, constituting a clearly individualized entity. This is also the case for the unique cover slab of chamber III of Péré at Prissé-la-

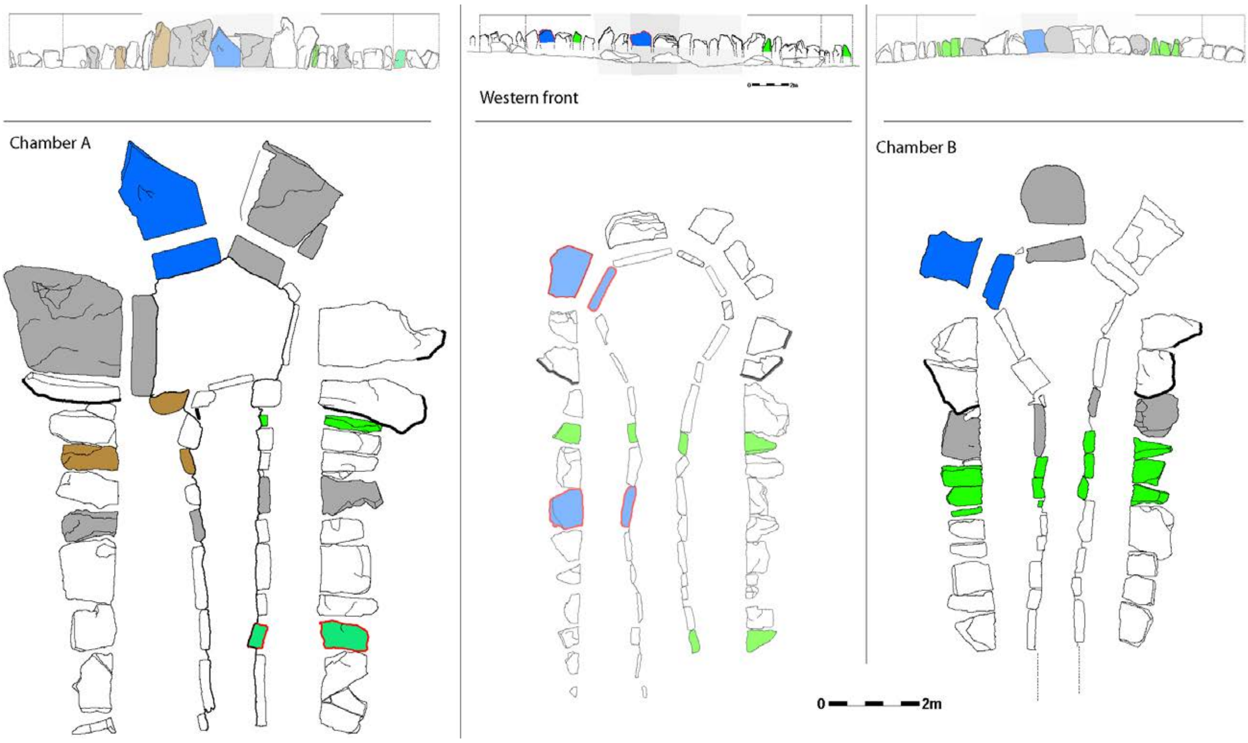

Figure 3. The row of upright stones on display in the western façade of the large Barnenez cairn is quite similar in structure to those inserted into the walls of tombs A and B, at the heart of the tumulus. However, different names are given to these large stones depending on the type of architectural feature in which they are placed (Laporte *et al.* 2017).

Figure 4. Upright stones (vertical), used for commemorative purposes, and boulder graves (horizontal), in a Naga cemetery in Maram Khullen, India (Photo L. Laporte).

Charrière, on the French Atlantic coast, which rests on walls built exclusively of dry stone (Laporte *et al.* 2021).

Sometimes, the capstone was extracted directly on site and then raised above the ground, as attested by the large pits found on the sites of certain Portal dolmens in Wales (Cummings and Richard 2021). These large blocks of stone seem to levitate in weightlessness. Conversely, the large stone slab placed horizontally over the interlocking bodies of a multiple burial at Pontcharaud, in Auvergne (France), at the beginning of the Middle Neolithic (Loison 1998), appears to crush the buried bodies with all its weight, perhaps to dispel the fear that they might return to the world of the living. As far back as the eighth millennium BC, nearly 300 kg of stones were placed on the torso of a Mesolithic burial at Auneau, in the centre of the Paris Basin (Verjux and Dubois 1997). In this way, megaliths comprise some very large vertically raised stones, and others moved to lay in a horizontal position (Figure 4). In both cases, some have been incorporated into a much wider construction while others seem, today, to defy the more elementary laws of gravity, pointing to the sky or standing high above the ground.

The first step in our thinking, then, is to distinguish the nature of the architectural structure from its main constituent elements, in quite the opposite way to that applied more than a century ago, when people learned to identify the nature of sometimes very different structures among ruins that were all made of very large stones with similar appearances.

The uniqueness of each stone

In megalithic structures, the 'rudeness' of the stones was long considered as no more than an economy of means. Although the risk of construing past or present-day builders and societies (rude stones / rude people) as primitive is now far behind us, implicit remnants of this can nonetheless be detected in our perception of megaliths. We will argue here that preserving the integrity of these very large stones resulted at least as much from a choice as from an economy of means. The remains of a megalithic structure in today's landscapes are characterized at least as much by an assemblage of distinct singularities as by the weight or volume of each stone, and it is these ruins that were first called megaliths in the history of our discipline (Figure 5).

There are in fact two distinct modes of human action on matter, one consisting of transforming raw materials to obtain a standardized product with a shape that can only be devised by a human mind, the other consisting of mobilising an entity with an individualized material envelope that already existed elsewhere (Laporte and Dupont 2019). These two forms of action on matter date back as far as the Palaeolithic, for example in the manufacture of objects of body adornment, which alternate between elements with geometric contours, such as rings and cylindrical beads, and others where the original shape of each element has been largely preserved, as in the case of certain shells or animal teeth. The hunter could then identify not only the corresponding species, as determined by our naturalist colleagues, but above all the particular living being to which this object was attached, sometimes in an attempt to appropriate some of the qualities or powers attributed to it. A wolf's canine, for example, was not merely a wolf's tooth but that of a specific wolf observed by the hunter during his lifetime, with all the uniqueness of each living being. This can also be applied to stones: 'Certain properties of a few remarkable stones – hardness, lustre, exceptionally smooth appearance, etc. – act as qualities that determine their participation in the living world and in the passing of time. [...] In this respect, certain stones can provide privileged settings for the expression of these sought-after qualities and thus establish a relationship from which we can aspire to extract for ourselves a little duration, lustre, resistance or hardness' (Adell and Charlier Zeineddine 2022: 210).

These two forms of action on matter were often mobilised together in the construction of an architectural structure, and can be detected in the materiality of many European Neolithic megalithic monuments. While the materiality of each entity (large stone) emphasises some singularities, the materiality of the whole structure is frequently inscribed in geometric contours. Such geometric contours can be a circle or an alignment of standing stones, while others have been obtained by transforming different raw materials, such as small or large stones, wood or even mudbrick constructions. The transformation not only concerns raw materials but the whole landscape, sometimes like an illusory attempt to 'domesticate' time and space

Figure 5. An assemblage of distinct singularities is what characterizes the remains of the megalithic system in today's landscapes, at least as much as the weight or volume of each stone. Le Mélus *allée couverte* (Côtes d'Armor, France). (Photo L. Laporte).

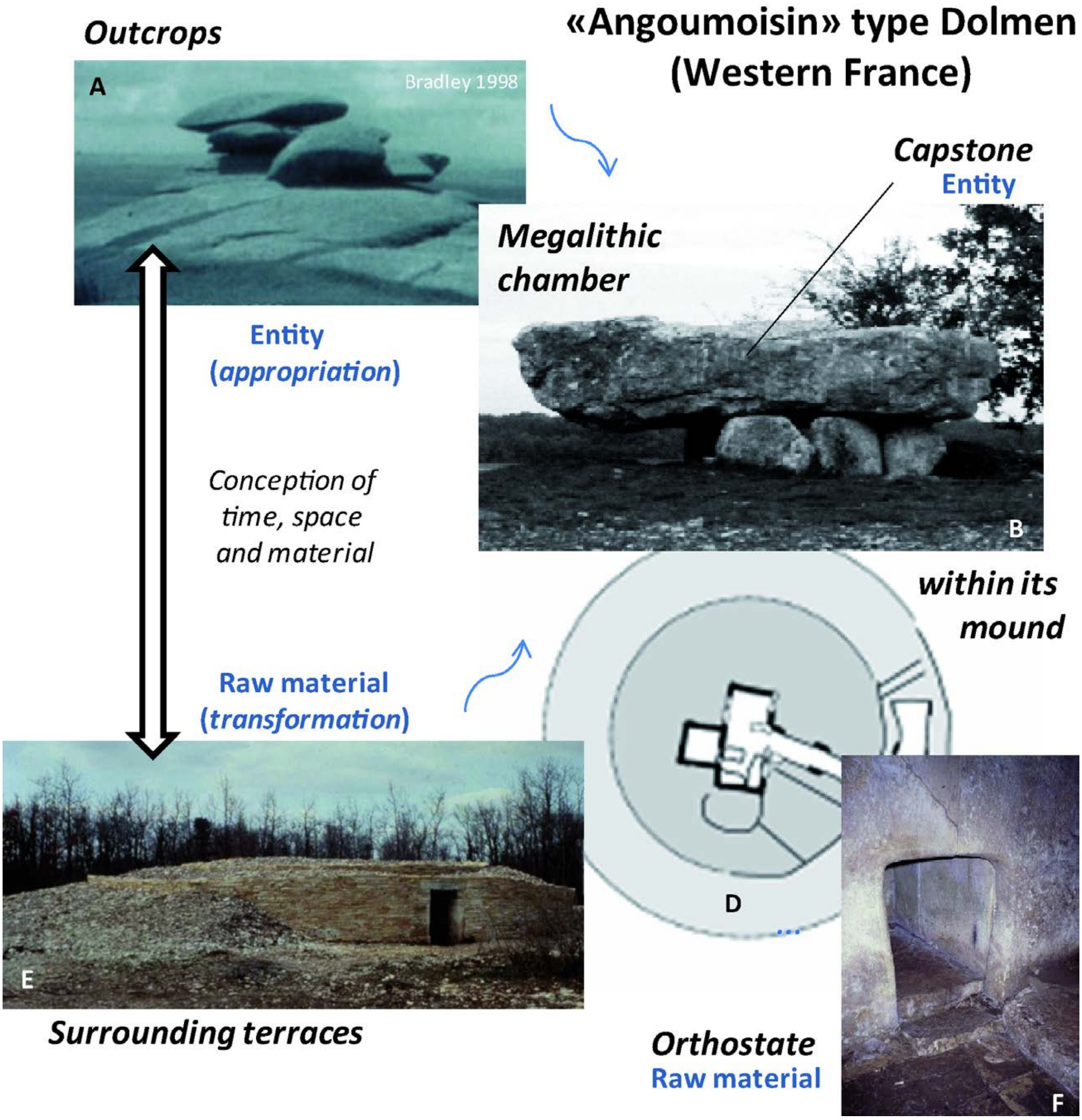

Figure 6. The desire to preserve the uniqueness of large stones, rather than an economy of means, is above all the result of two distinct modes of human action, one consisting in *transforming* raw materials to obtain standardized products whose form can only be conceived by a human mind, the other consisting in *reclaiming* some (non-human) entity whose individualized material envelope already existed and preserving at least some of its diversity (modified after Laporte and Dupont 2019). (B: La Petite Perrotte, Luxé, Charente, & s E and F: La Boixe B, Vervant, Charente: photo L. Laporte; A after Bradley 1998; plan of La Boixe B after Joussaume and Laporte 2006).

(Laporte 2015b). Each architectural project is part of a specific way of perceiving what is material, or not, what is time or space, if different. And the succession of different uses or even different architectural projects, in the same place, leads to a constantly renewed staging of their history recounted by Neolithic populations themselves (Cousseau 2016); in other words, to the creation of (megalithic) monuments.

Distinguishing more clearly between elements with seemingly preserved integrity and those resulting from the transformation of a raw material within the megalithic structure, sometimes reveals some of the builders' intentions, in a somewhat unexpected way (Figure 6). The *Angoumoisin* dolmens, for example, are characterized by an enormous non-modified overhanging capstone, which often extends well beyond the space to be covered, as at the Motte de la Garde, in Charente (France). On the other hand, orthostats are sometimes very finely worked, with smooth surfaces or even grooves so that the different blocks of stone fit tightly together, as at La Boixe B, also in Charente

(France). In the megalithic chamber, the very large orthostat stones were treated as raw materials, in the same way as the small stones of the peripheral cairn (Laporte 2022c). The stones standing vertically in the dry-stone walls of the corridor of the Motte de la Jacquille dolmen have rough surfaces and distinctive contours, particularly in the lengthened part of the corridor, in contrast to the uprights of the megalithic chamber (Ard *et al.* 2016). There, only the horizontally placed capstone has not been transformed, as is the case for some of the *Caussenard* dolmens in the south of France, and even for at least some of the Portal dolmens in the British Isles.

This distinction between a few entities with carefully preserved singularity (cf. also Large 2014: 98), and a more extensive use of raw materials for the construction of the monumental structure, does not always merely amount to the opposition between very large stone blocks forming the megalithic ruins and the use of sometimes more labile materials that outlined the contours of the edifice (Mens and Poncet 2022). In light of the previous distinction between vertical standing stones and horizontally displaced stones, this highlights a previously unnoticed structuring of space that goes well beyond the simple opposition between 'dolmens' and 'menhirs'.

Another example might be certain Portuguese *antas*, or Galician dolmens with polygonal chambers, where the capstone is sometimes just a little larger than the keystone at the top of a corbel, as at Barnenez in Finistère, Brittany. The sloping arrangement and natural curvature of the vertical uprights also considerably reduce the surface area to be covered. A similar observation was made for certain dolmens in the Creuse region of France (Joussaume *et al.* 2002). Finally, the internal volume of the chamber, composed exclusively of very large megalithic blocks, is quite similar to that of a circular chamber with walls made exclusively of dry stone. In the Portuguese Alentejo, each of the individual slender uprights forming the walls of the megalithic chamber at the Anta Grande de Zambujeiro monument is similar in shape to a large standing stele in the open air. Whether or not these are possible cases of reuse is another matter, but it does not alter the previous observation, namely that preserving the integrity of each of these very large stones was first and foremost a choice, and cannot solely be explained in terms of an architectonic function.

Stones that act

Bringing together in one place several distinct entities scattered across the landscape, as is the case of the erratic boulders of Northern Europe, or previously incorporated in the bedrock, has often been interpreted solely in functional terms. This is the case, for example, for studies comparing the number of blocks used in the construction of passage graves in northern Germany with the initial distribution of blocks dispersed during the Ice Ages. Transporting them to a single location necessarily freed up more land suitable for agricultural practices, and there is no doubt that this may have been one of the concerns of Neolithic builders, as is the case for many agricultural societies, leading to the accumulation of rock clearing piles. On the other hand, there are very few cases where such rock piles take the form of a funerary monument.

Once again, extending our perspective to other megaliths built elsewhere in the world, often in more recent times, and sometimes even by contemporaneous societies, draws our attention to a wider diversity of possibilities than we might have hitherto imagined. And a number of recurring themes deserve to be highlighted. Even today, for many human groups, the entity associated with each very large stone is not limited to its material envelope, nor to the physical characteristics that we can measure and determine as part of a scientific and naturalistic approach (Cooney *et al.* 2020). Ethnologists have long highlighted the density of social interactions around certain stones in the form of rituals to protect or embody ancestors. In addition to the human or non-human entities attached to certain stones which bestow life upon them as if by proxy, our colleagues are now also questioning the inert nature of the material, proposing 'in short, to shift from the social life of the stones to the study of life from the vantage point of stones or the life of stones' (Adell and Charlier Zeineddine 2022: 201).

In the Andes, for example, Aymara farmers cultivate stones that are distinguished from other living beings not by their immobility, but by the fact that they always return to exactly the same place. In the Marquesas Islands, the different vantage points of an observer bring the surface of the stone to life. The helical movement linking the subterranean world to celestial spaces, along the shafts of the standing stones on the plains of Mongolia, animates the running deer depicted there in a similar way (Figure 7). Is it possible to fully understand this movement without taking into account ways of representing space that, today at least, place the central post of the yurt of these nomadic herders at the centre of everything? Transforming landscapes by building megalithic structures also depends on how the very essence of what is material (or not) was conceived, of what is time and space (if different), and so on. The oldest architectural plan known to date may be the one engraved on a standing stone, representing a vast hunting enclosure, in Jordan (Crassard *et al.* 2023). In a similar vein, the Carnac alignments form a bar across the valleys of the coastal plain of the Gulf of Morbihan (Cassen 2009), in Brittany, which can only be grasped today by aerial photographs or map representations.

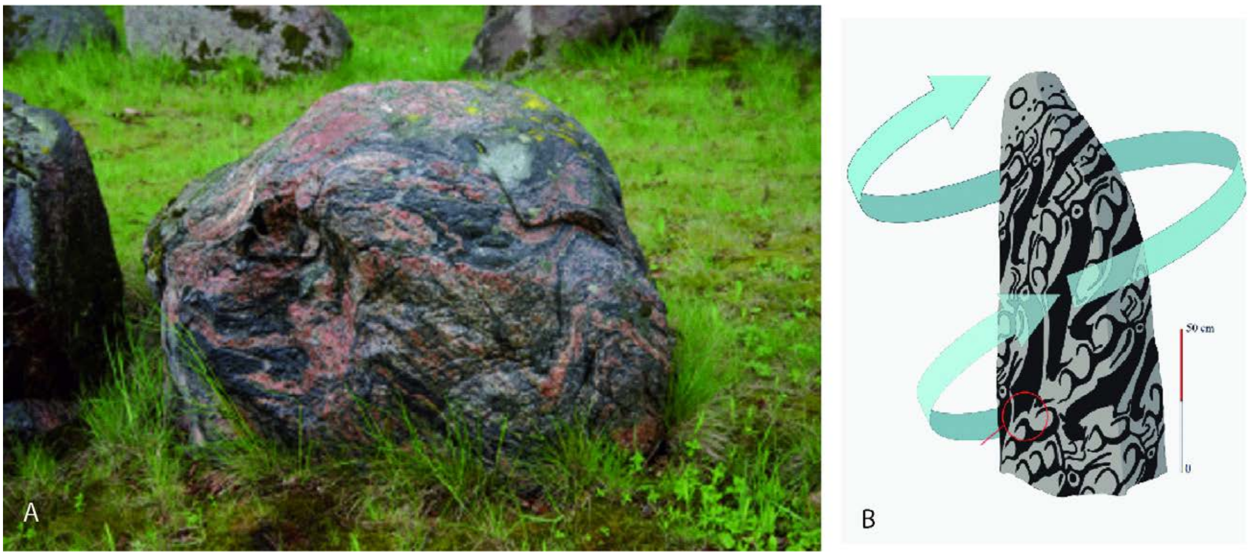

Figure 7. The movement imprinted in the stone by the folds of geological metamorphism, as seen here (A) in the Langbett 6 monument (Futterkamp, Germany), drawing our attention to a whole range of often overlooked possibilities, yet illustrated by many other examples associated with standing stones around the world, such as (B) the running deer linking the chthonian and celestial spheres on a standing stone at Tsatsiin Ereg, Mongolia. (A: photo L. Laporte; B: after Magail 2008).

What applies to very large upright stones is no less true for horizontally standing stones. In northeast India, the Naga inhabitants of the village of Khezakéno took us into the rice fields to explain their contemporary practice of burial under a slab, where a small canal passes through a very large horizontal slab, split in two, to supply the entire irrigation network. This is clearly much more than a technical action, without which the establishment of the village on the heights would not have been possible, in the absence of means of subsistence. The villagers wanted, above all, to underline their gratitude to the singular spirit attached to this very large stone, which accepted a partition of its material envelope to allow them to exist. Transporting a large slab to place over a grave also involves rites invoking the being attached to the stone. In Japan, the premise of similar beliefs to those associated with present-day Shinto, an animist religion, may have appeared on the archipelago at about the same time as the first megalithic builders on the island of Kyūshū, during the Yayoï period in the first millennium BC (Nespoulous 2022). Preserving the singularity of each stone points to its own individuality.

A single attribute is sometimes sufficient to characterize the very essence of the being concerned, if ever it is needed. In western France, during the Neolithic, only a few attributes, sometimes, define the specificity of certain elements, such as a face, a necklace or aligned protuberances, often interpreted as many pairs of breasts. As regards the latter, we frequently forget that other female mammals have more than two udders. For example, four protuberances sculpted in the round on the outer part of the end slab of the gallery grave of the Maison des Feins, at Tressé in Ille-et-Vilaine (France), are often cited as a representation of two pairs of female breasts. Yet they could just as well be four teats on a cow's udder; we simply do not know. The stone is undoubtedly female, but the being attached to it is not necessarily human, or even animal for that matter (Figure 8). It is unquestionably a singular being, like any living being, and sometimes the roughness of the exposed surface, the presence of a vein of white quartz, a fossil or a particular shape are enough to express the uniqueness of this being.

Elsewhere, representation is sometimes more explicit, which does not mean that the stone only has a supporting function. In the West Indies, and particularly in Puerto Rico, alignments of standing stones sometimes line vast palm courts built in the second half of the second millennium AD, and the present-day oral tradition still transmits information about them from generation to generation. At Caguana, for example, around the central plaza A, some of the standing stones each bear a different representation, including a *cacique* (chief) situated at the very centre of the western row 'linking ancestors and descendants, the non-living and the living, the personages of the primordial and the social/human world. [...] These petroglyphs/personages are not mere inanimate representations of potent beings. The indigenes believe they are beings imbued with the vital force of *cemí* (ancestral spirit or deity) and capable of engaging in social relations with living humans in the here and now' (Oliver 2022: 151).

This reasoning could just as easily be applied to the statue menhirs from the end of the Neolithic in the south of France, where discussions have tended to focus

Figure 8. The petroglyphs associated with each stone at the centre of the rows of standing stones lining Plaza A in Caguana, Puerto Rico, in the West Indies (A), illustrate the identity of the human and non-human beings attached to it. This example, like so many others of the same kind on different continents, prompts us to wonder about the sculptures in the round sometimes present on certain slabs of Neolithic gallery graves in Brittany (B): are they the simple representation of a feminine principle, or do they illustrate the being attached to each large stone in particular, beyond its shape, roughness, colour and everything else that makes it unique? (A: Oliver 2022; B Gallery grave of the Maison des Feins, at Tressé in Ille-et-Vilaine: photo L. Laporte).

on the type of attributes or details of the depicted items of clothing, with each author arguing over whether they are deities, heroized ancestors or real people (Maillé 2011). The alternative possibility that they are masks has scarcely been mentioned. In Africa, this is taken to mean a piece of clothing in which the wearer loses his or her own identity to embody a spirit through this physical envelope, which could just as easily apply to a very large stone as to a human being. To confine such practices to the 'primitive' populations of exotic lands would be to forget that even today, in southern Italy, masks still precede the herd when it departs on transhumance, even if they are now imbued with little more than 'folkloric' value.

Beyond the crude appearance of the large stones forming a megalithic structure, and well beyond the supposedly rudimentary nature of their shaping which has led to comparisons with scattered natural blocks, we wish to emphasise the individuality of each stone. Preserving this individuality is a choice, and sometimes a necessity. We postulate, along with Cummings and Richards (2021), that bringing together so many singular beings, where the power of each is materialised by an unusual size or weight, bestows a very special status on these places, with the added guarantee of durability that stems from the use of stone. On the other hand, whether or not it was absolutely necessary for these stones to be exposed to public view for them to have an effect is another matter altogether. The exercise of power also entails its share of secrets, which sometimes enforce very well-hidden ostentations (Hayden 2018). In the Grassland region of western Cameroon, for example, there are a number of royal necropolises where the presence of very large standing stones has, at best, only been glimpsed through the foliage of a sacred grove, as access to them is strictly limited to a few initiates (Notué 2009).

Citing such different examples, each from a very specific context, should not lead to over-hasty comparisons, but they all draw our attention to the fact that each individual stone block, such as those that make up a megalith, cannot be assimilated solely to building material elements. Appropriation of distinct entities and geometric constructions made of raw materials, as observed within megalithic structures during the Neolithic in Europe, are two facets of the materialization of an Ontology. For Neolithic periods, one that has now probably disappeared. And perhaps not only one.

Ontologies

Philippe Descola defines four main categories of ontologies: totemism, animism, analogism and naturalism (Descola 2004, 2017). In a recent work on the forms of the visible (Descola 2021), before attempting an anthropology of figuration, he first dealt with aniconic objects. He defines these as 'images that are nothing other than the figuration of themselves because they incorporate the presence of a being that is usually invisible or capable of taking on multiple forms, like the more or less amorphous stones that play a role in the cults of many civilisations' (Descola 2021: 32). The cited examples are mainly standing stones, sometimes megaliths, such as the Huacas of ancient Peru and the contemporary Andes, which often take the form of large blocks of stone standing vertically. Nabataean betyls 'are sometimes adorned with a roughly sculpted face in bas-relief; but most of the time they were not worked and nothing in their external appearance immediately indicated what they referred to. And there is a good reason for this: [...] the betyls were not images in the most immediate sense of the term, but the receptacle of the divinity, the place where it resided, so that worship of it was not addressed directly to the stone, but to the sacred

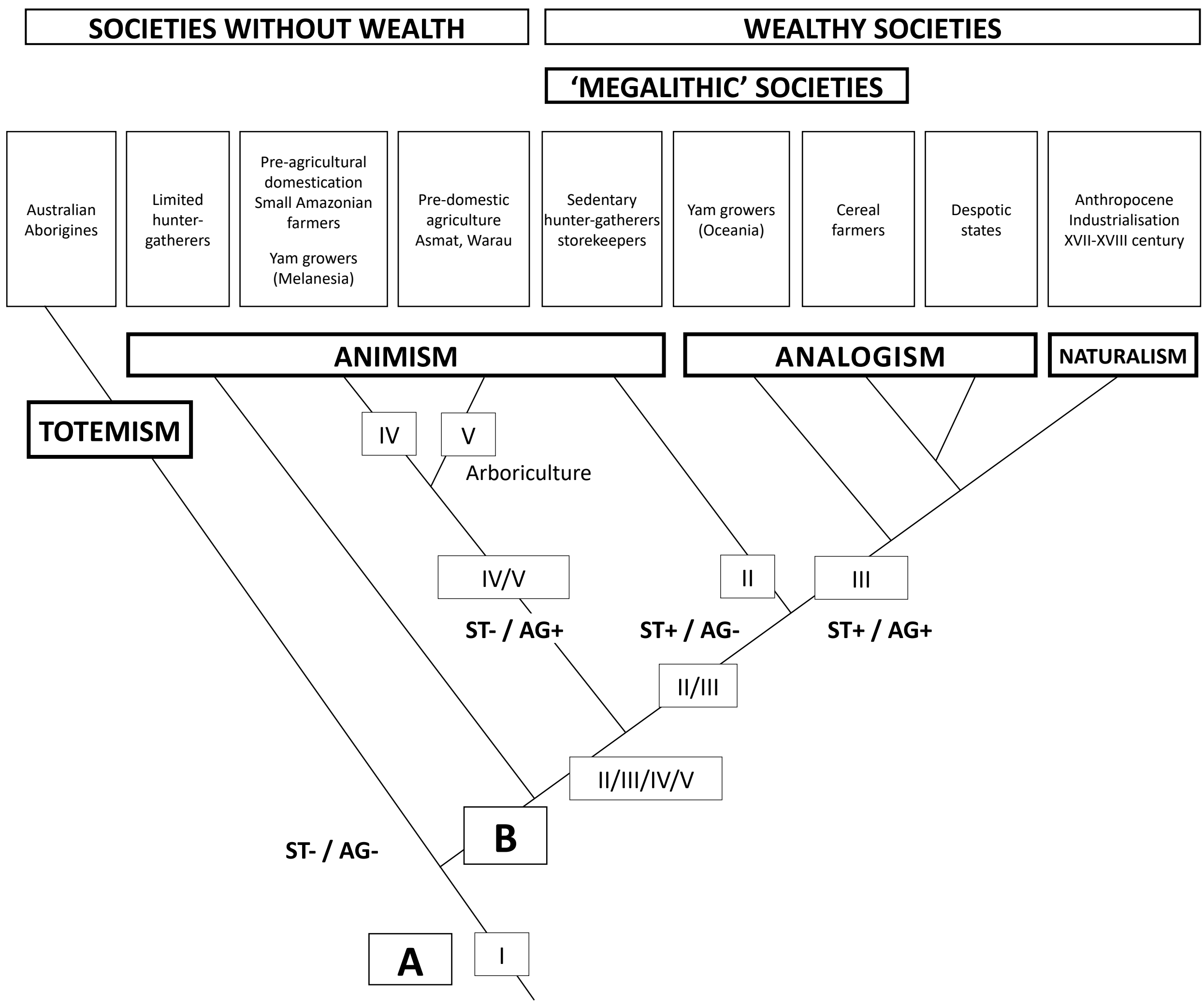

Figure 9. Cladistic diagram proposed by Alain Gallay presenting a classification of societies incorporating the theories of Alain Testart and Philippe Descola (after Gallay 2022).

presence that it made visible and that could be reached through it' (Descola 2021: 32).

Even more recently, Alain Gallay attempted to compare his classification of what he calls megalithic societies, first developed with reference to the work of the anthropologist Alain Testart (Gallay 2006), also based on the ontologies defined by Descola (Gallay 2022) (Figure 9). He takes care to point out, however, that Descola expresses explicit doubts about the possibility of extending these major families of ontologies observed in the present, to account for all the diversity of bygone pasts. Claude Lévi-Strauss expressed similar reservations about the analysis of myths in *Tristes tropiques*. Gallay associates most of the so-called megalithic societies with Analogism, which Descola characterizes as follows: 'Faced with the observation that the world is populated by singularities, it is a matter of organising these singularities into chains of meaning and tables of attributes in an attempt to give order and meaning to both individual and collective destinies' (Descola 2021: 57). Only a few groups of sedentary hunter-gatherers, among those who built megaliths, could have had an animist ontology: 'Animals, plants, spirits and certain objects are seen and treated as persons, intentional agents said to have a soul' (Descola 2021: 54).

In truth, preserving the singularity of each very large stone moved by humans could indeed point us towards analogistic thinking, when they are juxtaposed within alignments or as suggested by the arrangement of panels and historiated registers on the Saint-Samson stele, for example (Figure 1 B). Other examples of megalithic structures from Southeast Asia mentioned above, including some agricultural societies with an egalitarian ideology (Tiatoshi and Müller 2022), are more in line with animist thought, some of the principles of which also apply to contemporary societies in West Africa, although often with an analogist ontology. Some of the graphic representations found on the Okuniev stelae of Siberia (Magail *et al.* 2022) could have been conceived within the framework of an ontology with similarities to those defined as animistic. More generally, animist ontology systems of thought attach little importance

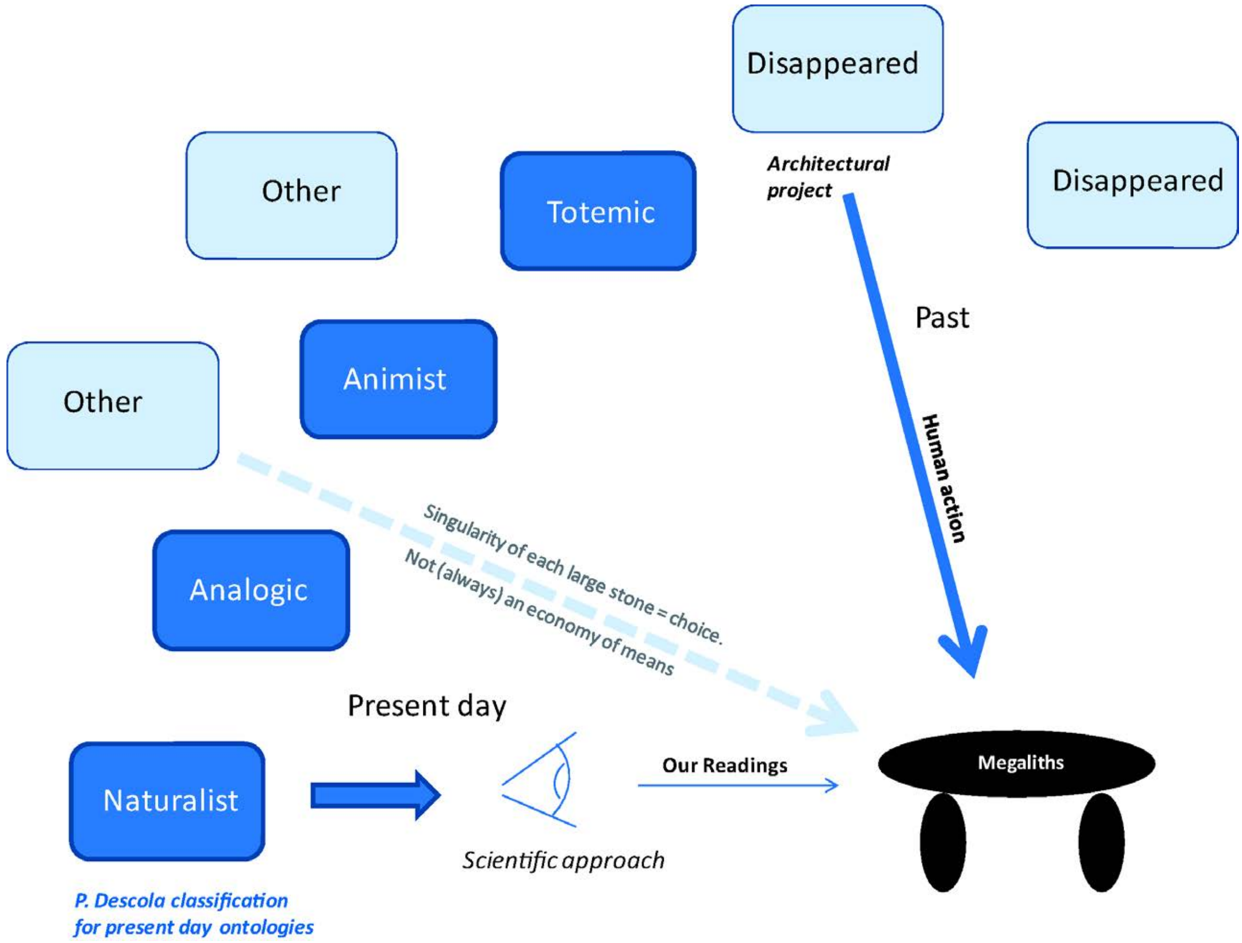

Figure 10. Megaliths were built by populations with systems of thought based on a very different ontology to the naturalistic ontology at the root of our own scientific approaches. Beyond the weight and size of each block of stone, perhaps it is the filter of this naturalistic ontology that resulted in the interpretation of their preserved singularity as a rudimentary characteristic for so long?

to the passage of time, and to ancestors; this is at least the case for the Achuars, dear to Descola, in Amazonia. At present, hardly any megalith builders are part of a totemistic ontology; Australian 'memory stones', sometimes placed vertically, are generally small in size (Urwin *et al.* 2022).

Neolithic megalithic architectural projects in Western Europe were created by populations whose ontologies have now disappeared forever (Figure 10). However, we can be certain that this was not a naturalistic ontology, which is the source of many scientific approaches and which Descola deems to emerge in Western Europe in the seventeenth century. Indeed, the King of England commissioned John Aubrey to draw up a measured plan of the circle of standing stones at Avebury in 1663, the first of its kind. Shortly after that, work carried out in 1685 on a megalith at Cocherel in Normandy was reputed to be the very first archaeological exploration in France (Scarre and Laporte 2022). And it is indeed a naturalist filter that led to the emphasis on the geological and petrographic determination of a stone, rather than the folds animating it (Figure 7A). Comparisons between megalithic ruins of dolmens and chaos of natural boulders were also made in the same context (Bradley 1997); primarily because of the individuality of each boulder in both cases? None of these very large blocks of stone can be described as 'amorphous', to use Descola's term.

Within megaliths, some stones were treated as raw materials, while for others the prime concern was preserving the integrity of what makes them unique, as is the case for every being on this earth. Highlighting each of these individualities does not exclude some economies of means. But presenting the latter as a primary principle, if only to highlight the ingenuity of a humanity with rudimentary techniques, was undoubtedly a fallacy.

Conclusion

We have come a long way from the presupposition of 'primitivism' that everyone now agrees is erroneous, but which still pervades so many studies of megaliths. Placing the megaliths of the Neolithic period in Europe in the wider context of megaliths around the world enhances our awareness of a hitherto unimagined range of possibilities. This broader framework marks a break with any form of over-hasty comparativism, and also sheds light on how our own approach, rooted in a naturalist ontology, imposes a distorting filter for interpreting architectural projects built by populations with such different systems of thought. Highlighting the fact that each of these very large stones is unique means that we can at least avoid prejudging what this might have meant in a slightly different way for each human group among megalith builders in the past. Distinguishing between the shaping of a raw material and the appropriation of always singular entities, learning to identify them and questioning their respective places, offers a renewed key to the study of these megaliths. The aim of this first article was to set out such principles. A subsequent article (at the CIMAR symposium in Trigueros) will explore some very practical applications.[2]

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Chapter 8
Current research on Westphalian megaliths

Kerstin Schierhold

Abstract

In many regions of Europe, megalithic buildings are among the oldest surviving architectural artefacts and still characterise our cultural landscapes in various ways today. Their equally monumental and mythical presence inspired a wide variety of theories centuries ago; this fascination continues to this day. New methods and perspectives from various sources are finding their way into archaeological research, making it possible time and again to address previously unasked questions about the monuments and gain new insights. In the last fifteen years, research into the megaliths of the Westphalian landscapes has provided many new insights into the overall picture, both through new excavations and scientific analyses of long-excavated finds. The use of virtual archaeology as a research method and overarching landscape archaeological questions provide additional insights into the world of the builders and users of megaliths. The virtual reconstructions are also used for the successful digital communication of archaeological findings about the megalithic structures of Westphalia to the public. In addition, the European Cultural Route 'Megalithic Routes' provides access to these oldest monuments in the region in a representative, modern and illustrative manner. The information points at the graves are supplemented by digital information accessible via QR code, which has the advantage of being able to grow with the respective state of research.

In Westphalia, two different types of megalithic structures are available for research and presentation: The above-ground megalithic tombs of the Funnel Beaker (FBC) communities in the north and west of Westphalia and the sunken gallery tombs of the Wartberg (WBC) communities in the south and east of the region.

Zusammenfassung

Megalithische Bauten gehören in vielen Regionen Europas zu den ältesten erhaltenen Bauzeugnissen und prägen bis heute unsere Kulturlandschaften in unterschiedlicher Art und Weise. Ihre gleichermaßen monumentale wie mythisch anmutende Präsenz hat schon vor Jahrhunderten zu verschiedensten Theorien inspiriert; diese Faszination hält bis heute an. Neue Methoden und Sichtweisen, die aus unterschiedlichen Quellen Eingang in die archäologische Forschung finden, ermöglichen immer wieder, bisher nicht gestellte Fragen an die Monumente zu richten und neue Erkenntnisse zu gewinnen. In den letzten fünfzehn Jahren hat die Erforschung der Megalithik der westfälischen Landschaften einerseits durch neue Grabungen, aber auch naturwissenschaftliche Analysen von Altfunden viele neue Erkenntnisse für das Gesamtbild erbracht. Der Einsatz virtueller Archäologie als Forschungsmethode und übergreifende landschaftsarchäologische Fragestellungen ermöglichen zusätzlich erweiternde Einblicke in die Welt der Erbauer und Nutzer der megalithischen Anlagen. Die virtuellen Rekonstruktionen werden aber auch für eine erfolgreiche digitale Vermittlung archäologischer Erkenntnisse über die Megalithbauten Westfalens in der Öffentlichkeit genutzt. Daneben erschließt die Europäische Kulturstraße 'Megalithic Routes' diese ältesten Monumente der Region analog im Gelände in repräsentativer, moderner und anschaulicher Weise, ergänzt um per QR-Code abrufbare digitale Informationen, die den Vorteil haben, mit dem jeweiligen Forschungsstand mitwachsen zu können.

In Westfalen stehen zwei unterschiedliche Arten von Megalithbauten für Erforschung und Präsentation zur Verfügung: Die obertägig errichteten Großsteingräber der Trichterbechergemeinschaften im Norden und Westen Westfalens und die eingesenkten Galeriegräber der Wartberggemeinschaften im Süden und Osten des Landes.

Keywords: Megaliths, Westphalia, Wartberg Culture, Funnel Beaker Culture, virtual reconstructions, presentation to the public

Introduction

Two research projects have significantly expanded knowledge about Westphalian megaliths in the last 15 years. First, investigations within the framework of the German Research Foundation (DFG) funded Priority Programme 1400 'Early Monumentality and Social Differentiation' should be mentioned (Müller, Hinz and Wunderlich 2019). This programme, conducted between 2009 and 2015, focused on the Neolithic period of the North European Plain, examining the emergence and development of large structures and early complex societies after the establishment of settlements around 4100 BCE. Monumental structures such as causewayed enclosures and megalithic tombs had emerged in the southern extension of the North European Plain and along the northern border of the Central Uplands, similar to the northern regions of Central Europe. However, aspects of the Neolithic package including settlement, agriculture, and animal husbandry had

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already arrived with the Linear Pottery culture, over 1200 years earlier. Despite these different circumstances compared to the northern regions, it appears that similar social structures conducive to collective activities such as the construction of monumental buildings had also developed. One opportunity to investigate this phenomenon was provided by the study of the genesis and structure of the Hessian-Westphalian megaliths using the example of the Soest group, which was the focus of the corresponding DFG sub-project (e.g. Klingner and Schultz 2019; Schierhold 2011; Schierhold 2012; Schierhold 2014a; Schierhold 2019a).

The Soest group, comprising several burial sites of the Wartberg communities, offered ideal conditions for addressing the main questions of SPP 1400 from a topographically peripheral perspective (Figure 1; Figure 2). The graves are located in the Hellweg Zone, which includes the loess-rich ancient settlement landscape of the Soest Börde. The Soest Börde lies on the north western periphery of the distribution of Hessian-Westphalian gallery graves belonging to the Wartberg Culture (WBC), which thins out only 30 km northward with three sites of the Beckum group. The distribution area (Figure 1) of the Western group of the Funnel Beaker Culture (FBC), which also constructed megalithic tombs, extends to the immediate vicinity of the Soest group or even overlaps, presenting the Hellweg Zone with burial rites that appear similar at first glance. In this strain between two societies

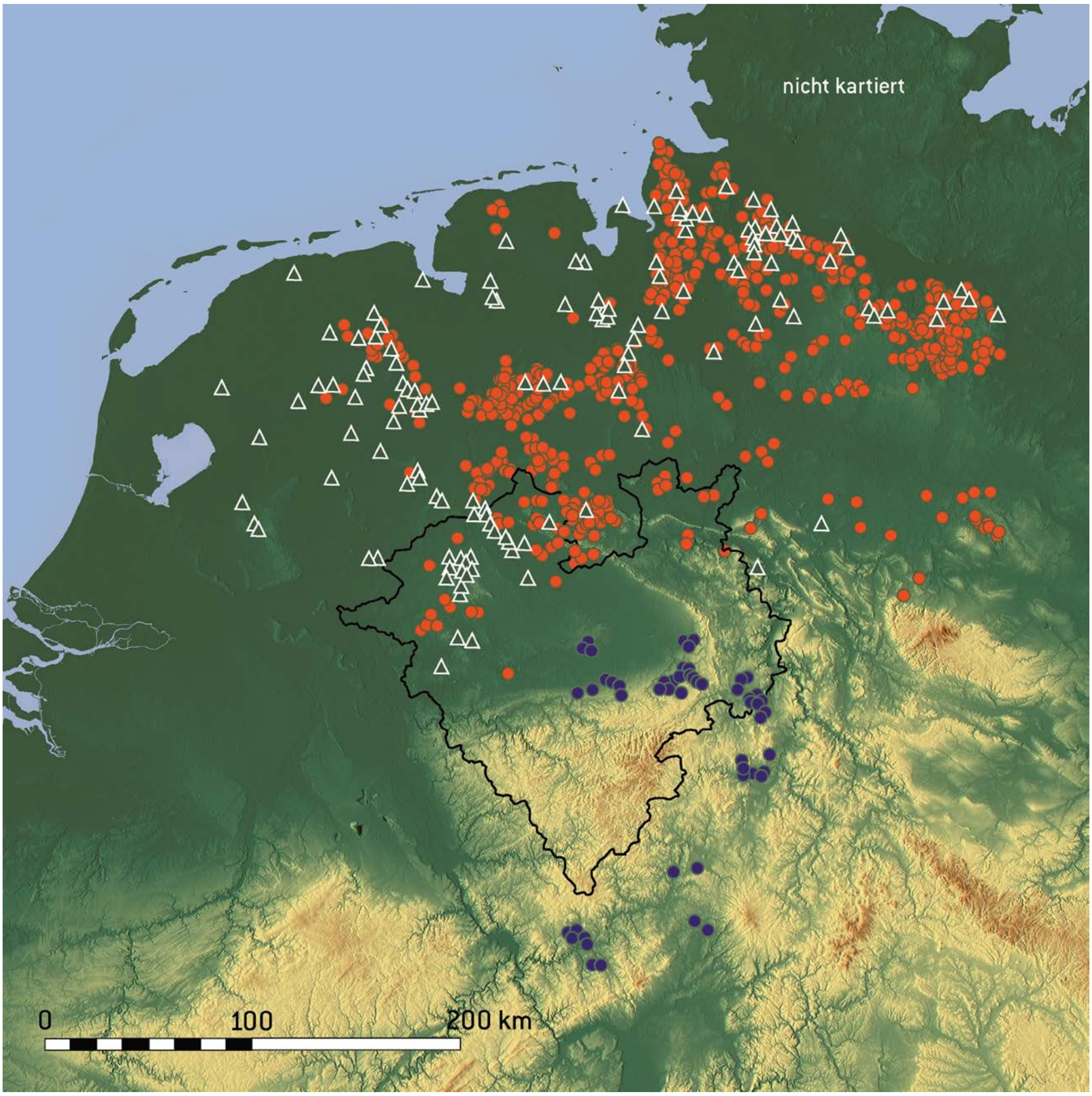

Figure 1. Distribution of megalithic graves of the FBC (red) and WBC (blue), and FBC flat graves (white) in Westphalia and beyond (Data basis Mennenga 2017; Schierhold 2012; graphic LWL-Archäologie für Westfalen/M. Kloss).

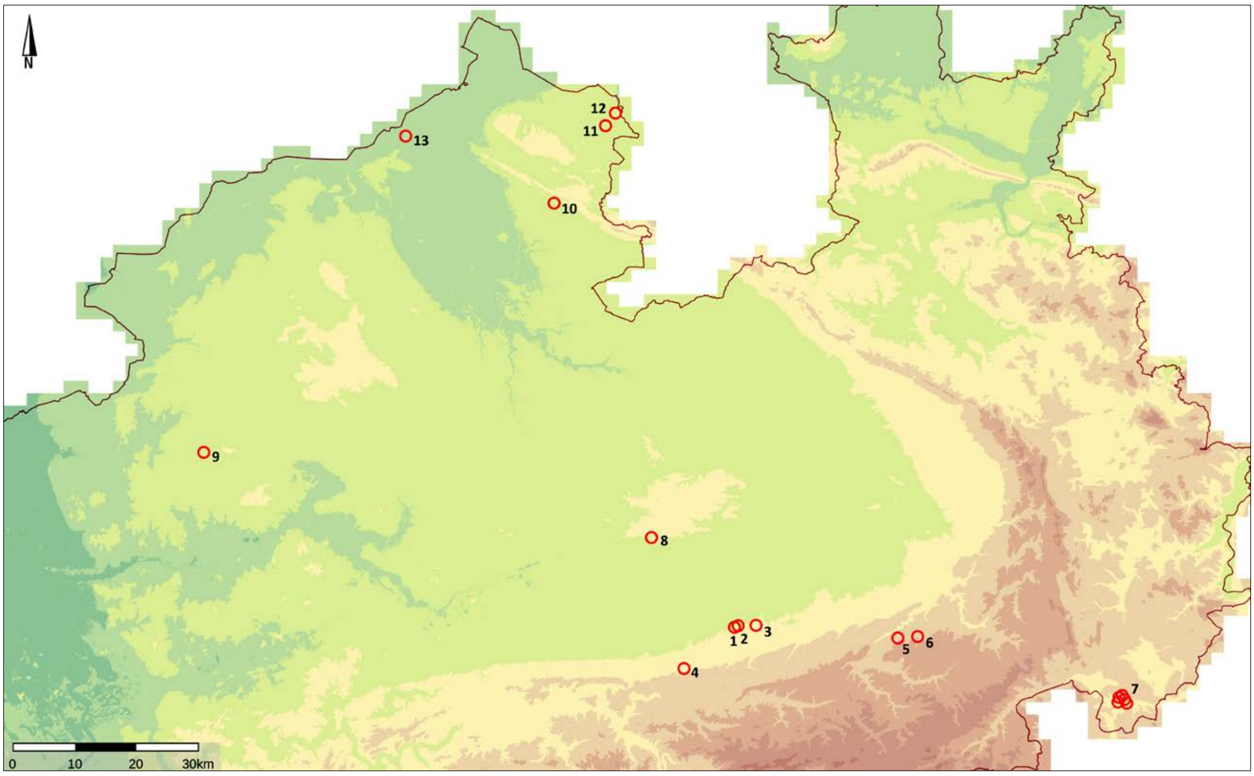

Figure 2. Distribution of Westphalian megalithic graves mentioned in the text. WBC: 1, 2 – Erwitte-Schmerlecke I+II; 3 – Erwitte-Völlinghausen; 4 – Soest-Hiddingsen; 5 – Büren-Brenken; 6 – Büren-Wewelsburg II; 7 – Warburg I-V (group); 8 – Beckum-Dalmer II. FBC: 9 – Heiden Düwelsteene; 10 – Lengerich-Wechte II; 11 – Lotte-Wersen Große Sloopsteene; 12 – Lotte-Halen Kleine Sloopsteene; 13 – Rheine-Schotthock (data basis K. Schierhold; graphic GEOBbasis. NRW https://www.govdata.de/dl-de/zero-2-0).

burying collectively but with different construction and burial concepts, lays the site of Erwitte-Schmerlecke, District of Soest (Figure 2). Here, two collective graves of the Wartberg culture were completely excavated. Simultaneously, the surroundings of four other known graves of the Soest group were examined for possible additional associated structures and settlement sites through surveys and small excavations. This included the analysis of the relationships between causewayed enclosures in the Soest Börde and gallery graves in their temporal and spatial dimensions, to understand the origins, significance, and possible connections of monumental construction based on collective labour efforts.

The documentation of the Schmerlecke graves, additional small excavations at other sites, and extensive archaeological and geophysical surveys allowed for a variety of different scientific analyses. For example, it was possible to trace the origins of building materials for the construction of the gallery graves in Schmerlecke through geological investigations. Various material analyses provided new insights into the use, reuse, and abandonment of artefacts from the burial context, and they also indicated regional communication networks and, through archaeo-zoological determinations, ultimately subsistence strategies. Furthermore, soil science and pollen analytical investigations shed light on the development of relief and landscape in the vicinity of Erwitte-Schmerlecke. One of the significant aspects is the good preservation of human bone material in the graves of the Hessian-Westphalian gallery graves, which also applies to the Erwitte-Schmerlecke sites. Analyses of the entire material were conducted not only using 'classical' anthropological methods but primarily with palaeo-pathological methods. A total of 80 new radiocarbon (AMS) dates provide a more detailed picture of the chronological classification of the collective burial custom of WBC. Isotope analyses (13C, 15N) provide insights into the diet of the Schmerlecke population. Ancient DNA (aDNA) analyses for determining origin or kinship structures were not fully completed due to challenging preservation conditions: The aDNA of 10 individuals examined in a pilot study using molecular genetic methods in 2012 initially revealed what appeared to be relatively advanced aDNA degradation despite (externally) good preservation of the bone material. Meanwhile, new methods were introduced and successfully tested for Erwitte-Schmerlecke (Lipson *et al.* 2017), so the results achieved provide a promising starting point for future investigations.

In 2014, a new research focus was established at the Commission for Westphalian Antiquities (Schierhold 2014a; Schierhold 2015). As part of a research project initially planned for five years, the Westphalian megaliths, as a unique group of monuments and the oldest surviving architectural remains in the region, were systematically documented, studied, and subsequently presented to the public for the first time in 40 years. The focus was on the region's uniqueness due to the coexistence of two different megalithic building communities in close proximity: WBC and FBC. The state of research on the individual sites, especially those of the FBC, varied significantly until then; hardly any of them had been archaeologically investigated. Nevertheless, they were always significant for the people living in their vicinity and for the regional history, as evidenced by various legends and their presence in educational and local history books.

A research phase was conducted to provide the technically qualified basis for a later tourist development, including the European Cultural Route 'Megalithic Routes'. All existing knowledge was compiled and reassessed: reports from excavations, literature, archival news, plans, information regarding local communities' interactions with the monument (reception/legends/stories/press articles), and the archaeological context. The preservation status of each site was recorded, concepts for conservation measures were developed, and ideas for tourist development were consolidated. The survey also included a catalogue of measures that drew attention to research needs and proposed methods to address them. This resulted in numerous individual projects. Initially, this included the re-survey of the visible graves in the field. These sites have been known for a very long time, remain impressive today, and are firmly embedded in the cultural memory of the region. It was therefore surprising that at the beginning of the work, hardly any FBC megaliths and only a few of the WBC were documented according to modern archaeological standards. Therefore, modern documentation using drone flights for orthographic photos and primary 3D recordings was initially pursued. Additionally, efforts were made to relocate sites that are no longer visible above ground. It is important for a comprehensive scientific study that also graves not immediately visible in the field are recorded, whose knowledge is owed to sources such as place names, old reports, maps, and similar archival materials. In some cases, an approximate location could be determined through these sources, which could be verified using geophysical surveys. This approach had previously been successful in Beckum, District of Warendorf (Heinen, Schierhold and Stapel 2012), and also in Erwitte-Schmerlecke, District of Soest (Schierhold 2012: 26-32). However, not only did the monuments present in the field require modern documentation, but also the rich ceramic material from the graves, especially those of the FBC. Their new documentation (e.g. Kopner 2020; Schierhold 2017) contributed to enriching typo-chronological issues discussed in research.

The preservation of bones in the FBC graves in the northern part of Münsterland is unique, as corresponding skeletal material from the more numerous graves in Lower Saxony, Schleswig-Holstein, and Mecklenburg-Western Pomerania is lacking. The skeletal finds thus occupy a key position in the exploration of the relationship between FBC and WBC and have accordingly been re-examined (e.g. Gerling, Maixner and Schierhold 2018). Furthermore, archaeological landscape analyses have revealed new aspects of the integration of megalithic structures into the prehistoric landscape. This involved not only the examination of additional visible archaeological evidence such as burial mounds or the location of potential settlement areas over time, but also the inclusion of research on ancient pathways as another focal point of the investigations of the Commission for Westphalian Antiquities (Klinke 2023a: 129-58; Schierhold and Pfeffer 2015).

In the first phase of the project, initial investigations were conducted using innovative archaeo-informatics methods, highlighting the significant potential of these techniques. Therefore, in a second project phase from 2019 to 2021, building upon the results obtained, the focus was placed on archaeo-informatics research concerning the Westphalian megalithic cultures (e.g. Klinke 2018; Klinke 2020; Klinke 2021a; Klinke 2021b). Recent instances of vandalism at the 'Große Sloopsteene' megalithic tomb abruptly emphasised the importance of digital conservation for heritage preservation. To preserve their current state for future research, all above-ground visible megalithic tombs in Westphalia were scheduled for digital conservation. Furthermore, new universally applicable workflows in archaeo-informatics were developed and optimised based on the Westphalian megalithic structures. Virtual reality (VR) technology was employed as a scientific research tool (e.g. Klinke 2021a). The resulting 3D models served as the basis for digitally reconstructing the tombs on a scientific basis. The objective was to virtually restore the original construction state of selected tombs to gain insights into construction techniques (technology, statics, and architecture) and use (passage heights, occupancy, and successive infill).

The ongoing third phase of the project, initiated in 2022, focuses on the various manifestations of FBC burials after surveying all graves and digitally conserving the extant structures. This includes megalithic tombs and non-megalithic flat graves found side by side in the western Münsterland region (Figure 1). The starting point is the megalithic tomb of Rheine-Schotthock, District of Steinfurt, which is still largely in its original condition (cf. Figure 2). Finds from a small excavation in 1983 (Eckert 1999), including human and animal skeletal remains as well as a large number of ceramic vessels, are being reanalysed using modern methods (Kopner, in press). In the immediate and wider vicinity of Rheine, numerous non-megalithic flat graves belonging to the same period have also been discovered. The relationship between the differently burying neighbouring settlement communities needs to be clarified, to the extent possible, in terms of burial customs and other funeral practices. This includes comparative analyses of inventories focusing on ceramic material culture. The results of these studies contribute to a European research project involving the Dutch regions of Overijssel and Gelderland, which started in October 2023 and is funded by the EU program 'Interreg Deutschland-Nederland' (Europäische Zusammenarbeit 2023).

Parallel, both projects have produced several research works that delve into specific questions in more detail. For example, the re-examination of ceramic finds from the megalithic tomb 'Düwelsteene', District of Borken (cf. Figure 2) (Kopner 2020), or the presentation of the Michelsberg causewayed enclosures of Müllingsen and Bad Sassendorf, District of Soest (Peters 2020). Moreover, the methods of virtual archaeology applied to the Westphalian megaliths, combined with a further focus on landscape archaeological questions, enable new approaches in the diachronic interpretation of landscape-defining monuments (Klinke 2023a; Klinke 2023b).

The following briefly highlights some insights gained from the research from both projects, which enrich the overall archaeological understanding of the Westphalian megaliths and facilitate successful knowledge dissemination to the public. The contribution concludes with an outline of the possibilities and opportunities for implementing the research on megalithic applied in Westphalia and its presentation to the public in a European context.

Grave Architecture – Building Material and Construction

The construction methods of Westphalian megalithic tombs, including the gallery graves of the Wartberg communities and the passage graves of the Funnel Beaker communities, are generally well-known and researched. However, new insights are continually gained, not only through large-scale excavations but also through small-scale investigations.

Wartberg Culture – WBC

Considering the gallery graves of Westphalia, they are characterised by the following features (Figure 3). They were sunken into the ground, covered only with a low mound, and barely visible above ground. The megalithic building material consists of limestone or sandstone slabs, occasionally of Nordic erratic boulders. They can reach lengths of up to 35 m and are typically 2 to 4 m wide. A characteristic feature is access through a narrow side via an antechamber, separated from the main chamber by a porthole stone (Züschen type); however, there are also tombs where access is from a long side through a passage, as known from the FBC passage graves (Rimbeck type). The Züschen type was already linked to the gallery graves of the Paris Basin in the 1920s (Schierhold 2012: 160) due to similarities regarding the sunken construction and the axial antechamber with porthole stone.

The excavations in Erwitte-Schmerlecke were in several respects informative for deviating variants of the stereotype described. It was geologically verified for the first time that the building material for the ceiling could not consist of the typically assumed limestone slabs (Schierhold 2019a: 294). The chambers of both graves were so wide that slabs spanning the space

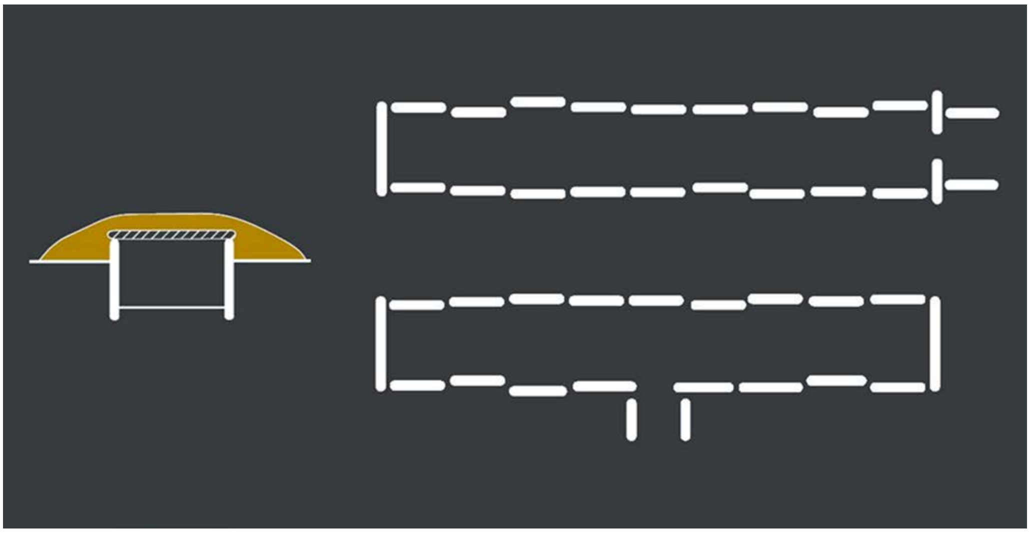

Figure 3. Schematic ground plan and elevation of a WBC gallery grave; above: Züschen type with antechamber; below: Rimbeck type with passage. (graphic Altertumskommission für Westfalen/L. Kopner).

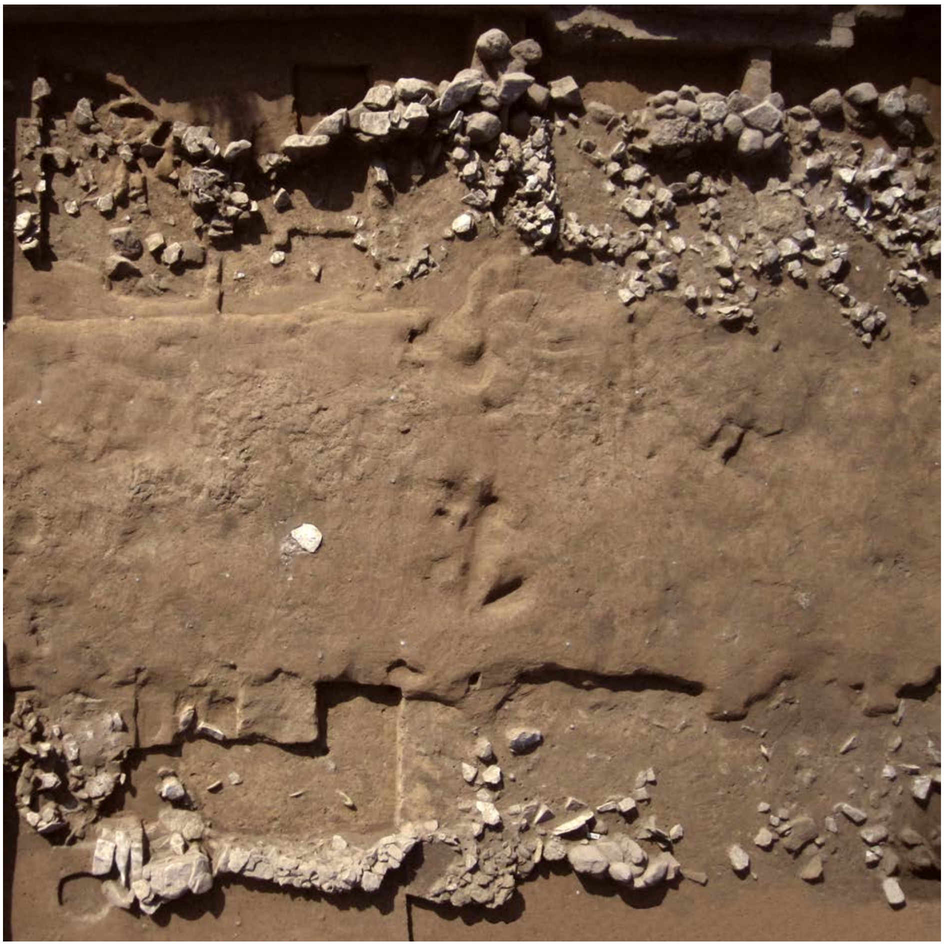

Figure 4. Erwitte-Schmerlecke, gallery grave I. Details of rounded masonry foundations in situ, with small limestone plates (bottom of photo, northern wall of the grave) and little boulders (top of photo, southern wall) (photo LWL-Archäologie für Westfalen/H. Menne).

would have required dimensions not available in the vicinity of the burial sites. Therefore, a covering of the chambers with wood is to be reconstructed. This 'mixed construction' of wood and megalithic material had already been hinted at in other structures (Schierhold 2012: 59) and now seems to be less of an exception and more of a pragmatic, availability-adapted construction method for the WBC graves. However, this also implies a certain vulnerability of the structure regarding the perishability of organic materials. With a documented period of use of at least 400 years in Erwitte-Schmerlecke, the wooden ceiling likely had to be repaired or replaced several times. Post holes in Grave I and a singular stone pillar as well as wedged stones in Grave II suggest support constructions.

In addition to the technical implementation of the construction of both graves, there are details that relate to visual aspects. Particularly noteworthy is the design of the facade of Grave I. The preserved evidence only at the base allows for various reconstructions of the superstructure. The longitudinal walls were enclosed on their outer sides with carefully crafted, rounded masonry made of small limestone slabs and boulders (Figure 4). This masonry was evidently constructed only for being seen, as its structure cannot be explained statically. A covering by the obligatory burial mound would have concealed the distinctive rounded features. However, the ends of the chamber in the west and east were not covered. One possible reconstruction assumes that the base of the mound was visually supported and terminated by a specially rounded masonry, tapering upward with each curve. The overall impression would thus have resembled from afar the envelopment of a tomb made of rounded boulders, as known from the FBC passage graves (Figure 5).

In this regard, the nearby grave of Völlinghausen, district of Soest (cf. Figure 2), located just a few kilometres away, is a comparative example (Schierhold 2012: 272-73). Here, distinctly separated masonry made of small limestone and boulders characterises the construction, which strikingly resembles the Schmerlecke feature. Another possibility was proposed by N. Reuther (Reuther 2016). In his reconstruction (Figure 6), the superstructure forms a cohesive facade that extends higher than the burial mound, similar to the monumental construction found, for example, at Newgrange in Ireland. However, from the author's perspective, the unstable and difficult-to-justify undulating form of the facade speaks against this interpretation.

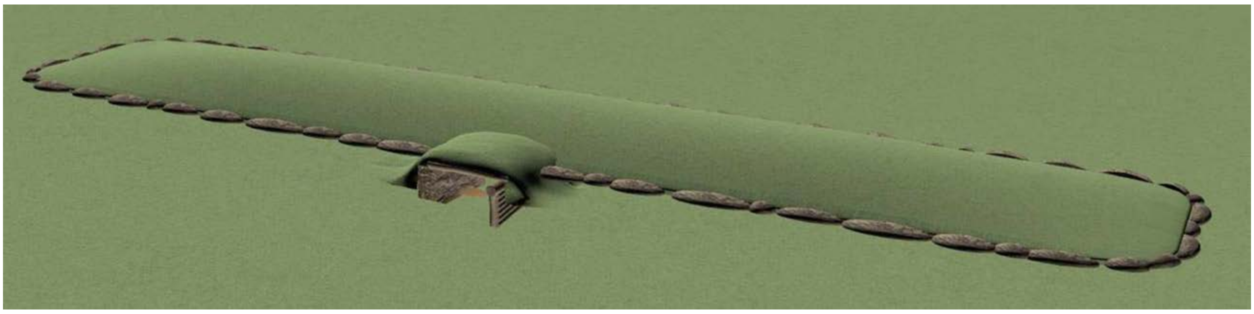

Figure 5. Erwitte-Schmerlecke, Grave I. Virtual reconstruction with “boulders” modelled from small-scale building material at the base of the flat mound. The impression is similar to that of the FBC passage graves (graphic Hochschule Bochum/A).

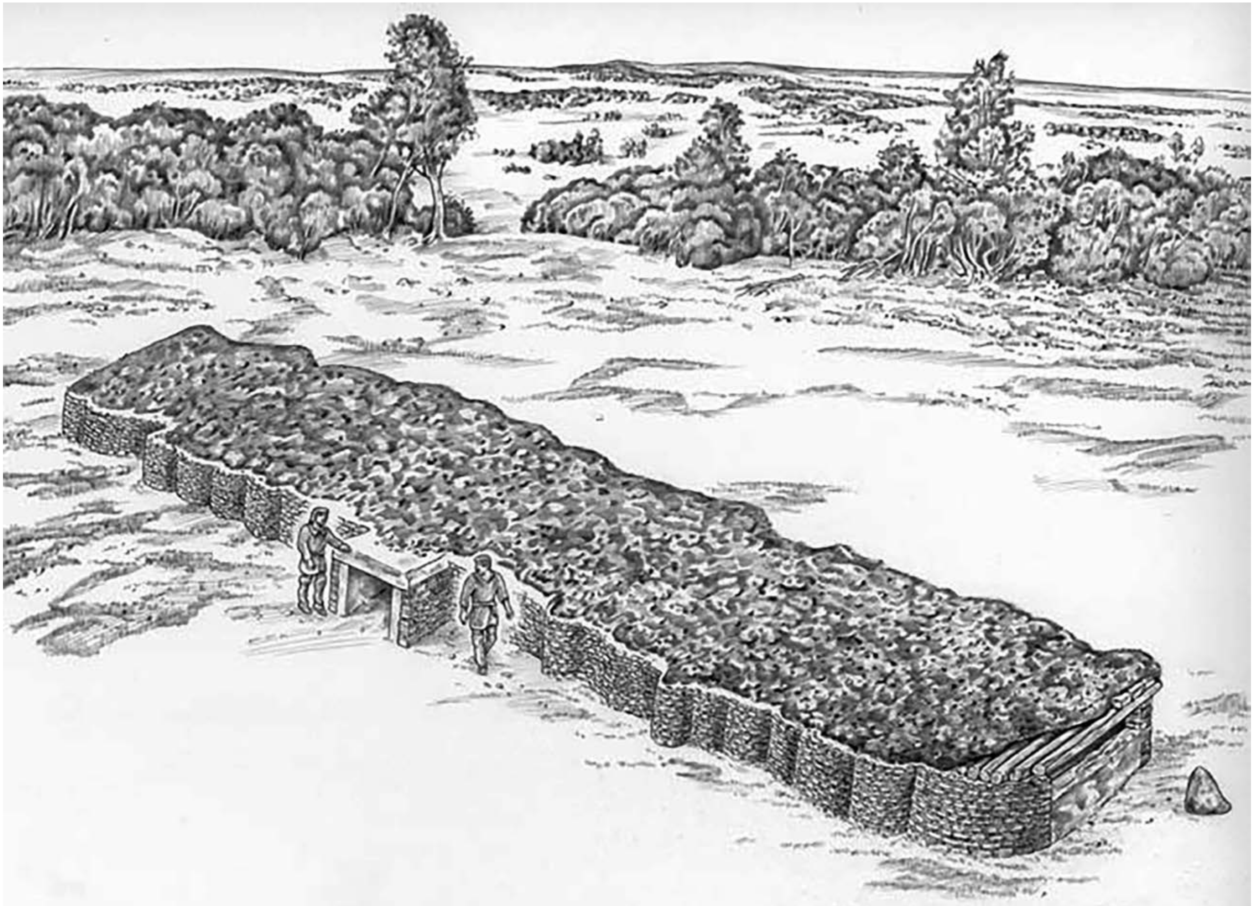

Figure 6. Erwitte-Schmerlecke Grave I. Reconstruction of the rising with a façade bordering the mound (drawing LWL-Archäologie für Westfalen/A. Müller).

Parallel to the investigations in Erwitte-Schmerlecke, two small-scale excavations were conducted in the years 2008 and 2013, which revealed another gallery grave in Westphalia near Büren-Brenken, district of Paderborn (cf. Figure 2) (Pollmann 2013). It is a structure measuring 31.5m in length and 2.3-2.5m in width, constructed from large limestone slabs. The floor of the interior chamber, which is 1.7 to 1.9m wide, lies 1.1m below the current ground surface. A small section through the chamber revealed the preservation of only a few human remains. Wilhelm Engelbert Giefers already described a grave made of ‘huge blocks’ in this area in 1855 (Giefers 1855), suggesting a rediscovery. However, this is unlikely as the newly discovered grave is completely sunken into the ground and was certainly not visible in Giefers’ time. Therefore, it appears to be another previously unknown gallery grave. After determining the key data for heritage documentation, work on the grave was halted to preserve the structure.

Merely 3km on a straight-line distance, near Büren-Wewelsburg, district of Paderborn (cf. Figure 2), a massive erratic boulder and human bone fragments were discovered in 1985, indicating the presence of

Figure 7. Virtual reconstruction of the gallery grave Büren-Wewelsburg II with witish limestone slabs, reddish layer of smaller granites on the chamber bottom and a big reddish boulder als supporting stone for the ceiling (data ALtertumskommission für Westfalen/L.Klinke; graphic University of Cologne/L. Tharandt).

a megalithic tomb (Schierhold 2012: 283). In 2017, another erratic boulder was unearthed during ploughing, prompting a small-scale investigation to assess the preservation of the feature (Klinke, Gleser and Spiong 2019). It was revealed that, in addition to the two erratic boulders, large whitish limestone slabs had been used as building material, of which only the lower remnants could be documented. Under the tilted erratic boulder that lied in the chamber, the chamber floor was preserved, covered with a layer of small red, highly porous granite fragments. This filling was also observed in Grave I at Erwitte-Schmerlecke. Through the digital documentation of the excavation, particularly of the erratic boulder that prompted the excavation, a digital and scientifically based reconstruction of the tomb was possible. The aim of the reconstruction was to visually depict a cross-section of the tomb (Tharandt 2020). The limestone and granite stones had specific colours that were reproduced as authentically as possible. The reconstruction impressively demonstrates the interplay of the various colours of the stone materials used (Figure 7): the reddish erratic boulder contrasts with the whitish shimmering limestone slabs and the chamber floor, laid with smaller reddish granites. The role of the colouration of the stone material used in the construction of megalithic tombs is evident in various regions of Europe; a well-known example being Newgrange, but also in the Stone Circle of Stonehenge, where the large light beige to brown-reddish Sarsen stones contrasted with the smaller blue-green Bluestones at least during the early period of their use, before weathering and growth of mosses and lichens began (Richards 2021: 199). Interestingly, the colour variations in the fully covered graves of the WBC were not visible to the living.

Funnel Beaker Culture – FBC

The Funnel Beaker Culture, primarily characterised by the eponymous vessel with a funnel-shaped neck, is also defined by the construction of megalithic tombs where the deceased were collectively buried. These tombs are found from north eastern Netherlands to Denmark and southern Sweden in the north, eastward to Poland, and southeastward to the Altmark region in Saxony-Anhalt. In northwest Germany and the eastern Netherlands, the FBC West Group is prevalent, with Westphalia lying at its south western periphery (cf. Figure 1). The known tombs here are at ground level and largely constructed from massive erratic boulders or Nordic boulders, which were transported by the glaciers of the Saale Ice Age to almost the southern edge of the Westphalian Basin. The surviving structures still impressively dominate their surroundings with their monumental size. The chambers are mostly oriented east-west and are accessed centrally via a passage on the southern longitudinal side (Figure 8). In Westphalia, they range in length from 10 to 40m with an inner width of about 2 to 3m. The chamber floors were often paved with small fieldstones. Gaps between the capstones and supporting stones were once filled with small dry stone walling to protect the chambers or their contents from external influences. Additionally, they were covered by an earth mound, mostly now disappeared, with the upper part of the capstones possibly remaining partially visible. An enclosure circle of smaller boulders surrounding the chambers formed the base of this mound.

The 'Große Sloopsteene' grave (Figure 9) is one of the most beautiful and best-preserved megalithic tombs in Westphalia (Schierhold 2016). Located in

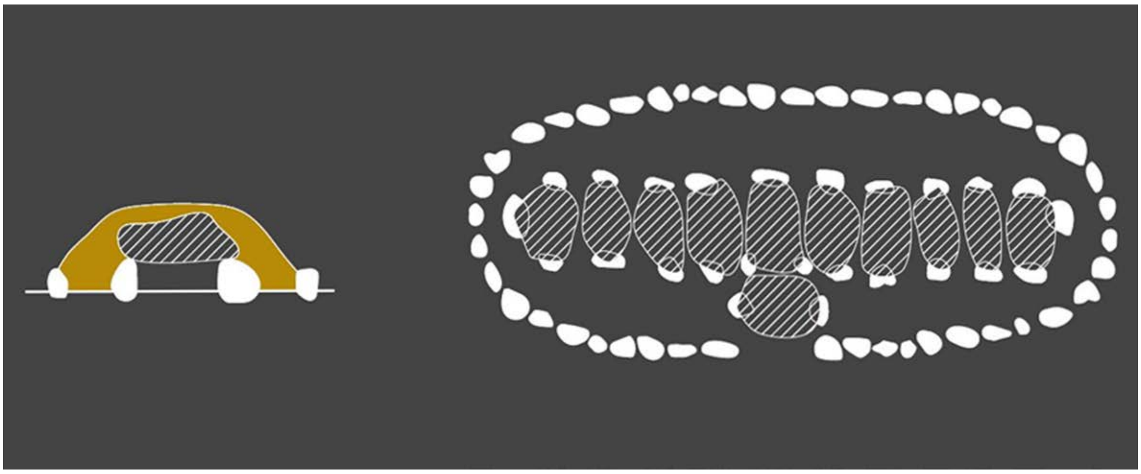

Figure 8. Schematic drawing of a FBC passage grave
(graphic Altertumskommission für Westfalen/L. Kopner).

Lotte-Wersen, district of Steinfurt (cf. Figure 2), directly on the Westphalian-Lower Saxon border within a small nature reserve, the grave was among the FBC megalithic tombs that were archaeologically underexplored despite or perhaps because of their good external preservation until it became the focus of the aforementioned research project. The above-ground structure, measuring 18.5m in length and 1.8m inner width, consists of massive erratic boulders. It is surrounded by a partially preserved circle of smaller boulders, which enclosed a 23.5m-long, now non-existent mound at its base. Five of the originally eleven large capstones are still *in situ* on the supporting stones. In the project of the Commission for Westphalian Antiquities, non-destructive methods are primarily used for the investigation of megalithic structures to avoid endangering their preservation.

Thus, initially, in 2014 a new digital orthographic photo was generated using drone aerial photography and compared with the only existing ground plan made in the 1920s. A digital profile view of the tomb allowed comparison with a sketch from 1807. It was revealed that the layout or the position of the boulders had hardly changed over the last 200 years, a rarity not only in Westphalia but in the entire distribution area of megalithic structures preserved in the field. This excellent preservation of the 'Große Sloopsteene' prompted the first complete digital documentation using 'image based modelling' to be carried out for a Westphalian FBC tomb (Klinke 2021a). This method works as follows: Through the use of two-dimensional photogrammetrically corrected photographs, 3D models of an object are generated. Using the Structure-from-Motion method, three-dimensional point

Figure 9. FBC passage grave "Große Sloopsteene", district of Steinfurt (photo Altertumskommission für Westfalen/L. Klinke).

clouds can then be calculated from the photographs. These point clouds resemble those obtained from laser scanners but also include colour values for each measurement point. The 3D point cloud simultaneously serves as a digital survey of the current condition, with each individual object being depicted in very high resolution, including visible undersides. – Thus, it was possible to preserve the current state of the 'Große Sloopsteene' in over 377 million measurement points. In further calculation steps, 3D models were generated from the point clouds using triangulation. With this method, all visible stones could be virtually restored to their presumed original positions (Figure 10). During the reconstruction process, many details of the construction were not only first recognised but also systematically documented. It was revealed that

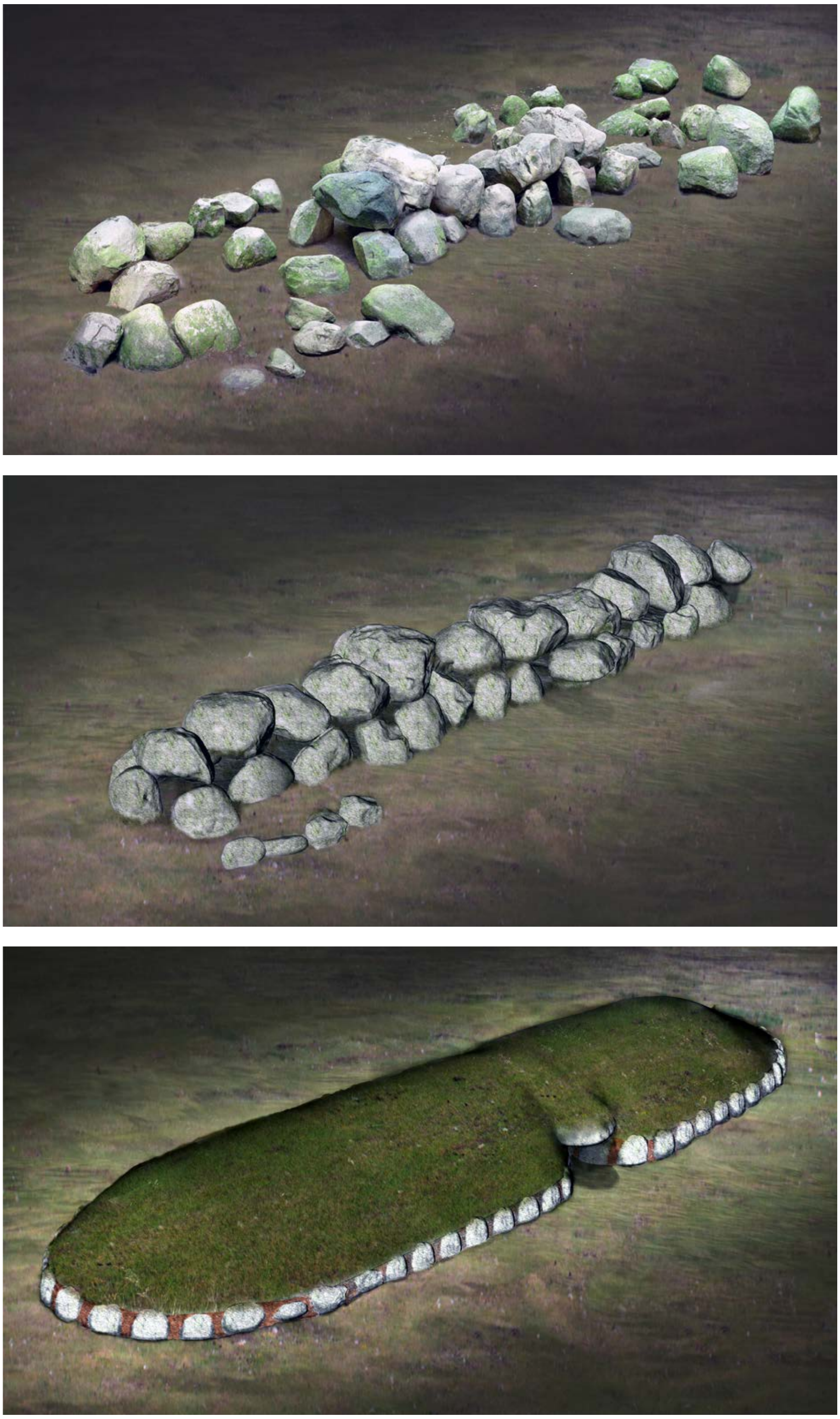

Figure 10. The current appearance of the Great Sloopsteene is more like a collection of colossal boulders than Neolithic architecture (up). In the reconstruction process, the stones were virtually moved back to their original position (centre). Originally, the structure was completely covered over, so that only the outer enclosure of smaller boulders and the capstone above the entrance were visible (down) (graphics Altertumskommission für Westfalen/L. Klinke; U. Haarlammert).

the natural shape of the stones was cleverly utilised to achieve structural stability. Accordingly, the Neolithic builders apparently deliberately sought out surfaces on the stones that they could use as supports and abutments, incorporating them into the architecture and statics before commencing construction activities. This conceptual preplanning required not only excellent spatial visualisation, but also precise analysis of the building materials, and an accurate construction plan based on these factors. Additionally, Leo Klinke (2021a: 306) noted an aesthetical construction characterised by a rhythmic use of texture and colour contrasts in the building materials, alternating the various shades of grey of the boulders with their large curved surfaces with reddish small sandstone slabs linearly stacked between in masonry technique. Klinke also illustrated the spatial effect of the interior of the tomb through the reconstruction. The imposing reddish capstone of the anterior bay south of the chamber entrance marked the entrance. The supporting stones of the passage and chamber entrance were of the same height as the stones enclosing the mound, requiring deep bending upon entering the chamber. Furthermore, intentional lowering of the ceiling of the right, eastern side of the burial chamber necessitated additional deep bending during burials and toward the inside of the chamber. Similar findings of lowered ceilings are also known from Scandinavian FBC megalithic tombs (Klinke 2021a: 302). Thus, the architecture of the 'Große Sloopsteene' reveals a regional cultural and conceptual exchange, indicating significant mobility of at least parts of the population during that time (Klinke 2021a: 306). – In 2018, it became possible to make the study of the reconstructed 'Große Sloopsteene' accessible to the interested public through a VR application, providing an immersive experience (Klinke 2019; Virtual Reality 2018). Upon virtually entering the approximately 0.8m high burial chamber (Figure 11), it becomes evident how much one had to bend their back and how imposing the massive capstones appear within the chamber. Despite their flat sides used to shape the inner chamber ceiling, their seemingly overwhelming mass is palpable, especially as they are perceived with a significant portion of the body, including the bent back, the neck, and the lowered head. Even with the artificial construction with fine masonry and a paved chamber floor, an almost cave-like space is created, which even virtually conveys a claustrophobic sense of confinement.

The megalithic tomb 'Düwelsteene' in Heiden, district of Borken (cf. Figure 2), is one of the most visited megalithic sites in Westphalia, alongside the 'Große Sloopsteene' (Schierhold and Stapel 2018). At first glance, this monument also appears to be exceptionally well preserved (Figure 12). However, its current condition is the result of (re-)construction activities in 1932, which involved substantial but archaeologically undocumented interventions in the structure, the outcomes of which now also represent historical and culturally valuable relics. Thus, virtual archaeology was the only means to study this prehistoric burial site (Jüngerich 2021; Klinke 2021b). Once again, the basis was the digital conservation of all boulders using the Image-Based Modelling method. The aim of the virtual reconstruction was to visualise the condition of the Düwelsteene before their rearrangement in 1932. Historical photographs depicting the site from as many perspectives as possible before the changes of the 1930s were required for this purpose (Figure 13). However,

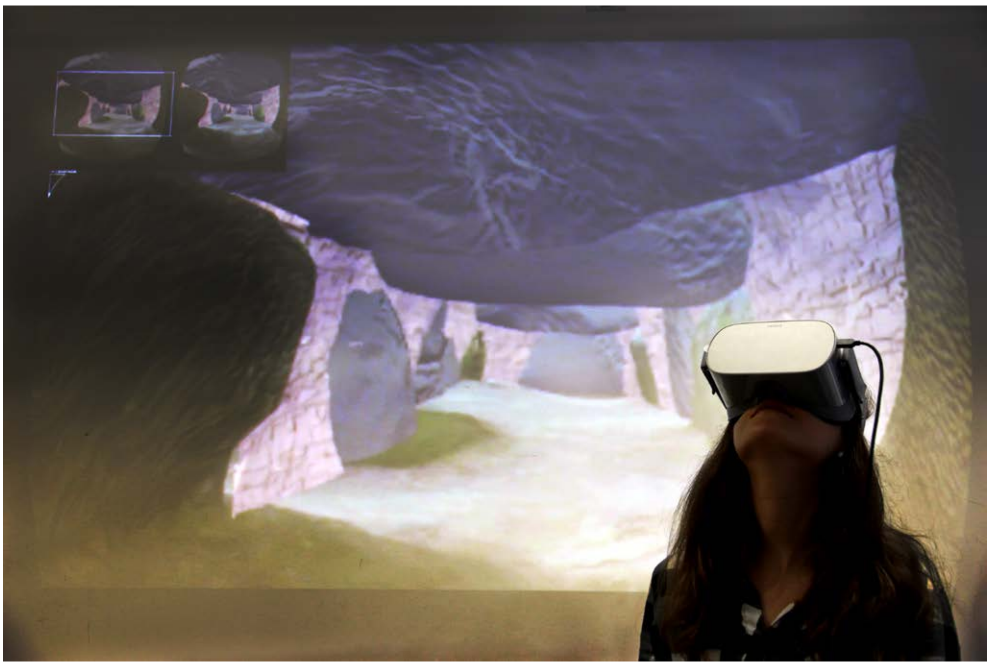

Figure 11. Virtual journey back in time: the reconstructed burial chamber of the Great Sloopsteene can be experienced in 3D with VR glasses (photo Altertumskommission für Westfalen/L. Klinke).

Figure 12. Current state of the Düwelsteene (photo Altertumskommission für Westfalen D. Priß).

since only a few relevant photographs were available in public image repositories and archives, this project was carried out in collaboration with dedicated citizens who researched their private photo archives for relevant images and made them available. Under the title 'Stone by Stone Back to the Past: Citizen Science Supports the Reconstruction of the Düwelsteene,' numerous previously unknown historical photographs of the Düwelsteene before 1932 were collected and documented (Klinke and Jüngerich 2022; Klinke and Jüngerich 2023; Stein für Stein 2023). In 2019, the project was awarded the University of Münster's first Citizen Science Prize for its archaeologically innovative approach, which is exemplary in terms of monument preservation and promotes cultural and historical identification. Due to the multitude of different perspectives now available on the Düwelsteene, the individual boulders could be virtually placed back into their positions before the changes of the 1930s on the PC (Figure 13). The virtual model thus provides a three-dimensional visualisation of the spatial distribution of the boulders before 1932. The reconstruction revealed, among other things, that the tomb was orientated differently than it is today (Klinke and Jüngerich 2022: 259-60). Several films show the individual steps of the reconstruction process, and are available online (Stein für Stein 2023; Tharandt 2022).

Figure 13 Here consists of two parts, which should be placed side-by-side.

A minimally invasive excavation in Beckum-Dalmer, district of Warendorf (cf. Figure 2) (Klinke 2022) provided an unexpected new insight into the construction of Westphalian megalithic graves. Two megalithic tombs were discovered here in the 1830s, one of which is still preserved today and is attributed to the Beckum group of Wartberg gallery graves (Schierhold 2012: 56). Geographically, the tombs are located in a region lacking of finds between the distribution areas of FBC and WBC (Schierhold 2013). Finds and features point to influences from both communities: The grave is made of erratic boulders, but is still deeply sunk into the ground today, it has a passage on the long side, but this is located in the northeast and not in the south as usual. As far as grave goods are concerned, only a few sherds or vessels are known, as is typical for WBC. FBC vessels were found in the neighbouring grave, but there were only two of them: typically there are hundreds in one chamber. The aim of the 2021 investigation was to better understand the architecture of the tomb and evaluate potential damage from inappropriate excavations in the 1970s (Klinke 2022). Indeed, numerous human skeletal remains were found in a small section next to the tomb, containing the chamber fill from the 1970s excavations. These remains are currently being examined. A singular feature in the construction of Westphalian tombs, however, is a continuous, 10-15 cm thick layer of white limestone covering the entrance area and the northern longitudinal side (Figure 14). An examination of the southern side yielded no comparable features. It is likely that the entrance area and possibly the entire northern side of the Beckum tomb were prominently visible during its use due to the covering of whitish limestone, as is also reconstructed for the well-known but significantly larger Newgrange tomb (Klinke 2022: 64). The visibility of the tombs appears to have been more important to the Funnel Beaker communities than to the Wartberg communities. However, the sinking of the structure suggests the stronger influence of the latter, as does the absence of pottery offerings, which could not be documented in the large quantities typical of FBC communities even with the excavation of the chamber fill.

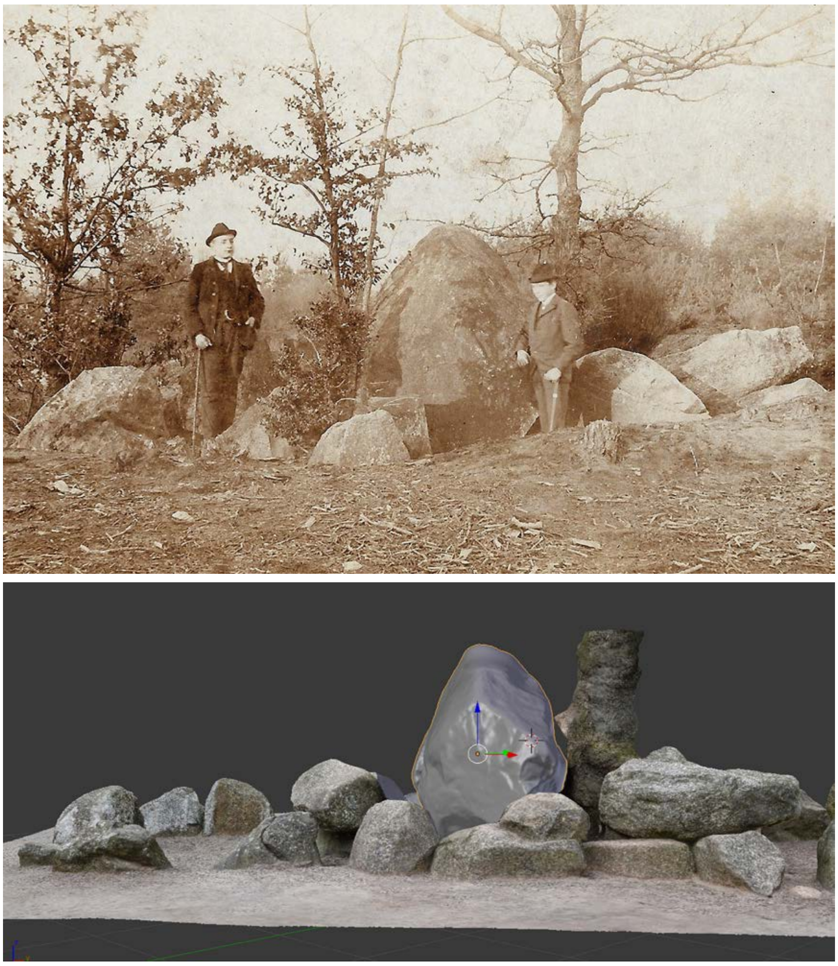

Figure 13. Up: The “Düwelsteene” 1894. Oldest photo available for the virtual reconstruction (photo Heimatverein Heiden e.V. 1922); down: central capstone, virtually rotated into the position of the oldest photograph from 1894 (graphic Altertumskommission für Westfalen/L. Klinke).

Figure 14. Virtual reconstruction of the shimmering whitish front of the Beckum II grave (graphic: Maßwerke/U. Haarlammert).

Scientific Analyses: New Insights from Human Bone Remains

Not only new excavations and even minimal invasive investigations in the field, but also the consistent re-evaluation and re-analysis of long-excavated finds from Westphalian megalithic graves using modern methods have led to a wealth of new insights. The following is a summary of the results obtained from the examination of human bone remains, which enrich the overall picture.

Dating

An established dating method that has gained significance in recent years through statistical modelling is AMS dating. Due to the good preservation of bones in Westphalia, a wide spectrum of new data has been obtained for both WBC and FBC, collected from newly excavated as well as archived bone material. Regarding the period of use of the graves at Erwitte-Schmerlecke, a total of 68 new AMS dates (58 from human bone material, nine from animal bones, and

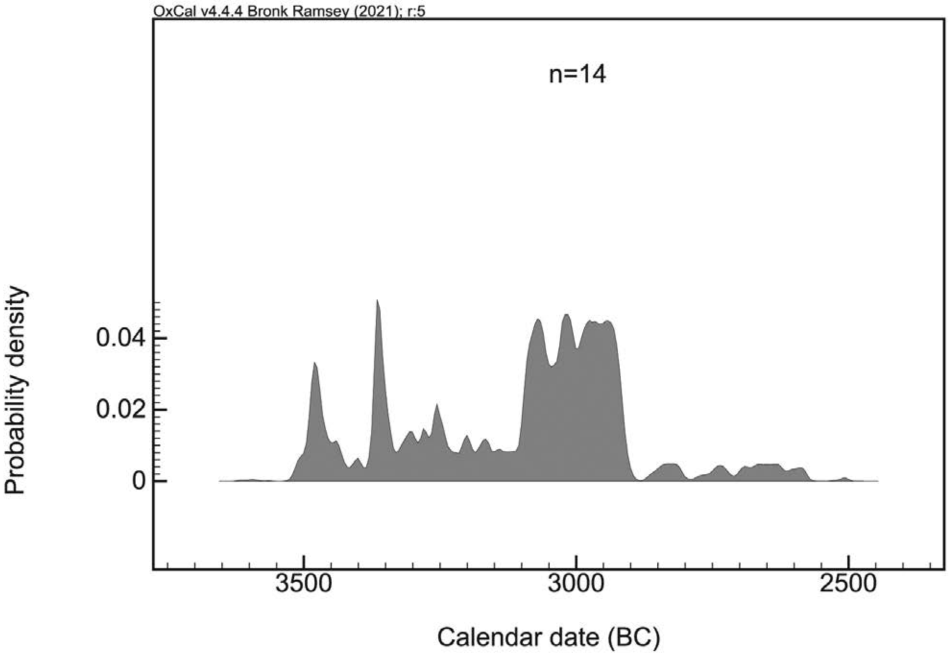

Figure 15. Sum calibration of 14 new AMS data from four FBC passage graves in Westphalia gained between 2016 and 2022 (graphic K. Schierhold).

one charcoal sample) provide information (Schierhold 2019a: 300-304). The majority of the data indicate intensive use of the sites primarily between 3400 and 2900 calBC. However, some data suggest an earlier onset of use or construction of the graves from around 3500 calBC. Thus, the graves at Erwitte-Schmerlecke fit into the known period of use of sites of the WBC gallery graves.

Within the framework of the research project of the Commission for Westphalian Antiquities, 21 new dates were obtained between 2016 and 2022. Fourteen of these are from five FBC graves (Lotte-Wersen Große Sloopsteene, Lotte-Halen Kleine Sloopsteene, Rheine-Schotthock and Lengerich-Wechte, all in the district of Steinfurt), thereby more than doubling the data pool for the Westphalian FBC and, for the first time, providing data from megalithic graves (except for a single date from Rheine-Schotthock). For Westphalia, the beginning of the use of FBC megalithic graves can now be absolutely dated to no later than 3500 calBC (Figure 15). Previously, only individual sherds from the grave of Lengerich-Wechte, assignable to Anna L. Brindleys stage 2, had suggested an early occupation from around 3470 calBC (Stapel and Schierhold 2018: 19-20).

For WBC, seven dates were newly obtained from the megalithic grave complex with four graves and a wooden structure at Warburg, district of Höxter (Gerling, Doppler and Schierhold 2019). Despite the exemplary documentation of the excavations (Günther 1997), which were already accompanied by diverse scientific investigations, there were previously only five radiocarbon dates for the entire site setting the chronological frame for the graves. Six of the seven new dates fall within the expected range for WBC between 3350 and 3100 calBC, while the result for sample 'WAR 1' suggests an early use of grave I around 3500/3400 calBC (Figure 16). Previously, only one dating around 3000 calBC was available for this site; the new date now ranks among the oldest measured so far and confirms the early beginnings of the construction of the necropolis.

Nutrition

In recent years, various new analytical methods have been developed for researching nutrition, in addition to anthropological and palaeo-pathological investigations. This includes the analysis of stable isotopes such as carbon (13C) and nitrogen (15N). In Erwitte-Schmerlecke, a total of 60 samples from humans and animals were measured (Schierhold 2019: 304-06). Individuals buried in Grave I seem to have primarily consumed a diet based on grains and legumes, but also with a portion of meat and milk. For Grave II, it was observed that nearly half of the examined individuals also had a plant-based diet, but most values indicate a significantly higher proportion of meat and milk compared to Grave I. Additionally, a regular intake of freshwater fish in the diet is possible. Only one value deviates from the overall pattern, implying a diet focused on freshwater fish for an individual from Grave I. Therefore, there appear to be differences in the diet of the individuals buried in Erwitte-Schmerlecke, with those from Grave II apparently consuming significantly more meat and likely fish than those from Grave I. The data from the cave 'Blätterhöhle' near Hagen, only 70km

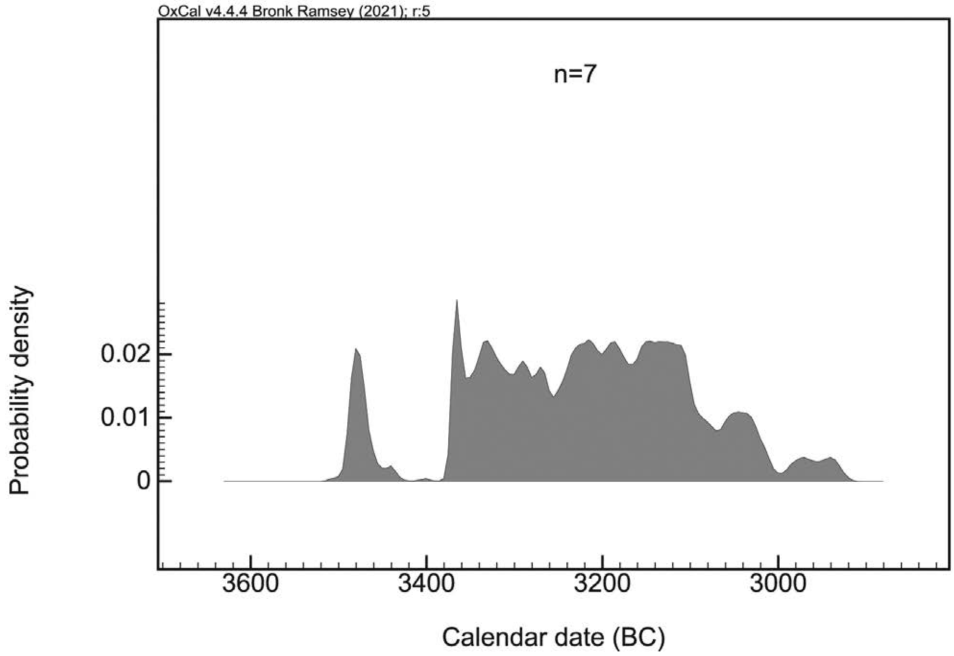

Figure 16. Sum calibration of seven new AMS data from three WBC gallery graves in Warburg (graphic K. Schierhold).

from Erwitte-Schmerlecke, also indicate that different dietary strategies were pursued simultaneously during the Late Neolithic period (Orschiedt and Burger 2021). Individuals with local, i.e. Mesolithic ancestors from the Blätterhöhle preferred a diet based on freshwater fish. However, individuals whose ancestors migrated to the Hellweg region 2000 years earlier consumed products of agriculture and animal husbandry. Similar patterns may be indicated in Erwitte-Schmerlecke. Furthermore, the data could suggest that the community of Grave I consisted mainly of farmers, while the community of Grave II had a higher amount of pastoralists. This hypothesis requires further investigation.

Mobility

The composition of burial communities in collective graves is an intriguing research question. Ancient DNA (aDNA) analyses can answer questions about kinship and allow for comparisons of genetic developments through the identification of haplogroups (e.g. Niedertiefenbach and Altendorf in Hesse: Drummer 2022: 173-202). In recent years, questions about the mobility of individuals have increasingly come into focus in research. It is not only possible to determine if someone was buried in a location different from where they lived, but also whether they lived in different places during their lifetime. A prerequisite for distinguishing between ‘local constancy’ and ‘mobility’ is systematic variations in the isotopic composition of the biosphere (e.g. Gerling, Doppler and Schierhold 2019: 234). The isotopic ratios of the element strontium vary due to geological differences, while those of oxygen vary due to factors such as precipitation, temperature, and geographical location. Humans absorb the location-specific isotopic ratios through food and drinking water, which are then incorporated into the skeleton, teeth, and tooth enamel. The incorporation of isotopic composition into tooth enamel occurs in early childhood and remains largely unchanged thereafter. Comparing the isotopic signal of childhood in teeth with the location-specific isotopic signal of the last years of life reveals whether an individual lived in one place consistently or changed their location after childhood.

This method was applied exemplarily to six individuals from the Funnel Beaker passage grave of Rheine-Schotthock, district of Steinfurt (cf. Figure 2), (Gerling, Maixner and Schierhold 2018) and seven individuals from three Wartberg gallery graves in Warburg, district of Höxter (cf. Figure 2) (Gerling, Doppler and Schierhold 2019). The burial sites were assumed to be the place of residence for the last years of life, so the location-specific isotopic signal, necessary for comparison, was determined based on modern vegetation samples from Rheine-Schotthock and Warburg. Five of the six individuals from the megalithic grave of Rheine-Schotthock (RS 1-6) exhibit strontium isotope ratios in their teeth (one per individual was examined) interpreted as ‘locally constant’. However, individual RS 6 falls outside this spectrum. The significantly more radiogenic value indicates that the origin of the adult male is characterised by an older geological substrate. Similar value ranges are known from Scandinavia and several regions in central and southern Germany. There are also other (more distant) areas that exhibit similar strontium isotope ratios. Based on the results of strontium isotopic analysis, the North German Plain can be excluded as the region of origin for RS 6. The slightly deviating oxygen isotope ratio also supports the hypothesis of a 'foreign' origin for RS 6.

Of the seven better-preserved individuals from Warburg, two teeth were examined for each. To capture the isotopic signature of early and late childhood, the first molar and either the second (WAR 3, 5, 6, 7) or third molar (WAR 1, 2, 4) were examined from the Warburg skeletons. Based on the determined strontium isotope ratios, three clusters can be distinguished with caution due to the small sample size: WAR 1 with very low 87Sr/86Sr ratios, WAR 2, 3, and 4 with intermediate values, and WAR 5, 6, and 7 with higher 87Sr/86Sr ratios, at least in one of the two analysed teeth. Interpreting the results in connection with anthropological assignments reveals some anomalies: The individuals identified as adult males show either no or very minor intra-individual mobility differences, while those who died in childhood or adolescence exhibit isotopes that indicate possible changes in location. This could be indicative of different mobility patterns or different lifestyles and subsistence, although the small sample size does not allow for differentiations among individual burial communities. However, it is noteworthy that both individuals from Grave IV experienced changes in location, whereas this does not apply to those from Grave I. For Grave III, both locality and change in location are evidenced. Additionally, the oldest skeleton according to AMS data (WAR 1, see above) differs from the other individuals. This individual may have lived in a different settlement than the others buried in Warburg. Even the initial samples from the three Warburg graves promise intriguing further research approaches and new insights into the relationship among the burial communities of Neolithic Warburg, inspiring not only Westphalian megalithic research but also contributing to broader archaeological knowledge.

Landscape Archaeological Research in Northern Münsterland

In recent years, several landscape archaeological aspects have already been considered in the study of Westphalian megaliths (e.g. Posluschny and Schierhold 2010; Schierhold 2012: 148-59). Leo Klinke now focuses on the region surrounding the Große Sloopsteene between Westerkappeln and Lotte, with its rich archaeological remains, from a diachronic and emic perspective of landscape perception (Klinke 2023a; Klinke 2023b). In addition to several late Neolithic megalithic tombs, this area contains burial grounds, Celtic Fields from the pre-Roman Iron Age and ridges and furrows from the Middle Ages, a late medieval land boundary system, and numerous traces of ancient paths. Klinke uses these diverse features as objects of analysis to understand the transformation of a landscape shaped by humans and simultaneously formed them. The mentioned ancient path traces, in particular, are keys to reconstructing the emic perspective, describing the perceptions of the natural environment and its successive cultural use that inspired people to develop and change the cultural landscape. Starting from (biological) principles of perception through the prospection of archaeological landscape relics to the reconstruction of chronologically fixed and detailed time slices analysed with archaeological informatics methods such as visibility or least-cost path analyses, Klinke develops a new theory of landscape perception. It describes the constantly changing interactions between nature and culture as well as the perception of people using the space and the influence of their experience spaces on their decision-making.

Without delving into the entire results of the study here, some aspects concerning the 'Große Sloopsteene' are highlighted. For instance, Klinke demonstrates through visual prominence analyses that the tomb was built on a geological terrace just a few metres in front of and below a prominent ridge, shielding it from one side (Klinke 2023a: 198). Furthermore, the passage leading into the burial chamber was precisely aligned with a geological phenomenon 105 meters away, a sinkhole. Visibility analyses, based on the virtual reconstruction of the 'Große Sloopsteene', confirm that the complete outline of the edges of the sinkhole was visible in the ground relief from the passage along its direction before the hilltop came into view. This created the impression of a round hole that could only be seen from the location of the grave with the corresponding orientation. Klinke concludes from this a deliberate landscape staging (Klinke 2023a: 201-02), in which the sinkhole was understood as a supernatural phenomenon and symbolically charged by the alignment of the grave. Additionally, broader visibility analyses between several megalithic tombs in the study area show that the view sheds between the grave groups barely overlap. From this, Klinke deduces visual perception of late Neolithic actors, through which they transformed the limited viewsheds into delimited territories or settlement chambers (Klinke 2023a: 203). Within the settlement area, the 'Große Sloopsteene' was located in a peripheral position, their entrance facing away from the Neolithic activity zone. A similar finding can also be observed for Dutch megalithic tombs. Klinke recognises in this a structural separation between the world of the living and the dead, but the visibility of the sepulchral buildings also illustrates the impermanence of human life as well as the connection to the ancestors (Klinke 2023: 203).

According to Klinke, the virtual reconstruction of the 'Große Sloopsteene' enables us to understand various perceptions of Neolithic actors. This includes, for example, the interaction of colours and shapes, which is composed of the grey and red tones of the stones used, the green of the covering mound, intricate structures of the layered masonry, and large rounded surfaces of the boulders on the elongated structure, repeated in a uniform rhythm. This artificial appearance, however, blends into the landscape. The harmony with the surrounding landscape is primarily due to the green covering of the chamber. However, this covering simultaneously obscures the view of the impressive architectural constructions and the immense effort involved. Consequently, Klinke does not only see the construction itself but the entire structure as a 'repository of memory' and a 'communal site of remembrance,' serving 'the transgenerational affirmation of community and group identity in the late Neolithic present with the aim of securing a communal future' (Klinke 2023a: 207).

Presentation of Megalithic Buildings in Westphalia to the public

Some of the scientific methods used to study the megalithic buildings in Westphalia in recent years are highly suitable for low-threshold presentation to the public.

Digital ways of presentation

The Commission for Westphalian Antiqutities seized its 125th anniversary as an opportunity to repackage the virtual reconstruction of the 'Große Sloopsteene' and the scientific insights gained from it for a public marketing campaign (Lammers and Brieske 2023; Wegener, Reck and Lammers 2022). The 'Archaeological Time Machine' embarked on a roadshow in late summer 2022, traveling for five weeks with the famous DeLorean from 'Back to the Future' as an eye catcher through the shopping malls of the region, aiming to get people excited for the archaeology of Westphalia with the help of VR. The show was preceded by five years of planning and a two-year implementation phase. The scenes shown in the 3D films were based as much as possible on scientific data while providing viewers with an immersive experience. For this purpose, a specialised company for digital historical film worlds was enlisted, and a scientific advisory board was established. Scenes were created based on current archaeological findings; possible actions were conceptualised, and filmed with real people and requisites. For example, 3D replicas of two typical funnel-beaker vessels from a Westphalian megalithic grave were incorporated into the film about the 'Große Sloopsteene' (Figure 17).

In the film, the grave itself is initially depicted as a construction site and at least as an overgrown mound in the vegetation (Figure 18) reconstructed by Klinke (2023a).

The response to all three films was overwhelming, not only from the public: 'The vividness of the digitally resurrected sites has surprised even the scientists: the dimensions and complexity, the interaction of sites and objects, which are otherwise known only fragmentarily and individually, the atmospheres of the scenes, brought to life by acting people' (Lammers and Brieske 2023: 273). Over 10,000 people watched the three VR films, and during the time of the roadshow alone, over 30,000 clicks were counted on the social media platforms of the Commission. These channels are being maintained: in a 2D version, all films are shown on YouTube, along with further digital preservations of Westphalian megalithic graves or 3D animations of individual artefacts. The films will also continue to be used at various events and are intended to be established in the three Westphalian Museums for Archaeology.

Figure 17. Screenshot from the 3D film about the "Große Sloopsteene"; scene of commemoration at the entrance to the grave; the vessels are 3D replicas of authentic objects (film still: Faber Courtial GbR).

Figure 18. The "Große Sloopsteene" with earth mound. This is what the grave looked like in its scientifically researched surroundings shortly after it was built (edited film still: Faber Courtial GbR).

Analogue ways of presentation

In addition to the digital presentation, the analogue preparation of information about the megalithic structures of Westphalia is also of particular significance. In order to make the new findings known to a wider public, the Commission for Westphalian Antiquities launched the series 'Megalithic Graves in Westphalia' within its established guidebooks (e.g. Schierhold 2016; Schierhold and Stapel 2018). Each issue of the series, known as the 'Grey Series', focuses on one megalithic tomb, with information on current research and its geological, natural, historical and contemporary context. In order to increase public awareness of the megalithic monuments in Westphalia, the Commission for Westphalian Antiquities has also been a member of the international association 'Megalithic Routes e.V.' since 2015 (LWL-Museum für Archäologie 2021; Schierhold 2019b). Science and tourism work closely together across Europe to present the megalithic monuments as a European cultural and historical phenomenon and to communicate their historical significance. The European Cultural Route 'Megalithic Routes', certified by the Council of Europe in 2013, serves as a platform. Besides Germany, members from the Netherlands, Denmark, Sweden, France, England, Spain, Portugal, Turkey and Italy are also involved. The aim of the touristic valorisation is to protect the monuments as part of the common cultural heritage and to enhance their international cultural and political value. The cultural route not only connects these oldest European monuments, but also highlights the varied character of the surrounding landscapes. It shows that megalithic sites have contributed to the formation of cultural landscapes throughout Europe. For the first time in history, people shaped their environment sustainably by building stone monuments and created an artificial landscape that was visible from afar; a joint achievement that required immense effort. The 'Megalithic Routes' cultural route is particularly visible in routes that are signposted and adapted to the respective regional conditions. For example, the Westphalian part has been implemented as the 'Path of the Big Stones' since 2020 (Brieske 2021; Schierhold, Klinke and Brieske 2021). As part of a competition at the Münster University of Applied Sciences for Design, a signage concept was developed that recognisably identifies all Westphalian stations of the European Cultural Route with two information objects in a stylised stone shape. While the first 'information stone' provides general facts about the Westphalian megalithic tombs, their different appearances and how they fit into the European context, the second one offers information on the current state of knowledge about the respective tombs, emphasises individual details and tells interesting stories about the site (Brieske 2021). The stations at 'Große Sloopsteene', 'Kleine Sloopsteene', 'Düwelsteene', Soest-Hiddingsen and at the former site of the Erwitte-Schmerlecke graves have already been realised (cf. Figure 2; Figure 19); further are in preparation.

The analogue information at the sites is supplemented by the aforementioned 3D models of the digital conservation, which can also be accessed directly at the stations using mobile devices via QR codes. On the occasion of the exhibition 'Stonehenge – People and Landscapes' (Mölders *et al.* 2021), all megalithic tombs still preserved on the site in Westphalia were filmed with a drone and short films were produced. A media station enabled visitors to 'fly' to the tombs individually and thus travel virtually, but was also intended to encourage people to visit the monuments in their landscape.

Most recently, the results of the virtual reconstruction of the Düwelsteene, which were developed with the help of citizen science, were shown in an exhibition that could be seen in Heiden and Münster in 2023 (Jüngerich and Kopner in press; Klinke and Jüngerich 2023; Stein für Stein 2023). In addition to the aim of virtually reconstructing the site as it was before it was improperly restored and starting from there to reconstruct its Neolithic appearance, another interesting aspect emerged: the photos from the last 120 years show how the socio-cultural approach to the archaeological monument has changed. In the oldest photographs, the focus was initially on the megalithic tomb itself, with the people occupying a secondary position and often standing to the side of the monument. Later, the framing changed and people moved to the centre of the picture, gradually making greater use of the monument as scenery for their presence. More recently, selfies have literally put people in the foreground and the

Figure 19. Modern communication: "Information stones" at the "Große Sloopsteene" (photo: Altertumskommission für Westfalen/A. Reck).

monument appears in the background, often out of focus.

Summary

Research in recent years has provided many new insights into both the megalithic structures of Westphalia and the people who built and used these impressive monuments. Not only 'conventional' methods such as excavations, but also the examination of long-excavated artefacts using other methods and questions has contributed significantly to this. Human bone remains in particular offer considerable potential in this regard through the use of aDNA analyses, various isotope analyses and AMS dating, for example. Material for these questions will therefore be specifically sought in the minimally invasive research excavations described, others not mentioned in detail here (e.g. Klinke and Stapel 2022) and future ones. Furthermore, virtual archaeology enables new perspectives on the megalithic structures of Westphalia. It is now highly relevant for research questions and also offers the advantage of long-term digital monitoring.

With a broader focus, information on megalithic monuments in particular is also predestined for landscape archaeological questions. They not only provide insights into the period of their construction and utilisation, but can also shed new light on how the monuments were treated after their active use ended, in the sense of a dense cultural landscape that has been charged over the millennia. Similar approaches can be seen, for example, in research into the Stonehenge landscape (Mölders *et al.* 2021).

The knowledge gained in Westphalia can not only be used as a model for researching other megalithic landscapes, but also as a way of communicating scientific findings to the public at a low threshold thanks to the vividness of the reconstructions. In this way, virtual representations can contribute to the protection and preservation of this fascinating type of monument by promoting understanding of the monuments.

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Chapter 9
Preserved and demolished megaliths from the Danish Funnel Beaker Culture

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Abstract

Over a few hundred years, between 3500 and 3100 BC, it is assumed that nearly 30,000 megaliths were built in the Danish area. They belong to the Neolithic Funnel Beaker Culture, the country's first Neolithic culture, which around 4000 BC followed the Mesolithic Ertebølle Culture.

Danish megaliths can be divided into two types: dolmens and passage graves. There is a large difference between the two types: dolmens are open monuments with a visible stone chamber with a single, often distinctive capstone, whereas passage graves are more complicated stone chambers laid inside an earthen barrow, with a covered passage reaching the foot of the barrow. There are only a few finds from the first stages of the stone chambers, and no material to prove that the chambers were originally intended to be places where deceased people were buried.

In connection with the excavation and research of the two causewayed enclosures at Sarup in Funen, Denmark, which are contemporaneous with the area's megaliths, a large series of demolished dolmens and passage graves have been excavated in the immediate area. This was done to obtain knowledge about their primary use and their possible relationship to the causewayed enclosures. Although the studies have taken place in a smaller area, they resulted in being able to see individual differences in how the monuments had been erected and how they had been used. It was observed that there could have been deposits of ceramics in various places around the monuments and that these deposits most often included carefully fragmented parts of ceramic vessels. Interestingly, similar types of deposits occurred in the causewayed enclosures in Sarup.

Several megaliths were built in areas where there had previously been settlements with houses, and we must assume that there was a relationship between those who lived in the settlements and those who built the megaliths. In addition, we have gained insight into how the settlements were organised.

Within a small area around Sarup, we now have traces of contemporary settlements with houses, megaliths, causewayed enclosures, and many finds, which are useful for interpreting the area's activities 5000 years ago.

Keywords: Funnel Beaker Culture, megaliths, dolmens, passage graves, causewayed enclosures, settlements, houses, deposits

Introduction

Between 3500 and 3200 BC, thousands of megaliths were built within the Danish territory. They belonged to the Funnel Beaker Culture, which was the first Neolithic culture in Denmark. Funnel Beaker Culture was also found in adjacent areas of Sweden, Poland, northern Germany, and the Netherlands (Midgley 1992). Around 4000 BC, the Mesolithic Ertebølle Culture was followed by the Funnel Beaker Culture, which ended around 2800 BC, with the Single Grave Culture taking over. The construction of megaliths did not begin until about 400 years after the introduction of Neolithic culture.

Large stones were used for the construction of megaliths, which were found in the Danish moraine landscape formed during the Ice Age. In this moraine, clay, sand, gravel, and stones were left behind by the ice. The stones in the moraine rarely exceed 4m in maximum measure, and their maximum weight is approximately 20 tons. As a result, Danish megaliths are limited in their dimensions. Thus, it has not been possible in Denmark to build large and impressive megaliths, as we know from other places in Western Europe. In turn, many megaliths have been built.

When we work with Danish megaliths, a distinction is made between dolmens and passage graves (Eriksen and Andersen 2016: 39-53). Dolmens is an open monument where at least 4 supporting stones/orthostats carry one large capstone. Dolmens can have a short passage, which is always without capstones because no earthen barrow covers the monument. Passage graves, on the other hand, are stone chambers with passages that, unlike dolmens, are covered with capstones. In addition, the passage is longer and reaches the foot of the barrow, where the entire monument is hidden. Dolmens are monuments to be seen, while passage chambers are enclosed in a barrow of earth.

Dolmens - architecture

In the 37th century BC, the first dolmens were preceded by the construction of long barrows, so-called un-chambered long barrows, i.e. elongated barrows containing one, perhaps more, earthen graves (Eriksen and Andersen 2016: 97-124). However, some barrows have been without barrow fill, which is why the term barrows is misleading; these are just framed, elongated areas. This type of monument is called the Barkaer feature. The site of Frydenlund is an example of a type of long monument without soil fill (Andersen 2015; Eriksen and Andersen 2016: 101-04). The funerals in these early long barrows were often man-long wooden plank coffins intended for burial by a single person. In one case from Barkær, the plank coffin is not made of wood but of stone slabs, and here we have an early form of a stone coffin, a so-called dolmen cist (Eriksen and Andersen 2014: 97-115; Liversage 1992: 22-23). Approximately 100 long barrows have been registered in Denmark.

Dolmens can be divided into four different types, see Figure 1 (Ebbesen 2007: 35-8; Eriksen and Andersen 2016: 41-44). The first type (Type I) consists of a rectangular, man-long chamber, where the supporting stones are set on their long side and all are equally high; that is, access to the chamber is closed. The chamber is covered with a distinctive and thick capstone, which is not the case for the dolmen cists mentioned above. For the next type of dolmen (type II), one gable stone was made lower, giving access to the chamber, but it is still a rectangular stone chamber.

In dolmen type III, there were some changes, as the supporting stones were placed on the short end, like orthostats. This ensures that the chamber becomes taller, up to 1.7m, and the capstone also gets a more distinctive expression. Often, we see that the dolmens now have one, maybe two, pairs of stones to mark the entrance. Dolmen type IV is similar to the above, but now the ground area has become polygonal, and several orthostats are used, usually five to eight. Orthostats may have an inclined slope that allows for a larger floor area inside the chamber. These dolmens can also have sets of passage stones, but there are cases in which they do not occur. Dolmen types III and IV differ from types I and II in that the supporting stones/orthostats now stand on the short edge, the chamber becomes taller, the floor area is larger, and they can have passages to mark the entrance. This marked change in shape may have been due to a change in the way the dolmens were used.

Dolmens can stand alone in the landscape but are often laid out in round or elongated constructions marked by large kerbstones (see Figure 2). Dolmens are called round or long dolmens. Round dolmens are usually circular frames of an area in which a single dolmen chamber is placed. The framing can be between 8 and 14m across. On some round dolmens, the kerbstones can be up to 2m high, thus achieving a distinctive and closed expression, that is, you can hardly see the dolmen chamber. In other cases, the kerbstones are only 1/2m high, which gives a more open expression, and without difficulty, you can see the dolmen chamber. It is interesting to learn that some of the kerbstones may have been chosen based on their colours, where stones in the shades of red, white, and black have been searched, a subject that should be studied more closely.

The long dolmens are usually 6-10 meters wide and 10-50 meters long, but a group of long dolmens are very long. The long dolmen at Tastum is the longest with a length of 184m (Eriksen and Andersen 2014:51, Fig. 5.11). Up to five dolmen chambers can be placed in long dolmens, but usually only a single chamber. In some cases, we observed a combination of two long dolmens.

Dolmens can be located very differently in the Danish landscape. Some can be laid on small natural moraine hills; some are laid with fine views of open water, lakes, and the sea; others can be laid in hollows surrounded by hills, which gives a closed view; and some can be located on islets surrounded by wetlands.

The capstones of the dolmens were much larger than necessary to cover a chamber. The capstones must have been selected to achieve extra monumentality to the stone chamber. The purpose of the capstone has certainly also been for the dolmen to be visible and inspire respect. The shape of the capstone can be cubic, but we often find a capstone of droplet shape, almost like a six-pence hat, with the shadow placed over the entrance to the chamber (Figure 3).

In Denmark, approximately 1800 dolmens are protected by the Heritage Law, but the original number has been much larger (see later).

Dolmens – function

We must be very careful when interpreting what dolmens were originally built for. In 1843, Danish archaeologist J.J.A. Worsaae believed that the dolmens were built as burial places for the Stone Age population, primarily for its leaders. He got this interpretation from the fact that in some dolmens, the remains of human skeletons had been found. Moreover, he was probably influenced by the thinking that society could not develop and carry out large projects without being led by a big landowner or an industrial leader (Worsaae 1843: 67). This interpretation has taken hold in archaeology, but it is difficult to present findings that can verify such an interpretation.

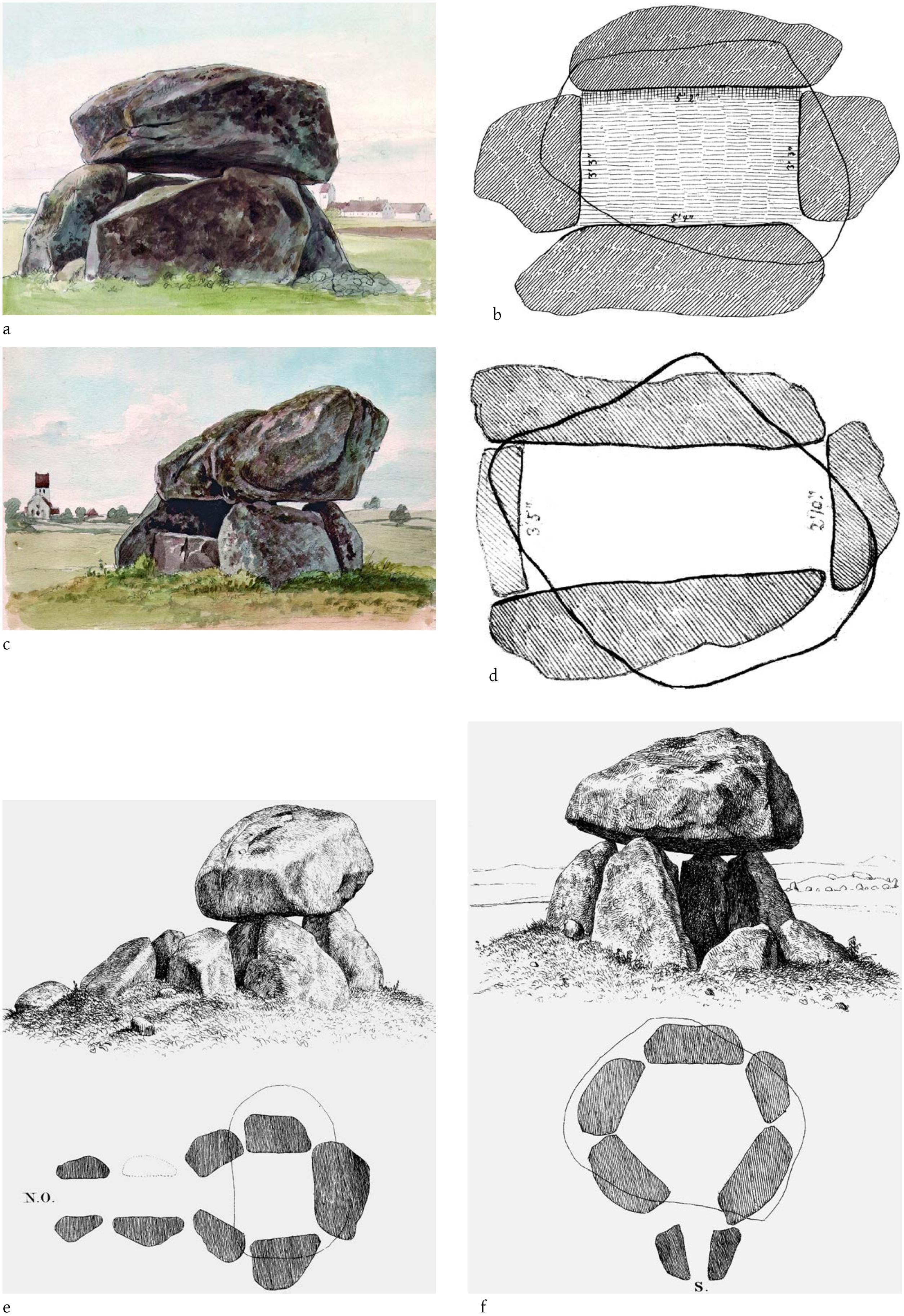

Figure 1. Dolmen types I – IV (Eriksen and Andersen 2016: 42, figure. 5.3).

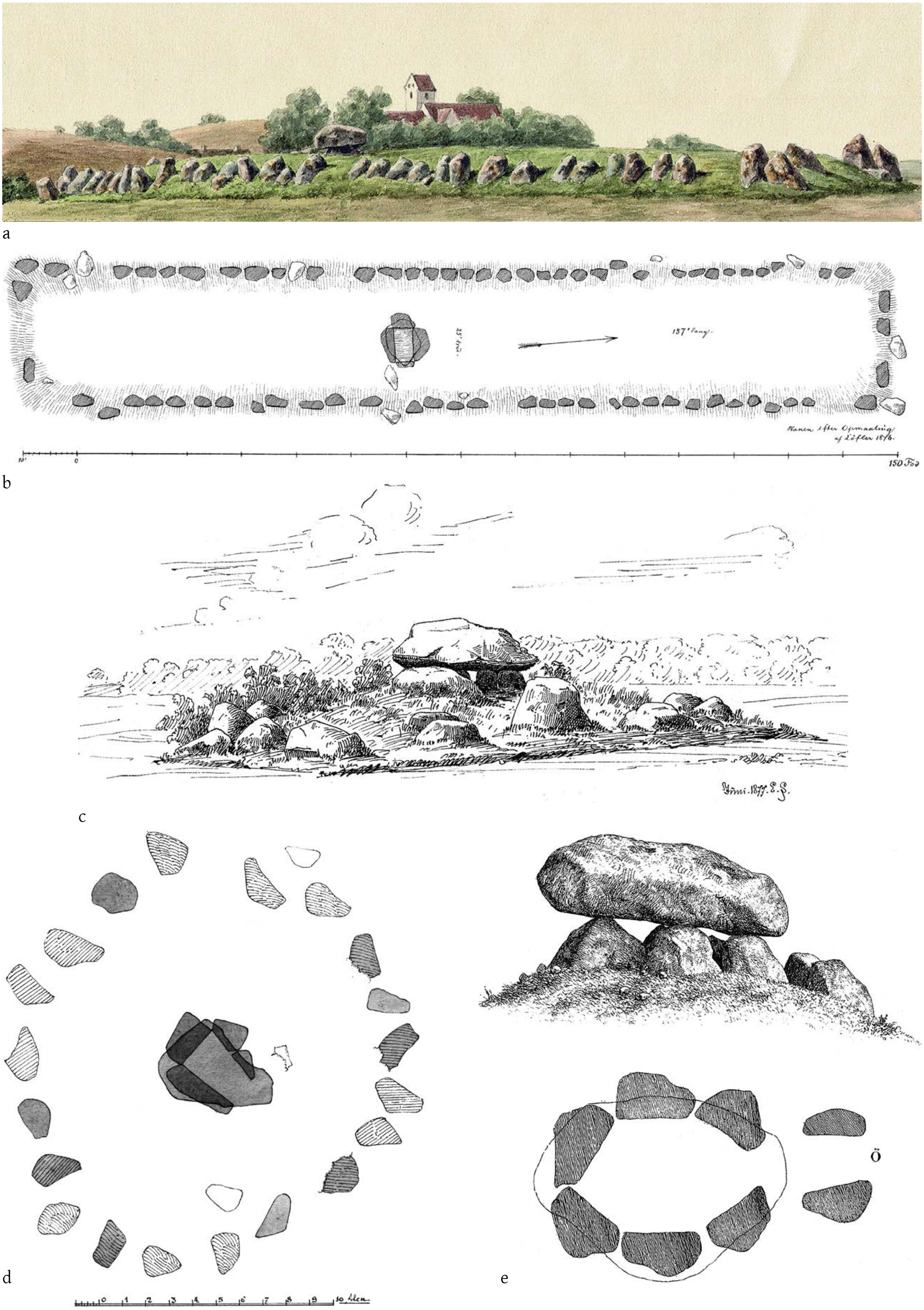

Figure 2. Examples of long dolmens, round dolmens, and stand-alone dolmen chambers (Eriksen and Andersen 2016: 48, Fig. 5.8).

Figure 3. Dolmen with a distinctive capstone in the shape of a six-pence hat. The Skellerup dolmen south of Knebel on Mols, East Jutland (photo: Niels H. Andersen).

Although several hundred dolmens have been excavated in Denmark, only 29 have had human skeletal remains, just as only 123 have had grave goods (Ebbesen 2007: 21 and 43; Eriksen and Andersen 2016: 273). Where it has been possible to excavate undisturbed dolmen chambers, it is peculiar that 1/3 of them have contained no finds at all.

Some dolmens contained finds that must date to a later part of the Funnel Beaker Culture. In the long barrow Bogø, around the traces of a skeleton, no less than nine thick-necked flint axes were found, which must be dated to approximately 2800 BC, that is, hundreds of years later than the time of the dolmen's construction (Eriksen and Andersen 2014: 282, Figure 21.8; Midgley 2008: 136, Figure 4.15).

However, in some dolmen chambers, human bones have been found, which can be presumed to be from the time of the construction of the chamber. This applies, among other things, to the dolmens Kellerød, Klokkehøj, Ølstykke, and Grøfte (Eriksen and Andersen 2016: 273-80).

For these finds of human remains, it is possible to learn that not whole corpses are buried in dolmens but that human bones have been deposited here. Some of these bones were skeletonized before the deposit and they have also been exposed to wind and weather before their deposit in the chambers.

A special find in connection with a dolmen chamber was made in a type II dolmen excavated in Flintbeck near Kiel in northern Germany. Here, it turned out that the deposited human bones were at least a hundred years older than the time when the dolmen were erected (Eriksen and Andersen 2014: 282-85; Mischka and Fuchs 2017).

The few dolmens with presumed primary finds cannot confirm an interpretation that dolmens were built to be burial places where, for example, the leading figures of a Stone Age population were placed. If that were the case, in addition to whole skeletons, there should also be whole and exquisite objects. We should accept a different interpretation for the use of dolmens, where they have engaged in acts which have also involved the deposit of human bones, in some cases even of old and 'worn' bones. In our interpretations, we should also look at the change in the expression of dolmens from types I and II with a low coffin shape, almost a closed expression, to the taller, more open chambers of types III and IV dolmens and with a marked entrance. Types III and IV seem to express an open and accessible gathering place, which in some cases is enhanced by distinctive boundary stones that may be set around them.

Passage chambers – architecture

With the advent of passage graves around 3200 BC, we see a completely different expression for megalithic monuments, as the entire structure is now hidden inside an earthen barrow. It is included in the definition that Danish passage graves have a passage that goes from the chamber to the foot of the barrow, possibly out to the kerbstones, with which the passage is then built. The passageway is covered with capstones. Because the passage rarely reaches heights above one meter, you must crawl to get to the stone chamber. This contrasts with the conditions of type III and IV dolmens, where one can enter the chamber almost upright.

The chambers of passage graves can either be rounded and thus resemble dolmens of type IV in shape, or their chambers can be elongated. The elongated chambers can be oval, rectangular, or trapezoidal. In addition, some may be equipped with bee chambers, and there are cases where two passage chambers are built together, so-called twin passage graves, where they have a common gable stone. Unlike dolmens, passage chambers always have more than one capstone above them (Hansen 2016).

The areas between the supporting stones in the chamber and in the passage are always filled with stacks of horizontal, 2 - 5cm thick red flagstones, so-called drywall tiles. They were carefully chopped to exactly fit to close the gaps. A white lime mass or birch bark may be laid between individual tiles. The placement of birch bark in the structure itself provides material for carbon-14 dating of the time when the passage room was built (Dehn and Hansen 2006).

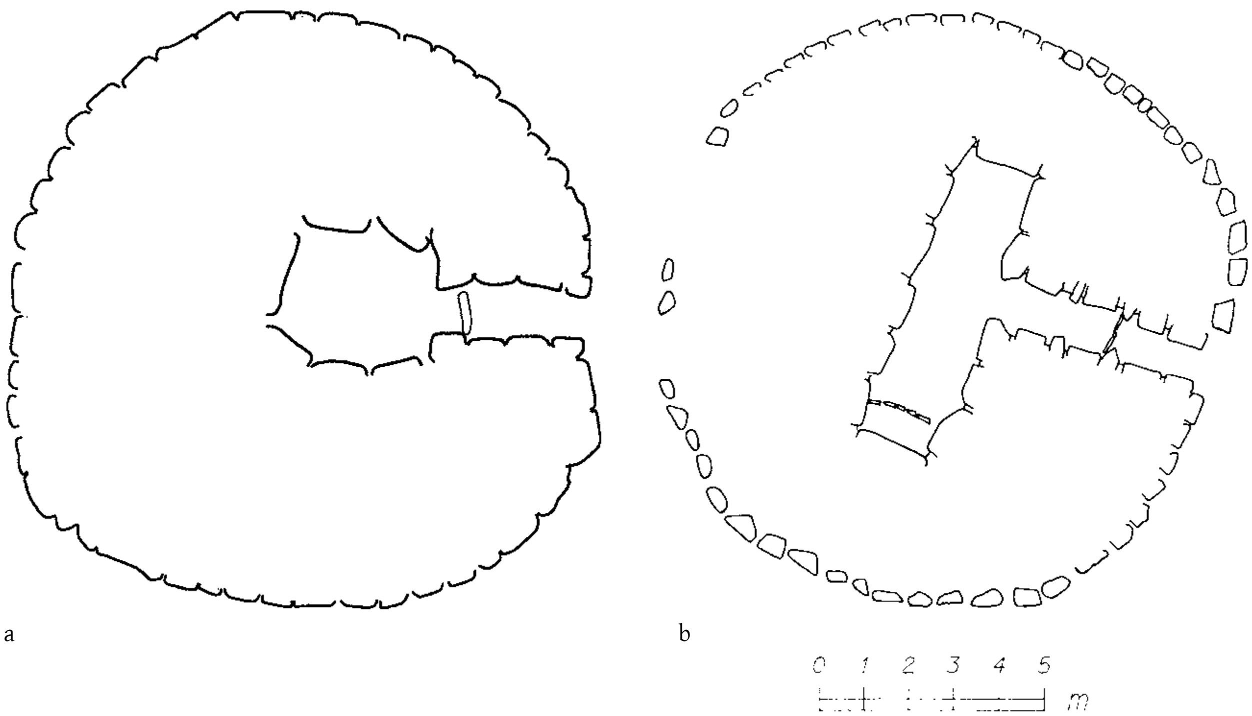

Figure 4. Floor plans of two types of passage graves. On the left is a round chamber, where the passage starts from a narrow side, and on the right is an oblong chamber, where the passage starts from a long side. The passages are integrated into the kerbstones around the barrows (Eriksen and Andersen 2016: 44, figure. 5.6).

The width of the chambers is usually about 2.4m but can vary between two and three meters. The length of the chambers fluctuates between 2.5m and 14m. In twin passage graves, however, the length can reach up to 20m (Hansen 2016: 58). As a rule, the height of the chambers is about 1.7m, but in a few cases can reach up to 2.5m. This height was achieved by laying additional layers of large stones on top of the supporting stones, creating almost artificial vaults. The highest passage chamber is in Rævehøj, which is in West Zealand, south of Kalundborg (Ebbesen 2009: 244; Fig. 187).

Passage chambers were always placed inside the earthen barrows. Barrows can be round or elongated, approaching a rectangular shape. They were usually framed with kerbstones between 1/2 and 1m in height. Kerbstones are usually set on the short side, and stacks of drywall tiles can be placed between them, as observed between the supporting stones in the passage and chamber.

Barrow construction in passage chambers is very complicated, as it is not just a question of filling the soil to cover the chamber and passage; they used different types of soil and stone layers to stabilise the structure, as well as ensure that water is led away from the barrow so that the chamber and passage remain dry (Hansen 2016: 119-124). It was important for Neolithic peoples to secure dry chambers.

The function of passage graves

Large numbers of human bones have often been found in the chambers of passage graves, which can represent up to a hundred deceased persons. The bones are not found in anatomical order, but in heaps, and sometimes you see that skulls and the long bones can be located separately (Ebbesen 2009: 79, figure 62). Analysis shows that the number of bones that would have been expected if whole corpses had been placed in the chambers was not present (Bennike 1985). Carbon-14 dates of the bones also show that they usually date to the second half of the third millennium BC, that is, to the time shortly before the beginning of the Bronze Age.

At present, we lack taphonomic analyses of human bones. With such analyses, it is possible to obtain information on whether the bones were skeletonized for a long time before their deposition, whether they had previously been stored elsewhere where they were exposed to wind and weather, whether they had been subjected to peri-mortem manipulations, and so on.

In the chambers, you will usually find many ceramics, objects of flint, and amber. The grave finds can be whole, but there are also cases in which deliberately fragmented objects are buried here. Finds can most often be dated to the 3rd millennium BC, that is, several hundred years after the construction of passage graves.

The many bones found inside chambers have led to the interpretation of chambers as places for collective burials of an area's population. Such an interpretation may be acceptable if we only look at the many skeletal parts from the second half of the third millennium BC, but the interpretation cannot be used if we want to examine the original function of the chambers. Thus, we do not have any findings from the time of chamber construction; based on the available findings, we cannot interpret the primary function of the chambers.

However, the chambers and the entire structure certainly have special significance. We see this, among other things, from the fact that large amounts of ceramics are often deposited on both sides of the entrance, up to the outer side of the periphery. In some cases, it can be entire clay vessels, but most often as fragments of clay vessels, possibly just a few sherds. Normally, there are a few thousand sherds in the areas in front of the kerb stones of passage graves, but at the passage grave of Sarup Gamle Skole II, 27.131 sherds were found, and passage chambers in Scania can have up to 50.000 sherds in front of the kerb stones (Hårdh 1986: 16). The deposits took place not only during the period when the passage graves were built but also in the centuries that followed.

Summary of dolmens and passage graves

Two types of megalithic monuments, dolmens and passage graves, were erected between 3500 and 3100 BC. Both types have approximately the same distribution in the Danish area. Today, 1800 dolmens are protected, and 600 passage graves are protected by the Heritage Law. As we have seen, there is a large difference between the two types of megalithic graves, where dolmens are open structures that seem to be seen, whereas passage graves are complicated and large structures that are hidden inside an earthen barrow.

The finds in dolmens and passage graves provide little help in interpreting the purpose of erecting these monuments. Previously, it was assumed that both types of structures were built primarily as burial sites. However, the late dating of the finds and the way they are deposited in stone chambers show that one must be open to other interpretations.

Such other interpretations can be obtained by carrying out new analyses of the previously excavated finds from the monuments, but we should also try to obtain new knowledge by conducting new excavations of megalithic sites. In Denmark, only a few dolmens and passage graves have been the subject of scientific excavations, and only a few excavations have been conducted within the last 50 years. One reason for this is that it is very expensive to carry out these excavations, but above all, the monuments are protected by the law, which also protects them from archaeologists' excavations!

Because it is difficult to obtain permission for studies on protected monuments, it is obvious to examine demolished sites, which were mostly demolished a few hundred years ago. In the Danish area, there has always been a need for large stones for the construction of churches, manor houses, bridges, roads, etc. so it was easy to pick up building materials in megalithic monuments. However, many of the megaliths thus demolished may still contain interesting features and artefacts that can provide new knowledge about monuments. In Denmark, there have been two projects in particular which have concentrated on the study of demolished megaliths.

One project took place on the island of Langeland and the surrounding islands, where there was a project to study the Neolithic settlement of the area. Within an area of 485km^2, 577 megaliths have been registered, of which 109 are still preserved and protected by law. In the 1970s, some of the island's megaliths were investigated by archaeological excavations, the results of which were published in 1985 (Skaarup, 1985).

The second project was carried out in the Sarup area in the south-western part of Funen, where the author of this article has been active since 1971, let's look at this project.

Sarup area

On a 9-hectare sandy headland near the village of Sarup, two well-preserved causewayed enclosures were found in 1971 and excavated from 1971 to 1984. The enclosures can be dated to the Fuchsberg phase of the Funnel Beaker Culture, approximately 3400 BC, and to the Kintebakke phase from approximately 3200 BC (Figure 5). The Sarup enclosures were precisely from the periods when dolmens and subsequent passage graves were also built in the Danish area (Andersen 1997, 1999, 2018; Midgley 2008).

The two causewayed enclosures were very similar. The first site, Sarup I, has framed an area of just under 9ha, while the younger site, Sarup II, has framed approximately 3ha (Figure 5). Therefore, these are mega-sized monuments.

A characteristic of causewayed enclosures is that they are framed by rows of system ditches, that is, rows of elongated ditches laid in the extension of each other. These ditches are between 7 and 20m long, about 5m wide and their depths vary between 0.2m and 2m. The varying depths indicate that the system ditches were not dug to supply raw materials for earthen embankments.

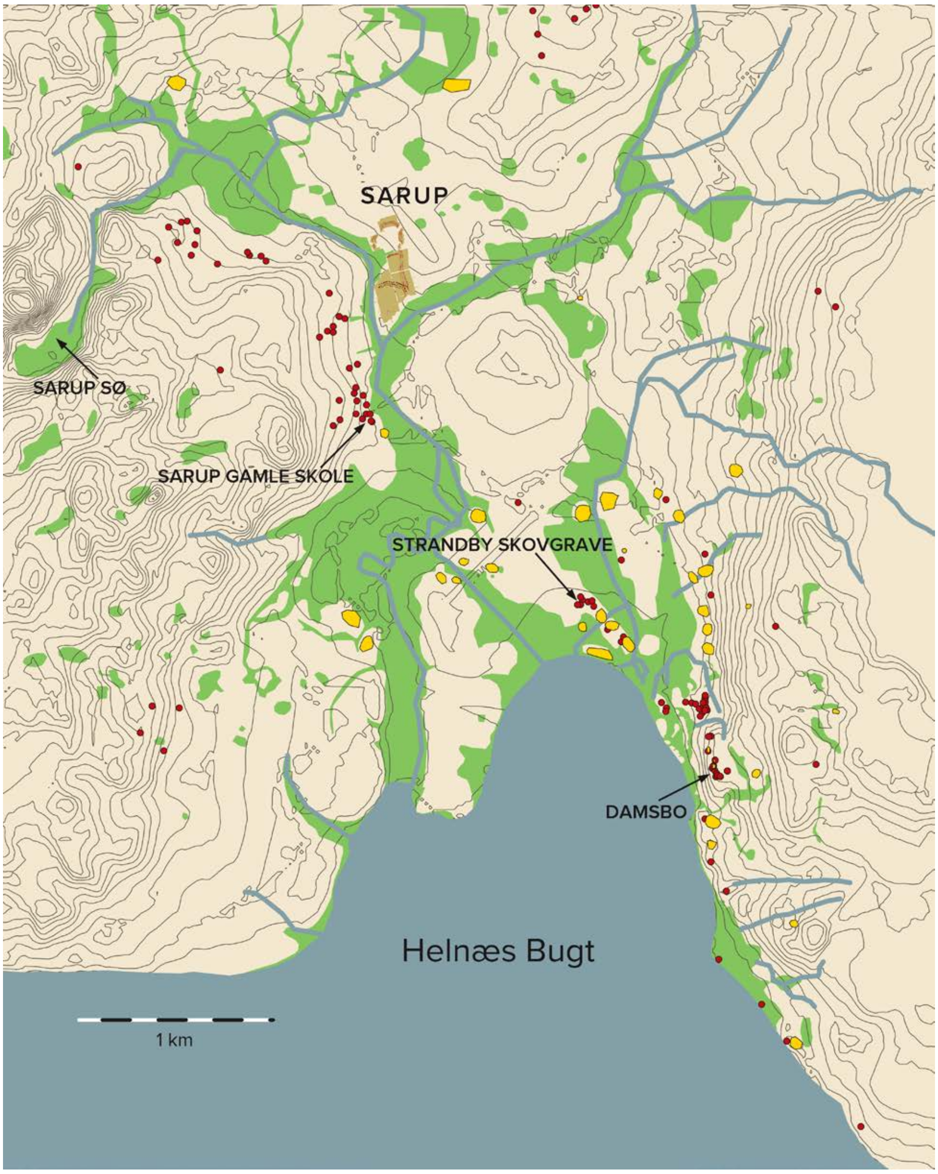

Figure 5. Sarup area between Assens and Fåborg in south-western Funen, Denmark. Here are the locations mentioned in the text. Red marks indicate places with traces of megaliths and yellow indicates the location of settlements that are contemporaneous with the construction of the enclosures at Sarup and megaliths.

Excavations of the ditches showed that very few artefacts were deposited on their bottoms and that this material was most often fragmented and weather-beaten. The human jaw found on Sarup I thus had traces indicating that the jaw had dried out before the deposit and that it had been worn by wind and weather (Andersen 1999: 249, Figure 5.85). Similar traces can be seen in pottery and flint. Studies of the soil layers also show that the system ditches were filled with soil dug up by them. The absence in the sandy soils of naturally deposited silt layers indicates that backfilling has occurred very quickly, perhaps within the same day (Andersen 2022; Andersen 2023: 369-373).

On the framed inner surfaces of the sites, large parts of which were exposed at Sarup, only a few pits and postholes were found, several of which contained a special material, for example, whole ceramic vessels, axes, compacted waste, and charred grain. A posthole contained the burnt bones of a young woman whose skeleton had dried out, a process that took 10-15 years after which her bones were burned. Only 1/10 of the expected number of bones of the young woman was selected for deposition at Sarup (Andersen 1999: 250, figure 5.86).

Other burnt bones, also of humans, were found in the handfuls of large lumps in the fill of palisade trenches that accompanied the inside of the system ditches in Sarup I. In the filling, there were also many single sherds from finely ornamented clay vessels that must have been votive gifts.

The two enclosures at Sarup are part of a large group of enclosures found throughout most of Europe, dating to the 5th and 4th millennium BC. (Andersen 1997; Grünewald 2022; Whittle 2014). The type of causewayed enclosure was recognized in the 1880s, and today more than 1000 such monuments are known. Their special shape, size, and special finds make it still difficult to interpret the function of the causewayed enclosures.

One way of studying the purpose of enclosures may be to excavate many sites and obtain material that can help interpret the purpose of large, framed enclosures. Another possibility may be to study contemporary features and finds in the vicinity of these sites. The construction of the enclosures at Sarup required the active participation of at least 1000 people who gathered in a short period. We must therefore assume that there are features and finds in the immediate area that can help interpret the area's settlement system, as well as give us a closer knowledge of the time and area in which the enclosures functioned. For the Danish area, it will be a question of studying the area's dolmens, passage graves, sacrificial sites, and settlements.

An area of approximately 4 × 5km around Sarup was chosen for a close study of the area's settlement at the time of the Funnel Beaker Culture (Figure 5). In the museums' archives, there were reports that four megaliths, two demolished, and two protected structures had been in the area, as well as a couple of Stone Age settlements. In the late 1980s, all available fields within the selected research area were traversed by intensive reconnaissance. This was done by experienced people walking through the fields at intervals of approximately five meters. In this way, all visible features were registered, and all findings were collected. In addition, visits were made to all farms on which field artefacts had often been collected for generations. Almost 15.000 artefacts were collected from the area. This testifies to a dense settlement in ancient times.

In addition to reconnaissance, 200-year-old maps were studied, whose signatures and place names could indicate any removed ancient monuments. Aerial photography was used to a lesser extent, just as geomagnetic surveys were only used 10 years ago in an area five kilometres west of Sarup, but with good results.

Reconnaissance in the Sarup area

Before our reconnaissance in the Sarup area, four megaliths were registered from the time the enclosures at Sarup were in use. It was possible to locate traces of 112 megaliths (see Figure 5). Thus, the number of megaliths in the Sarup area has increased by a factor of nearly 30! This tells us about the great activity that has been involved in building megaliths during Neolithic times, but it also tells us how much has been demolished over time. Despite the lack of systematic reconnaissance, many demolished megalithic sites have also been located on Langeland, which is slightly more than five times the number of those today protected by law (Skaarup 1985: 83).

In the Danish area, as mentioned, we have approximately 2600 megaliths protected by the law, but the original number must have been much larger. The number of megaliths should probably not be increased by a factor of 30 in relation to the registered megaliths, as in the Sarup area, or by a factor of five, as in Langeland, and perhaps by a factor of 10. This means that only 1/10th of the original number of megaliths has been preserved to this day and protected by law. Therefore, we can assume that the original number of megaliths in the Danish area was probably at least 26000-30000. These megaliths have been built for about 300 years, that is, almost 100 megaliths a year, or two a week!

In addition to the discovery of many megaliths, reconnaissance also found traces of approximately 80 settlements dating to the Stone Age. Approximately half of these settlements contained dateable material, indicating that they can be dated to the same time as the construction of megaliths and enclosures (see Figure 5).

Through 16 excavation campaigns carried out from 1986 to 2012, traces of four long barrows, 29 megaliths, and four settlements were excavated in the area. Traces of five house plots were found in two of the settlements. From the whole area, 407188 artefacts have been collected, as well as a larger number of samples with macrofossils (Kirleis 2019). Our excavations have thus secured extensive and varied find material from the time of the Funnel Beaker Culture before the prehistoric features were demolished by intensive agricultural tillage.

For the excavations, megaliths located near Sarup were chosen, but also in areas where reconnaissance showed that several megaliths were placed close together. The purpose of the individual excavations was to study how the megaliths were constructed, how and when they were in use, and whether they were in special locations, for example, in settlements or fields ploughed with the ard.

Many of the megaliths studied were demolished before the mid-1800s, which was of great luck to us because in these megaliths, we can often be lucky to find untouched layers of finds on the still intact chamber floors. This is because these megaliths were made invisible before the new interest in antiquity that emerged in the 1800s and led to the preserved stone chambers being emptied in the quest to collect antiquities. Thus, almost 200 years ago, a large part of the protected features was deprived of finds and information about their use.

Chamber finds can still be found in the demolished megaliths because, during the destruction, the large supporting stones were usually removed by pulling them backwards and away, thereby only to a limited extent destroying the layers of finds in the chambers. Through careful excavations, demolished megaliths can thus be wrested for important information and artefacts that cannot be found today in preserved and protected megaliths.

Our exposing of four large areas of megaliths, additional traces of megaliths emerged here than had been found during the reconnaissance. Traces of individual dolmen chambers were observed. It is also interesting that there was a tendency to cluster megaliths together, and there seems to be a pattern in the way this happened. They began with a long barrow, possibly a long dolmen, and then two separate dolmen chambers were built, ending with the construction of a passage grave. This tells us that they returned to the same location for at least 300 years, just as happened in the system ditches of the enclosures at Sarup (Andersen 2023: 373-75). In addition, there was great variation in the way the megaliths were constructed, and the materials used.

Perhaps the connection to a particular locality may have something to do with a settlement's connection to it. Future analyses of the richly ornamented ceramics, as well as new methods of analysis that we do not yet know, may help us gain more knowledge about the relationships between individual megaliths, megalithic groups, enclosures, and settlements.

The dating of the megaliths presented here has been based on the occurrence of ceramics, which can be dated more closely by the fine stratigraphic conditions that exist for Neolithic ceramics in the enclosures at Sarup (Andersen 1997: 22-35; Andersen 1999a: 29-34). To carry out carbon 14 dating, some organic material was collected from the individual excavations discussed below, especially charcoal, but also macrofossils and bones. However, the material comes from megaliths, which often turn out to be in places with traces of past activities, usually in settlements. We must therefore assume that older material is mixed with the soil used in the construction of the individual megaliths, which is why 14C dating cannot be expected to be credible beforehand. However, some bone material found on floor layers in megalithic chambers has been dated using the 14C method, and it turned out to date from the second half of the third millennium BC.

Megaliths in the immediate area of Sarup Site

Within a kilometre of the Sarup Site, approximately 30 megalithic sites were located during reconnaissance. In seven excavation campaigns, 11 megaliths were examined, but two were so damaged that the type of megaliths could not be determined.

The excavated sites are at the Sarup Gamle Skole, located 300 to 500m southwest of the Sarup Site (Figures 5 and 6). There are four sites of passage graves,[1] as well as a complex with a Neolithic earth grave, a post-fenced un-filled long barrow around a small dolmen, two more dolmens, and system ditches for an enclosure.[2] Since the latter site has previously been presented in a publication, we only need to present the five passage graves excavated in the area (Eriksen and Andersen 2016: 255-58).

Three of the passage graves were in round barrows with cross dimensions of 9.6m to 15.7m, while the last two were placed in a long barrow that was 18.2m long and 7.4m wide. Kerbstones framed all barrows. These kerbstones were about 0.6m wide and about 1m high, that is, not very significant stones. Four of the chambers were long oval-shaped, with the passage extending from the narrow side. These chambers were 2.3m to 2.7m long and between 1.5m and 2.2m wide, and the chambers consisted of six to seven supporting stones. The passage grave Sarup Gamle Skole II has an oval chamber, where the corridor extends from one long side (Figure 7). This chamber was 4.2m long and 2.4m wide. The passages were 2.0m to 2.9m long and consisted of 2 to 3 sets of supporting stones. The passages were built together with kerbstones.

The orientation of the passages fluctuated between the east and northeast and east-southeast, that is, between 75° and 150° (Figure 6).

Passage graves were laid on previously cultivated fields, where furrows from the ard showed that these fields had been ploughed a few times. Some ard furrows went over postholes and pits, so former settlement areas were likely cultivated before passage graves were built.

In areas close to the outside of the kerbstones, several smaller stone layers are usually placed, which can cover up pottery deposits. However, such deposits also exist between and above the stone layers. At the passage graves, Sarup Moelle I and Sarup Gamle Skole I, an approximately 0.5m wide layer of fire-crack flint has been laid, almost like a kind of 'sidewalk'. We also found flint layers in the long barrows at Strandby Skovgrave (Figure 8). Similar white flint layers are known from the areas in front of the Irish passage grave in Knowth (Eogan and Cleary 2017: 222, Plate 2: 79).

The floors of the chambers can consist of sandstone flags, round, hand-sized stones, crushed fire-crack flints (which are completely white), or layers of white seashells. We cannot be sure that the original floor layers were found during the excavations. The passage

[1] 7353 Sarup Moelle I, 7360 Sarup Gamle Skole I, 7361 Sarup Gamle Skole II and 7369 Sarup Gamle Skolel X.z.

[2] Sarup Gamle Skole XII (Eriksen and Andersen 2016: 255-258).

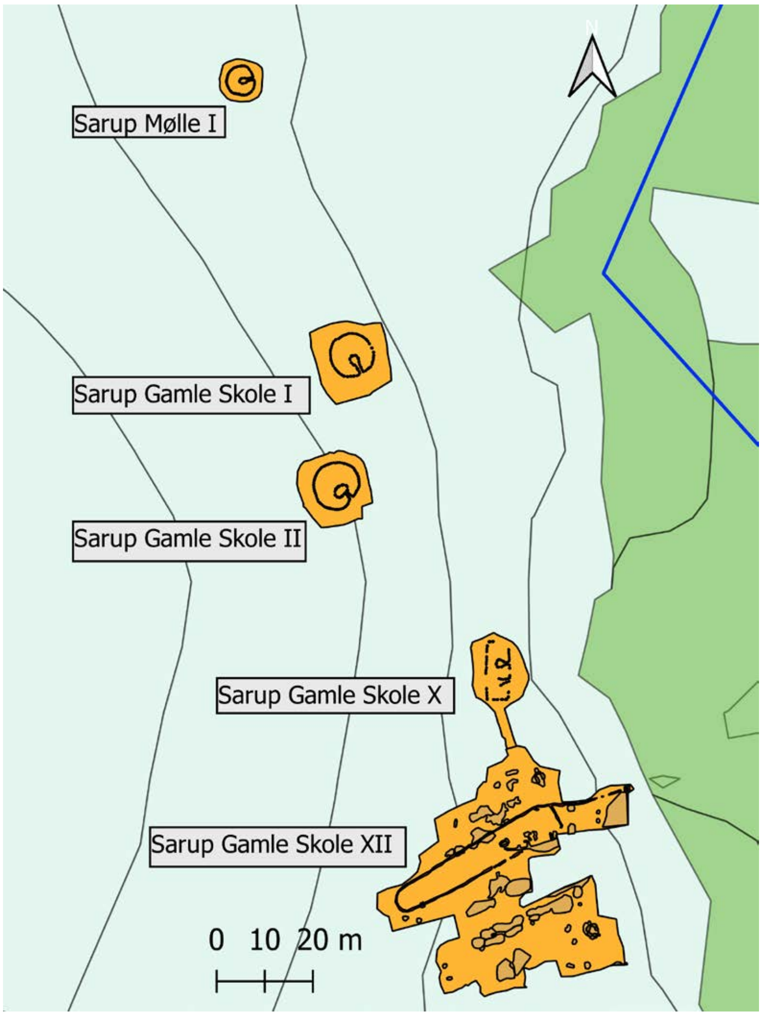

Figure 6. The area around Sarup Gamle Skole south of the Sarup Site with uncovered sites mentioned in the text (see also Figure 5).

graves Sarup Moelle I and Sarup Gamle Skole I contained several shells of Cardium, which are also known from the passage grave Damsbo A1 (Figure 10). The calcium from these shells has meant that they provide good preservation conditions for bones. Carbon-14 dating of selected bones from these chambers with shells gives results around 2300 BC, that is, from the time of the Bell Beaker Culture. White shells were used as floor coverings, whereas they had previously used fine fire-crack flints.

Several ceramics have been found in front of the passage grave entrance areas, which have been deposited here in connection with activities that have taken place in this area. There is great variation in the number of sherds deposited here varying from 2053 finds at Sarup Moelle I, to 27.131 finds at Sarup Old School II. The latter passage grave is the one in Denmark which has the largest number of finds. This requires considerable work to process large amounts of finds, which is also delayed by the fact that many sherds are deliberately fragmented to sizes of approximately 5 × 5cm. Thus, whole clay vessels, that is, containers, seem to have been deposited, but only fragments of the vessels, and these fragments may be spread over several square meters. It is often observed that only a single sherd from a vessel is deposited.

The oldest finds in the passage chambers were from the Klintebakke phase (MN Ib), which determines the time of construction. In subsequent centuries, repeated deposits occurred at the entrances.

Inside the chambers, a fairly varied supply of artefacts has been found, which most often date to the 3rd millennium BC, that is, from a time that can be up to a thousand years younger than the construction of the monument.

The passage grave Sarup Gamle Skole II is different from the other passage graves nearby, in that the passage starts from one long side (Figure 7). Large amounts of ceramics were deposited in front of its entrance. During excavation, two-floor layers were preserved in the chamber. The top layer consisted of hand-sized stones, laid very carefully on this, and in the fill above it, approximately 500 objects were found to be dated to the time of the Blandebjerg phase, that is, from approximately 3.100 BC, as well as from later periods. This floor layer sealed the lower floor layer, which could be attributed to the time of the first activities in the chamber.

The lower protected floor layer consisted of flat sandstone. These sandstones were laid only in the southwest half of the chamber, that is, in the left half when entering from the entrance. The right half consisted of sand. It is worth noting that the left side of the passageway was aligned with the edge of the floor. It appears that the passageway primarily has access to areas without floor tiles.

On the floor, a few artefacts were found, including a few bones and teeth from a human, possibly a young woman, as well as five pieces of flint waste, three small sherds, a flint split, a flint knife, an arrowhead, and an amber bead. The material found was fragmented and worn and did not correspond at all to the expectations before the excavation of the floor layer. Here, we expected to find one, perhaps several, whole skeletons, as well as whole vessels and other valuable materials that would

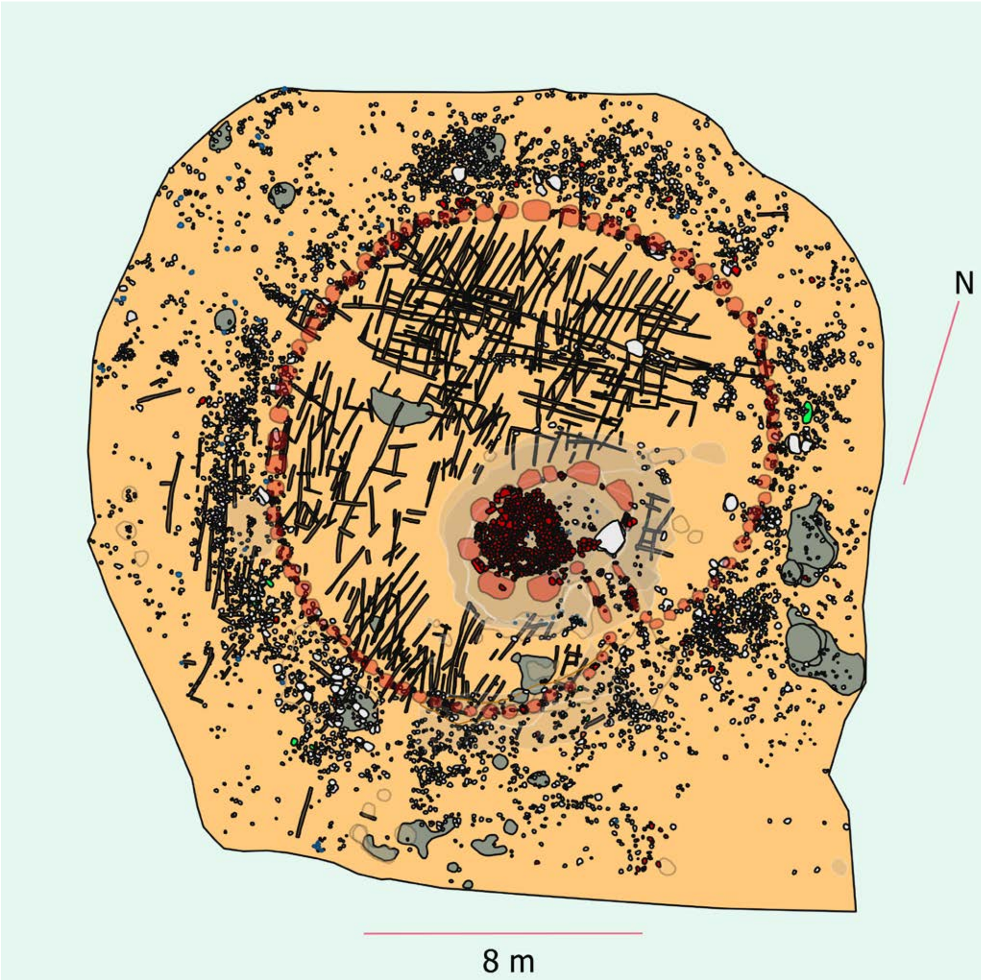

Figure 7. Traces of the passage grave Sarup Gamle Skole II. The largest transverse dimension of the barrow was 15.7m, and the greatest length of the chamber was 4.2m. The lower floor layer of the chamber can be seen.

have been a good fit for such an extensive monument. Of course, it cannot be ruled out that the chamber had been cleared of burial and grave finds before laying the new floor layer, but why lay a new floor?

The untouched material that lies on the lower floor of the passage grave must have been previously placed elsewhere where it has been demolished and subjected to degradation. This is very similar to the types of finds we observed at the bottom of the system ditches in the enclosures at Sarup (Andersen 2022: 8, Figure 3). The fortunate circumstances of the discovery in the chamber at Sarup Gamle Skole II, show that something completely different from what might be expected was deposited here.

Studies of demolished megaliths near Sarup have provided rich and varied findings, which have shown us that there was a great deal of activity in the area when the Sarup II enclosure was built. We see here two expressions of monumental architecture at the same time, which have required a great deal of coordination and the active participation of many people. Special activities took place in both types of monuments, which included deposits of exquisite ceramics, flint axes, and human bones. At both types of sites, a large part of the artefacts was deposited as deliberately fragmented pieces that only represented parts of the item, just as the material before the deposits had often been exposed to the influence of wind and weather; that is, a used and worn material was selected for disposal.

Other megaliths in the Sarup area

In addition to the excavation of megaliths close to the enclosures at Sarup, excavations have also been carried out at sites located up to three kilometres away from Sarup. At two sites, larger areas have been cleared, whereby several megaliths could be investigated. These two locations have previously been presented, which is why they should only be briefly mentioned (Eriksen and Andersen 2016: 258-69).

Strandby Skovgrave

This locality is located 1.8km southeast of Sarup. It is laid on an oblong sandy headland surrounded by wetlands on three sides. An area of 46 × 60m (2710m^2) was uncovered, and there were fine traces of two long barrows that had been surrounded by kerbstones, as

Figure 8. Site Strandby Skovgrave, where traces of DI – stand-alone dolmen chamber with passage-stones (type IV) were excavated; DII – long barrow with soil fill, kerb-stone, and a passage-grave; DIIN – dolmen chamber (type II) in a small round barrow; DIII – long barrow without soil fill, but with kerb-stones and a dolmen chamber (type IV), destroying a part of a previously set post-enclosure; DIV – stand-alone dolmen chamber (type IV).

well as two single dolmen chambers (see Figure 8). The excavation showed that the two long barrows had a complex history.

The first activity took place in an unfilled long barrow DIII by erecting a 26 × 8m fence with wooden posts. In the middle of this enclosure was a gravel of stones, around which several sherds were placed, which were contemporaneous with a pair of fine decorated vessels set on the west side of the post fence. The finds here must be dated to the time of the Fuchsberg phase, that is, from the time of Sarup I, approximately 3400 BC (Eriksen and Andersen 2016: 261, figure 20.9 A and B). This is an unknown type of monument which may have framed a burial site demolished by a later dolmen.

Around the same time, a small dolmen of type I was placed at the north end of the later-built long barrow DII; that is, all supporting stones were equally high and placed on the long sides. However, the dolmen was quite demolished, so the possibility that we have Type II dolmen with a lower gable stone at one end cannot be ruled out. The chamber was in the middle of a low round barrow, which was only 7m across, without kerbstones. In the chamber, sherds of vessels dating from the time of the Fuchsberg phase were found.

The next activity at the site appeared to be the placement of a Type IV dolmen chamber in the middle of the unfilled long barrow DIII. The dolmen had an entrance to the southwest but was without passage stones. In this work, parts of the older stone gravel were demolished. Simultaneously, the entire monument was framed by a long rectangular unfilled barrow consisting only of kerb stones. This construction was approximately 31 × 13m in size. On the west side, a 'sidewalk' of small pieces of fire crack flint was constructed. Ceramics belonging to the Klintebakke phase, approximately 3200 BC, were located on both sides of the kerb stones.

Four meters west of the long barrow DIII, a large dolmen chamber of type IV was also placed, which had an entrance to the west but without passage stones. This dolmen had a large inner area of 2.6 × 2.7m. There were no traces of earthen barrows around the chamber.

Easternmost in the excavation, nine meters from long barrow DII, a Type IV dolmen was placed, which too was without a surrounding barrow – dolmen DI. This dolmen had an entrance to the southwest that was marked with a set of passage stones.

Finally, we see the construction of a 39 × 8m long barrow with soil fill – long barrow DII. In the middle of it was located a small passage grave with two sets of passage stones. These passage stones were integrated into the edge of the long barrow. On the west side of this long barrow, there was also close to the kerb stones placed a 'sidewalk' of fire-cracked flint, which we find from form the unfilled long barrow DIII, at Sarup Moelle I and Sarup Gamle Skole II.

The three dolmen chambers of type IV, as well as the passage grave in DII, all have ceramics from the time of the Klintebakke phase – approximately 3200 BC, as its oldest finds. This indicates that these chambers were built within a short construction period.

The fact that an earthen barrow was preserved at DII tells us that the unfilled barrows at the DI, DIII, and DIV dolmens were not due to erosion in the area, but that they were built without barrows. This was also confirmed by the fact that large quantities of ceramics were deposited at DIII in the areas inside the kerb stones, both from the time of the Klintebakke phase and the time of the subsequent Blandebjerg phase (approximately 3100 BC).

Interestingly, all the stone chambers here have openings to the southwest to the west, that is, not to the east to southeast, as is usually seen in Danish megaliths.

The locality Strandby Skovgrave has given us insight into the fact that the appearance, locations, and architectural expressions of dolmens can be quite varied. In addition, it is interesting that a relation to the same area was maintained over several hundred years, where we see that the long barrow DIII with kerb stones carefully included the rectangular post-fence enclosure, which was erected a few hundred years earlier, just as the earth-filled long barrow DII in its northern part carefully framed older type I dolmen in its new construction.

Damsbo

One kilometre further southeast of Strandby Skovgrave, an area of 170 × 90m or 1.5ha was uncovered on a slope to the west in the years 2003 to 2008 (Figure 9). Traces of seven dolmens, two passage graves, and features from the later use of the area were uncovered here. Five of the megalithic sites were pre-located using reconnaissance and aerial photography; however, it is thought-provoking that four more megalithic sites were only found upon the clearance of the area.

Eight megaliths were in two groups of four each. To the south was a group consisting of a very demolished long barrow (A6), a small dolmen of uncertain type (A38), a large polygonal dolmen chamber of type IV but without passage stones (A5), and a small passage chamber in a barrow without kerb stones (A4). In the middle of the excavation, a long unfilled dolmen barrow (A2) with a small dolmen chamber of type IV, dolmen whose type could not be determined (A32), polygonal dolmen of type IV (A3), and a passage grave with a barrow framed by kerbstones (A1) were uncovered. Northernmost in the excavation was an unfilled long barrow with a dolmen chamber of type IV (A121), the northern part of which was not accessible.

From the time before megaliths were built at the site, traces of two-aisle houses have been found under three megaliths, as well as some waste from settlement activities. The settlements were in areas for megaliths A1, A2, A4, and A121 (Andersen 2019: 130 Figure 8). The pattern on the ceramics found at the three sites shows that they must be dated to the time of the Fuchsberg phase, that is, approximately 3400 BC, or from the time of the Sarup I enclosure. Between the houses, there is a distance of 25 to 50m. About 50m south of the A2 settlement, in and around passage grave A4, there was also a concentration of finds from the time of the Fuchsberg phase, but no traces of a house were located, here the subsoils were very gravely.

Whether the house plots were a simultaneous settlement or a relocation of individual farms is debatable, but the short distance between the settlements suggests it must be a simultaneous settlement. With this finding, we have thus gained insight into how people lived and organized themselves during Sarup I's time.

The areas of two of the longhouses – A2 and A121 – were framed by long dolmens, and each dolmen chamber was placed directly between two sets of roof-bearing post holes in each of the two houses. The third house, on the other hand, was framed by the western half of the barrow for passage grave A1, such that the house plot lay exactly within the kerb stones and touched the back of the passage chamber wall to the east (Figure 10). This house from the time of the Fuchsberg phase is thus

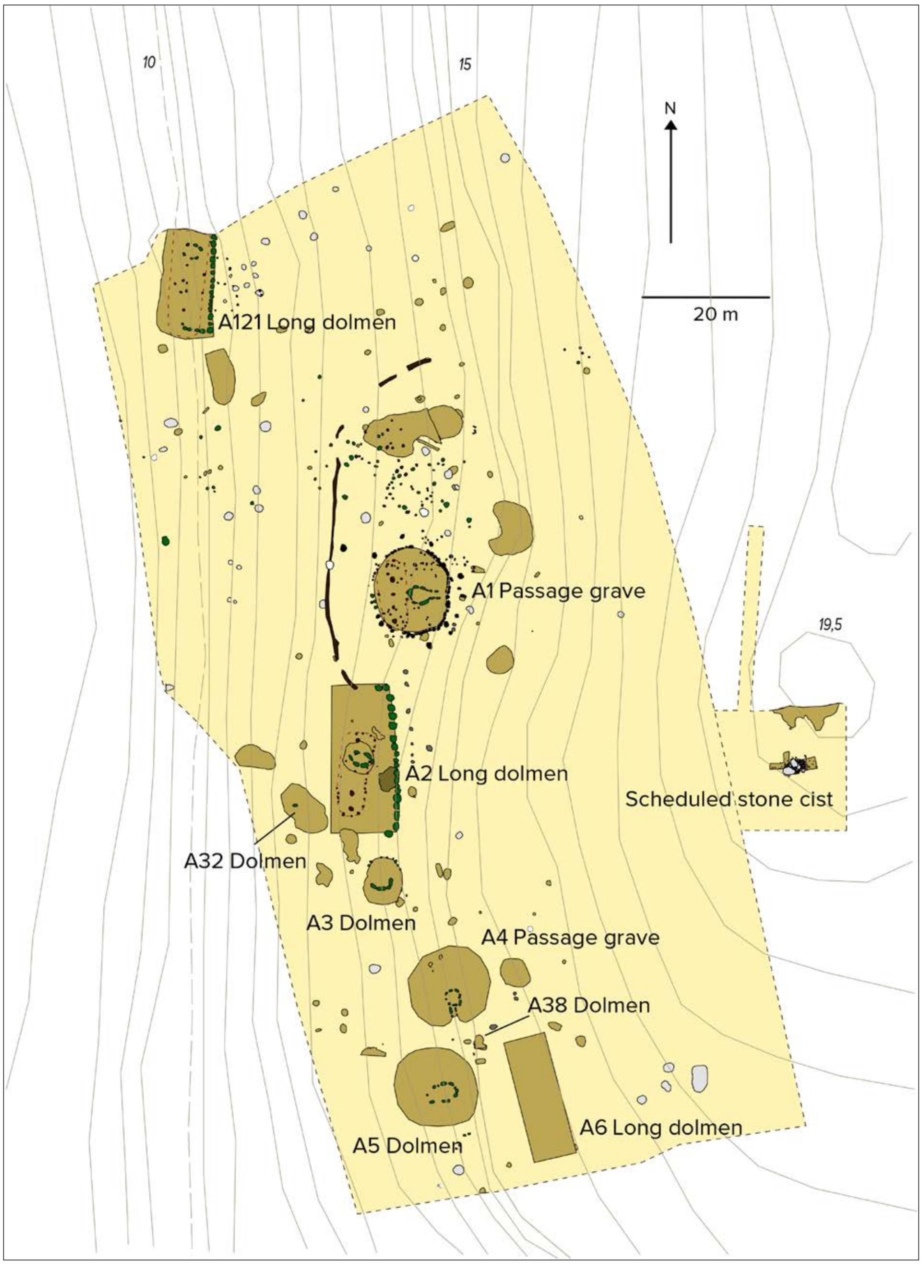

Figure 9. The Damsbo Mark site with traces of nine megaliths in three groups.

framed into a barrow structure, which is approximately 200 years younger because the passage grave is believed to have been built during the time of the Klintebakke phase, that is, approximately 3200 BC. There must have been a memory of the exact location of the house plot.

On two of the houses, the lengths were measured as 11m and 14m respectively. On all three house plots, the width can be measured and is between 4.6 and 5.8m. The two-aisle houses correspond to those found in a 200 year older settlement in Frydenlund. Here, two houses were parallel to each other with less than 6m. (Andersen 2015: 19, Figure 1; Andersen 2019: 124, Figure 2).

Passage grave A1 at Damsbo was relatively well preserved, as the kerb stones in the eastern part of the monument were still preserved on the site. The excavation revealed that this was a complicated megalith with several construction phases (Figure 10). The first activity on the site was about 3400 BC with the construction of two-aisle longhouses, which have been mentioned above. Then, approximately 3200 BC, an oval passage chamber was built, with a set of six supporting stones, and with a passage facing east with two sets of stones. The dimensions of the chamber are 2.8 × 2.4m and the length of the passage is 1.8m. This time, the passage reaches the foot of the first earthen barrow on the site, which is without large kerb stones but marked by a circular row of head-sized stones. Within these stones lay similar rows of stones, but they are now laid in a spiral shape. About 1.5m outside the corridor opening was a row of meter-high kerb stones, which framed the entire monument.

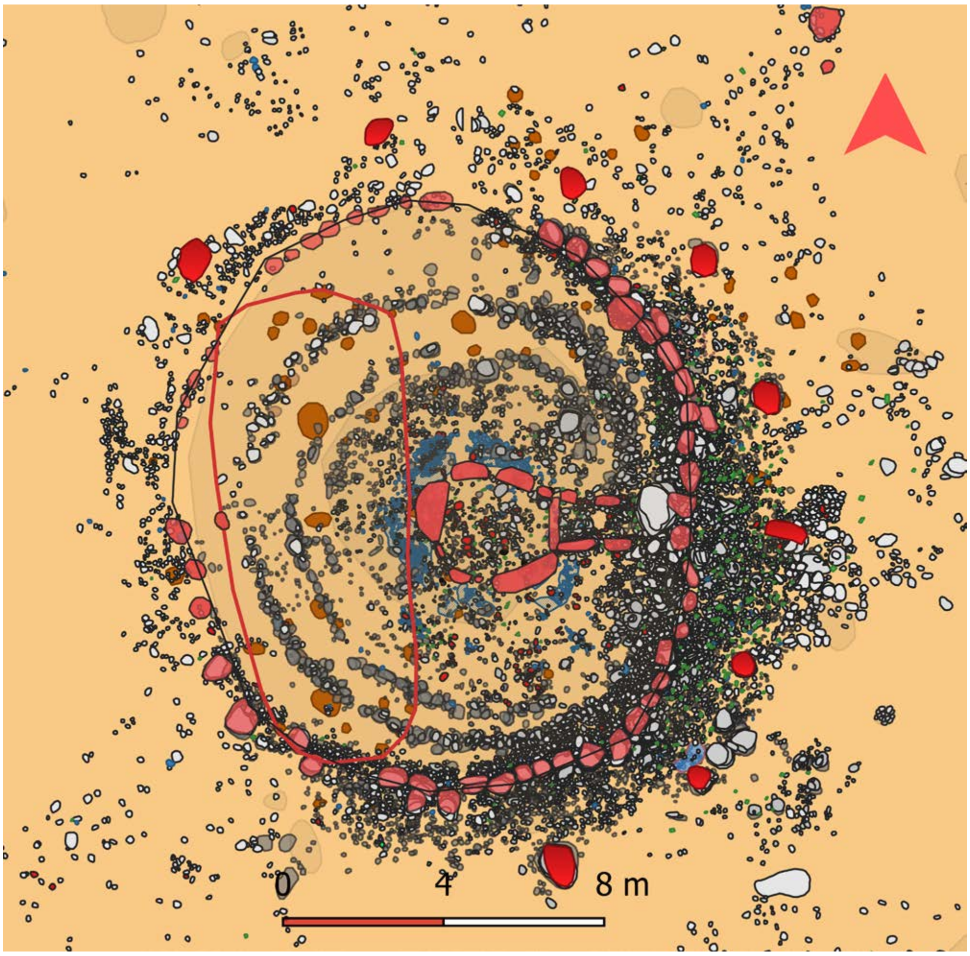

Figure 10. Plan of passage grave A1 on Damsbo Mark with cross dimensions of 15m. The middle traces of a demolished passage chamber with the passage facing east. The chamber was surrounded by a spiral consisting of head-sized stones. The entire object was framed by a row of kerb stones (pinkish), and outside, there was a row of larger granite stones (red). On the left side of the barrow are the traces of a two-aisle longhouse that is 200 years older than the construction of megaliths.

Decorated ceramics from the Klintebakke phase have been found not only on the outside of the kerb stones, as seen at other passage graves, but also on the inside of the kerb stones. Initially, these kerb stones did not mark the foot of an earthen barrow but were intended to frame an area in the middle of which we have a passage chamber with a low barrow. This corresponds roughly to those observed at Long Barrow DIII in Strandby Skovgrave (Figure 8). The deposits inside the framed area have included parts of clay vessels, some of which are deliberately fragmented into smaller sherds, laid out in piles, and in some cases with the handle of the vessel placed at the top of the piles (Andersen 2013: 521, Figure 5). At the time of the Blandebjerg phase, that is, approximately 3100 BC, large amounts of ceramics were again deposited in front of the passage grave, but now only on the outside of the kerb stones. This must be interpreted as meaning that, in the meantime, an extra barrow of earth has been laid on top of the former smaller one with the passage chamber, thus concealing the activities that took place within the kerb stones. Thus, soil has been applied to the monument several times.

A few meters outside the kerb stones were a row of monoliths, placed at about 3.5 meters from each other. In the eastern half of the monument, nine monoliths were preserved, whereas they were removed in the western part of the monument. In relation to the centre, the stones were set at approximately 30°; therefore, originally, there were probably 12 monoliths.

The floor inside the passage chamber was covered with a layer of white calcium shells. This resulted in well-preserved bones in the chamber. The carbon 14 dating of bones shows they are from the second half of the 3rd millennium BC. This dating fits well with the discovery of materials, including a wristguard, which can be attributed to the Bell Beaker Culture.

The Damsbo site provides further information on the area's megaliths. The monuments are laid out in groups, where each group consists of a long unfilled barrow, then a couple of dolmens, and finally a passage grave. The megaliths in each group were placed close together, although there was sufficient space in the area. Interestingly, each group was placed on top of the older settlements from the time of the Fuchsberg phase. Megaliths were placed such that they considered the location of the settlements' house plots. Concerning the above-mentioned passage graves excavated by Sarup, passage grave A1 at Damsbo provides a different picture of the construction and use of passage graves in the area.

End

In the Danish area, we have different types of megaliths. They can be separated into two main types: dolmens and passage graves. For dolmens, we refer to an open stone monument covered by a single capstone. The dolmens can be distinguished between those where the supporting stones are on the long side (types I and II) and those where the supporting stones stand upright on the short side, as orthostats (types III and IV). The latter two types may have entrance openings that may be marked by a pair of passage stones. Dolmen chambers usually have a large and very distinctive capstone. Dolmens appear to have been built from 3500 to 3200 BC.

Passage graves are a completely different type of stone monument in that the whole monument is covered by a barrow of earth, and it is always provided with a passage that reaches the foot of the barrow. The passage is always covered by capstones. Passage graves were constructed from 3200 to 3100 BC.

Little is known about the primary use of dolmens and passage graves; therefore, a series of demolished megaliths were uncovered in connection with the Sarup project. Hereby, we provide interesting new knowledge about these types of monuments. The megaliths were often laid in places where there had been settlements, and the Neolithic peoples returned to the same areas at intervals of many generations. In each area, there appears to be a group of four megaliths, consisting of a long, often unfilled barrow, two single dolmens, and a passage chamber. Although the Sarup project covers only an area of 4 × 5km, our studies show that there was great variation in the way megaliths were built and in how activities took place.

From studies in the Sarup area, we learned that demolished megaliths can provide interesting new knowledge, which is often difficult to obtain in preserved megaliths because it is not possible to obtain significant observations, as layers of soil are not accessible or demolished, and objects have long been removed from them. Such additional knowledge is important for gaining insight into the purpose of the construction and use of megaliths.

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Chapter 10
'Linking megaliths'. A computational approach to the study of movement and mobility in the megalithic complex of Galicia (Northwest of the Iberian Peninsula)

Miguel Carrero-Pazos and Devin A. White

Abstract

In this paper we study the spatial relation of more than 3,000 mounds with the natural movement through the landscape in Galicia (NW Spain). We adopt a computational approach by creating three geospatial models of pedestrian transportation networks in a GIS environment which comprised the creation of almost 19 billion routes in the whole region, taking into consideration as the mobility factors the slope, rivers, and land cover. In a second step, we generated an aggregate viewshed map using a regularly-spaced grid of observers across the region, in order to see if the megaliths are located in areas of high visual prominence. Finally, spatial statistical analyses were applied to see if the sites are situated near places that would naturally channel pedestrian movement at local and regional scales, and areas with high visibility.

The results point out a clear spatial relation of the megalithic monuments with the movement through the landscape, a trend that might be common to the Atlantic façade of Europe. We argue that this relation could be interpreted as a way of connecting the daily lived human landscapes and long-distance routes which not only physically connected the communities but also enabled the expansion of funerary ideas through terrestrial routes.

Keywords: Megaliths, Spain, Least-Cost Path, Viewshed, Geographic Information Systems, Spatial Statistics, Mounds, Geography of movement

Introduction

The megalithic monuments represent the materialisation of one of the social and cultural transformations in Europe during the Holocene, specifically in the Neolithic period. They are among the most common archaeological remains on the Atlantic Façade of Europe. In Western Europe, their chronology is often associated with both the Neolithic and the Bronze Age period. Across this territory, more than 30,000 dolmens, mounds, and other monuments are still preserved, serving as a testament to a number that was likely much higher in the past (Schulz Paulsson 2017). Well-known core areas with a high concentration of sites include regions such as Brittany, central Portugal, the British Isles, and Denmark.

While there is a clear temporal uncertainty behind this number, as the majority of these remains consist of unexcavated mounds, these monuments have been analysed from a broader perspective. The idea is that their significance in the landscape extends beyond their chronology. The Neolithic period witnessed a significant increase in the extent to which humans actively structured and reshaped their landscapes through monuments, essentially transforming natural environments into human-influenced ones (Criado Boado 1989; López-Romero 2005; Schulz Paulsson 2017). Megalithic monuments played a crucial role in this transformative process (Furholt and Müller 2011; Scarre 2005). Essentially, they have been understood as traces of communal possession of the land (Hanks 2008; Saxe 1970), justifying societal cohesion (Chapman 1981; Tilley 1994), or serving as territorial markers to exert control in different parts of the landscape (Lagerås 2002; Last 2007; Thrane 1998: 275; Tilley 2004: 197). Additionally, they are integral to wider cosmological landscapes (Bourgeois 2013), where topographical elements and the presence of other monuments play significant roles as references in culturally and socially humanised landscapes (Criado-Boado and Villoch Vázquez 1998; Cummings and Whittle 2004: 82; Lagerås 2002: 188). The construction of these enduring monuments is seen as a symbolic act, reinforcing the unity and cohesion of groups; indeed, a milestone for society (Delibes de Castro 1991; Renfrew 1976).

Furthermore, the placement of these monuments in the landscape is not random. Various locational patterns in different areas have been identified through fieldwork and modeled with GIS tools. For instance, some proposals suggest that megaliths were strategically placed in zones with topographic prominence, near flooding areas, or near transit paths connecting different parts of the landscape at local and general

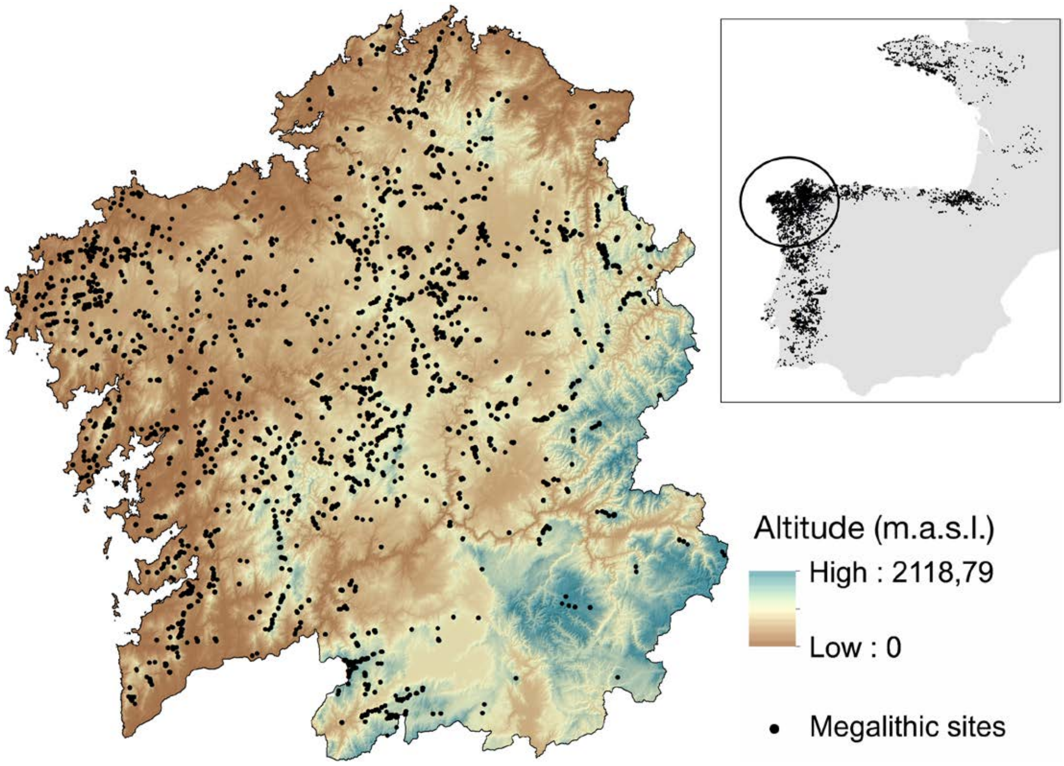

Figure 1. The megalithic phenomenon of Galicia (NW Spain). Data gathered from the megalithic studies group of the University of Santiago de Compostela (currently with 3,305 sites). Upright: The megalithic sites of the Atlantic façade of Portugal, Spain and part of France (data gathered from public sources. © MegaScapes project).

scales. The aim of this paper is to delve into the latter aspect by employing computational approaches.

Study area and background research

Up to the north-west of the Iberian Peninsula, Galicia, a region of approximately 30,000km², is characterised by rugged geography with medium-high elevations in the inner parts that are intersected by flattened valleys and lowlands that normally drain to the coast (Figure 1). Galicia shows a very high concentration of unexcavated mounds and megaliths, with more than 3000 sites in our current database, but with possible estimates raised to more than 7,000 sites (data from Xunta de Galicia Government, 2013; Carrero-Pazos 2017). Although this density has proven to be an inherent factor of the Galician megalithic phenomenon—in comparison to other regions (see, e.g. Scarre 2019: 190)—there has also been a great effort by researchers to carry out survey works from the nineteenth century and especially in the last forty years when several projects from universities and the official government ended up with the creation of the official catalog of mounds and megaliths (see, e.g. Rodríguez Casal 1990).

Regarding the relation of megaliths with natural pathways, there is also a long tradition of researching this topic in Galicia, with early researchers stating that 'mounds are built in the bottom of valleys or plains, over the hills (...), and sometimes in tight enclosures' (Martínez de Padín 1849: 231), or that 'mounds were built aligning prehistoric paths' (Maciñeira 1935;1943-44). Later, others stated that megalithic monuments are located near current transit routes but pointed out previous historical pathways built in Neolithic times (Bello Diéguez *et al.* 1982a: 3, 1982b: 117).

These initial interests prompted the analysis of the general spatial patterning of mounds and megaliths, leading to the definition of new horizons in research known as the 'geography of the movement' (Criado Boado *et al.* 1990-1991; Vaquero Lastres 1993-1994; Criado Boado *et al.* 1994) (Figure 2). Subsequent analyses have concluded that there is a spatial relation of megaliths with transit areas throughout the landscape (e.g. Eguileta Franco 1997, 1999, 2000), identifying prehistoric routes using ancient and medieval paths (see, e.g. Martinón-Torres 2001).

Building on these studies, however, in recent years, new analytical approaches have focused on GIS applications and spatial analyses to study the relationship of megaliths with pathways at local scales (Carrero-Pazos and Rodríguez Casal 2019; Llobera 2015; Rodríguez Rellán and Fábregas Valcarce 2015, 2019). Despite being case studies, all these investigations conclude that the spatial relation of megalithic sites with the movement through the landscape could have been a crucial

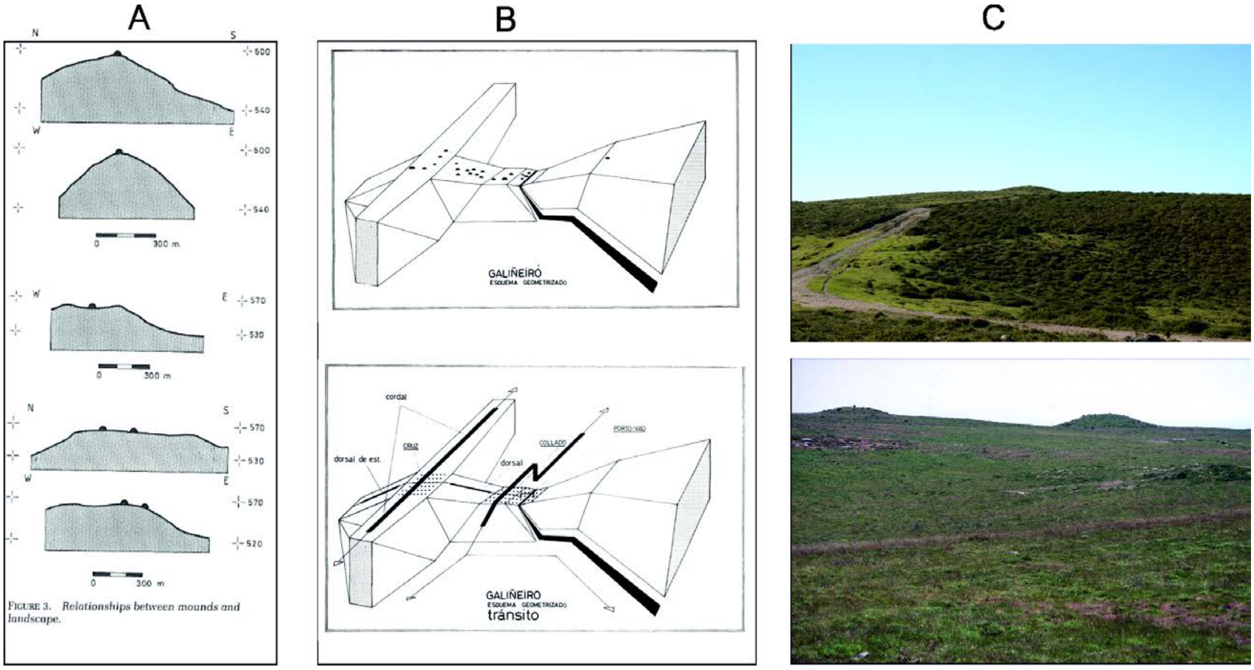

Figure 2. Former (pre GIS) studies about landscape location and the relation of megaliths with the transit through the landscape (A: Criado Boado, Fábregas Valcarce, 1989; B: Vaquero Lastres, 1993-1994). C: Examples of megalithic mounds in Serra do Barbanza (up), and Serra do Leboreiro (down).

factor in choosing their specific settings, along with visibility considerations (see, e.g. Carrero-Pazos, 2018a, b). This paper marks the first attempt in the Iberian Peninsula to examine this locational factor for an area encompassing almost 30,000km^2.

GIS pedestrian and view shed models

The study of movement and mobility in past landscapes has been a significant focus of GIS applications in archaeology, covering interests ranging from reconstructing trading routes, analysing site location patterns to studying economic networks, among others (see, e.g. Bell and Lock 2000; Carballo and Pluckhahn 2007; Howey 2007; Leary 2014; Sherman *et al.* 2010; Polla and Verhagen 2014). Technically, research has predominantly oriented toward using least-cost paths to reconstruct natural corridors in landscapes or the pathways and roads between specific archaeological sites (see, e.g. Lewis 2024; Llobera 2015; Murrieta-Flores *et al.* 2014; Standley 2015; Van Lanen *et al.* 2015, Wheatley *et al.* 2010; White and Barber 2012; Zakšek *et al.* 2008).

While computational methods have advanced in recent years through high-performance computing (Crabtree *et al.* 2021; Llobera 2020; White and Barber 2012) and advanced spatial statistics (see, e.g. Bevan 2020; Verhagen 2018), some initial and well-known issues of classic approaches, such as the use of different cost surface algorithms, are still under discussion and development (see, e.g. Herzog 2013). New research is now focusing on network analysis (Brughmans 2010) to analyse patterns of communication, introducing variables such as 'the memory of the landscape' (Fovet and Zakšek 2014; Verhagen *et al.* 2013; Verhagen 2018) and how earlier least-cost paths influence the construction of newer ones (Llobera 2020), or incorporating chronological uncertainty (Groenhuijzen and Verhagen 2017; Prignano *et al.* 2019).

In this paper, we develop three pedestrian models to analyse the relationship of megaliths and mounds with natural corridors within the region of Galicia (Table 1). Therefore, the aim of this work is not to reconstruct prehistoric paths but to observe the inherent structure of the mobility through the landscape, using spatial statistics to check if sites are related to areas of potential movement and if those areas maintain high visibility values.

We opted for choosing the FETE approach ('from everywhere to everywhere', many-to-many path relationships) developed by D. White and S. Barber (2012), which generates a network of least-cost paths based on topography and land cover without requiring origin and destination points be supplied in advance (Figure 3).

The FETE algorithm calculates the least-cost paths from all the points in a sampling grid, or specific set of points provided by the user, back to the current origin (see Figure 3D). Then, the locations of the paths are recorded in an accumulative surface, which, in a next step, resembles a road network (as seen in Figure 5A).

PEDESTRIAN MODELS				
	Objective	Characteristics of LCPs	Characteristics of agent	Number of routes generated
Model 1 (male)	To detect natural and general pathways by examining travel across the region	FETE analysis, points derived from vector boundaries of the region, all connected to one another	Male, 165cm tall, 64kg, 25 years old and 4kg of additional load	7,721,312,641
Model 2 (male)	To analyse the relation of sites with pathways by examining travel *within* the region	FETE analysis, regularly spaced grid of points connected to one another, 25-cell spacing	Male, 165cm tall, 64kg, 25 years old and 4kg of additional load	5,585,469,696
Model 3 (female)	To analyse the relation of sites with pathways by examining travel *within* the region	FETE analysis, regularly spaced grid of points connected to one another, 25-cell spacing	Female, 160cm tall, 60kg, 25 years old and 4kg of additional load	5,585,469,696
** Agent characteristics are based on the work of Hermanussen (2003).				

Table 1. Pedestrian models designed for this study.

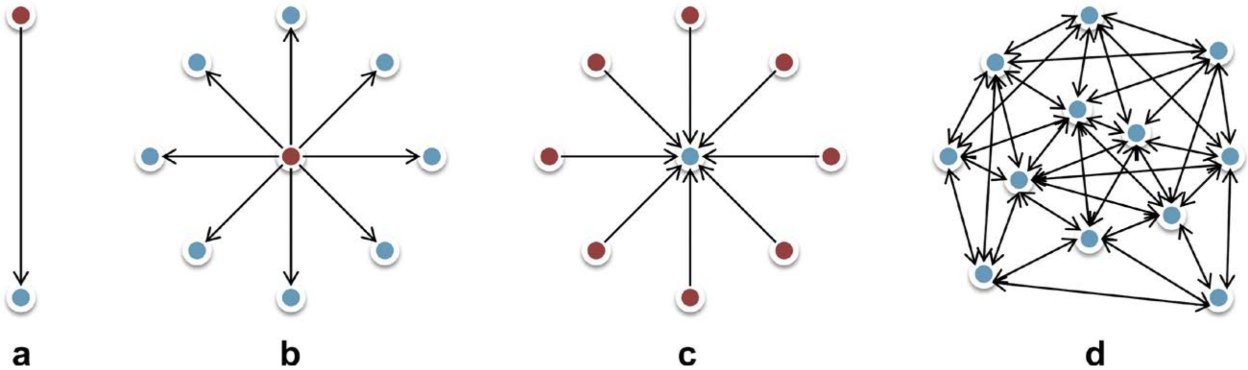

Figure 3. Connectivity options for point travel calculations. A: one-to-one. B: one-to-many. C: many-to-one. D: many-to-many (After White, Barber 2012: 2685).

The FETE algorithm was run over two kinds of procedures. First (Model 1, so-called extents), using the vector limits of the study area as origin and destination points, where the polygon was rasterised to match DEM resolution and only the border cells were used (Figure 4A). Secondly (Models 2 and 3), using a grid of points regularly distributed over the whole study area, every 25 pixels (Figure 4B).

All the analyses were carried out over a 25m DEM (LiDAR based), obtained from the Spanish National Cartographic Service (http://centrodedescargas.cnig.es/CentroDescargas/index.jsp), CC BY 4.0 https://www.ign.es/.

Analysis and results

The FETE models were calculated using a 25m Digital Elevation Model (DEM) with basic land cover data from MODIS MCD12Q1 for 2016. Streams, rivers, and lakes from OpenStreetMap were incorporated as the primary walk impediments. Using the method devised in Crabtree *et al.* 2021, we parameterised the travel function by assuming the least anisotropically 'costly' movement (in terms of caloric expenditure) across the landscape, using, as said before, the streams, rivers and lakes as walk impediments. In the simulations, travellers attempted to move from their origin point to their designated destination while minimizing caloric costs. When estimating the energetic cost of travel from one grid cell to another, the FETE calculates a generalised estimate of walking speed using a scaled version of Tobler's hiking function (see Crabtree *et al.* 2021, 'modelling travel').

We ran the models enough times to generate over 19 billion routes (Table 1), tracking each time a traveller crosses a pixel, thus creating pathways that transect the whole territory. The number of times a pixel was crossed indicates the 'attractiveness' of that cell for the movement. We then applied crossing thresholds to the pathways to identify those in the 1, 5, and 10% attractiveness levels considered across the simulations.

The results generated a total of 18,892,252,033 least-cost paths for the entire region, signifying a substantial advancement in terms of the scale of analysis compared to previous approaches. The creation of nearly 19 billion LCPs was necessary to capture the complexity of the landscape and the multitude of potential routes available, something not approachable from a regional or local point of view. This extensive computational effort allows us to explore not just the most direct or obvious paths, but also less apparent routes that

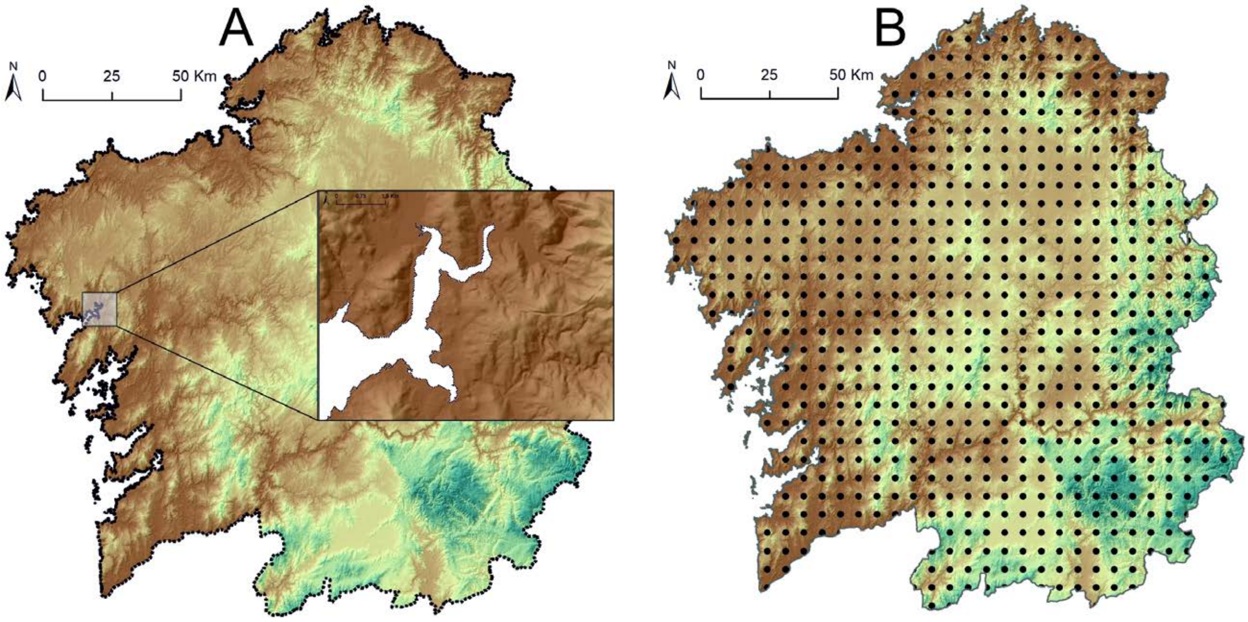

Figure 4. Methodological designs for FETE calculations.
A: Extents (model 1). B: Regular grid (separation of points exaggerated for visualisation purposes) (models 2 and 3).

may have been utilised for various purposes, thereby providing a more comprehensive view of human mobility.

To analyse the positioning of megaliths, we derived four different versions of each model, representing the full network thresholded to the top 20%, 10%, 5%, and 1% of high-traffic routes, as using the entire raw network became unmanageable for calculations. Additionally, we conducted an aggregate viewshed analysis for the entire Galicia, employing an observer every 10 pixels (resulting in 466,779 regularly-spaced individual viewsheds), to assess whether sites are situated in areas of high visibility.

We calculated the minimum three-dimensional travel distance from each megalith to four versions of each of the three models, representing the full network thresholded to the top 20%, 10%, 5%, and 1% of high-traffic routes (Figure 5). The three-dimensional walking distance refers to the travel distance that accounts for both horizontal movement across the landscape and vertical changes in elevation. Instead of measuring distance in a straight line on a flat surface, it includes the impact of hills, slopes, and other elevation differences that affect the effort or time needed to travel. This is particularly important in archaeological studies, where the complexity of the landscape can significantly influence human mobility. The method is used to assess how close each point on the terrain is to prominent landscape features, considering the terrain's complexity and the effort involved in walking across it (see Crabtree *et al.* 2021 for the technical details of the approach). The raw results for all the cut-offs can be found in the supplementary material under the folder 'Site distances.'

As seen in Figure 6, if we use the 20% cut-off traffic routes, sites are located much closer to the routes, and in the cases of the gridded models, the majority do locate in the near vicinity (50-100 meters). Also, we see that the sex is not introducing any substantial difference on the results.

Utilising the methodology described in Crabtree *et al.* 2021, we then tested the ability of each network thresholded to the top 20%, 10%, 5%, and 1% of routes (12 total) to reproduce the spatial pattern of megaliths by using a multi-staged process. We first calculated the shortest, three-dimensional travel distance from each megalith to each thresholded network, depending on surface elevation, using a standard anisotropic approach for generating a least-cost surface, as mentioned above. Each cell in the resulting grid, which matches the DEM in extents and spatial resolution (25m) represents the shortest travel distance from that location to the thresholded network and we averaged the values for a 100m neighbourhood of cells around each megalith to produce more comprehensive distance estimates. This creates a new coordinate system where the entire thresholded network is represented by the origin (0, 0) as a single point, which allowed us to standardise the distances across varying landscapes, enabling a direct comparison of spatial patterns. In other words, the frame of reference and per-megalith distances from that point can be used as a metric in two standard statistical clustering tests for complete spatial randomness—Kolmogorov-Smirnov (K-S) and Besag's

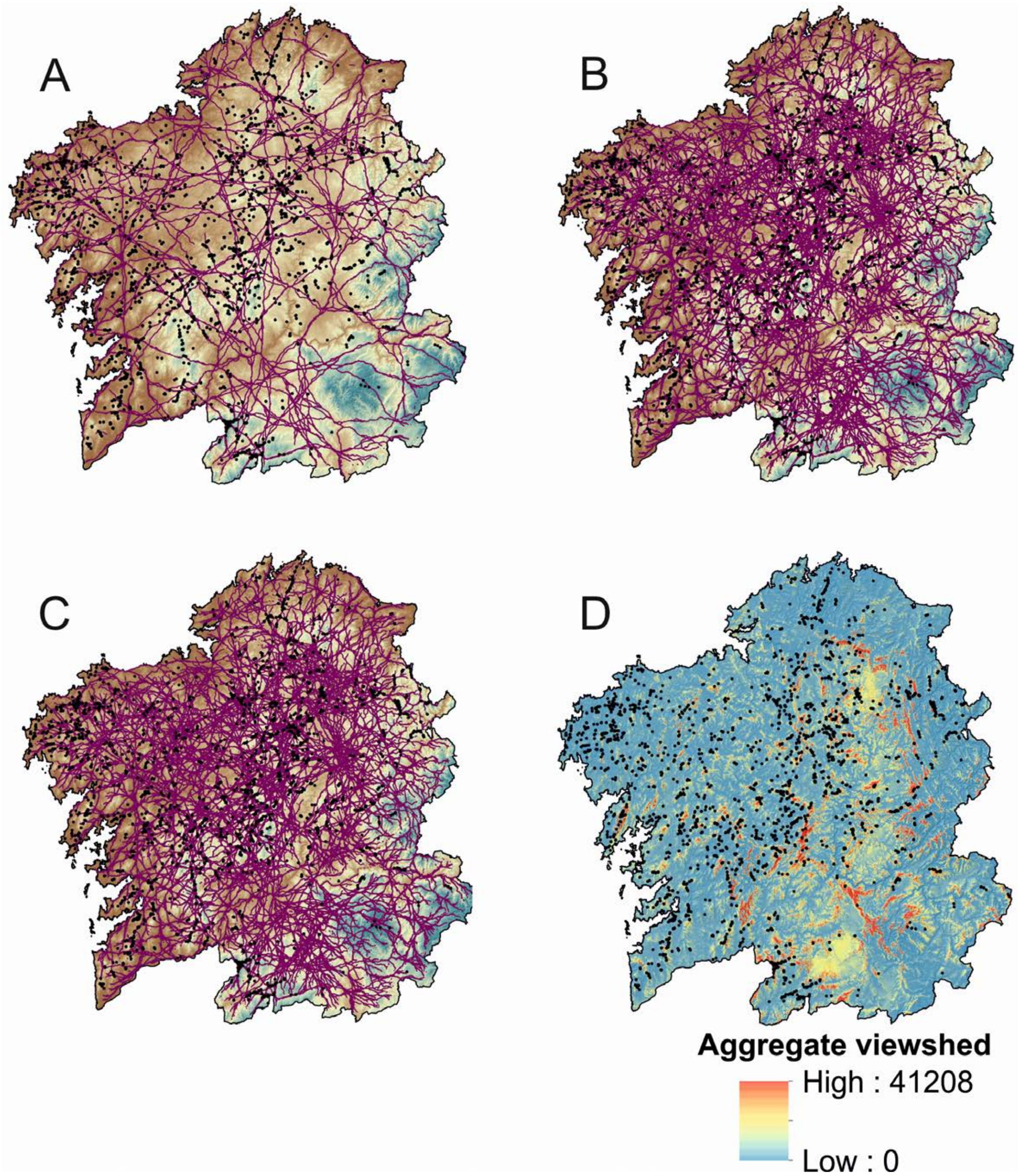

Figure 5. FETE models and aggregate view-shed analysis. A: Model 1, built with origin and destination points from the vector limits of the region (extents) (showing the top 1% of the generated network); B: Model 2, male agent (showing the top 5% of the generated network); C: Model 3, female agent (showing the top 5% of the generated network). D: Cumulative view-shed analysis based on 466,779 regularly-spaced individual viewsheds (observer every 10 pixels).

L-function (a normalisation of Ripley's K function) —to determine how well each thresholded network explains megalith locations. The stronger the clustering, the stronger the relationship.

Both clustering tests require the comparison of megalith distances to those obtained from the same number of randomly generated points—a process that is generally repeated many times to estimate an empirical value; for this analysis we selected 10,000 trials. The Kolmogorov-Smirnov test is straightforward and indicates whether two samples are drawn from the same distribution. If a large enough number of the comparisons between megalith distances and those for random points pass the test, which is based on a standard uniform distribution probability, complete spatial randomness cannot be ruled out and the thresholded network in question is declared uninformative.

If enough simulated estimates do not pass the Kolmogorov-Smirnov test, indicating that megalith locations are not random with respect to a thresholded

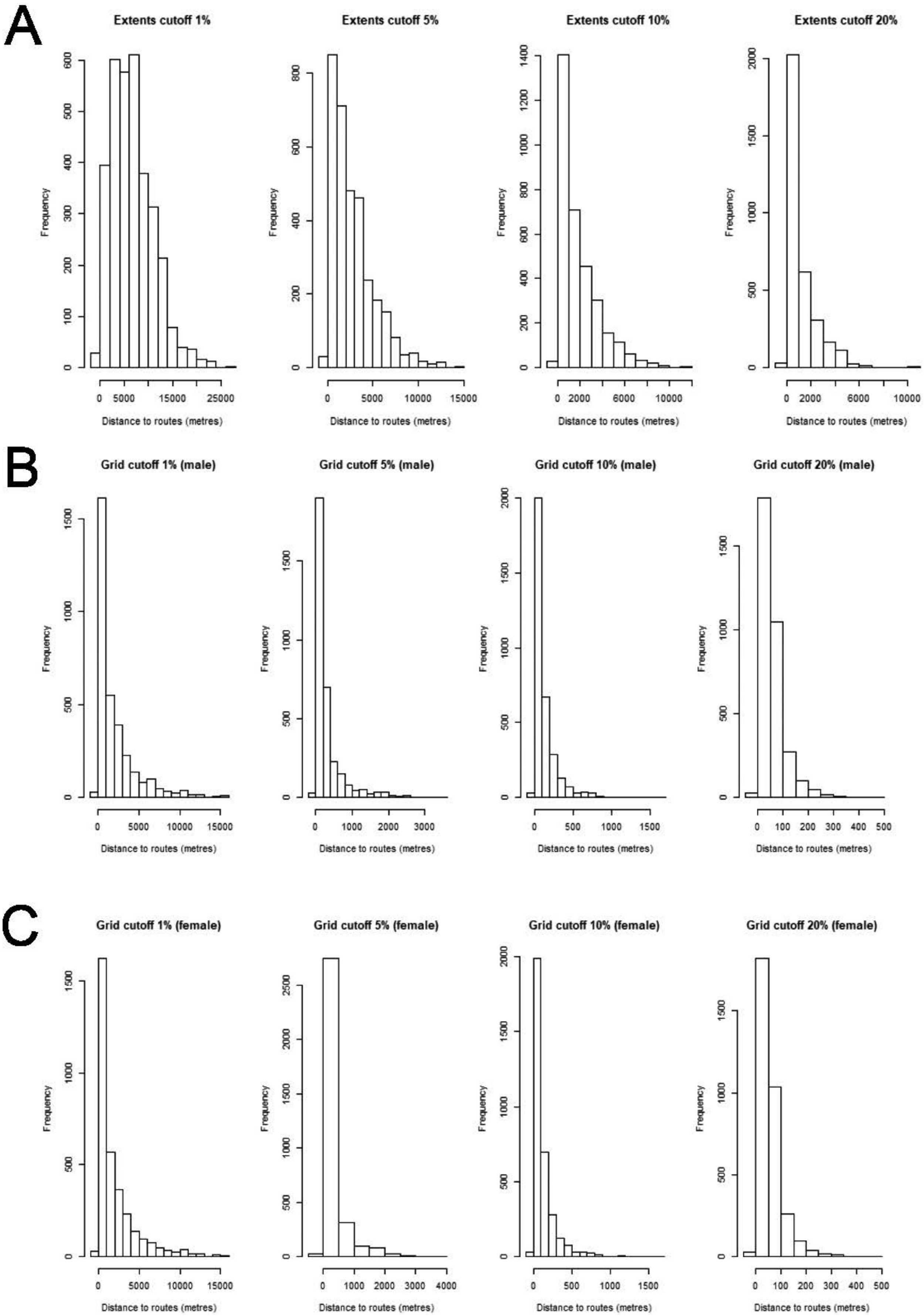

Figure 6. Histograms of distance to routes from megaliths.
A: Extents model; B: Male model; C: Female model.

Model 1		Top 1%		Top 5%		Top 10%		Top 20%	
	Alpha	K-S	L	K-S	L	K-S	L	K-S	L
Extents	0.001	Not Random	Partial Pass	Not Random	Full Pass	Not Random	Full Pass	Not Random	Full Pass
	0.005	Not Random	Partial Pass	Not Random	Full Pass	Not Random	Full Pass	Not Random	Full Pass
	0.025	Not Random	Partial Pass	Not Random	Full Pass	Not Random	Full Pass	Not Random	Full Pass
	0.050	Not Random	Partial Pass	Not Random	Full Pass	Not Random	Full Pass	Not Random	Full Pass
	0.100	Not Random	Partial Pass	Not Random	Full Pass	Not Random	Full Pass	Not Random	Full Pass
Model 2		Top 1%		Top 5%		Top 10%		Top 20%	
	Alpha	K-S	L	K-S	L	K-S	L	K-S	L
Male Grid	0.001	Not Random	Full Pass	Not Random	Full Pass	Not Random	Full Pass	Not Random	Full Pass
	0.005	Not Random	Full Pass	Not Random	Full Pass	Not Random	Full Pass	Not Random	Full Pass
	0.025	Not Random	Full Pass	Not Random	Full Pass	Not Random	Full Pass	Not Random	Full Pass
	0.050	Not Random	Full Pass	Not Random	Full Pass	Not Random	Full Pass	Not Random	Full Pass
	0.100	Not Random	Full Pass	Not Random	Full Pass	Not Random	Full Pass	Not Random	Full Pass
Model 3		Top 1%		Top 5%		Top 10%		Top 20%	
	Alpha	K-S	L	K-S	L	K-S	L	K-S	L
Female Grid	0.001	Not Random	Full Pass	Not Random	Full Pass	Not Random	Full Pass	Not Random	Full Pass
	0.005	Not Random	Full Pass	Not Random	Full Pass	Not Random	Full Pass	Not Random	Full Pass
	0.025	Not Random	Full Pass	Not Random	Full Pass	Not Random	Full Pass	Not Random	Full Pass
	0.050	Not Random	Full Pass	Not Random	Full Pass	Not Random	Full Pass	Not Random	Full Pass
	0.100	Not Random	Full Pass	Not Random	Full Pass	Not Random	Full Pass	Not Random	Full Pass

Table 2. Summary of the K-S and L tests for all thresholded models.

network, Besag's L-function evaluates how resilient the relationship is by examining it at multiple spatial scales. The greater the number of scales where it passes, the stronger the explanatory power. Instead of comparing megalith distances to each set of randomly generated points, we use all sets of randomly generated points to create a single empirical estimate of randomness against which the set of megaliths can be compared at a series of distances (1-26km, in 1km increments). The test was limited to a distance of 26km because that is the maximum distance travellers can be from any megalith in the region or from the borders of the region, based on least-cost, three-dimensional travel distance. We then pooled results across all distances to create a single probability estimate for each thresholded network. The *L*-function can test for either clustering or dispersion with respect to a given frame of reference. For this analysis, we considered clustering.

Table 2 contains the results of all tests on all 12 thresholded networks. With respect to the K-S test, all networks had non-random spatial relationships with all megaliths in the region, and all but the top 1% network for Model 1 fully passed the L test for resiliency at all distances. The top 1% network for Model 1 passed at all distances except for the first few kilometres, so it recorded as a partial pass. The raw results of each are included in the supplementary materials.

Another question that we want to analyse is if these transit areas have also visual relations with the sites. A positive confirmation would suggest that megaliths functioned, to some extent, as landmarks, as theorised. If so, are the sites strategically situated in the most visible areas of the landscape when viewed from these paths?

To address this question, we initially extracted the visibility values (the raster file is available in the supplementary material) and compared the resulting trend with 999 Monte Carlo simulations. These simulations utilised an equivalent number of points spread across the study area (Figure 7A). Additionally, we conducted a cumulative viewshed analysis from the pathways (thresholded to the top 10% cut-off), as using the entire network again became unmanageable. We employed the QGIS plugin 'Visibility Analysis' created by Z. Cuckovic (http://www.zoran-cuckovic.from.hr/QGIS-visibility-analysis/). In technical terms, we calculated a cumulative viewshed analysis using 6,459,029 observer points taken from the routes (Figure 7B), using 1km as the maximum viewshed distance.

From Figure 7, we observe that megaliths are not situated in the most visible parts of the landscape, whether considering the general cumulative viewshed approach (representing the background) or using the routes as observers. Instead, they are positioned in areas with medium visibility levels, indicating that other parts of the landscape offer higher visibility. This observation extends to the visibility from transit routes. However, this does not diminish the importance of that locational criteria. The trend depicted by the monuments in both Monte Carlo simulations (Figure 7A, below) suggests that the viewsheds of megaliths differ from those of

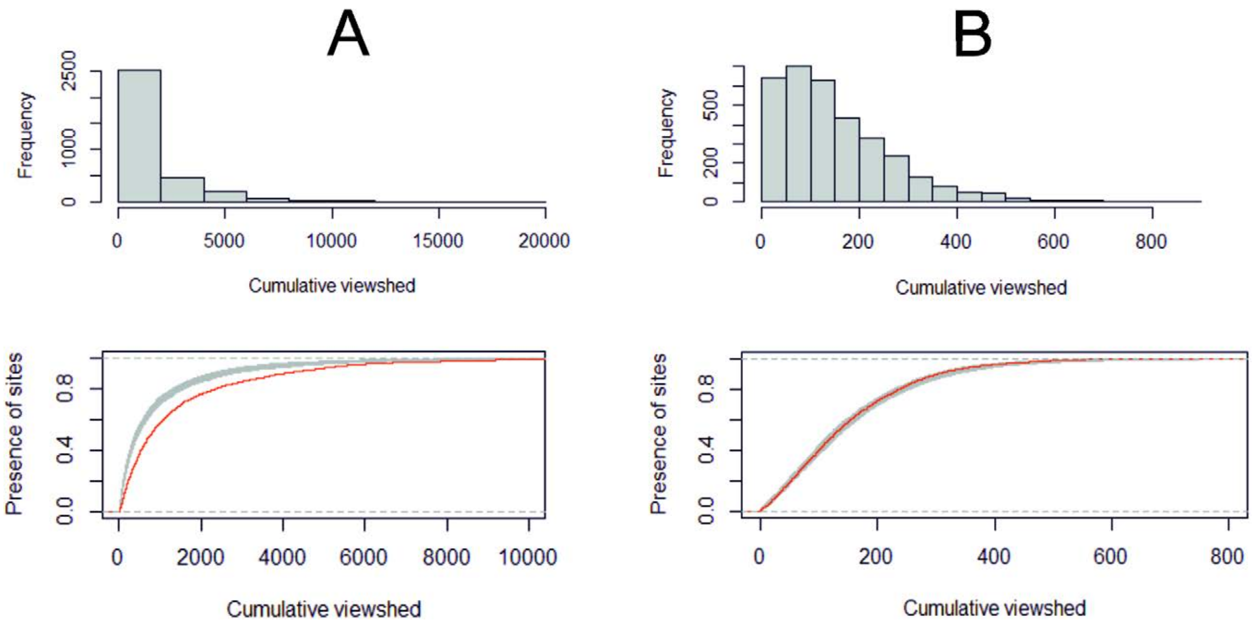

Figure 7. A. Histogram with site's values (up) and Monte Carlo Simulation (down) for the regularly-spaced grid cumulative viewshed approach. B. Histogram with site's values (up) and Monte Carlo Simulation (down) for the cumulative viewsheds with the pathways as observers.

the random background population. As highlighted in other research (see Carrero-Pazos 2021), it is plausible to conclude that the visibility is a significant locational factor, especially when considering sites with restricted views.

Discussion

The implementation of the FETE models in this study represents a significant advancement in our understanding of the spatial role of megalithic monuments and their relationship with natural transit routes in Galicia. By employing a quantitative approach, we contribute to a body of research which is exploring how prehistoric societies interacted with their regional landscapes. The integration of movement studies into archaeological research offers a robust framework for examining the human behaviour in relation to environmental factors. In the context of megalithic monuments, understanding how people moved through the landscape can illuminate the social and cultural significance of the underlying social structures. This study has focused on least-cost paths to provide a tangible means of exploring how megalithic sites were built in relation to natural transit routes, suggesting that the sites were not merely isolated markers but strategically positioned to facilitate movement and communication among communities.

The FETE models allowed us to create, for the first time, the most detailed network of natural transit (least coast path density) in Galicia. A simple density analysis indicates those areas which present high traffic natural routes (high frequency) versus those with low frequency (Figure 8).

Following the works of A. Bevan (*et al.* 2013; Bevan 2020), we further inspected this by comparing the location of the 3305 megaliths with 999 random samples (each one composed by 3305 points) spread across the entire study area, in order to build a 95% confidence envelope. The results, depicted in Figure 8 (graphs), reveal that the positioning of megalithic monuments deviates from randomness. Although not absolute, it is evident that there is a discernible correlation between megaliths and areas that guide the pedestrian movement through the landscape. While a broad view (e.g. map in Figure 8A) may suggest that a significant number of monuments are not situated in potential transit areas, a closer examination reveals that many of them form linear concentrations precisely along transit routes (Figure 9). Unlike previous methods that often relied on simple proximity measures, our approach utilises a network analysis framework to assess the role of megaliths within broader landscape dynamics. This methodology is consistent with contemporary research trends in archaeological science, which emphasise the importance of spatial analysis and modelling to understand ancient human behaviour (see e.g. Lewis 2024).

The non-random distribution of megalithic sites suggests a conscious effort by Neolithic societies to integrate these structures into their daily life and movement patterns. The evidence indicating that

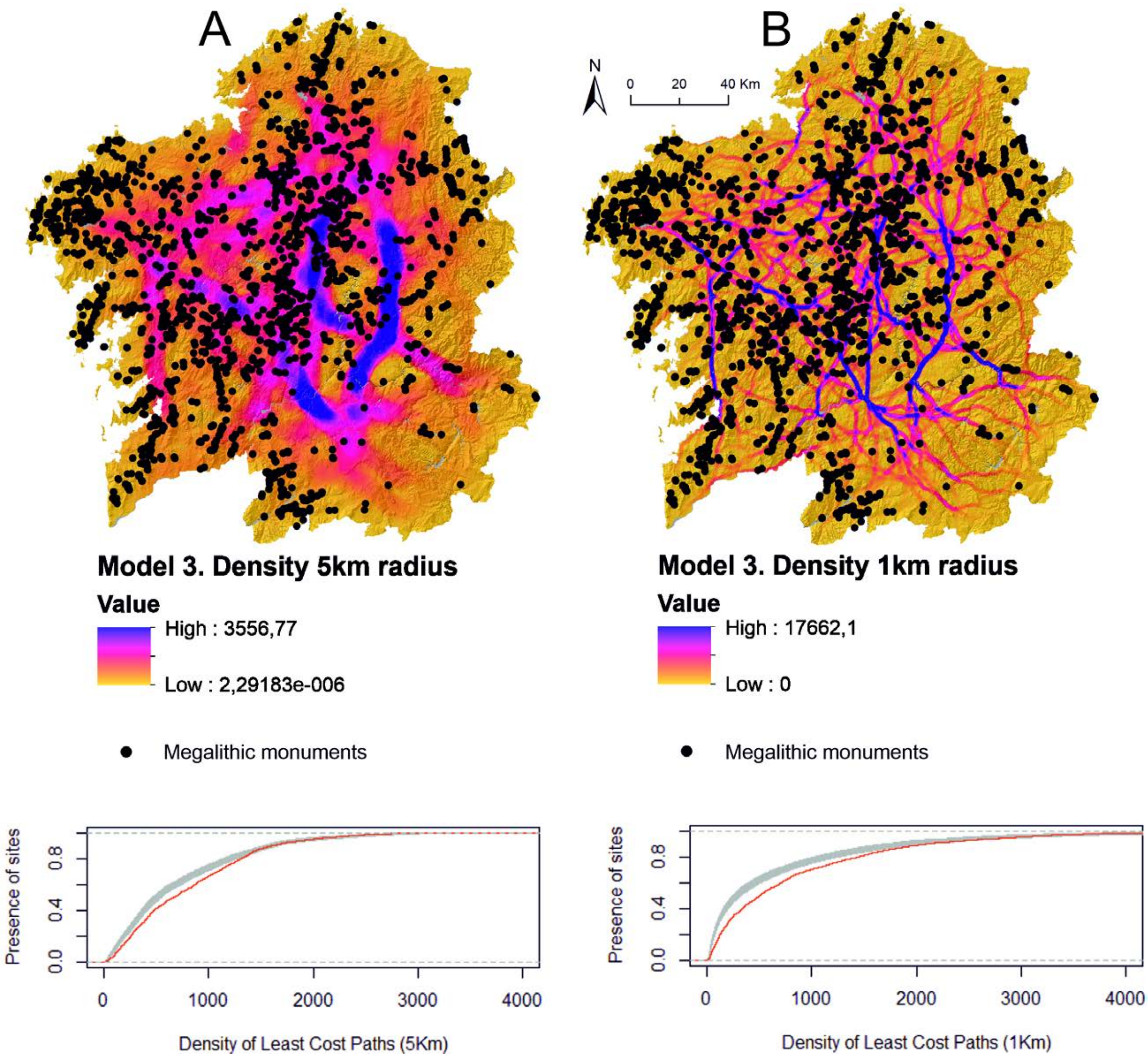

Figure 8. Density of the generated Least-Cost Paths (full network, model 3), and Monte Carlo Simulation for conditional random simulation (results reduced to 4000 cells for visualisation purposes). A: Density calculated with 5km radius; B: Density calculated with 1km radius.

megaliths are located along high-density transit routes implies that these monuments played a vital role in the social landscape, possibly serving as focal points for community gatherings, rituals, and the delineation of territories. This perspective enhances our understanding of megaliths as not just funerary sites but as vital components of a larger social network.

Comparative visibility analyses help reinforcing this idea. The observed tendency for monuments to be located in areas with medium visibility—rather than high visibility—suggests that these structures may not have aimed to visually dominate the landscape. Instead, they may have been intended to serve as more nuanced markers of transit routes, allowing visibility only from specific vantage points or routes, reinforcing their presence to those traversing particular paths rather than the entire region. This finding would suggest a more nuanced visibility framework, where megalithic monuments could be strategically placed to control or demarcate specific areas without necessarily aiming to stand out prominently across the entire landscape, as stated for specific areas (e.g. Carrero-Pazos 2021). This selective placement may have served to reinforce social identities and facilitate the communication between groups, ideas that have been also suggested in regional approaches (see e.g. Eguileta Franco 1999).

All this raise questions about the role of megaliths in cultural memory and the formation of social identities, suggesting that these structures may have acted as social markers (Renfrew 1976), guiding both physical and cultural movement across the landscape. Moreover, the clustering tests, particularly the Kolmogorov-

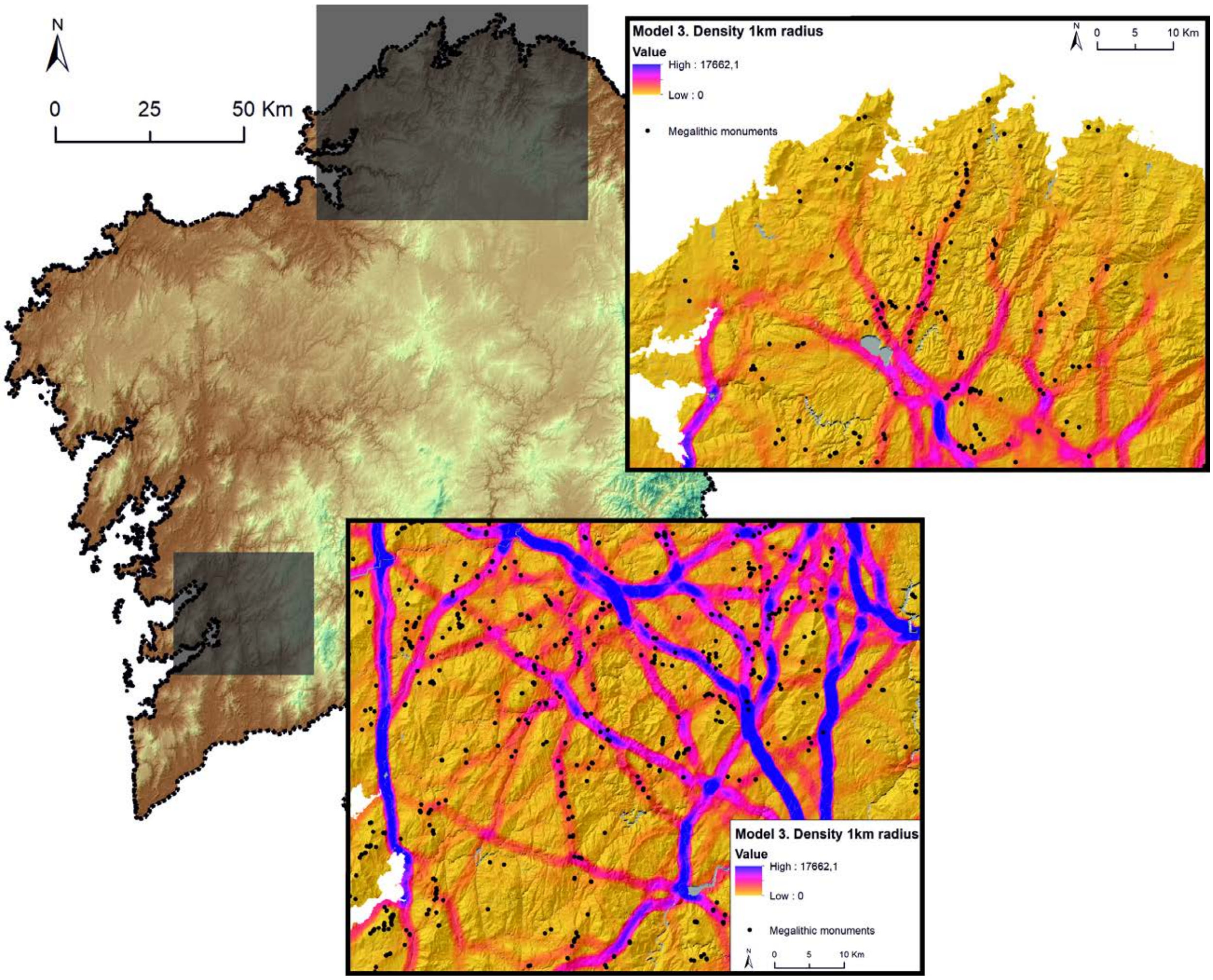

Figure 9. Closer looks to examine the location of megaliths in areas of traffic density.

Smirnov (K-S) and Besag's L-function, confirm the significance of natural transit paths in the spatial distribution of megalithic sites. The K-S test results indicate that the arrangement of megaliths does not match a pattern of complete spatial randomness, while the L-function shows clustering across multiple spatial scales, affirming the durability of this spatial relationship. This result implies a robust connection between the megalithic placement areas and the transit routes, possibly suggesting that the monument construction was influenced by not only accessibility but also by the need to reinforce certain social pathways or boundaries. Such interpretations align with the views of e.g. P. Murrieta-Flores (2012a, b) for similar areas in the south of the Iberian Peninsula, who argue that megalithic monuments often marked significant places in landscapes shaped by the movement.

Conclusions

In historical terms, the megalithic monuments interact with a humanised natural landscape from the moment architecture arises, with natural conditions actively shaping the choices of Neolithic societies, especially in selecting specific sites for tombs. The natural spaces transform into monumental and, consequently, social entities with visual interactions extending to their immediate surroundings. These interactions are linked not only to the tombs themselves but also to mobility across the territory.

While it is widely acknowledged that megalithic monuments had functions beyond funerary purposes, such as marking communal land possession or acting as territorial milestones in Neolithic landscapes, contemporary computational approaches provide an opportunity to revisit these ideas more formally and quantitatively.

This paper has examined the significance of proximity to natural routes as a locational factor for megaliths in Galicia. Similar importance of this locational factor has been observed in other Iberian and European regions (e.g. Andrés Ruperez 1999; Cabras 2018; Carrero-Pazos 2021; López Plaza 2000; Murrieta-Flores 2012a, b; Murrieta-Flores *et al.* 2014). However, this paper, for the first time, quantitatively assesses this relationship with more than 3,000 sites in a region spanning over 30,000km^2. This suggests that the connection of megalithic sites with natural transit through the landscape, whether understood from a local or regional perspective, may be a common feature in broader contexts, such as the Atlantic façade of Europe. The presence of a shared spatial pattern along the Atlantic façade hints at the potential of an overarching cultural strategy across distant regions. The structural similarity of the landscape use in Galicia to patterns observed in other areas, such as the southern part of Iberia, suggests that the megalithic sites may have been part of a larger network of symbolic or territorial markers in the Neolithic. This shared locational strategy could reflect a broader cultural phenomenon where the monument location was something intended to manage not only immediate social territories but also a broader landscape control. Such a perspective opens avenues for future studies to explore this concept of a 'transit-oriented' spatial strategy across the European megalithic landscapes.

This research has enhanced our understanding of megalithic landscapes in the broader Atlantic context and highlights the importance of natural routes in shaping spatial practices in the Neolithic. While further studies are needed to extend these findings, this approach provides a model for quantitatively assessing the relationship between ancient monuments and natural transit networks. The big scope adopted in this paper offers a promising context for researching the underlying social and spatial logics that governed the megalithic placement in prehistoric Europe.

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Supplementary material and replicability

The data used in this paper is available in a *Zenodo* public repository (https://zenodo.org/records/14036933; https://doi.org/10.5281/zenodo.14036933). We emphasise that the data is released under the CC-BY4.0 license, and we are sharing the FETE extracted routes for the models defined in this work in shapefile format. These pedestrian models have significant potential for reuse in other archaeological studies in Galicia. The baseline methodology for FETE is not reproducible in this paper, but it can be accessed through the paper by White and Barber (2012), with additional modifications applied in Crabtree *et al.* (2021) (see https://github.com/dawhite/sfa). We refer the reader to those papers for a detailed explanation of the FETE methodology used here. The code for reproducing the K-S and L tests can also be accessed in the GitHub public repository: https://github.com/dawhite/sfa.

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Chapter 11
Multi-method geophysical survey in megalithic landscapes: case studies from Ireland and Sweden

Stephen Davis, Tony Axelsson, Knut Rassmann and Karl-Göran Sjögren

Abstract

This paper brings together results from surveys across three megalithic landscapes in Europe: The Brú na Bóinne World Heritage Site, Ireland, the island of Rousay and Falbygden, Sweden. In each case a significant window of geomagnetic prospection has been obtained using multi-sensor instruments, with complementary high-resolution topographic survey and, in the case of Brú na Bóinne and Falbygden, smaller windows of complementary GPR data. Minimally-invasive methods (e.g. drilling) have also been used in both Brú na Bóinne and Falbygden.

Despite some similarities in the monumentality of these areas the data from survey campaigns is occasionally strikingly different. This is the result of a range of factors including geological, geomorphology and the differing archaeological trajectories of the areas in question. Both Brú na Bóinne and Rousay are landscapes of enclosure, while this does not appear to be the case at Falbygden. Similarly, some areas of Brú na Bóinne are more complex and most likely more multi-period than is observed in the other locations. The results of GPR-based prospection are compared and contrasted with those from the geomagnetic surveys. This highlights the need for multi-method survey and the application of complementary methodologies.

By exploring these datasets we outline a 'toolkit' approach to large-scale prospection within megalithic landscapes. This not only avoids the need for a 'one size fits all' approach to survey but also highlights potential research trajectories in these places. In particular this speaks to the further potential for survey in megalithic landscapes across Europe and provides an insight into best practice in such analyses.

Introduction

The comparative perspective on the European megalithic tomb phenomenon and on megalithic landscapes presented here is not fundamentally new and has been a core objective of the Megalithic Studies Group since its foundation in Gothenburg in 2004. What is, however, new is the attempt to approach the comparative perspective through joint research by international groups and employing approaches that tend towards 'big data' – large area geophysics and remote sensing surveys. A first step in this direction was the implementation of the Boyne to Brodgar network between researchers based in Ireland and the UK (Sheridan and Cooney 2014). Under this broad scientific umbrella, Irish and British researchers and the Romano-Germanic Commission, Frankfurt (RGK) have been carrying out large-scale prospection in Brú na Bóinne World Heritage Site, Ireland since 2014 and on the Orkney island of Rousay, best known for its dense concentration of megalithic tombs (cf. Davidson and Henshall 1989), since 2018. Also, since 2018, the RGK has participated in a parallel research project into the megalithic landscape of Falbygden at the invitation of Swedish researchers led by Karl-Göran Sjögren. This paper presents some key findings that are the result of ongoing research collaborations between University College Dublin (UCD), the University of Gothenburg and the Romano-Germanic Commission in the internationally significant megalithic landscapes of Brú na Bóinne and Falbygden, Sweden from over a decade of research (Figure 1).

The research questions of these internationally-oriented projects are primarily concerned with the nature and intensity of connections between European megalithic landscapes. This includes the central question of how the megalithic phenomenon developed and distributed, and how megalithic monuments interacted with their landscapes, including with other monument classes (e.g. enclosures; timber monuments). The increased emphasis on large-scale (sometimes termed 'landscape-scale') prospection methods such as geomagnetic prospection, ground penetrating radar, drone-based sensors and other remote sensing platforms (e.g. satellite applications) has opened up a wider view beyond the monuments to their surrounding landscape (e.g. Brend *et al.* 2023; Darvill *et al.* 2012; Davis *et al.* 2013; Gaffney *et al.* 2012, 2018; Megarry and Davis 2013; Ovenden *et al.* 2009).

These expanded and enhanced research perspectives open up opportunities to trace the nature of socio-cultural, ritual and perhaps economic structures in these

Figure 1. Map showing the locations of the two survey areas.

regions through time. Linked to this are considerations as to how new insights into the formation and genesis of the megalithic tomb phenomenon can be gained from the comparison of European megalithic tomb landscapes, based on a view of structural differences and similarities.

The acquisition of reliable empirical data is of fundamental importance for enhancing our understanding of these megalithic landscapes. The joint research undertaken across these different megalithic regions has provided an opportunity to obtain standardised datasets of the same quality and nature in geographically disparate megalithic regions. These large-scale datasets provide an important tool in providing comparative perspectives between regions. The research approaches employed are dynamic, and have been modified with each deployment, triggered by the data obtained and their analysis. The targeted ground penetrating radar and magnetic measurements presented in this paper reflect this process.

The experiences of vehicle-based ground penetrating radar and magnetic measurements of the Swedish-German partners on Falbygden were the starting point for the plans to carry out an identical prospecting design in the Brú na Bóinne WHS. It was advantageous that the measurements were carried out with identical technology by the same people. In the processing, evaluation and interpretation of the data, experience in handling geophysical methods and data as well as many years of archaeological expertise from numerous excavations were combined. The results discussed in the following are not to be regarded as final results, but reflect the current state of knowledge, gained from ongoing research in Brú na Bóinne and Falbygden.

Methods

Magnetometric surveys were carried out in both areas by DAI Frankfurt using their in-house equipment. This consists of a vehicle-mounted 16- and 14-channel magnetometer. Both the 14- and 16-channel magnetometers (SENSYS MAGNETO®-MX ARCH) were manufactured by Sensys GmbH, Bad Saarow, Germany. They are made entirely from fibre-reinforced plastic. Both systems used included FGM-650B tension band fluxgate vertical gradiometers with 650mm sensor separation, a±3000nT measurement range and 0.1nT sensitivity.

The GPR survey was conducted by Gothenburg University using an 8-channel 400MHz MALÅ Imaging Radar Array (MIRA) with 8cm inline and cross-line spacing, pulled by a quadbike. The 8-channel system covers a 64cm-wide swath for each driven track, making this instrument a fairly efficient tool for large-scale surveys. Under favourable conditions it is possible to cover a hectare a day with the setup used here. An RTK GPS (Leica GS18i) was used for data positioning.

In Falbygden, the geophysical methods were supplemented by drone surveys, using a DJI P4 multispectral drone. The P4 records five different spectral bands (Red, Green, Blue, Red Edge, and Near Infrared) which were used to calculate various vegetation indexes reflecting aspects of vegetation health. It uses RTK GPS for exact positioning. Further, public domain aerial photos and satellite images were inspected, although access to high resolution satellite data was limited.

The predictive modelling in Falbygden was carried out in ArcGis Pro using data on megalithic tomb location, hydrography, historic roads and topography, all suggested to be relevant location factors for Danish causewayed enclosures (Klassen 2014).

Historic roads were digitised from the 1880 economic map of Sweden. A distance raster to nearest road was calculated and reclassed into <1km=6, 1-2km = 3 and >2km =1.

Water courses were downloaded from Lantmäteriet and wetlands from the Swedish Geological Survey. Distances from water courses were reclassed into <250m=6, 250-500m=2, 500-1000m=1.5 and >1000m=0.5. Distances from wetlands were reclassed into <500m=7, 500-1000m=2 and >1000m=1.

For topography, a 2m DEM was downloaded from Lantmäteriet. Elevations above 250 masl were masked to exclude the mountain tops. The DEM was classed into ten landforms in Saga GIS, using the Topographical Position Index. The categories mid-slope ridge and local ridge were selected and distances to these landforms calculated and reclassed as 0-50m=7, 50-100m=2, 100-500m=1.

These themes were then combined to produce the final prediction, with higher values indicating higher probability for enclosures being present.

The archaeological landscape of Brú na Bóinne, Ireland

The Archaeological Ensemble of the Bend in the Boyne (Brú na Bóinne) is most frequently characterised as a landscape of middle Neolithic (*c.* 3500-3200 BC) passage tombs: there are between 40-50 such monuments, including some of the largest monuments of their kind in the world – the 'megatombs' of Knowth, Dowth and Newgrange (Eogan 1984; 1986; Eogan and Cleary 2016; O'Kelly 1982; O'Kelly *et al.* 1978). A number of these monuments also include significant quantities of megalithic artwork, generally comprising abstract designs of concentric circles, spirals, lozenges or serpentiform designs (Eogan and Shee-Twohig 2023; O'Sullivan 2006). Although the focus of discussion is usually on these funerary monuments, the Brú na Bóinne landscape is very much a palimpsest (Figure 2). A significant complex of late Neolithic henges and timber monuments has been known for decades (cf. Stout 1991; O'Sullivan *et al.* 2012; Leigh *et al.* 2018; 2019) but has been substantially enhanced in recent years through serendipitous aerial photographic discoveries (Condit and Keegan 2018; Murphy 2019) and a programme of large-scale geomagnetic survey (Rassmann *et al.* 2019; Davis and Rassmann 2021). The organisation of the Brú na Bóinne landscape in the Neolithic has received remarkably little attention, although the development of the passage tomb cemetery and its probable agricultural landscape was explored by Cooney (1999: 29-33). The river clearly plays a very significant role in the development of Brú na Bóinne through prehistory (cf. Lewis *et al.* 2017), especially in the post-passage tomb period.

This is interspersed in some areas by concentrations of ring ditches – later prehistoric funerary monuments – and field systems, some of which have the coaxial form usually associated in British examples with the Bronze Age. Beyond this there is a concentration of early medieval enclosures (*c.* 400-1000 AD), especially occupying the steep scarps overlooking the River Boyne (e.g. Davis *et al.* 2012; Davis and Rassmann, unpublished data). Some of these are very substantial and likely represent very high status trading or craft-working centres (see also Eogan 1991; 2012; Stout and Stout 2018). These are in turn overlain by elements of Cistercian land organisation (the Townland names of Newgrange, Roughgrange and Sheepgrange suggest Cistercian grange farms – Stout 2002; Stout and Stout 2022) and, in some areas both Anglo-Norman (e.g. Byrne *et al.* 2008; Cummins *et al.* 2017) and later C18th demesne landscape plantation (Fenwick 2013). From this very brief summary it is hopefully clear that this is a landscape of immense archaeological complexity and depth, including a genuine diversity of archaeological features.

In 2009 the Heritage Council published the Brú na Bóinne Research Framework (Smyth 2009), a visionary document that provided a blueprint for future research in the World Heritage Site. Among the recommendations of this Framework were the implementation of large scale geophysical surveys, paralleling similar developments in the Stonehenge (e.g. Darvill *et al.* 2012; Gaffney *et al.* 2012, 2018) and Heart of Neolithic Orkney (Ovenden *et al.* 2009; Brend *et al.* 2023) landscapes, and increased use of remote sensing approaches (cf. Davis *et al.* 2013; Megarry and Davis 2013). In part these recommendations led to the collaborative project between UCD School of Archaeology and the Romano-Germanic Commission

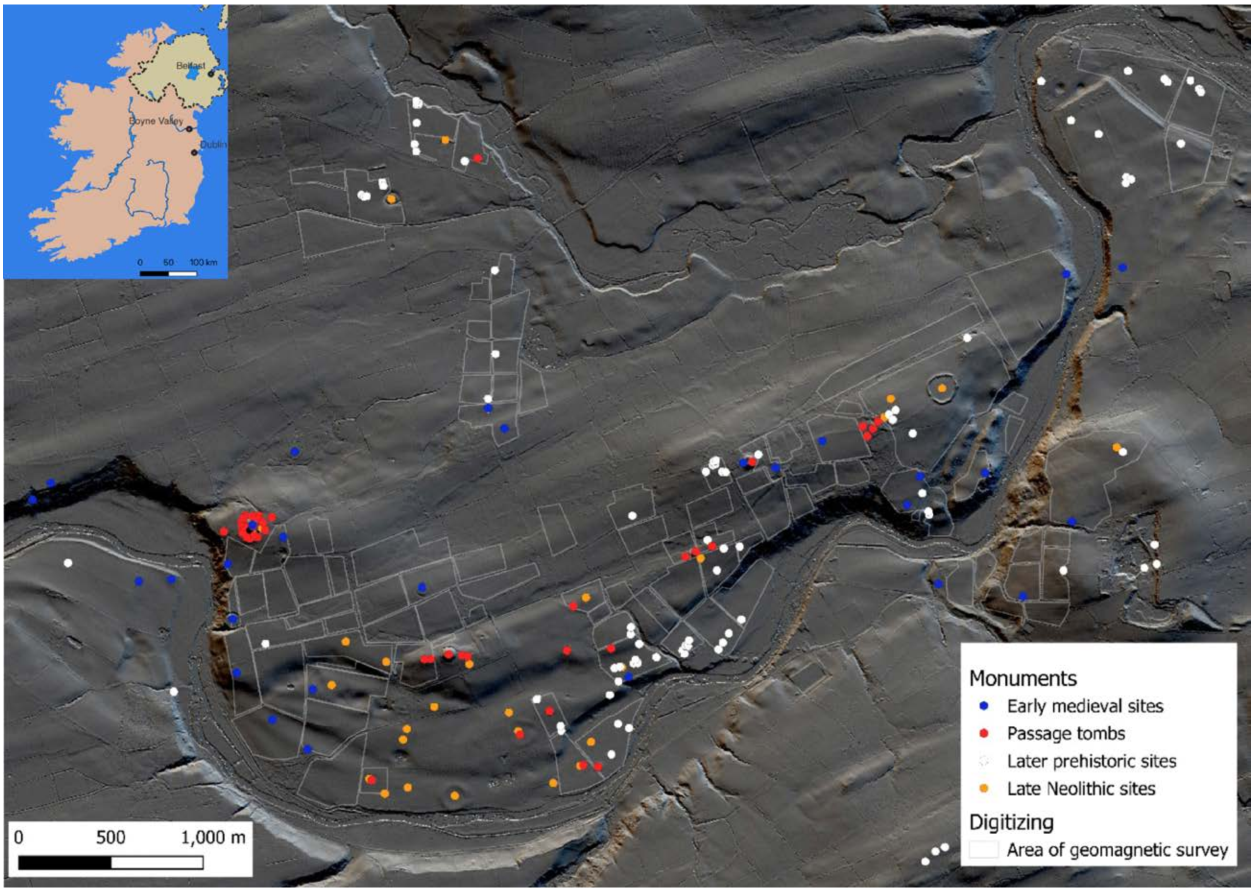

Figure 2. Map of Brú na Bóinne with potential prehistoric archaeological features assignable to period. Early medieval and later landscape features are not plotted.

that has to date collected over 4 km^2 geomagnetic survey data across the Brú na Bóinne landscape (Davis *et al.* 2019; Rassmann *et al.* 2019; Davis and Rassmann 2021), identifying dozens of potential archaeological sites and thousands of geomagnetic anomalies. What has been unclear, however, is how much of the story the geomagnetic survey leaves untold. This led us to explore some of the areas previously addressed with magnetic survey using multi-channel GPR in spring 2023.

Dowth Henge

The large enclosure of Dowth Henge (sometimes known as Site Q – cf. Stout 1991; Figure 3) is one of the largest earthen henge monuments in Ireland. Located approximately 1km ENE of Dowth tumulus, it occupies an unusual position in comparison to other similar monuments in Brú na Bóinne, most of which are found on the floodplain between Newgrange and the river (O'Sullivan *et al.* 2012; Davis and Rassmann 2021). In contrast, Dowth Henge overlooks the river and is located in an elevated position, closely mirroring another large earthen henge at Ballynahatty, Co. Down (Collins 1957; Hartwell 2002; Hartwell *et al.* 2023). Dowth Henge was one of the first monuments surveyed by the collaborative UCD/RGK project, following on from previous surveys by UCD in 2012 (Davis 2013). These identified the presence of both inner and outer ditches and the presence of a central cluster of magnetic anomalies, most likely representing a megalithic structure (Davis 2013; Rassmann *et al.* 2019; Figure 3, top). This again mirrors Ballynahatty, where a simple passage tomb is located centrally within the monument. The presence of two substantial opposing entrances at Dowth Henge has remained controversial, with Stout (1991) suggesting that the NE entrance was secondary and the result of later landscaping.

GPR survey both outside and within the henge has significantly enhanced and altered our understanding of this monument and its development through time. The central possible megalithic structure is very clearly visible as a radar-dense layer – possibly a denuded cairn (Figure 4, bottom). This has clearly been cut by a narrow northwest-southeast trench and also possesses a central void, directly aligned with the opposing entrances and the axis of symmetry of the enclosure itself. To the northeast and abutting the north-eastern entrance another radar-dense area is visible (Figure 5). This is at greater depth and appears to have been partially cut by the ditch of the henge. While the magnetic survey suggested the north-eastern entrance to be an original feature, the terminals of the inner ditch of the henge are very clearly visible in the GPR survey, suggesting a

Figure 3. Dowth Henge, looking northeast. Image courtesy of Ken Williams.

very narrow original entrance to this direction, perhaps narrower than the south-western entrance. Strikingly, both internal and external to the henge, a large-scale programme of drainage seems to have been implemented at some point in the post-medieval period. This has involved the insertion of a large, linteled drain into the outer ditch (which was presumably visible at the point in time that the drain was inserted) and a 'herringbone' drainage pattern within the henge itself, one branch of which corresponds with the aforementioned northwest-southeast cut in the megalithic structure noted above (Figures 4 and 5).

As a point of comparison, while the geomagnetic survey allowed us to identify specific anomalies within the megalithic structure (Stone sockets? Postholes?) it failed to identify the cairn or the central 'chamber', both of which are clearly visible in the GPR survey. Likewise, while the north-eastern entrance to the henge was clearly visible in the magnetic data, the ditch terminals themselves remained unclear. This is not the case with the GPR, which also identified a second potential megalithic structure. Most strikingly the drainage patterns, so clear in the GPR survey, were invisible within the geomagnetic data. Presumably these were dug and refilled in quite short order and so provide no magnetic contrast for detection, while it seems likely that the stone-linteled structure of these offers excellent contrast in the radar data.

Newgrange Site NG26

In 2017 a large circular enclosure was identified less than 300m to the west of Newgrange (Figure 6). Typologically this appeared to belong to the complex of four-post structures that have been identified between Knowth and Newgrange – a group of sites which have associations with Grooved Ware pottery and the immediate post-passage tomb period in the middle third millennium BC (Carlin 2017; Davis and Rassmann 2021; Eogan and Roche 1994; Hartwell 2002; Smyth 2014). The exact nature and purpose of these

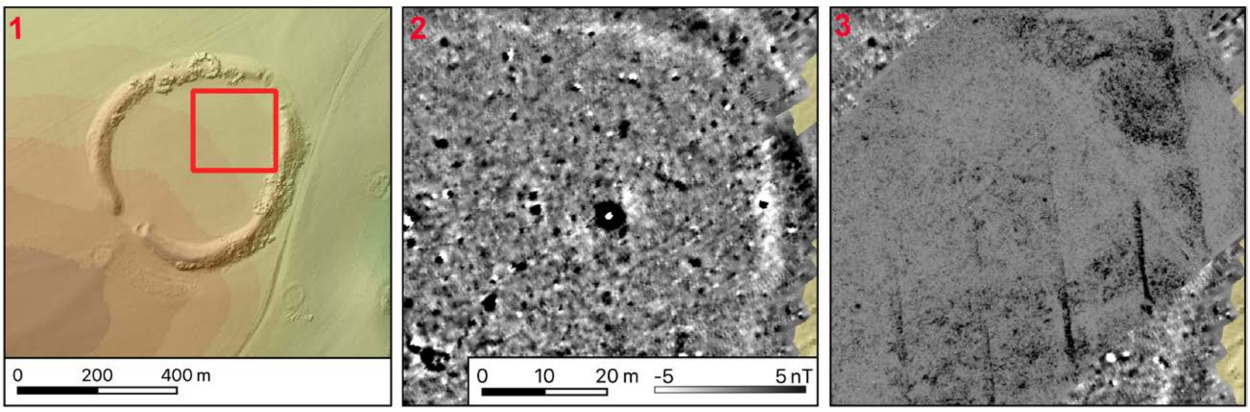

Figure 4. Geomagnetic data and GPR, Dowth Henge NE entrance. 1) Overview Dowth Henge. 2) Geomagnetic ramp ±4 nT. 3) GPR depth slice 92cm with clear drainage patterns visible as an approximately N-S trend.

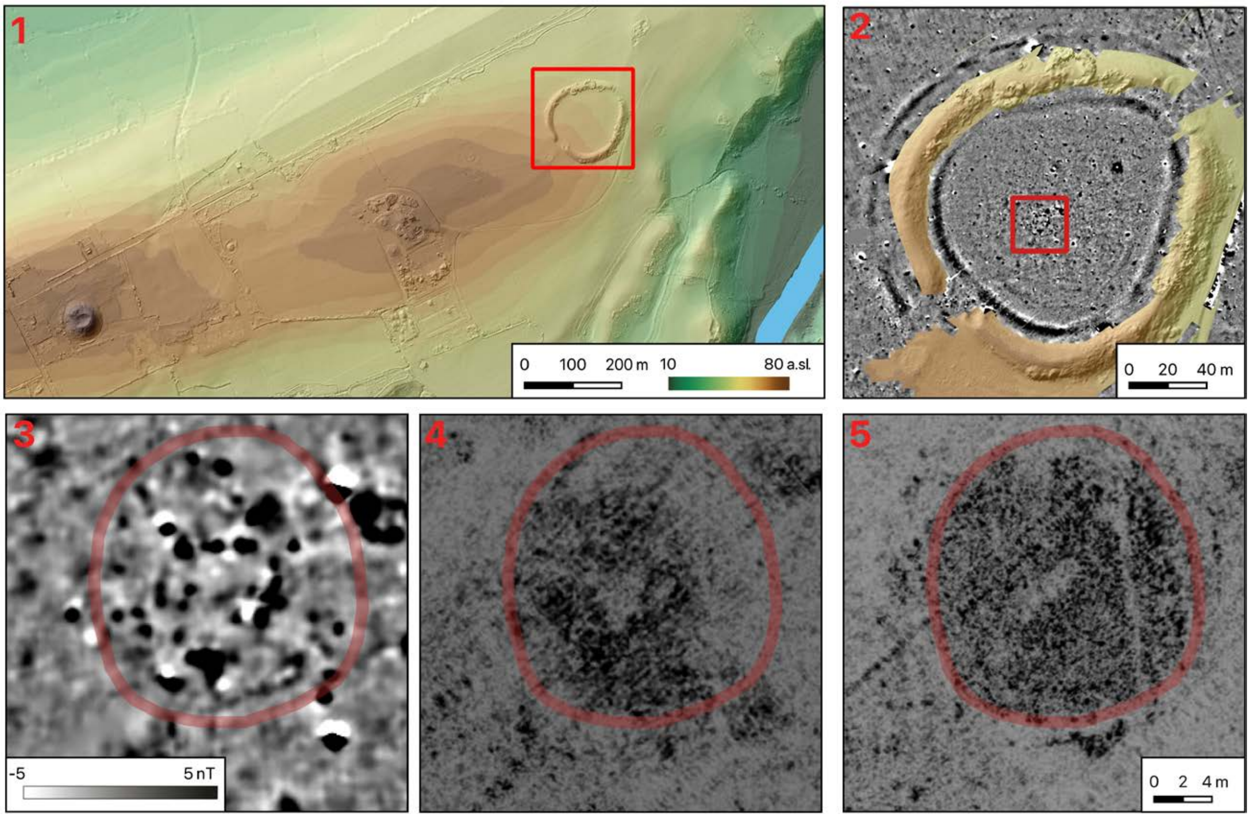

Figure 5. Dowth Henge. 1) Overview with DEM based on Lidar scan with Dowth Henge, the great passage tomb of Dowth and in the center, Dowth castle. 2) Magnetic Map of Dowth Henge. 3) Magnetic Map of the remains of a destroyed passage grave inside the Dowth Henge. 4) GPR data of the same at a depth of *c.* 0.5m. 5) GPR data of the same at a depth of *c.* 1.0m.

sites remains enigmatic: Hartwell (2002) suggested they might have served some sort of mortuary function, but in design they clearly have connections to domestic architecture. The Newgrange site (given the unique identifier NG26) is by some distance the largest and most complex site of its kind identified so far. Geomagnetically the site appears to comprise a circular enclosure or possibly palisade, 47 m diameter, within which were traces of at least two further post circles, visible only to the southeast. This is likely to be related to patterns of structured deposition within the site itself – in the excavated example at Knowth, Co. Meath (Eogan and Roche 1994) there is an emphasis on the deposition of burned material within post-holes towards the site entrance. The central portion of NG26 comprises a double row of strong magnetic anomalies, aligned northwest-southeast with a pair of discrete anomalies located to the northwest defining an axis of symmetry within the site. This alignment (towards the SE) appears to correspond with the winter solstice sunrise – effectively making this site a timber parallel to the tumulus of Newgrange itself.

The challenge for the GPR survey here is that the anomalies being investigated comprise not concentrations of dense material but cut features – post-holes – where, even if the fill contains a larger proportion of stone or burned material this does not supply enough physical differentiation for the features to appear as reflective anomalies. This means that, in contrast to the situation at Dowth where some features were very clear in the radar survey, at Newgrange interpretation is significantly more difficult. On a positive note the radar survey clearly delimits two rings of large pits or post-holes which run for a full circuit (Figure 6), demonstrating that the magnetic enhancement to the southeast highlights only part of two entire post rings. This is likely to be the case in other similar sites within Brú na Bóinne where double post rings are hinted at in geomagnetic surveys but the outer ring is usually largely invisible (cf. Davis and Rassmann 2021). The central and highly magnetic 'passage' is, however, not visible in the GPR data, although a central large rectangular feature with a reflective edge was observed (perhaps a stone-defined hearth) in upper depth slices (Figure 6, top) and a potential dense sub-circular core in lower slices (Figure 6, bottom).

Donore Hill

At Donore Hill, south of the River Boyne survey targeted three areas prior to limited excavation in July 2023. These comprised a small enclosure at the summit of the hill that surrounds a greywacke standing

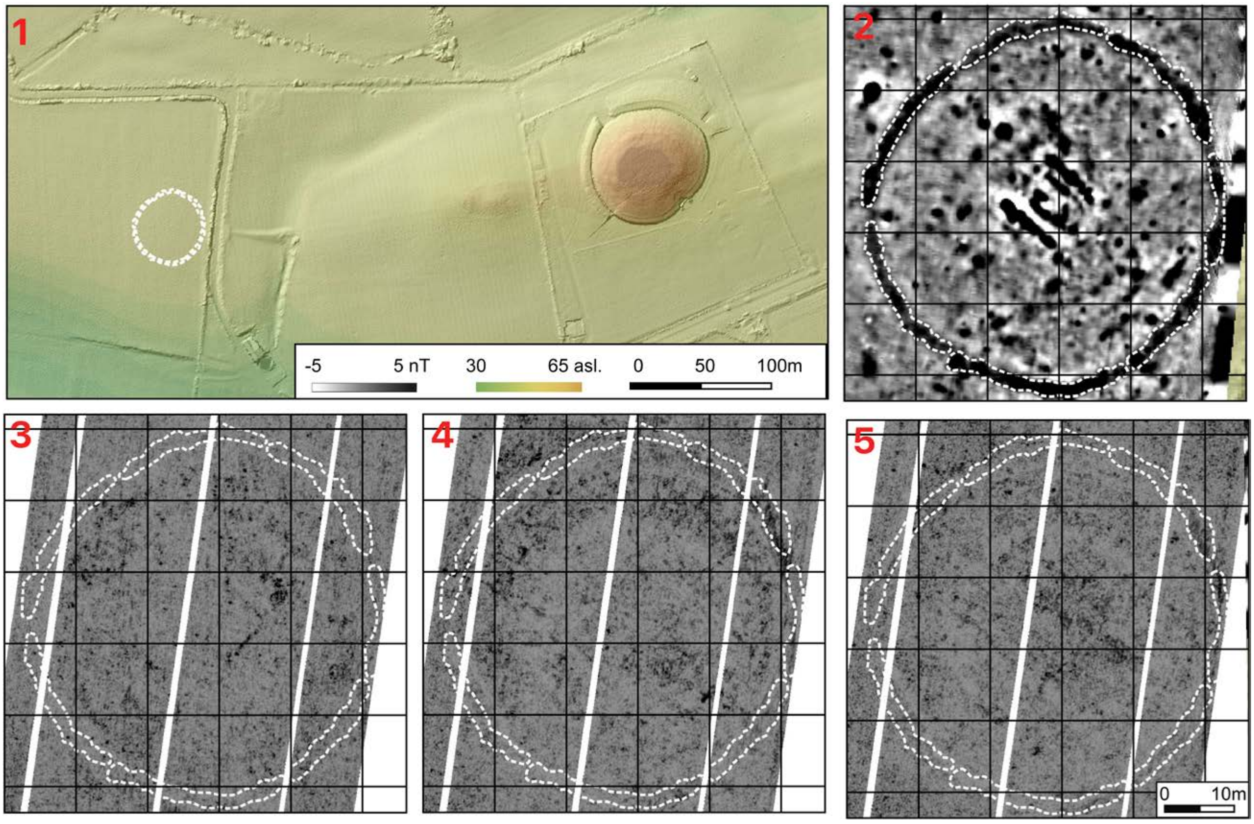

Figure 6. Newgrange Monument NG 16. 1) Overview with DEM based on Lidarscan with NG16 and the great passage tomb. 2) Magnetic map of NIG 16 (-5/+5 nT). 3) GPR map depth 0.39m. 4) GPR map depth 0.70m. 5) GPR map depth 0.86m.

stone – perhaps part of a former megalith, an adjacent post row and part of a large irregular enclosure to the south – possibly an early Neolithic causewayed enclosure. All of these features demonstrate strong responses in the geomagnetic survey. Of the three, the standing stone enclosure (OLD16) is somewhat confused, most likely owing to later impacts; however, the other two sites are very clearly defined. The post row (OLD12) runs for a minimum of 45m SE-NW and comprises a series of large, magnetic anomalies between 1.2-1.5m apart with *c.* 3.4m between rows, terminating in a hairpin loop to the NW (Figure 7, top). Beyond the inner larger anomalies are a series of much weaker anomalies defining an approximately rectangular area measuring 45 x 10.5m. This is one of several post-rows within the Brú na Bóinne area (Davis and Rassmann 2021; Leigh *et al.* 2018; 2019; Stout *et al.* in press) and most closely resembles a site excavated at Ballingowan in Co. Kerry (Moloney 2013) that was hypothesised to be of early Bronze Age date.

At a distance of 650m southwest of here, a very large hilltop enclosure was identified in the geomagnetic survey (STA2; Figure 8). This comprises at least two irregular causewayed ditches and is flattened slightly to the north. The approximate original dimensions of the enclosure are 285 × 223m with its long axis running NW-SE. The exact nature of this monument remains unclear; however, the geomagnetic signature bears significant similarities to the causewayed enclosure partially excavated at Hughestown, Co. Wicklow and dating to the mid-4th millennium BC (O'Brien and O'Driscoll 2017).

In two of these three areas the GPR survey proved disappointingly uninformative (Figure 7, bottom). While the ditch at OLD16 was equally visible in both the GPR and geomagnetic survey, both the post row and causewayed enclosure are very poorly defined by GPR. At OLD12 there it is virtually impossible to pick out any variation in reflectance as part of the GPR survey. Similarly, while hints of features are visible at the enclosure of STA2 these are very difficult to fully define, and certainly less well-defined than in the geomagnetic data. Test excavations at one of the probable post holes of OLD12 demonstrated that the features are large (*c.* 1.5 × 1m), deep (*c.* 1.5m) and have charcoal-rich fills, clearly archaeological in nature. Likewise, at STA2 excavations revealed a broad ditch, although archaeologically quite sterile in nature beyond a limited lithic assemblage and a small quantity of charcoal.

Discussion

It is apparent that the combination of geomagnetic and GPR survey represents a powerful methodological

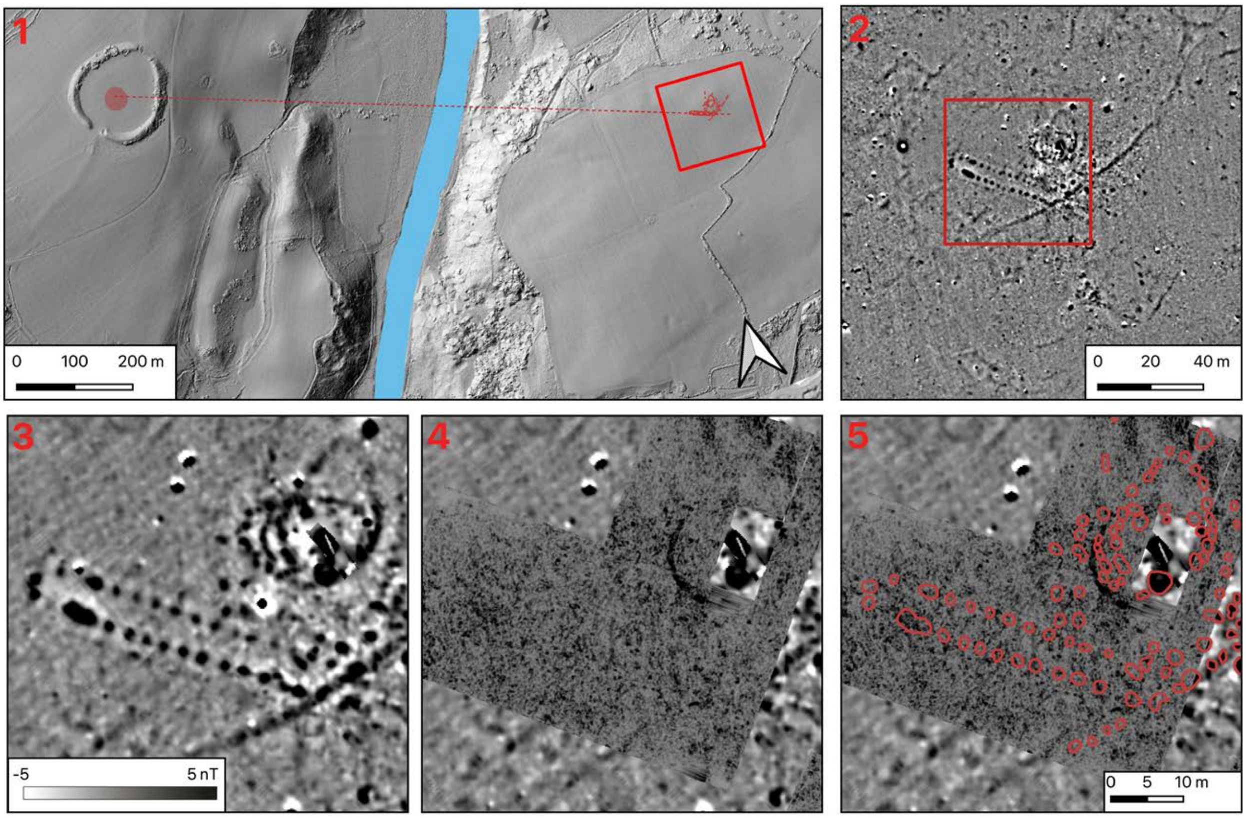

Figure 7. Donore Hill. 1) Overview with Lidar scan with Dowth Henge and the Donore Hill. A red dotted line runs exactly through the center of the parallel postholes and ends at the remains of a destroyed passage tomb inside Dowth Henge. 2) Magnetic map of the Donore Hill. 3) Magnetic Map of the posthole and pits. 4) GPR data of the same at a depth of *c.* 0.6m. 5) GPR date and the in red enlightened post holes and pits.

Figure 8. Excavated anomaly at Donore pit row (OLD12). Image courtesy DigVentures.

approach within the Brú na Bóinne landscape; however, the methods do not always represent equal partners.

It seems likely that the main limiting factor within Brú na Bóinne is the bedrock geology (Figure 9). The main area of Brú na Bóinne south of Newgrange comprises shales, sandstones and limestones of the Walshestown Formation. To the north of Newgrange this transitions to coarse sandstones of the Balrickard formation with a further transition to micrites, calcarenites and shales of the Loughshinny Formation further north again. Dowth Henge and NG26 are both located in areas of Balrickard formation At Donore, the sites investigated belong to the Donore formation of shale, sandstone and limestone (Cózar and Someville 2020; 'Donore Shales' – Somerville and Waters 2012;). In excavation it was clear that the shales at Donore are extremely soft and friable – in fact they are softer than the overlying clay-rich redeposited subsoil. It is likely that these redeposited subsoils are responsible for significant loss of signal and may be masking archaeological features that would otherwise be visible. At Newgrange and especially Dowth this masking appears to be absent, suggesting it is related to the parent material of the subsoil itself.

Falbygden

The area of Falbygden in western Sweden is well suited to studies of Neolithic landscape organization, as well as questions of economy and social structure. The landscape is topographically and geologically clearly structured and demarcated from the surroundings by an isolated formation of sedimentary Cambro-Silurian rocks, surrounded by Precambrian gneisses and other volcanic rocks. The sedimentary bedrock is covered by moraine deposits of variable thickness, containing a mix of local material and ice-transported Precambrian

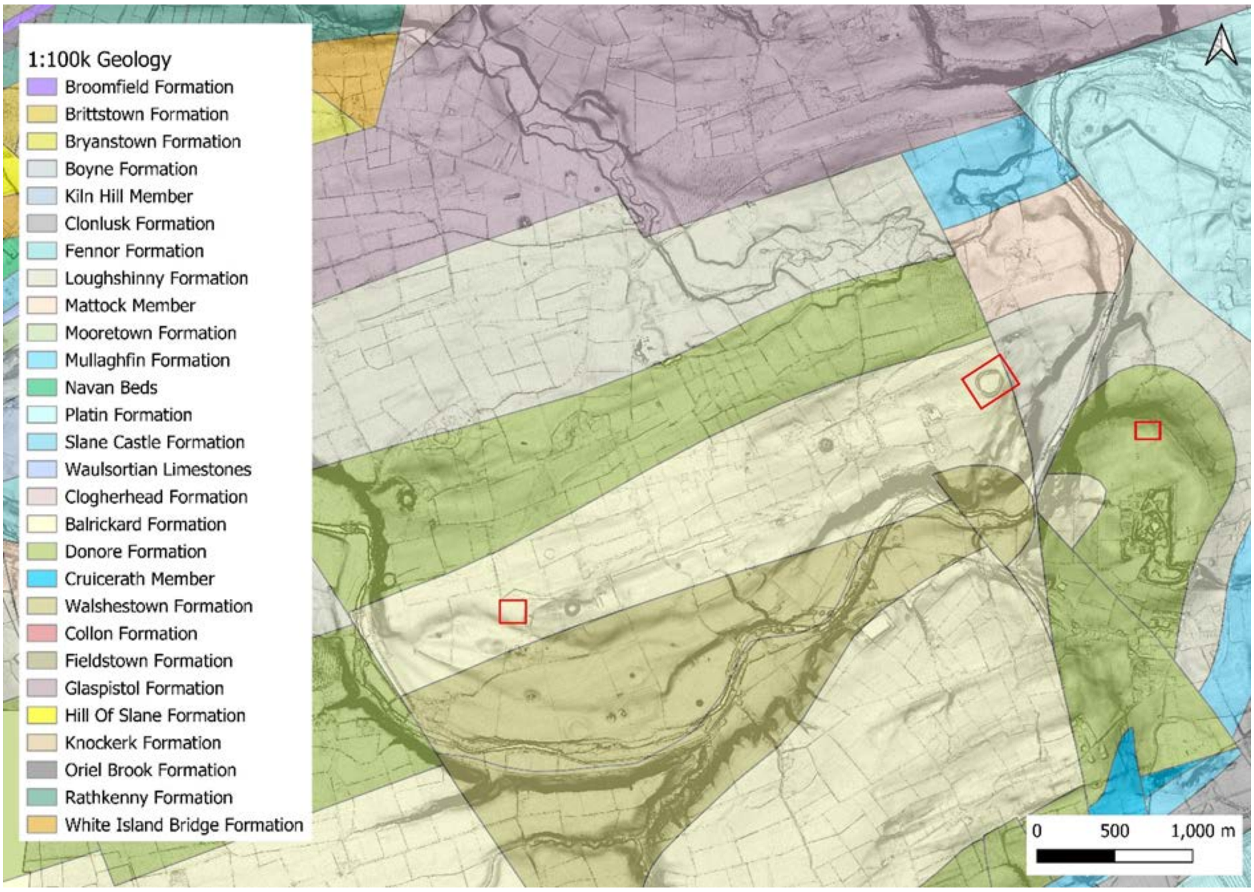

Figure 9. Brú na Bóinne 1:100.000 bedrock geology
(Data: Geological Survey of Ireland); sites in text marked.

material (Påsse and Pile 2016). Human and animal bones are well preserved due to the calcareous soils. The area contains a remarkable concentration of at least 255 passage graves and nine to ten dolmens from the Funnel Beaker period, and at least 135 late Neolithic gallery graves.

Since 1985, several projects have been carried out in the area, centred on the megalithic tombs and Funnel Beaker settlements in the region. In the 1980's and 1990's the project 'The passage graves in Västergötland and their background' excavated several passage graves (Persson and Sjögren 2001). Within the project 'Coast to Coast', material from earlier work was analysed and interpreted (Sjögren 2003). Another project, 'Anonymous Ancestors?' (2006-2009) aimed at analysing the human bone material and the burial practices at the Frälsegården passage grave (Ahlström 2009; Sjögren 2008, 2015). Since 2012, new investigations of Neolithic settlements in Karleby have been carried out, with the project 'Neolithic Lifeways' aimed at analyzing the results from this fieldwork. This work has revealed a wealth of information regarding dating, burial practices, settlements, subsistence, genetics, landscape structure, and vegetation (Ahlström 2009; Axelsson 2010; Axelsson 2013; Blank *et al.* 2020; Seersholm *et al.* in press; Persson and Sjögren 2001; Sjögren 2003; 2008, 2015, 2017; Sjögren *et al.* 2019; Sjögren *et al.* 2021; Sjögren *et al.* 2023).

Previous studies suggest that the Neolithic landscape was highly structured, with settlements and megalithic tombs defining separate spaces, most probably linked to an established cultural landscape; in some ways this echoes some of the spatial partitioning evident at Brú na Bóinne, although settlements are poorly-defined within the Irish site. Tombs form linear or rounded clusters, perhaps corresponding to settlement clusters and social subgroups. On a higher spatial level, a centre-periphery structure is suggested, with larger and more monumental tombs in the central area. Links between spatial subgroups may be suggested from pottery decorations and tomb orientations, indicating that social and spatial proximity do not correspond, but that related social groups may be found at some distance from each other, with neighbouring subgroups belonging to other social groups (e.g. clans, lineages etc.). Further, strontium isotope studies suggest that the Falbygden population was involved in a wider network covering large parts of western Sweden, through which people and animals (particularly cattle) were exchanged (Sjögren *et al.* 2009; Sjögren *et al.* 2023; Sjögren and Price 2012).

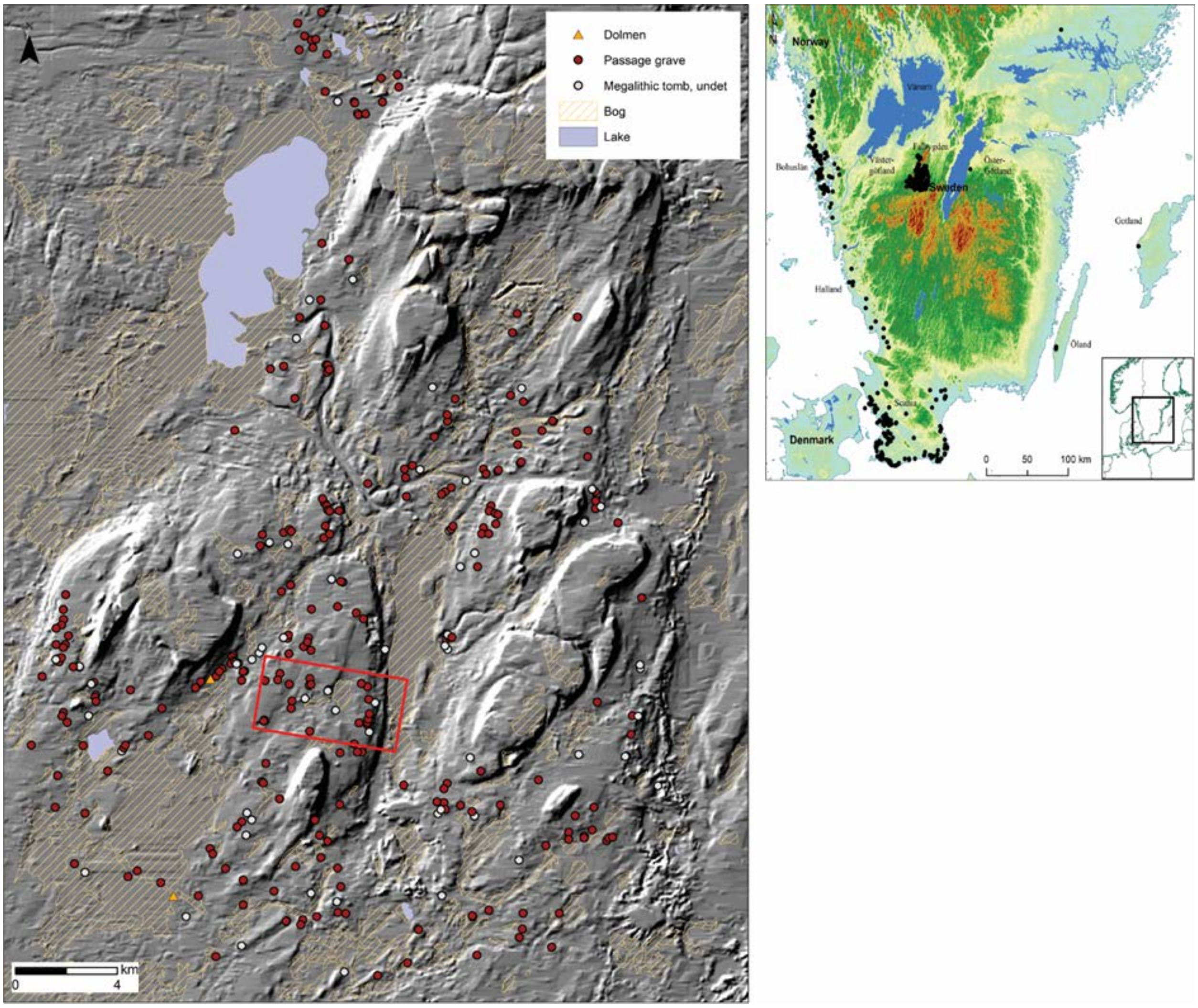

Figure 10. Falbygden with megalithic tombs. The central survey area is marked with a red rectangle.

Some elements of the landscape are missing, however, such as the large ceremonial enclosures known from other Funnel Beaker regions. In the ongoing Hidden landscapes project the aim has been to locate Neolithic enclosures using a combination of methods, including drone, aerial and satellite images, geophysical prospection, GIS modelling and archaeological fieldwork. In total 8 square kilometres have been surveyed by magnetometer (Figure 10) and 5 square kilometres by multispectral drone (Figure 11). In addition, smaller areas have been investigated with ground penetrating radar.

The project can be divided into two main phases. In the first phase, prospection aimed at covering a large and as far as possible contiguous area, including different landscape niches and with differing relations to known neolithic monuments. The aim was to cover all different parts of the landscape, without consideration to previous knowledge about the location of neolithic enclosures, from the bottom of the Åsle valley, through the village of Karleby with its monumental passage graves, and westwards over the limestone plateau towards Falköping town. In a second phase, predictive modelling of probable enclosure locations was made, based on our knowledge of Danish and north German enclosure sites from the TRB period. The predicted areas were then targeted for geophysical and drone survey.

The limestone plain west of Karleby village

In the central part of Falbygden is Karleby parish, an area that has been in focus for many archaeological studies and excavations. In Karleby there are 13 passage graves and many settlements from the TRB period (Axelsson 2010; Sjögren 2003).

In the Karleby area the magnetometer showed a variety of indications (Figure 12), such as old field boundaries, roads, drainage systems etc. Most of these were late historical features. Certain natural features were also clearly visible, such as water courses or bedrock fissures. The fields were also surveyed by multispectral

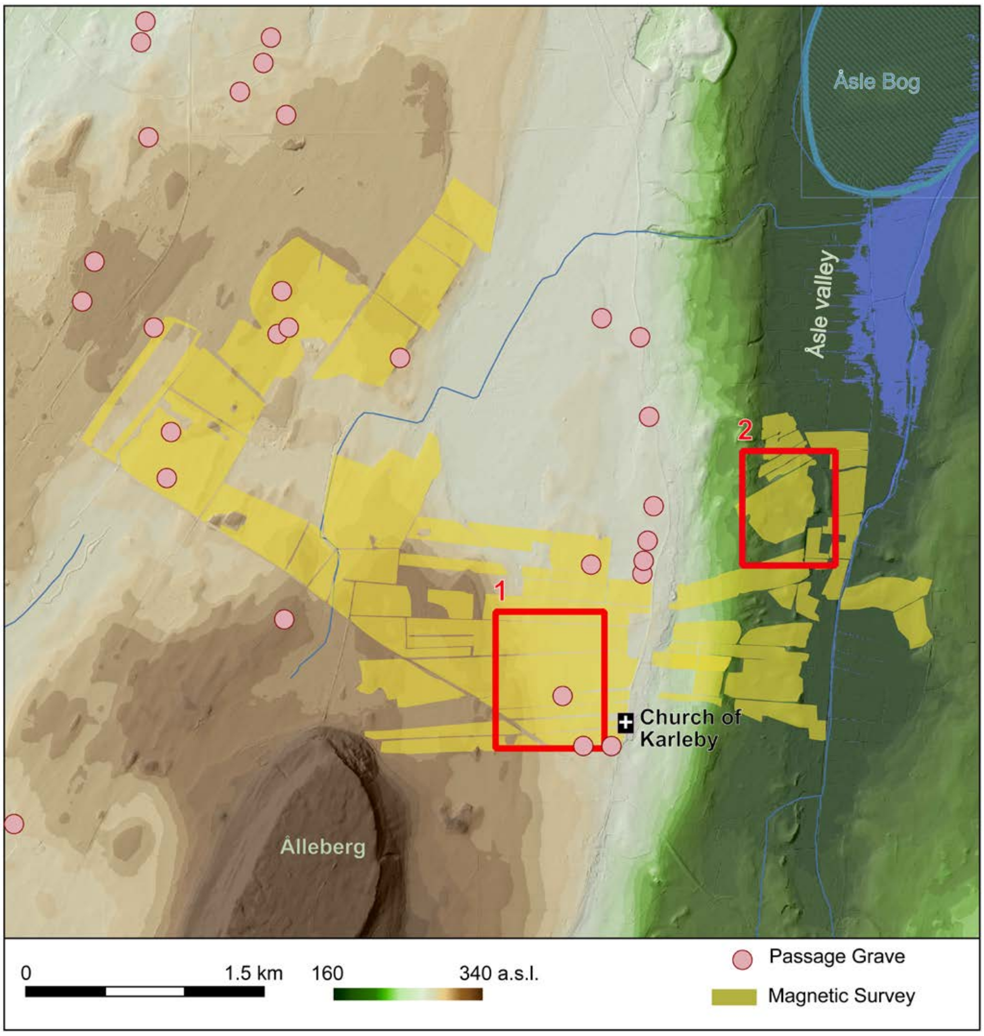

Figure 11. The area surveyed by magnetometer in Karleby. Marked by red numbers: 1) Surveyed area west of Karleby (see Figures 12-14). 2) Surveyed area Tjurhagen, east of Karleby, see Figure 15.

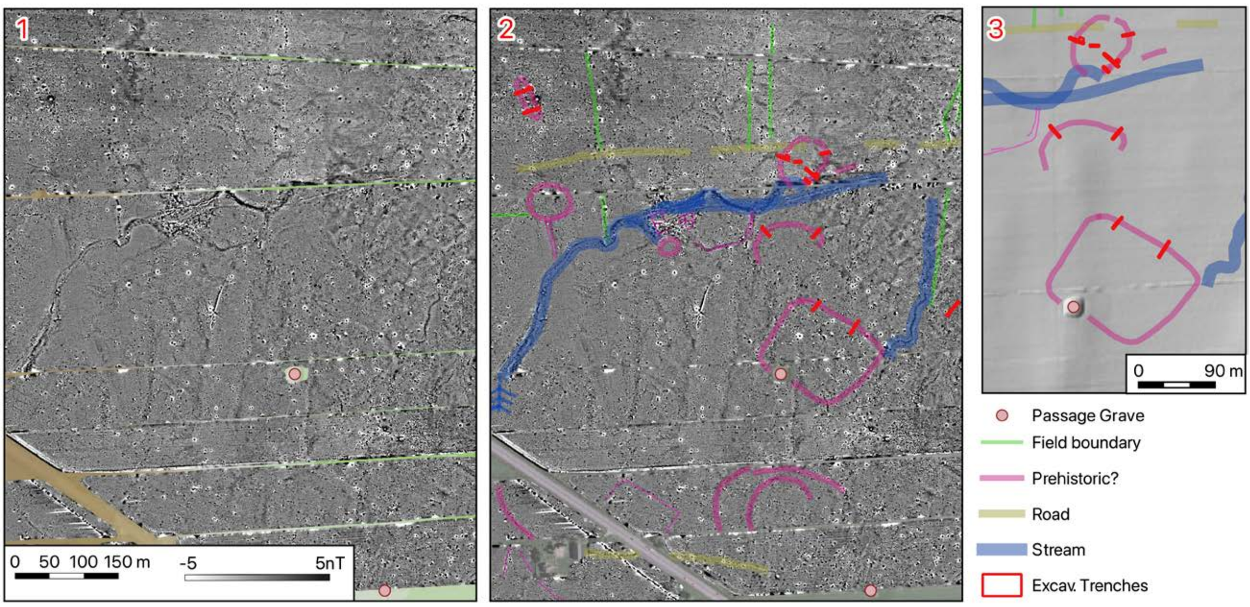

Figure 12. Indications from the magnetometer survey in the area west of Karleby. 1) Magnetic map. 2) Interpretation and location of excavation tenches. 3) Hillshade with interpretation.

drone on repeated occasions. These showed in many cases the same indications, with some deviations. A few of the indications were classified as possible traces of prehistoric features. A selection of these potential sites were targeted for GPR survey and later also for archaeological excavation.

High-resolution GPR survey was carried out over limited areas. In some cases, this detected the same features as the magnetometer survey, while in other cases it picked up indications that were not visible in the magnetic data. One example is the field boundaries from the late 18th century, recorded on historic maps. These boundaries were barely visible in the trenches, but were visible in the survey owing to a subtle difference in material compared to the surrounding material. Probably, these boundaries once were shallow ditches, and their basal fills have become sorted by water.

The difference between the results from the magnetometer and the GPR, however small in these cases, shows the value of combining the two methods. One obvious and significant limitation of the GPR equipment used here, is that it is impossible to cover such large areas as the magnetometer can in reasonable time. Five indications were selected for test excavation based on what was visible in the magnetic data and/or the multispectral images and/or in the GPR data. The results were, however, negative from an archaeological standpoint.

In Figure 12, three of the formations targeted are visible. The rectangle in the south measured 140 × 120m and was clearly visible by all three methods employed (Figure 13). It enclosed one of the passage graves in the area. The GPR data was interpreted as representing ditches; however, the excavation only revealed glacial formations consisting of sorted sand and gravel layers, suggesting sedimentation in water. Glacial tectonics (ice front pressure) had probably led to folding of the layers, as they were found standing at steep angles. These geological contrasts had an effect on the crops in the field, and they showed up as crop marks. The geophysical surveys likely also picked up the distinctions between the gravel and sand layers. The semi-circular feature in the middle had similar stratigraphic layers and was given the same interpretation.

The formation to the north had a different explanation. It was visible as a 70 × 50m large oval in the magnetic data but was not visible in multispectral or GPR data (Figure 14). This lack of signal was explained by the unusually thick colluvial deposits, extending to a depth of almost 1.5m in the area of the oval. In the centre, however, the plough soil was only *c*. 0.2m thick. Clearly, agricultural activity had substantially changed and levelled the topography, which is now almost flat. The length of the oval thus followed the edge of what was once a small rounded hill. Beneath the colluvial deposits were thin sedimentary layers of sand and gravel, deposited in water, and with small frost wedges. This indicates the presence of a small late glacial ice lake, and the magnetometer signal can be interpreted as coming from a shoreline formation with iron oxidation in gravelly layers.

Predicted areas in the Åsle valley

Another area of interest was located east of Karleby at the bottom of the Åsle valley. This area was surveyed in the second phase of the project, selected after predictive modelling. The area is a prominent ridge, formed by glacio-fluvial sand and gravel, stretching out into what today is the Åsle bog. In the Neolithic, it was likely surrounded by marshes and semi-open water. Just south of the ridge, a thin-butted flint axe was found during peat digging in 1934 (Falbygdens Museum 515).

Here the magnetometer picked up several linear indications running across the top of the ridge (Figure 15). These were also visible in GPR data as well as aerial photography. Our hypothesis was that they indicated ditch systems, possibly Neolithic. Archaeological test trenches revealed a very different situation, however. Instead of ditches, they again showed sedimentary layers of sorted sand and gravel standing at steep angles, sometimes almost vertical. After discussion with a geologist, we arrived at the conclusion that the layers had been formed by glacio-fluvial tectonic processes. In other words, a glacial river had deposited sorted sand and gravel layers, which had been compressed and folded by pressure from a temporarily advancing ice front. In summary, we can say that the geophysical indications were confirmed, but that our interpretation of these results was wrong.

Between the two outer linear features there is a lighter (i.e. less magnetic) indication running parallel to them. This proved to coincide with a shallow depression in which TRB pottery and worked flints were found, likely from a settlement that had otherwise been destroyed by ploughing. Several trenches were excavated to locate features and delimit the layer. It can be concluded that on top of the ridge, the layer was removed by agricultural activities and moved down the slopes. The find area partly coincides with a shallow depression as well as with the magnetic anomaly. This depression is, however, not visible in the two trenches further to the south. The cause of the magnetic indication is therefore not clear.

Discussion

We have carried out large-scale geophysical and remote sensing prospection of strategic parts of the Falbygden landscape, covering 8km^2 and different landscape niches. The most convincing indications of enclosures or other Neolithic monuments were tested by GPR survey and archaeological excavation. In spite of this large-scale prospection, none of the suspected enclosures could be substantiated. In most cases, the tested indications could instead be explained as late glacial ice-lake shoreline formations

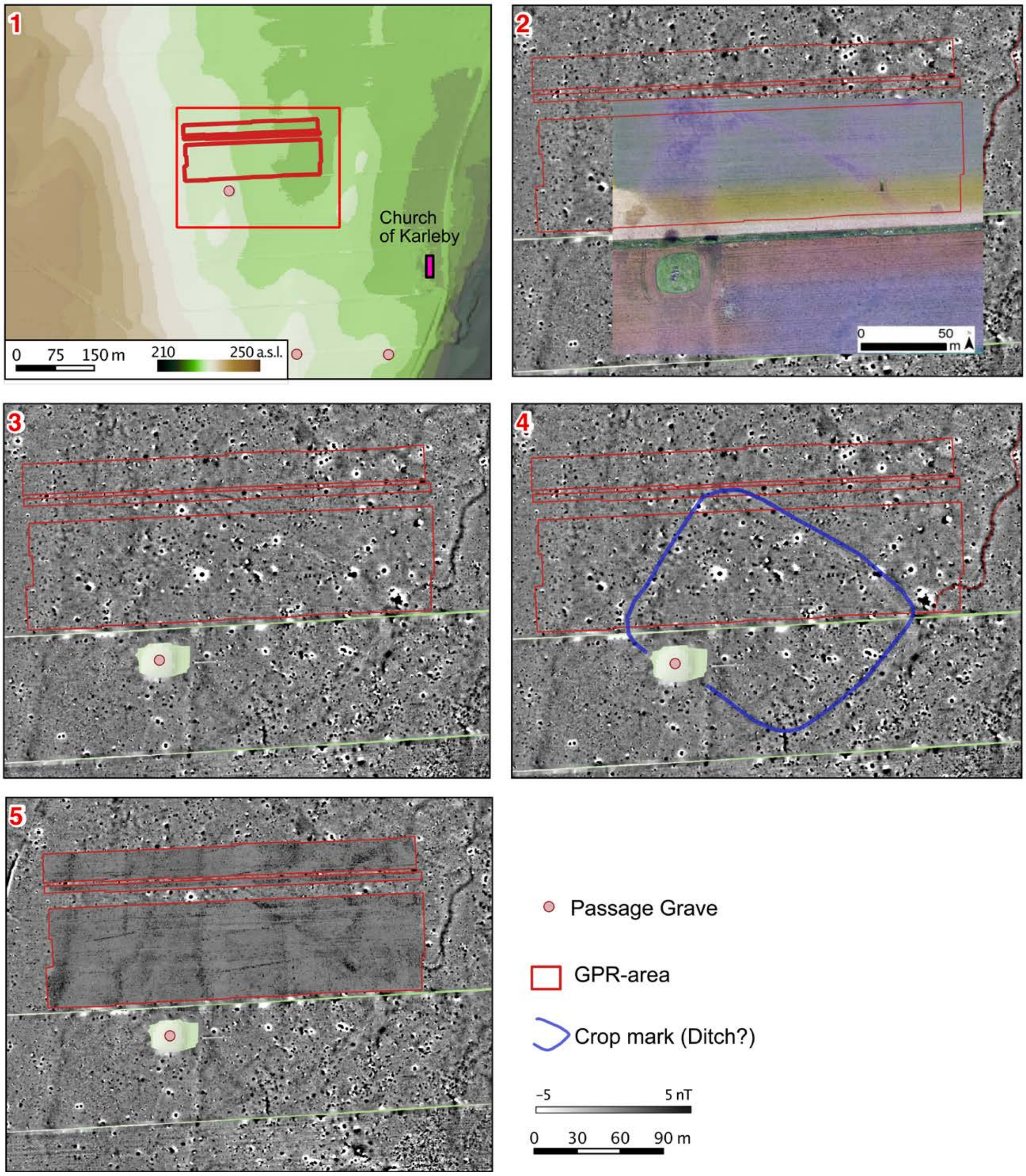

Figure 13. The rectangular structure west of Karleby. 1) Overview. 2) Drone RGB photo.
3) Magnetic map. 4) Course of the rectangular structure. 5) GPR-data.

or by glacio-fluvial tectonic processes. In one case, a cropmark resembling a long barrow or long dolmen turned out to be historic in origin. The main result of our Falbygden prospection project is, therefore, — so far — negative. We can not confirm at present the presence of Neolithic enclosures in Falbygden, and in view of the large area that has been surveyed, we believe that they most likely do not exist in this area.

This conclusion must, however, be qualified. Firstly, the interpretation of magnetometric data turned out to be challenging owing to the noisy character of the data. This problem arises from the presence of magnetic stone material within the moraines in the area, emitting strong magnetic signals that tend to mask the finer nuances related to archaeological features. Various filter techniques were tested to deal with this problem, but this remains a largely unsolved issue. It

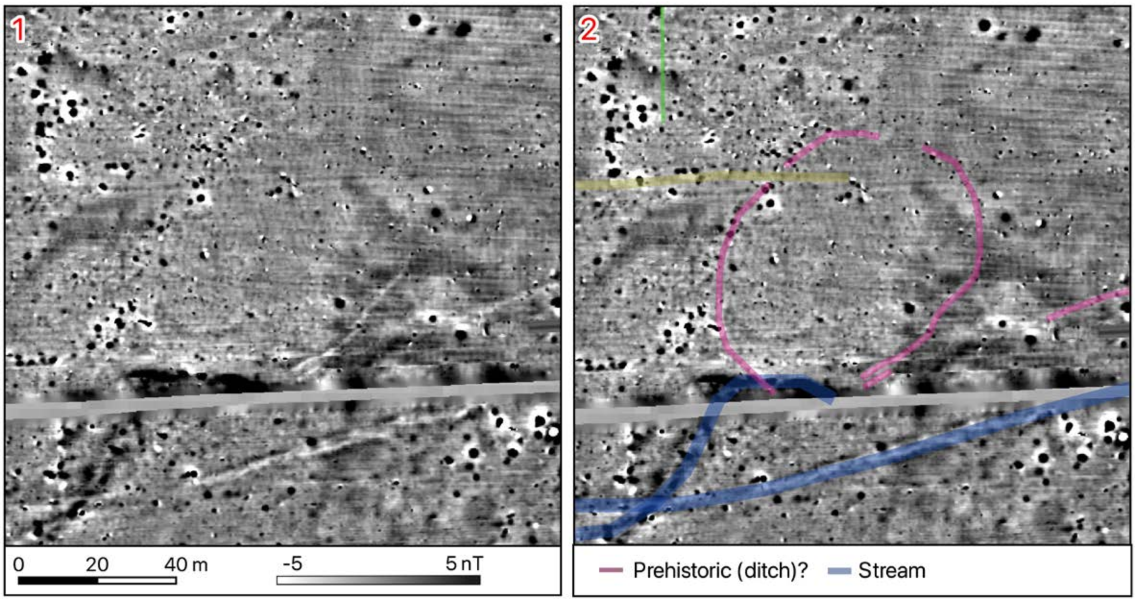

Figure 14. The oval formation northwards of the rectangular structure.
1) Magnetic map. 2) Course of the oval structure.

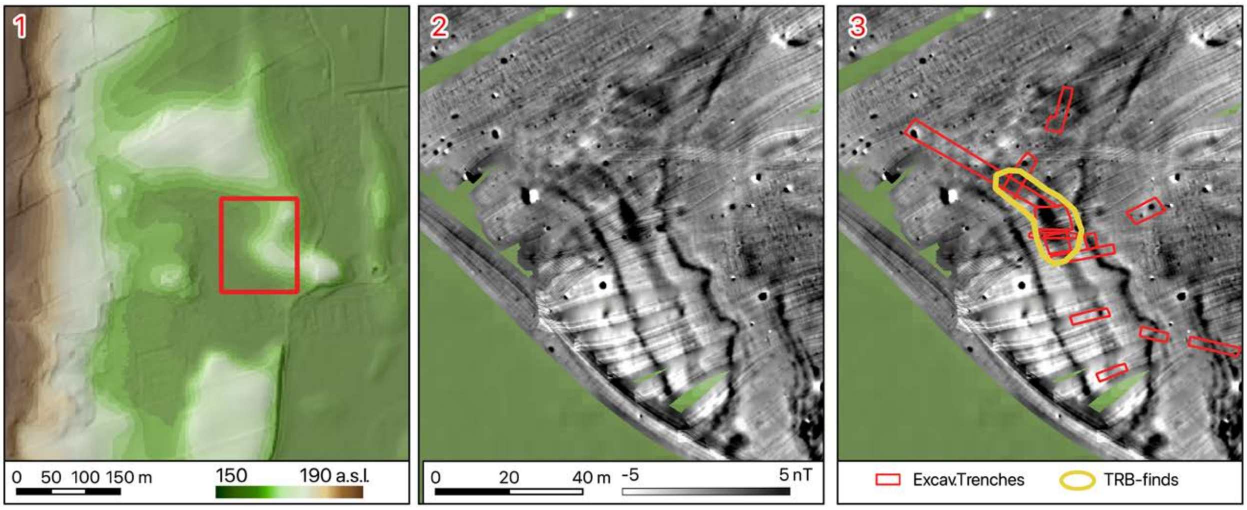

Figure 15. Tjurhagen. 1) DEM with the location of surveyed area. 2) Magnetic map.
3) Magnetic map with excavated trenches and the area with TRB finds, marked in yellow.

is therefore theoretically possible that archaeological features could be found in our data by applying better analysis methods.

In spite of these difficulties, we were able to distinguish large numbers of non-natural features in our data, such as old field boundaries, roads, drainage systems etc. Most of these were late historical features. Certain natural features were also clearly visible, such as watercourses or bedrock fissures. This demonstrates the feasibility of the prospection methods in this landscape, although certain features may have been missed or overlooked. The identification of such features, which are, after all, a key component of the archaeological landscape, is a successful outcome, although not necessarily the one looked for in the prospection design.

Secondly, in the final phase of the project we identified a previously unrecognised type of enclosures in the area, consisting of small hilltops enclosed by earthen ramps and possibly ditches. These were visible in LiDAR and DEM data, partly also in aerial photographs and drone imagery. These sites do not match the south Scandinavian Neolithic enclosures, but they also are not typical Iron Age defensive sites. Four such sites have so far been recognised. No archaeological investigations have yet been made at these sites, and their date and function remains unknown.

Three main questions emerge from these results, one methodical, one empirical and one interpretative. The methodical question concerns how to develop tools to deal with and filter out the strong noise in Scandinavian geophysical data, arising from moraine containing partly magnetic rocks. The empirical question regards the dating and function of the newly discovered group of walled enclosures on small hilltops, none of which has been excavated yet. On the interpretative level, the apparent lack of enclosures of Sarup type leads to questions about the organisation of the Neolithic societies on Falbygden and why they differ from south Scandinavian TRB societies.

Conclusions

Methodologically, the approach we have outlined leads to a potentially massive quantity of data, the interpretation of which is not always straightforward (e.g. Verdonck *et al.* 2019). While the geomorphological history of the two landscapes discussed differs, some of the same problems present themselves, namely large numbers of anomalies, numbering in their thousands, and, at times, a low signal to noise ratio, where background noise is occasionally high and geophysical anomalies are not always strongly defined. It is likely that the current explosion of automated feature detection approaches seen in aerial survey (especially lidar – e.g. Orengo *et al.* 2020; Herrault *et al.* 2021; Verschoof-van der Vaart and Lambers 2019, 2022) will soon be mirrored by similar developments in geomagnetic prospection (cf. Karamitrou *et al.* 2022; Strohm *et al.* 2023). Obviously, the incorporation of additional methods – especially 3-dimensional methods such as GPR – leads to an enormous increase in data. As yet, this surfeit of data, and limitations in survey speed remain a limit to true large-scale GPR for most projects. It is also clear that non-invasive methods can only go so far as regards understanding these anomalies. This is especially clear at Falbygden where a range of features that were identified as potentially archaeological in nature proved to be more natural in origin. As such, we would stress that at least minimally invasive methods (e.g. coring) or small-scale excavation is required for calibration and correct interpretation of these datasets.

Unsurprisingly, the methods employed in these surveys have proved to be complementary, and features that are visible using one method are not always visible using the other(s). However, the circumstances in which certain features are observable are very nuanced: in some cases this might be predictable based upon bedrock geology and subsoil data, in combination with geomorphological data (e.g. at Donore and some of the Falbygden examples); nevertheless, some other examples are less predictable (e.g. some of the features at Dowth Henge).

Finally, while both the Irish and the Swedish landscapes display quite clear spatial patterning of monument classes, the distribution of these is quite different. At Brú na Bóinne, settlement is still a potentially significant absence. Previous surface collection (Conor Brady) has demonstrated that there is substantial activity within the core area of Brú na Bóinne, but thus far the number of potential settlement structures is very small. This is in part due to visibility of features, especially as a result of variations in agricultural regime (e.g. much pasture, so irregular opportunities for collection or APs). Meanwhile, at Falbygden, arguably, enclosures occupy a similar niche – something that one might reasonably expect to find within such a landscape but that the methods so far used have failed to satisfactorily locate. Whether these absences are real or a factor related to survey design and instrumentation remains unclear. Clearly, the more methods applied without locating such structures raises the potential that they are genuinely absent; however, it is possible that the lacunae we are seeing relate to the limits of our current detection methodologies.

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Chapter 12
Geoglyphs, petroglyphs, and megaliths

Richard Bradley

Abstract

The definitive publication of George Eogan's excavations at Knowth brings together three features that can be compared for the first time. There are: the layout of the individual tombs; the pecked decoration associated with individual structures; and the small stone settings whose sites have been identified outside the monuments or underneath them. All these features have parallels elsewhere in the Boyne Valley and at other passage graves in Ireland. They assumed a similar form in each of these media: a circular enclosure with an entrance, or a series of concentric arcs. In some cases they made lavish use of quartz. How were these elements related to one another, and what ideas were they intended to express?

Keywords: Megalithic art, stone settings, passage graves, quartz, spirals, and circles

Walls within walls

Contemporary displays of megalithic tombs show some striking contrasts. Were their exteriors stepped, or were internal walls entirely hidden from view? Modern reconstructions are influenced by the condition of the structure, but there are regional traditions in how the sites are presented. Stepped monuments feature in Atlantic France, like those at Bougon, Barnenez, and Le Petit Mont, but they are absent among the structures shown to the public in Britain and Ireland. The one exception is at Wideford in Orkney where this interpretation was rejected by the excavator (Figure 1; Kilbride-Jones 1973).

Corbelled chambers required a cairn to support them, but some of the 'walls' found within the body of a mound could not have retained much material. That is why they have been described as 'symbolic kerbs'. A good example is the 'boulder wall' illustrated by the excavator of Newgrange - in his published photograph it is a single row of stones (O' Kelly 1982: pl. 39). According to Gordon Childe (1956), the internal walls at Maeshowe were equally exiguous. The first great passage grave at Knowth (Site 1 B) never had a kerb (Eogan and Cleary 2017: 137-41), and according to Palle Eriksen (2008), the kerb of Newgrange might have been a secondary construction.

In a recent article Vicki Cummings and Colin Richards (2017) discussed the unusual forms of passage graves in Britain and Ireland. They drew on the concept of 'wrapping' - the internal walls were meant to contain or protect something powerful and dangerous. It might be a stone chamber or a basin holding human remains, but it could also be a monolith or simply a rock outcrop. Some structures were built of materials brought from separate places. They might have been contributed by different groups of people, and these deposits were distinguished from one another by enclosing them by rings of boulders. Guillaume Robin has argued that a passage grave like Newgrange was conceived as a series of circles, breached by a passage leading to their centre. The back wall of the chamber

Figure 1. The passage grave at Wideford, Orkney, reconstructed as a stepped cairn.
Image: Creative Commons.

was the portal to another world (Figure 2; Robin 2009: 251-53).

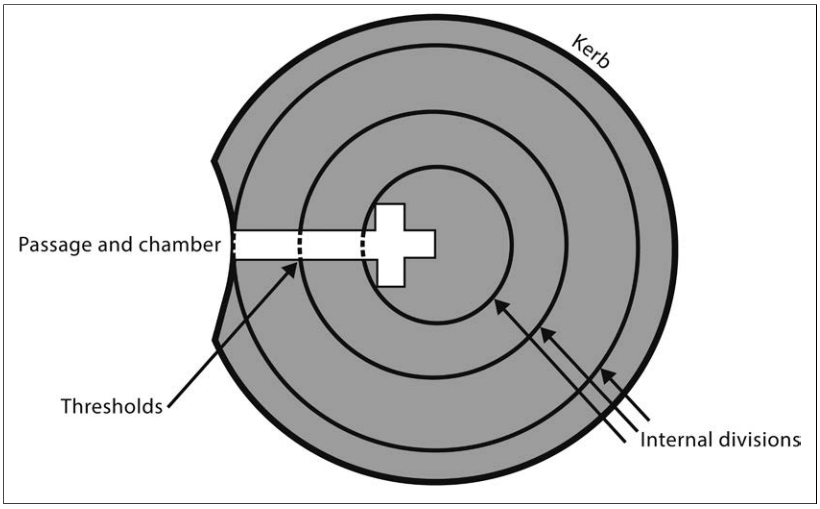

Figure 2. An Irish megalithic tomb interpreted as a set of concentric barriers breached by a passage leading to the centre. Information from Robin (2009) and Bradley (2023).

In the light of their discussion, we need to distinguish between three very different phenomena:

1. Walls that fulfilled a practical function in retaining parts of a cairn;
2. Arrangements of stones that indicated where structures were to be built during a subsequent phase; and
3. Boulder settings which could not have played any practical role.

Two Irish examples are revealing (Figure 3). The three concentric walls at Ballycarty could have retained a body of rubble, but they were placed so close together that this arrangement might have been unnecessary (Connelly 1999). It is likely that the interior was filled in one operation - had the structure originally been an open enclosure? The passage grave at Townleyhall presents another difficulty (Eogan 1963). It overlay the remains of an older settlement and several stone settings were discovered *underneath* the mound.

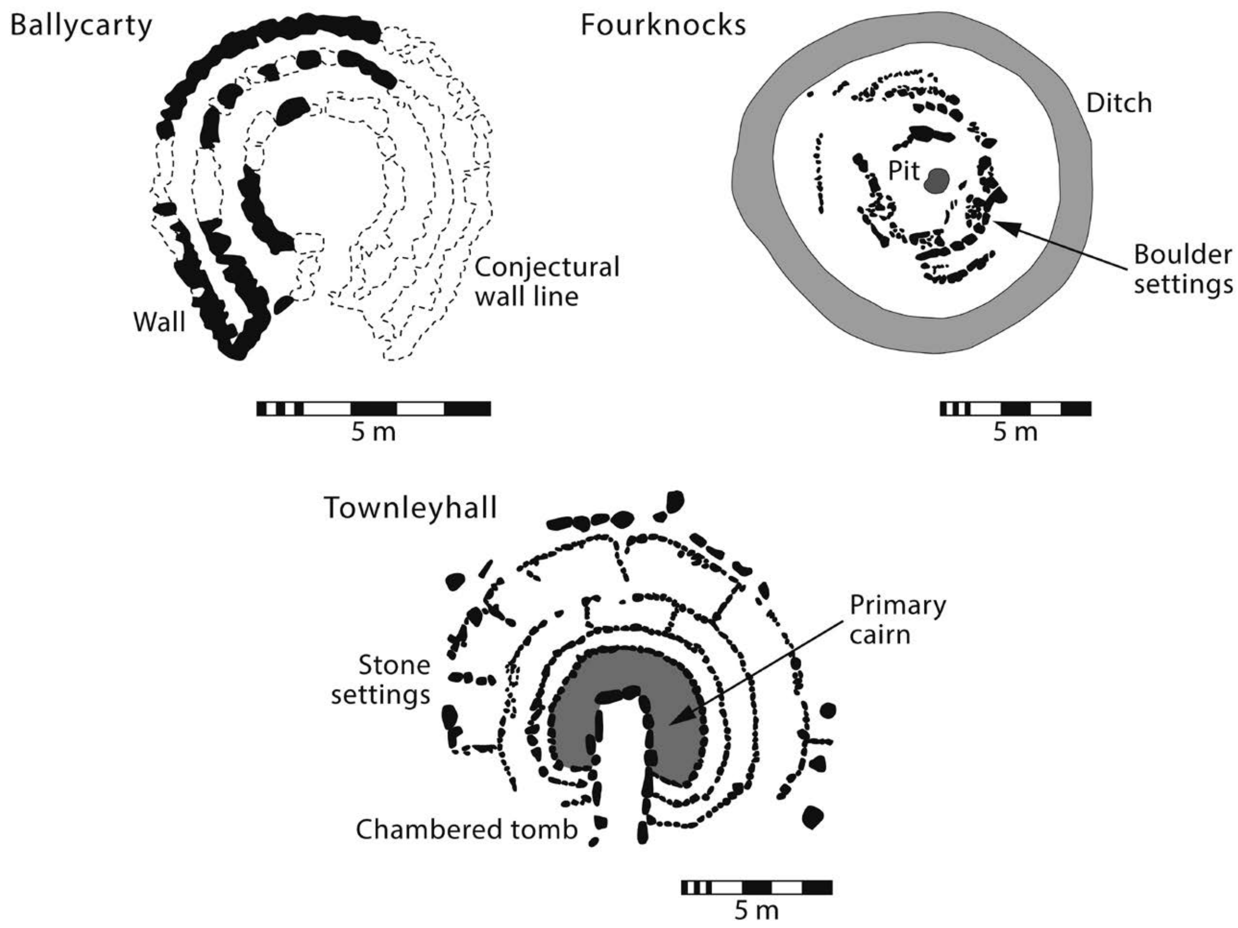

Figure 3. Concentric walls or other settings of boulders in the structures of three Irish monuments. Information from (Connelly (1999), Hartnett (1971) and Eogan (1963)).

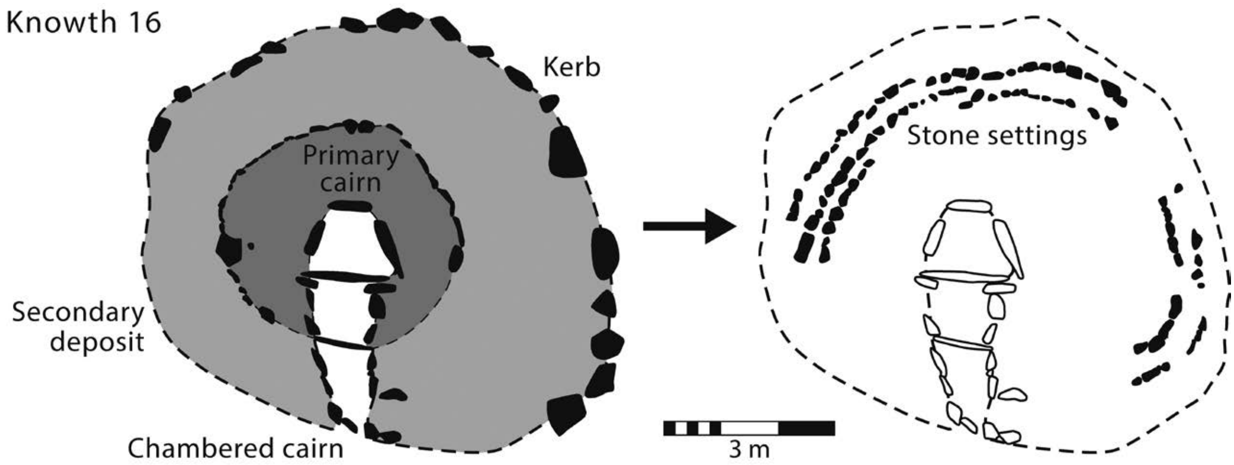

Figure 4. Outline plan of Knowth Site 16 showing the layout of the passage grave and the concentric arcs of boulders on the surface of the monument. Information from Eogan (1984) and Eogan and Cleary (2017).

Their configuration anticipated the final layout of the monument.

At Knowth, boulders were arranged in straight lines along the ground and might have marked the course of a later passage (Eogan and Cleary 2017: 175-85). Curvilinear elements, however, raise more difficult questions:

1. Did these boulder settings predate other parts of these monuments? The excavator of Carrowmore saw them as secondary features (Burenhult 1984: 64), but at Fourknocks concentric rings of boulders enclosed a pit with human bones. It happened *before* any mound was built there (Hartnett 1971). In turn, that earthwork was buried beneath a larger monument containing a megalithic tomb.
2. Did similar settlings of boulders extend outside the perimeter of the associated mound or cairn? Much depends on accidents of preservation, but one reading of the evidence at Townleyhall is that at one time they continued beyond the rubble core associated with the chamber and passage. They might have remained exposed until the barrow was enlarged (Eogan 1963). The same observation would apply to Knowth Site 4 (Eogan 1984: 32-9; Eogan and Cleary 2017: figure 2.60).
3. Why were other stone settings built *on top of* cairns? At one small passage grave, Site 16 at Knowth, the evidence is unambiguous (Figure 4; Eogan 1984: 109-32; Eogan and Cleary 2017: 255-56). Concentric arcs of boulders were displayed on the surface of the monument. They were put there on more than one occasion and would have been visible to anyone approaching the tomb. This may have been a unique occurrence.

Where the boulders were arranged in rings or arcs their forms resembled designs in Irish megalithic art. There were similarities and contrasts between these media. The images associated with passage tombs included numerous spirals, but these circular settings of boulders followed the same outline as other pecked motifs at these monuments. The positions of the decorated surfaces could be equally significant. Curvilinear imagery played an important role on the kerb of Site 1C at Knowth where the most ornate designs extended for up to 50m from the entrances (Figure 5). In contrast, angular motifs were more frequent in the interior (Eogan 1986; Eogan and Shee Twohig 2022: figure 3.8).

Geoglyphs

Another comparison is equally informative. As the name suggests, 'glyphs' are 'visual images like characters or symbols, and the term geoglyph describes those composed by arranging small stones on the ground to outline a distinctive motif. They were quite different from more conspicuous settings of monoliths. Such circular settings of pebbles, boulders, or slabs surround some of the larger cairns in Irish cemeteries, and those at Newgrange and Knowth have been investigated in recent years.

Knowth

These features were located close to both entrances of the principal monument at Knowth: six outside its western passage, and another seven to the east (Figure 6; Eogan and Cleary 2017: 216-43). On its western perimeter three of the settings abutted the outer kerb. They were up to two metres in diameter. Another five circular or semi-circular settings were attached to the kerb by the opposite entrance. They were of similar dimensions, but in this case a larger stone setting six

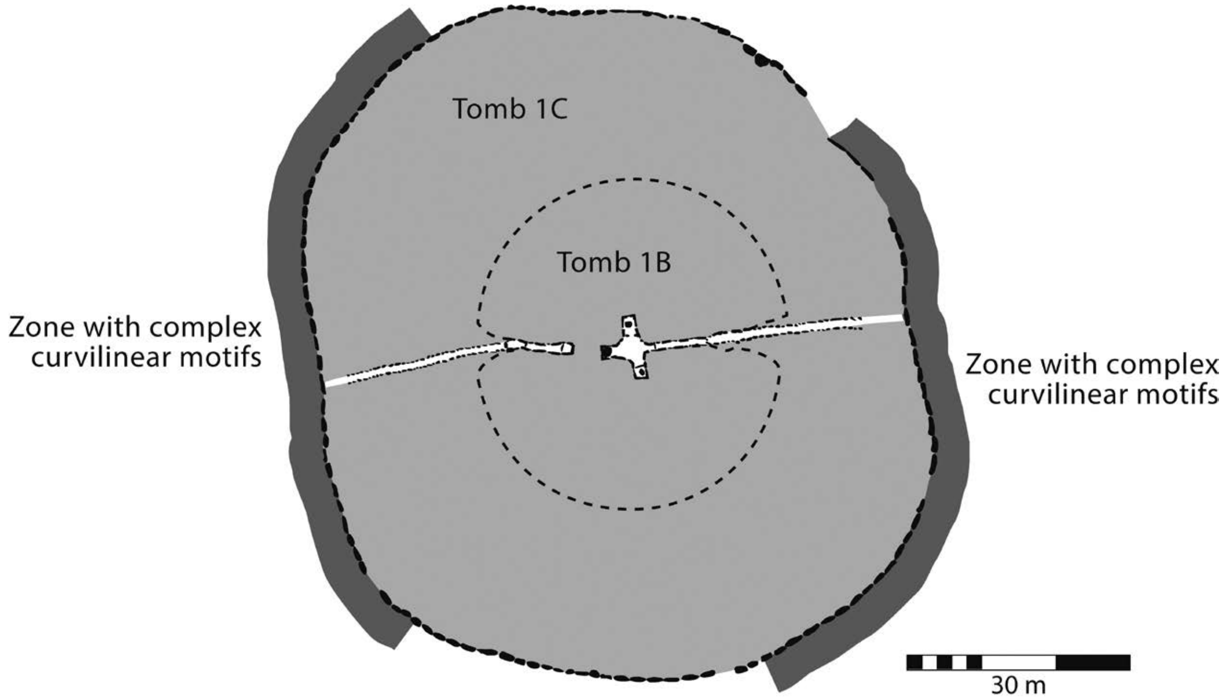

Figure 5. Outline plan of the principal passage grave at Knowth, showing the concentrations of complex curvilinear images on either side of both entrances. Information from Eogan and Cleary (2017) and Eogan and Shee Twohig (2022).

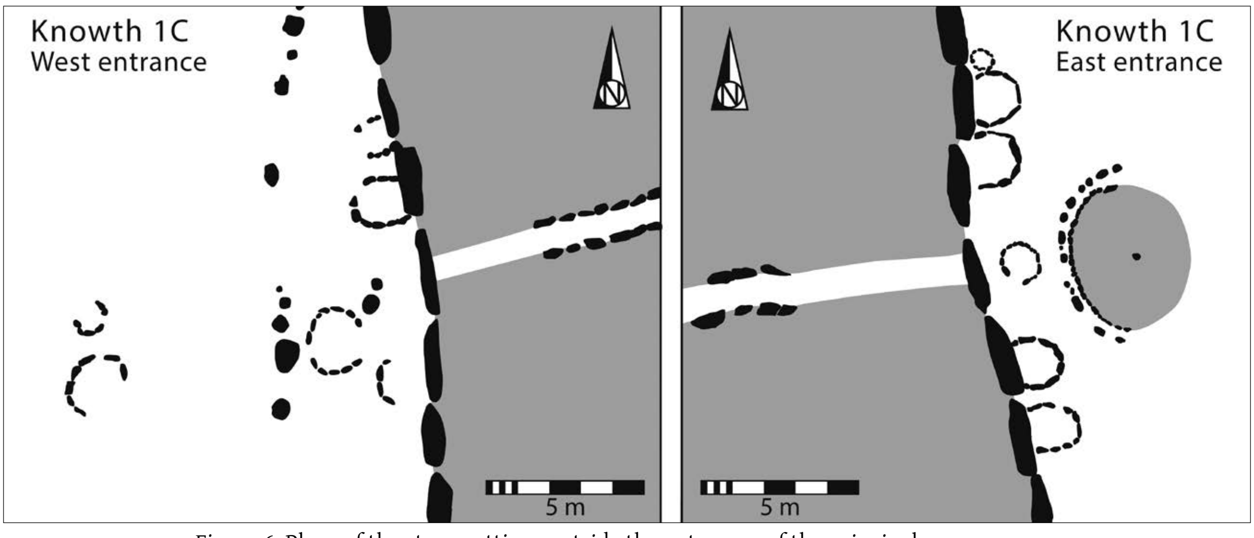

Figure 6. Plans of the stone settings outside the entrances of the principal passage grave at Knowth. Information from Eogan and Cleary (2017).

metres in diameter was established in line with the passage. It was enclosed by two concentric rings of stones and had a monolith on the side facing the tomb. Like the other circular settings, it was constructed over a shallow depression in the subsoil. Both groups of features were within a wider spread of quartz and other imported stones including banded siltstone and granodiorite.

Comparable features were found at other points at Knowth. Two of them are particularly informative. Beside the kerb of Site 1C there was an oval pebble setting measuring four metres by five metres (Figure 8). It was filled with small pebbles but was not enclosed (Eogan and Cleary 2017: 240-42). This contrasts with the situation on Site 4 - one of a ring of monuments that surrounded the principal tomb - where a circular stone setting two and a half metres in diameter, was built outside the entrance of another passage grave. A setting of quartz was delimited by three concentric rings of boulders (Eogan 1984: figure 15 and pl. 5a). Again, a circular stone setting was integrated into the design of a chambered tomb.

Newgrange

There might have been similar features outside the entrance of Newgrange. One was immediately in front of the passage and was originally identified as the site of an oval house (O'Kelly 1982: 76-77). It bounded a slight hollow in the subsoil measuring three metres by four metres and was defined by a perimeter of posts and pebbles. It is difficult to interpret, but in its filling were a flint axe and part of a stone bowl.

The other structure was more informative. It was almost the same size and was very like the external stone settings at Knowth. The excavator described it in detail:

> [There was] a low oval mound of waterworn quartz pebbles... and mixed through it were fragments of quarried quartz and rounded boulders of grey granite .... Protruding through it were the tops of a setting of small thin slabs ... These were found to form a border to a pavement partly cobbled and partly flagged' (O'Kelly 1982: 75-6).

To judge from a published photograph, there might have been a third curvilinear setting at Newgrange (Lynch *et al.* 2014: figures 18 and 19). It was composed of smaller pebbles and was overlain by the kerb of the principal cairn. It could have abutted the turf mound which was the earliest structure on the site.

Common elements

The geoglyphs in the Boyne Valley had several features in common. The small stone settings outside the main monuments were bounded by boulders or low slabs. In one case at Knowth (S 1) the interior was defined by several concentric settings of stones. These features were generally circular, but several were more U-shaped and abutted the outer edge of the kerb. Their interiors were slightly recessed into the subsoil and some of these small structures were paved (Eogan and Cleary 2017: 216-43). In some cases, the U-shaped examples give a viewer the impression that they extend beneath the kerb. It is hard to see why this happened, but it might have suggested the idea that a complete circuit continued underneath the mound.

Quartz and other imported stones featured in approximately half the settings at Knowth. The same material was spread on the surface in between them. This observation is important as quartz was also used to embellish the faces of the large tombs there and at Newgrange (Cooney 2006; Hensey and Shee Twohig 2017). Similar settings are associated with other passage graves in Ireland. They were discovered during an early excavation at Loughcrew (Conwell 1872), and others have been identified from surface evidence on Knocknarea (Bergh 1995: 246). There are parallels in Britain. The oval structure identified as a 'house' at Newgrange resembles a smaller timber setting beside a decorated outcrop at Torbhlaren in western Scotland. It was associated with a radiocarbon date of 2580-2340 BC (Jones *et al.* 2011: figure 3.20). In the same way, there were three small rings of boulders on a platform in between the ditches of a henge at Thornborough in north-east England (Harding 2013: figure 5.25). Like the Irish sites, the rock art at Torbhlaren was associated with deposits of worked and broken quartz. They also featured at the Irish tombs of Knockroe (O'Sullivan 1993) and Loughcrew (Conwell 1872), while the inner bank at Thornborough was coated with gypsum which would have had the same visual impact (Harding 2013: 78-81 and 209-10).

Geoglyphs and petroglyphs

Again, it is interesting to compare these stone settings with the repertoire of megalithic art. Their main element was a continuous circle. In most cases its outline was marked by a line of slabs or boulders, but a few examples included concentric rings of stones; the greatest number was three. The same outline was displayed on the kerbs of Irish tombs. Those at Newgrange also featured single rings; like the geoglyphs, they were about the same size as one another (O'Kelly 1982: 146-85). Elaborate curvilinear decoration was also found at Knowth where isolated circles were unusual (Eogan and Shee Twohig 2022: 99-115).

Few of the pecked designs enclosed other elements - cup marks appear only occasionally, although they are recorded at Loughcrew (Shee Twohig 1981: 205-20). That did not apply to the stone settings. Not all of them contained distinctive elements, but some deposits were carefully organised in the ground. Although the more complex examples resemble the motifs on the kerb, the clearest link between these structures was the use of quartz.

Geoglyphs, petroglyphs, and megaliths

There are several cases in which designs in these media occurred together. There were hints of this at Newgrange, but it is has become more apparent with the publication of George Eogan's excavations at Knowth (Eogan and Cleary 2017; Eogan and Shee Twohig 2022).

At Newgrange the most convincing stone setting was outside the only entrance to the tomb. It was composed of three concentric circles. They were in front of a kerbstone embellished with four curvilinear motifs: a single ring and three larger spirals (Figure 7; O'Kelly 1982: figure 34). It is likely that their juxtaposition was deliberate.

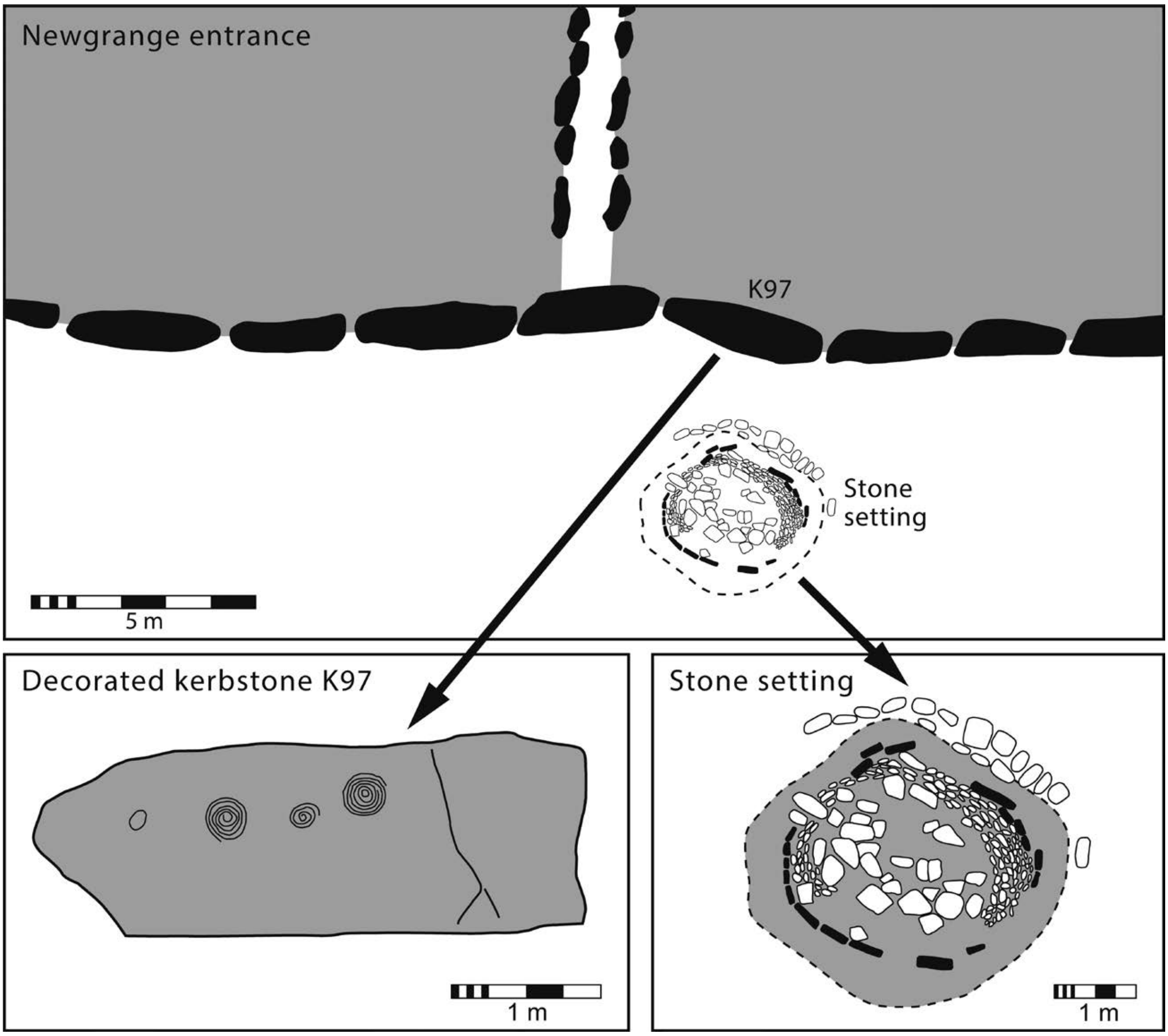

Figure 7. Plan of the excavated stone setting outside the entrance of Newgrange, with a detail of the imagery on the nearest kerbstone. Information from O'Kelly (1982).

At Knowth there were many more stone settings: 15 candidates, compared with three possible examples at Newgrange. In this case the full extent of the kerb has been recorded in detail and more is known about the pecked motifs displayed around the limits of Site 1C. It is difficult to link individual components in these media, but one relationship is obvious. All the geoglyphs were close to sections of the perimeter with elaborate curvilinear designs. *They did not occur in those parts where the motifs were simpler or the kerb was left undecorated.* The distribution of complex images focused on the entrances of the main passage grave at Knowth but extended for a significant distance beyond them (Eogan and Shee Twohig 2022: figure 1.4). On the other hand, almost all the stone settings were within ten metres of an opening into that monument. Curvilinear designs played an important part in both media.

Occasionally there were more specific relationships. The largest external feature at Knowth - an oval setting of small pebbles (Feature A) - was immediately in front of two distinctive kerbstones. Both bore similar designs and they have been compared with a pair of eyes looking towards the distant monument of Newgrange (Figure 8 a; Eogan and Cleary 2017: figure 2.55). They created a single panel because they were framed by stones which were treated in a different way. In this case the petroglyphs and Feature A might have formed a single composition.

It was not the only example. At Knowth there were several cases in which a circular stone setting was directly linked to a particular kerbstone. They must have been erected together as the perimeter of small slabs extended underneath it. Sometimes these elements were paired (Eogan and Cleary 2017: figure

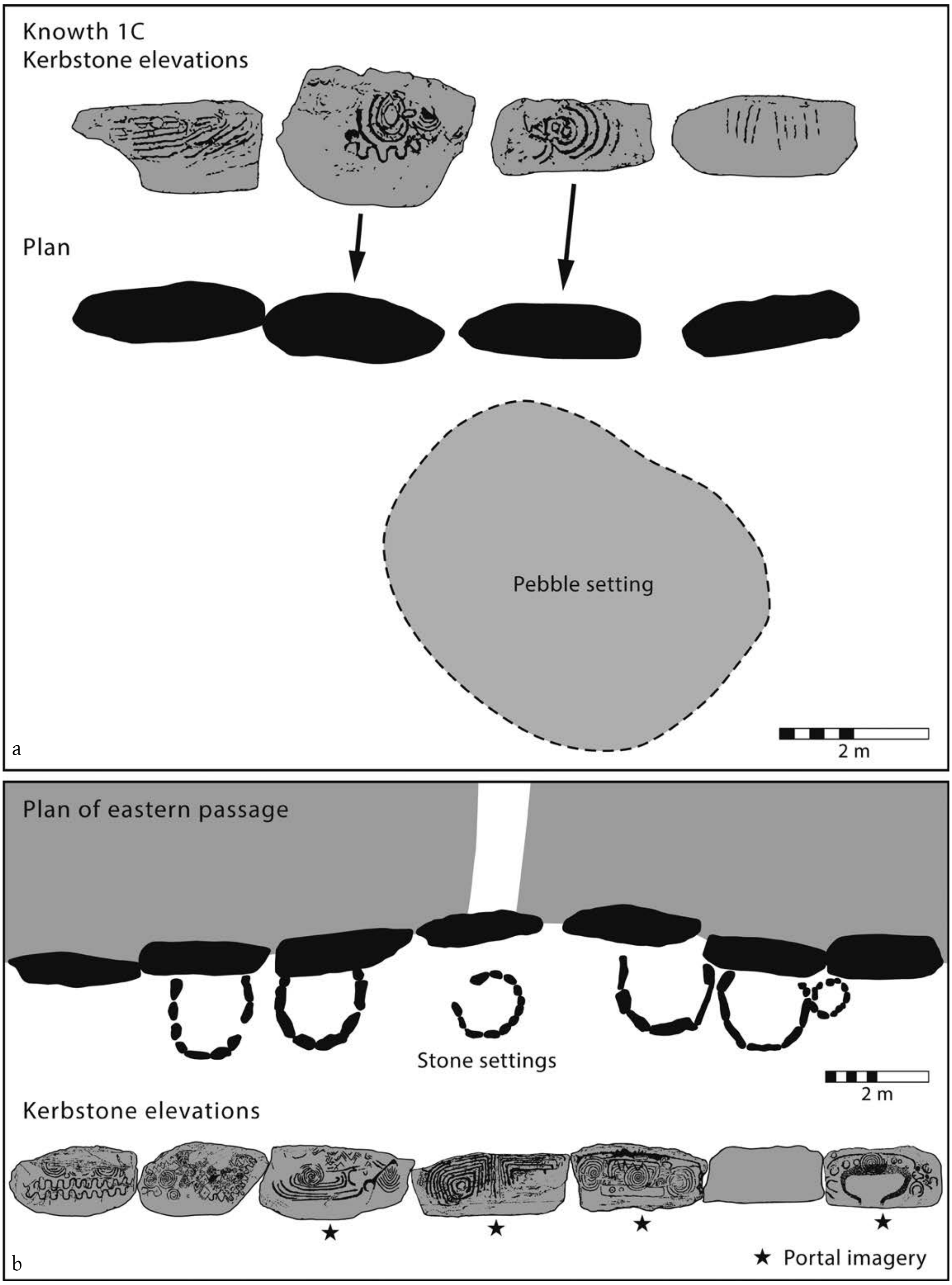

Figure 8a. Outline plan of a pebble setting outside principal tomb at Knowth, together with elevations of the nearest kerbstones and details of their pecked decoration. Information from Eogan and Cleary (2017) and Eogan and Shee Twohig (2022).
Figure 8b. Outline plans of the stone settings outside the east entrance of the principal tomb at Knowth, together with elevations of the kerbstones and details of their pecked decoration. Information from Eogan and Cleary (2017) and Eogan and Shee Twohig (2022).

2.51, S3, and 4; figure 2.53, S 6, 5, 4, 3, and 2; but there were few obvious connections between the choice of pecked motifs and the structures distributed around the west entrance of Site 1C. On the other hand, all the decorated panels featured curvilinear designs, including single circles, multiple circles, spirals, and oval enclosures. Angular designs were less common (Eogan and Shee Twohig 2022).

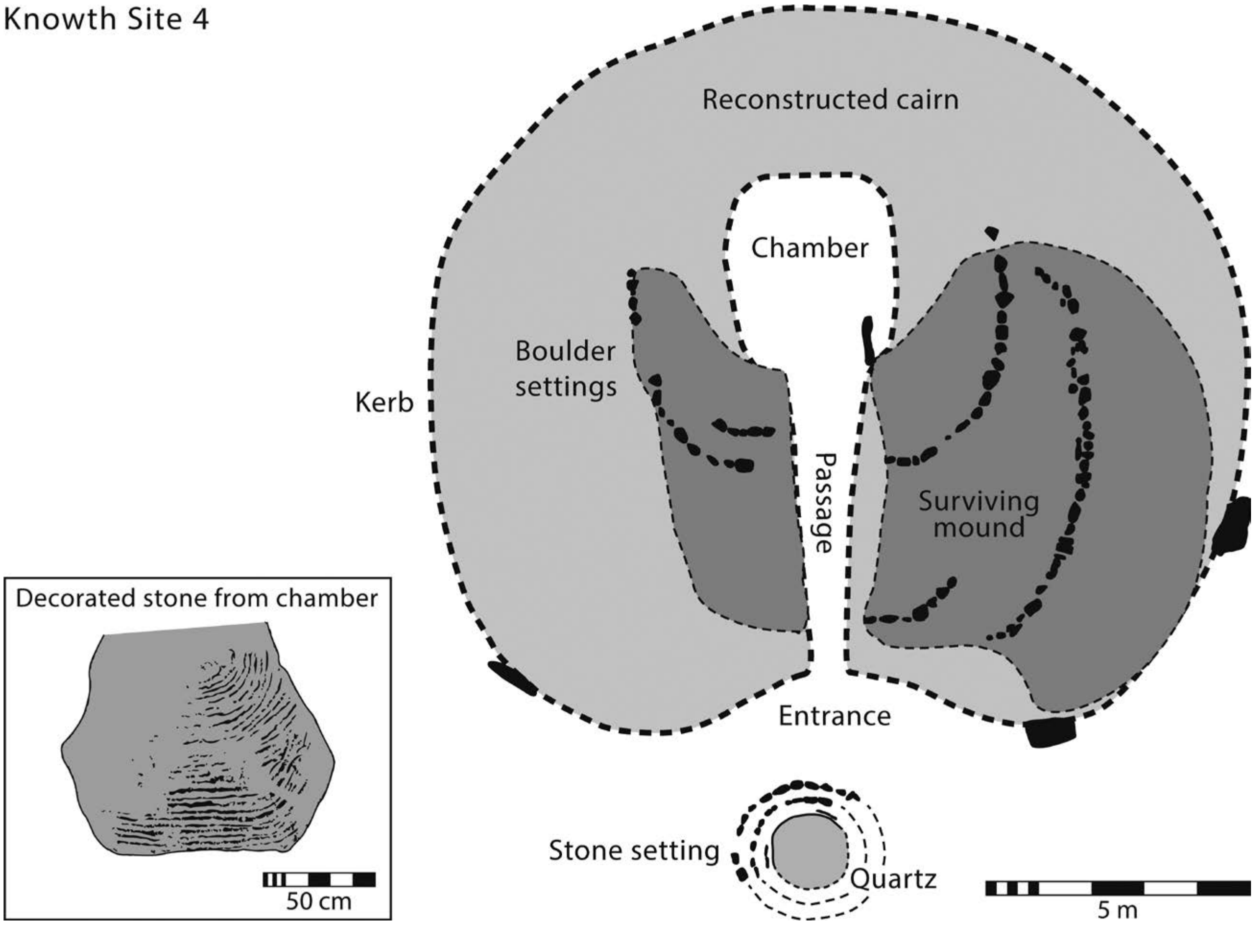

Figure 9. Reconstructed plan of Knowth Site 4, showing the boulder settings underneath the monument. The inset shows one face of the decorated stone found in the chamber. Information from Eogan (1984), Eogan and Cleary (2017), and Eogan and Shee Twohig (2022).

The situation was different on the opposite side of the mound where four circular or oval stone settings were bonded into the kerb. Again, curvilinear motifs were displayed on the exterior of the monument, although there was no direct relationship between the outlines of the stone settings and the character of the nearest petroglyphs. There is one exception. Distinctive motifs featured on either side of the east entrance, and both were abutted by small structures of this kind (Figure 8 b; Eogan and Cleary 2017: figure 2.51; Eogan and Shee Twohig 2022: figure 6.10). The pecked designs combined circles and spirals with an unusual rectilinear frame or enclosure that recalls the decoration on the stones that close both passages. They include the same elements, but in this case one of them was inverted. Were these panels meant to indicate 'portals' leading into, or under, the mound?

When the main tomb was built at Knowth its kerb incorporated the position of an existing passage grave, Site 16. The older monument raises many of the problems considered in this article (Eogan 1984: 109-32). It was decorated with incised and pecked decoration, but this was predominantly angular or linear. On the other hand, the exterior of the cairn was embellished with rings of boulders of the kind considered earlier; they were replaced by a similar setting during a subsequent phase. The kerb of the principal monument emphasised the same contrast between these elements (Eogan and Shee Twohig 2022: figs. 6.10 and 6.15). On one side of the junction with the older structure the kerb of Site 1C was largely undecorated (Kerbstones 123-127), but on the other side there were panels with linear decoration, spirals and a series of nested arcs (Kerbstones 1-5).

Finally, Site 4, another small passage grave outside the principal tomb at Knowth, has a contribution to make (Figure 9; Eogan 1984: 32-39; Eogan and Shee Twohig 2022: 654-56). The surviving part of its cairn was associated with arcs of boulders laid out on the land surface like those at Townleyhall. In front of its entrance was a feature described earlier: three concentric rings of pebbles enclosing a setting of quartz. The tomb was also associated with a piece of decorated stone (Orthostat / Sillstone A). Its original context is not clear, but it was found in the position of the chamber. It had been worked on two surfaces and along one edge. The most complex design is angular, but on the opposite face is a series of arcs similar in form to the stone setting underneath the cairn. All the elements considered in this article - geoglyphs, petroglyphs, and a megalithic tomb - are brought together here.

Correspondences

What are the implications of this analysis? It has been an attempt to bring together elements which are treated separately in most accounts of megalithic tombs: their plans and structures, and the pecked or incised images that are generally considered as 'art'. There is a further possibility. Are the curvilinear geoglyphs attached to their kerbs three-dimensional equivalents of the designs that attract so much attention?

Although Continental passage graves can include internal walls – that is why some of them are reconstructed with stepped exteriors - their equivalents in Ireland and Britain have other features. They include the slight stone settings described as 'symbolic kerbs', and their surfaces can be embellished with curvilinear designs. Knowth includes more decorated panels than any other site in Europe (Eogan 1999). The mounds or cairns may be situated inside larger enclosures which seem to have formed part of the original design. Examples include the great stone circle at Newgrange (Williams 2023) or the ditch and platform at Maeshowe (Richards 2005: 229-48). Like some of the diagnostic elements of Irish megalithic art, these were local phenomena and lacked exact counterparts in mainland Europe.

Although insular monuments have often been compared with Continental examples, radiocarbon dating sets limits on this approach. Chris Scarre (2015) has shown that there was an overlap of no more than two hundred years between the last use of passage graves in northern France and scientific dates for their presence in Britain and Ireland. When tombs like Knowth, Newgrange and Maeshowe were built new kinds of monuments were favoured in the nearest parts of the mainland. The people who erected the chambered tombs in the Boyne Valley were in contact with other parts of Atlantic Europe (Eogan and Shee Twohig 2022: 247-57), but they built in a style of architecture that had gone out of use in neighbouring regions. It is not surprising that insular traditions became so arcane.

Perhaps the notion of containment supplies the missing term of the equation. The walls of passage graves protected a dangerous but potent space from the world outside. It might have been where people could communicate with the dead, and access was carefully controlled. That might have been just as true in other regions, but in Ireland the same idea was expressed by the striking images displayed on the largest tombs. It may be that the circular settings which abut the kerbstones (Eogan and Cleary: 216-43) were also conceived as portals through which people could communicate with the interior.

That might explain other developments that occurred during, or soon after, the time when these monuments were erected. The first is the creation of a series of enclosures in Britain and Ireland: henges, palisades,

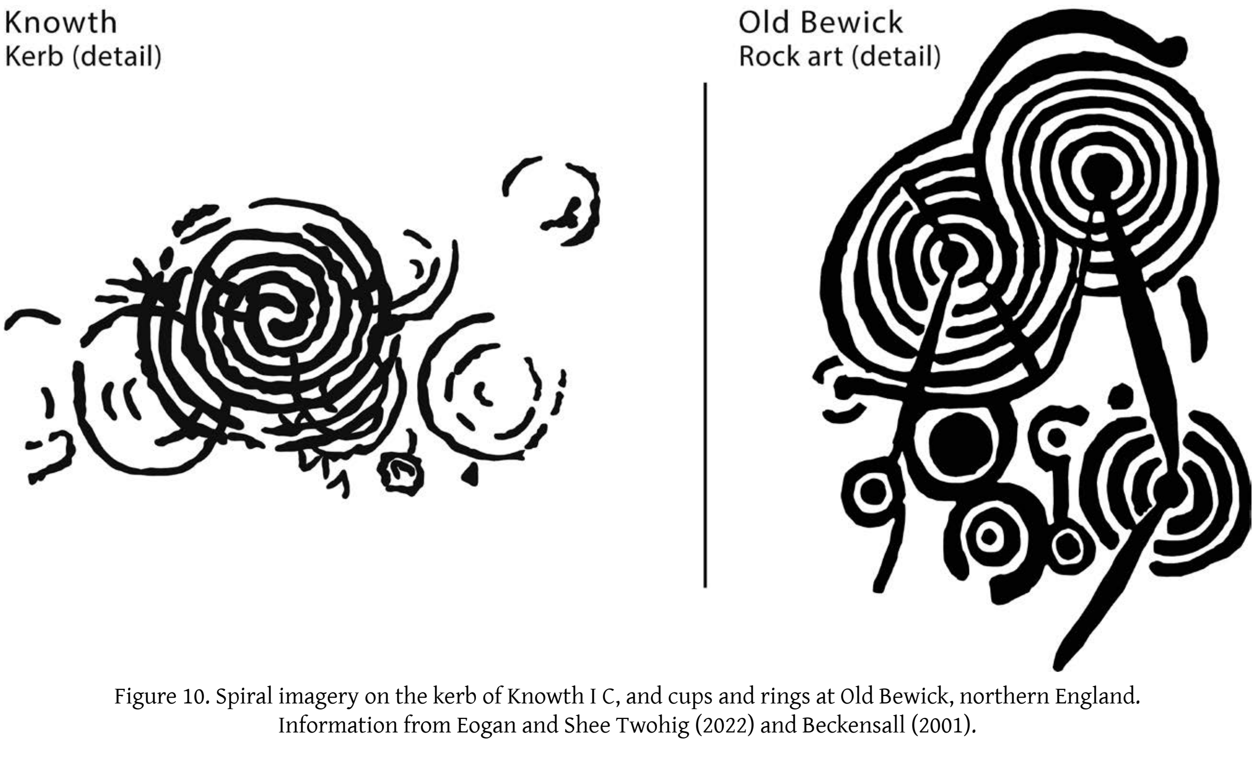

Figure 10. Spiral imagery on the kerb of Knowth I C, and cups and rings at Old Bewick, northern England. Information from Eogan and Shee Twohig (2022) and Beckensall (2001).

and the earliest stone circles. They showed the same concern to protect a circular space in which special events could happen (Bradley 2019: 124-39). Some of the most convincing examples have been identified outside Newgrange (Davis and Rassmann 2021), but there is similar evidence from Orkney where allied structures were erected near Maeshowe (Edmonds 2019). Monuments of all these kinds were built and used long after chambered tombs went out of fashion.

The second element concerns the transformation of megalithic art. Although the evidence is all too limited, it seems likely that the open-air rock art of Ireland and Britain developed at the same time as decorated tombs and remained in use into the Early Bronze Age (Bradley 2023). It had a comparatively limited repertoire as almost all the images were curvilinear. The main element was a ring or a set of concentric rings. The perimeter was interrupted where a radial line led to (or from) a central cup. Again, the idea of containment must have been important as this design shares features with the plans of major monuments: henges, passage tombs, and stone circles.

There was an important contrast between the cups and rings formed on natural outcrops and the specialised designs associated with Irish passage graves. In both cases curvilinear designs played an important part, but they took different forms (Figure 10). *Concentric circles* breached by a radial line illustrate a direct route leading to a central point (Bradley in press). *Spirals*, however, followed a more sinuous path and in the mind's eye the passage into the interior would have been more difficult to trace. Following it was like entering a maze. The contrast between these images reflects the settings in which they were made. The pecked motifs in the open landscape suggest that people or other beings could pass directly through the surface of the stone, but at the decorated tombs the spiral was only one of the obstacles – both real and metaphorical - that were placed in their path. There were kerbstones, internal walls, and the materials out of which the mounds were built. Taken together, these elements made the passage from the outer world more difficult. For that reason, they were particularly powerful.

At monuments like Newgrange and Knowth the features discussed in this paper worked in combination. That is why it is possible to consider them together.

Acknowledgements

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Chapter 13
Building space. A structural model of space in megalithic landscapes

Felipe Criado-Boado and Jadranka Verdonkschot

Abstract

An abstract model of the organisation of the monumental landscape has been proposed for Galicia, NW Iberia. This model uncovers an order behind the empirical reality of the megalithic landscape which, to the bare sight of a modern observer (removed from either megalithic rationality or the one embedded in a rural vernacular tradition), appears to be random, contingent or disorganised.

In contrast to this impression of disorder (natural for any pre-hermeneutic observation, prior to the understanding of meaning), the relationships of the megalithic mounds (called *mámoas* in Galician language) among each other, with the physiography and the elements of the natural topography, with movement and transit, and with the visual impact and references, materialises the logic of the prehistoric megalithic landscape. These elements show a regularity that is the result of certain rules or principles (it will be discussed later whether this is, in fact, structural) that regulate the location of the *mámoas* and give rise to a certain pattern of order, of imposition of the megalithic cultural order on the world, and configure a structural model of the megalithic landscape. Such is our proposal here and hereinafter we will test it, calling attention of megalithic scholars to the fact that something similar should happen in any other megalithic landscape throughout Europe. 'Structural' here means that it is an abstract organisational model of the empirical landscape, a model to which the organisation of the empirical reality (or ground reality) can be reduced.

Keywords: Megalithism, Neolithic, Structural Model of Space, North-western Spain, Landscape

Introduction: purpose, scope and organisation

Territorial planning, and by extension urban planning as we know it nowadays, is older than we might suspect. This kind of planning and perception of the environment came into artificial being when the very first stone was erected by humans (the cast of its shadow proclaiming the invention of the future). Although planning, in some form, has always existed as an inherent part of the ordering of the world in human culture, we believe this reached beyond what archaeology has been able to recognise up until now.

As part of a rationality, the environment has always been incorporated in social practices and physical expression of societies (Criado-Boado 1993; Ingold 2000; Merleau-Ponty 2013; Molina and Toledo 2014; Radkau 2008). The question explored in this paper is whether this implies that vernacular constructed spaces (from any rural countryside to a megalithic necropolis) and materialities are just as planned and ordered as the blocks shaping a metropolitan setting. The key point is to explore when 'order' is the result of an explicit planning decision and practice, or rather arises 'naturally' from human practices, as the materialisation of their cultural order. As a matter of fact, archaeology and history are familiar to the perception that 'order' is something implicit in cultural constructions. Moreover, it is suggested that codes can be identified, expressing underlying systems of meaning that guide a society's understanding of the world. These codes, embedded in practices, materials and spaces, are key in interpreting the meaning of archaeological materialities and thought in the societies that produced them. Although this is a claim that lies at the basis of archaeological knowledge, what will be explored here is the compatibility of said codes on different scales and in varying dimensions of materiality and the validity of tracing underlying structures.

The article will begin by outlining the theoretical foundations of this approach and its relevance to archaeological interpretation. To illustrate this, a structural model of space will be presented, offering examples in an increasing scale in order to examine a structural model of megalithic space. Megalithic examples are a superb phenomenon to explore this topic. Through them, we exemplify that this structuralist approach provides a framework for interpretation. In doing so, we demonstrate not only how the underlying structures of society can inform us, but also how this contributes to studying human thought and expression.

Theoretical Framework

Appeal for a structural approach

When discussing structuralism here, it is important to note that we are consciously dealing with these concepts from a moment in time when the classical structuralist discourses have necessarily been transformed (for a recent example of an updated use of structuralist thesis, see Lahire 2023). It is the privilege of this 'view from afar' that brings us to speak about structuralism anew, a privilege that goes hand in hand with Stenger's appeal for slow science (Stenger 2017). It is the nuancing of the levi-strausian by Godelier who makes the ideal compatible with the material (in his work re-visiting Lévi-Strauss' thought: Godelier 2018), thanks to Foucault who carries structuralism to the realm of post-structural approaches (Foucault 1969), ultimately Clastres, who could value processes of social resistance and re-evaluate anarchism by introducing a much-needed sociological component (Clastres 1987). As even the shortest summary would transcend the limits of the article, we confide in the reader's comprehension when we say that we further see this approach enriched by Derrida's deconstruction (throughout his works, but originating in Derrida 1976), Lyotard's postmodernity (introducing the concept to social sciences in Lyotard 1984), Deleuze's folds in time (notably in Deleuze and Strauss 1991), Viveiros de Castro's perspectivism (originally in de Castro 1996, and in an English publication in 1998), Latour's turn of the things (Latour 2015), and Jullien's silent transformations (Jullien 2011).

It is from this extended structural position, that we aim to explore the possibility of a structural model of space. In this, the structural is not conceived as a fixed underlying single system. It should rather be perceived as an order which is always structuring and being structured (Ruijter 1983), guided by social processes and the rationality incorporated in all actions, fully embedded in its context, i.e., in history. In this sense, we call upon the example invoked earlier, of the designed urban planning and the vernacular order guided by an internal logic, in order to explain that in our proposal we perceive a design in both cases, with the important distinction that the latter is rather a design by formalisation of normativity. Precisely because of this externalisation of social norms in a material niche, the interpretation of such an embedded normativity (Criado-Boado 2013; for more information specifically from an Active Inference point of view, which is further discussed below, also see Guénin-Carlut and Albarracin 2023) provides insight into the rationality of a society.

The functioning of a society's rationality is to produce an order encompassing both culture and nature and their relation to one another (Criado-Boado 2000; Lévi-Strauss 1962). The 'structures' we talk about when we make an appeal for a structuralist approach are the forms imposed on occurrences of life and content (Descola 2021). These structures are at the same time shaped by and resulting from a continuous process of feedback. In order for a rationality to be effective in its functioning and ordering the whole of a group needs to understand, accept and transmit it. This way, each culture maintains its own logic, epistemology and metaphysics (Criado-Boado 2012).

According to Lévi-Strauss, the identifying of such structure can be approached through several mechanisms: dual conceptions, oppositions, symmetries and classification (Criado-Boado 2000; Descola 2014; Lévi-Strauss 1962). Although in Lévi-Strauss' work there is a strong emphasis on the linguistic and mythical dimensions in interpretation, structuralist lines can be proposed for archaeological research and material analysis too (Criado-Boado 1989a, 2000). After all, their application to forms and material expressions is one of its unexplored capacities; (Levi-Strauss' structuralism is firmly rooted in the formal analysis of V. Propp (Propp 2011 [1928], even if it overcomes its original application to folk tales). One of the authors of this article postulated a model of monumental architecture in the previously cited 1989 article, emphasising megalithism as a defined materialisation of the concept of space and the emergence of this strategy of materialisation as the expression of a transformation of the thought process. More specifically, it proposed the transition from Lévi-Strauss's 'savage mind' to a rationality inaugurating the 'domestication of the world' (an idea previously developed in Criado-Boado 1989b). This gave way to a branch of landscape archaeology which contributed to an archaeology of thought and of the concept of space. In the current article, we aim to revisit this line of interest from current research and postulate a structural model of megalithic space to update these ideas to afford forthcoming research studies.

The design at play in vernacular environments, though not necessarily expecting it had to be previously meditated and imposed, is overall a design that is incorporated in the social process and maintained by an internal logic. Rather than being guided by powers from above, what is at work here is the concept of a relational distribution of power-knowledge (Foucault 1980). Structure, in the non-opposing sense of spontaneous and self-organised order, becomes a material design. A structure that comes into being in such a way can inform us on the rationality of the society that created it (Criado-Boado 2000). These initial assumptions have been further developed in recent research in the XSCAPE Project on Material Minds (Criado-Boado *et al.* 2023, 2024; Millán-Pascual *et al.* 2023). This project is, among other things, a synergic combination of neurosciences, cognitive sciences, archaeology and anthropology that sets out to explore the structuring of material forms as the joint result of the historical process and human cognitive processing. Currently, several lines of research can be followed in cognitive literature dealing with the interplay between humans and their environment and, more importantly, the cognitive processes involved in this. Different takes are debated, including the work of Andy Clark, centred around an extended functioning of cognition (Clark 2024; Constant *et al.* 2021, 2022). This considers external materialities, as in the subject of archaeological study, and how these are part of the very processes of cognition. Interesting is also the slightly different take of other authors, who argue that cognition is not so much extended, as it is scaffolded, meaning that agents do not only adapt to their environment (in the broadest material sense) but also adapt this environment to them for an optimal functioning, in an act that is referred to as niche construction. In this way, the environment becomes scaffolded for the functioning of cognition (Sterelny 2010). This is relevant in our topic of research because of the definition that the construction of a material niche is a participative process in which the development of complex cognition is scaffolded by externalising the cognitive load (Guénin-Carlut 2024; Guénin-Carlut and Albarracin 2023). This is an interesting take to think about the meaning and implications of built space. Also, the concept of a distributed cognition, as Sutton defends it, resonates with our claims in this article. Because of the attention to the aspects of layered and place-based (multi-temporal) meaning in his work, it provides a sensible application to much work in archaeological interpretation (Sutton 2020a, 2020b, 2022). The present piece of research does not aim to further explore these approaches on a critical level here, but rather rests in a topic that is also dealt with in and backed up by cognitive literature. For the present text, the specifics of how a structured environment shapes cognition is less relevant than the affirmation that it does, recognising the validity of this effort to detail a structural model of space from an archaeological point of view.

Components of a structural model of space

A structuralist approach means that the system of thought in specific cultures is sought to be unveiled, by assessing the relationship between the rationality and society itself. This provides the framework wherein worlds of thought are constructed. In order to be able to read this meaning, however, the understanding of the codes carrying this meaning in archaeological contexts is key. Structures are historically determined and the different expressions of codes within one society are compatible structurally. Above, we have argued that this rationality can be accessed through an approach in which a structure can be identified as the result of the ordering of a certain mode of thought.

To identify the structure underlying material expressions is useful both as a predictive model as well as an interpretational tool. In order to do so we have several techniques at our disposition in a structuralist approach for archaeology. A structure is preceded by patterns, in which we recognise a consistent repetition of elements. From this, in turn, comes regularity, which is the impression that there is a systematic order whose structure is not yet understood. Thus, according to Lévi-Strauss, dual conceptions, oppositions, symmetries and classification are what we have to look to in order to disclose the structural logic. In the archaeological study of landscape and other materialities as socio-cultural products, different expressions and codes of the same structural order can be identified. The sense of each sign is established through its correlation with the others. In this way the spatial rationality that is in place in the imaginary dimensions of cultural objects is unveiled. By uncovering which are the mechanisms in place that guide, orientate and predetermine perception here, in the material expression of thought, we place ourselves within the material level upon which observations are constructed and the cultural rationalities that shaped it (Criado-Boado 1993; Criado-Boado and Villoch-Vázquez 2000). Concepts such as the visibility, movement or scenography in spatial settings, interplaying with perception, are valuable subjects for this study.

A tentative model for archaeological interpretation was detailed in Criado-Boado's book (Criado-Boado 2012: 206-214; for a version of this method, see Higginbottom's chapter in this volume, where the theoretical foundation is adapted for the selection of proxies and indicators used in statistical and interpretive analyses of dolmens). In this model, which we will loosely follow below, a specific scale or aspect of a phenomenal context of the studied context is taken as the starting point. From the common form discovered in this, a first hypothetical model is deduced. Consequently, other scales and aspects are identified, deducing further hypothetical models. Together, these hypothetical models would allow for the identification of an organisational structure and thereby an ideal concrete model. The way to test the validity of this concrete model as a general model, is by assessing further hypothetical models that are deduced from other phenomenal contexts and areas. Only after this routine, a structural code can be formulated, which should be contrasted with other cultural contexts, finally unveiling meaning through the differences or similarities. Below, we will illustrate this method for the case of the structural model of megalithic space.

Analysis: scales of structure

For the example delivered below, we will provide a short overview of the classification we are making. The phenomenal contexts of the studied topic (the megalithic structure of space) would be the different scales presented here as individual examples. The different scales interact with each other as part of a zoom-in/zoom-out analysis (a 'zoom effect'). This strengthens the comparison because instead of comparing similar things (such as the architecture of megalithic burial chambers), different scales of the megalithic phenomenon are compared, searching for similarities and differences. These scales of analysis are constituted by (1) a megalithic chamber (dolmen), (2) a megalithic burial mound, (3) a ceremonial enclosure, (4) a post-megalithic-monument and (5) a megalithic landscape. The latter is the most innovative contribution of the approach we are proposing as the replication of the basic structural elements of the simple architectural scales of megalithism at this scale is unexpected. The aspects of common forms are described for each example. Finally, the general hypothetical model constructed from this is contrasted with some examples from other contexts, that account for a wider validity of this structure, perhaps at the whole level of Atlantic megalithism. To start, we will present a brief overview of Galician (NW-Iberian Megalithism), followed by a summary of the basics of the space's structure embedded in this phenomenon.

A short introduction to Galician Megalithism

Megalithism was a prominent phenomenon in the Galician region of NW Iberia, with the oldest monuments dated to 4400-4300 cal BC, slightly after the agriculture is evidenced here (López-Sáez *et al.* 2010). These early structures were relatively small, featuring mounds between 15 and 20 meters in diameter and small polygonal chambers. By 3900-3700 cal BC, megalithic construction became more widespread, with larger mounds (*mámoas*) reaching diameters of 20-35m and heights of up to 2.5m. Over time, chamber sizes also increased, eventually evolving into corridor chambers. A hallmark of Galician megalithic architecture, akin to practices in much of Portugal, is the use of seven-slab chambers, with one slab serving as the central structural component, and two marking the transition between chamber and corridor (Criado-Boado and Fábregas Valcarce 1989; Fábregas Valcarce and Vilaseco Vázquez 2006).

Around 2700 BC, these larger chambers were intentionally closed and subsequently abandoned, likely signalling a shift in cultural practices. Simpler tomb monuments were constructed during this period, and earlier monument were occasionally reused or reconstructed by the Bell-Beaker people. While many of the chambers are oriented towards the sunrise at the winter solstice, recent research has revealed that their astronomical relationships were more complex, aligning with various solar and lunar events and considering neighbouring monuments or significant natural landmarks (González-García *et al.* 2019).

Perhaps the most distinctive feature of the Galician megaliths is their density. Current estimates suggest that nearly 11,000 megaliths still exist across the region (Berganzo-Besga *et al.* 2021; Carrero-Pazos *et al.* 2020), with some researchers estimating the original number of monuments to have been as high as 20,000. This is particularly striking taking into account that the total surface of Galicia is ca. 30,000 km^2.

Since the early 1980s, various researchers, including one of the authors, have adopted a landscape archaeology perspective in studying these monuments. This approach, which has included pioneering work on route networks and visibility studies, provides the foundation for the structural analysis proposed here. Evidence of ritual practices and settlement structures associated with these megalithic monuments are very limited, but some have been documented nonetheless (further discussed below).

Basic model of the structure of space in Galician Megalithism

The megalithic architecture of Galicia frequently follows a recurring model that can be briefly summarised as a circular space with two opposing halves oriented along an E-W axis, or more specifically, a SE-NW alignment. The southeastern half is associated with the world of life and light, while the north-western half, by contrast and following the logic that the NW is a point of absolute shadow, is linked to wilderness and darkness. This symbolic division is further reinforced by solar movements: the axis of articulation corresponds to the sun's path from its rising at the winter solstice (in the southeast) to its setting at the summer solstice (in the northwest). At the summer solstice, the sun reaches its northernmost point before beginning its southward movement again.

It is this SE-NW axis that plays a central role in the spatial organisation of megalithic structures, rather than the more conventional N-S axis. For societies without knowledge of terrestrial magnetism, the concepts of 'north' and 'south' were derived from the movements of the sun and moon, rather than being inherently obvious (Ruggles 1999). Sun solstices, equinoxes, and lunar standstills (moonstices) provided the reference to establish cardinal directions as the midpoint on the horizon for the apparent motion of the celestial bodies. In the absence of a compass, the N-S axis would have been a derived observation rather than an a priori reference point.

Scale 1: the megalithic chamber

The articles in this volume testify to the variety of megalithic chamber forms across different regions. In some areas long passages appear (in parts of Britain and Ireland, but also southern Iberia), elsewhere covered galleries or *allées couvertes* (France). In Scandinavia and Orkney, quadrangular chambers are prevalent, while other forms exist elsewhere. However, the morphological characteristics of Galician and Portuguese chambers particularly exemplify the structure discussed previously, with seven-stone polygonal chambers, predominantly circular, featuring a distinct entrance and a short corridor. This spatial model is consistently reproduced in Galician megalithic chambers and, while it appears throughout the Atlantic and broader European megalithic world, it manifests with particular prominence and regularity in the Galician and Portuguese megalithic provinces.

The construction typically follows a pattern: a headstone is positioned in the northwest of the planned chamber, with one face oriented towards the sunrise at the winter solstice, and the other towards the sunset at the summer solstice (complementary orientation of the previous). The remaining six stones are placed symmetrically around the headstone, with the opposite side left shaping the entrance to the chamber. The orientation of this entrance, generally accessed through a short corridor of one to three sections (never exceeding three in Galicia, though longer multi-section corridors are common in central Portugal), is typically clustered around where the sun would rise at the time of winter solstice (González-García *et al.* 2019; Higginbottom *et al.* 2023, 2024).

This alignment suggests a symbolic division, where the entrance - connecting the world of the living and the realm of ritual - is illuminated and faces east-southeast. Conversely, the headstone and burial chamber, representing the world of the dead, are oriented towards the northwest, symbolising darkness and the shadowed domain.

Examples of this structure are evident in key sites, such as the main chamber of Dombate (Rodríguez 2011) and Forno dos Mouros do Bocelo (Criado-Boado *et al.* 1991). The consistent southeast orientation of Galician chambers, coupled with their architectural layout, ensures that the lighting conditions throughout the year reinforce the spatial dissymmetry. Recent studies suggest that this orientation, particularly towards the winter solstice, results in the southern half of the funerary chambers receiving some light - occasionally even direct sunlight - while the northern half remains in perpetual shade (González-García *et al.* 2019).

This light-based dissymmetry sometimes extends to the architectural design of the chambers. In certain cases, despite being constructed with seven slabs, the chambers exhibit an east-west distortion, with a smaller NE part and a slightly protruding SW part, producing an inverted P-shape. A clear example of this can be seen at Casa dos Mouros de Regoelle, in Dumbría (Coruña) or Forno dos Mouros do Bocelo (see Figure 1) (Criado-Boado *et al.* 1991).

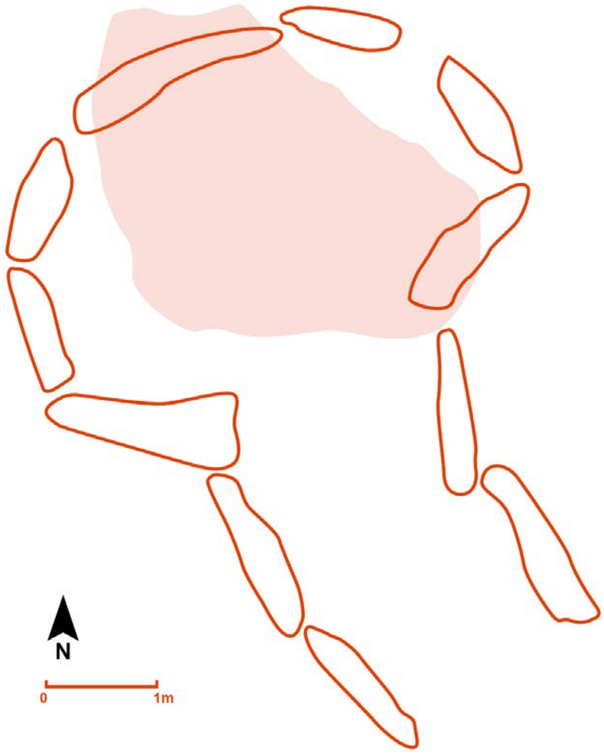

Figure 1. Lay-out of the first monument of Forno dos Mouros do Bocelo (Image adaptation by authors, after Criado-Boado *et al.* 1991).

The structural model of megalithic space, as presented in the megalithic chambers, appears from the earliest stages of Galician megalithism, further supporting this analysis. The oldest reliably dated chamber in Galicia, within the *mámoa* 5 monument of Forno dos Mouros da Coriscada, provides critical evidence (Mañana-Borrazás 2005). Though the large polygonal chamber it contained has since disappeared, excavations revealed that the larger tumulus, constructed in the 4th millennium BC, incorporated an earlier tumulus in the north-western sector. This earlier structure contained a small polygonal chamber with a short corridor, dated to approximately 4400 cal BC. The structure and orientation of this ancient chamber align with the patterns described above and continue to develop in later periods.

Notably, the NW-SE dissymmetry of this early monument is materialised through the different stones used for the chamber's slabs. While the slabs on the north and west sides of the chamber were dark slate (either grey or blackish), those facing the southeast, including the corridor slabs, were white quartz. The contrast between dark and light stone mirrors the NW-SE orientation symmetry (see Figure 2).

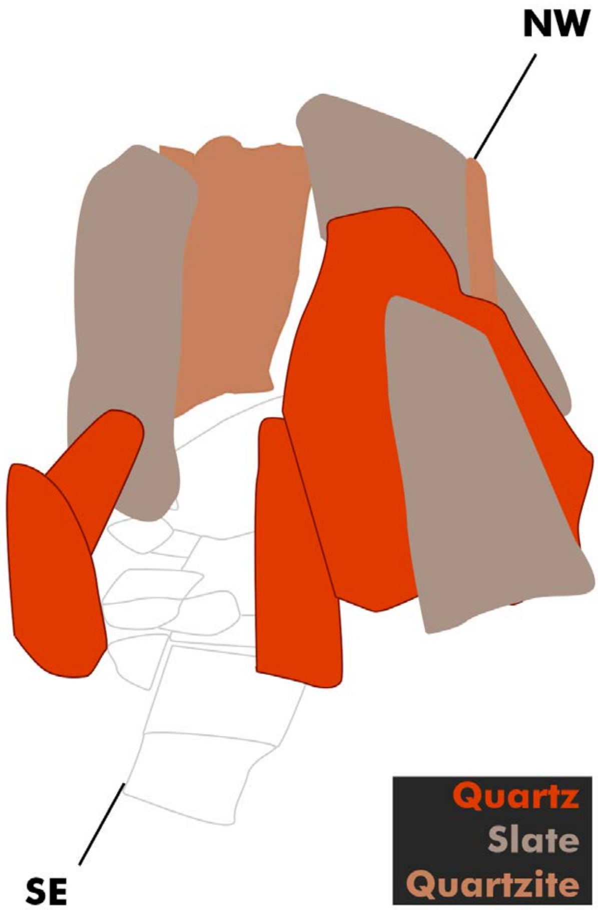

Figure 2. Reconstruction of the chamber of Forno dos Mouros da Coriscada (Ortiguiera), marking the lithological differences (Image adaptation by authors after Mañana-Borrazás 2013).

Scale 2: the mound

While the observations described above are well established, Galician archaeology has paid relatively little attention to the fact that the architecture of the mound covering the burial chamber mirrors the same structural scheme. First of all, the mound often features an access point oriented towards the southeast, extending the chamber's corridor and opening into a court or ritual space placed in the south-eastern sector of the mound. Often evidence of ritual activities is found in this area, such as fires, deposition of anthropomorphic idols, and concentrations of ceramic and lithic materials. These concentrations may represent either grave goods, offerings, or remains of rituals that mediate interactions between the living and the dead. Notable examples of this include Argalo, Dombate, and Forno dos Mouros do Bocelo (Criado-Boado *et al*. 1991; Rodríguez 2011). In many cases, this south-eastern space, particularly in large polygonal chambers from the 4th millennium BC, was violently sealed off around 2700 BC. By tearing rocks from the mound's cover a filling part of the entrance with them, access to these monuments would be effectively blocked (Criado-Boado *et al*. 1991; Fábregas Valcarce and Fuente Andrés 1991).

The architecture of the stones covering the mound (*coraza* – a sort of shell made up of small stones) reflects this same structural pattern in various ways. In some instances, the difference is materialised in the lithology of the used stones. Light-coloured stones, often quartz, tend to dominate the south-eastern side, while darker stones are more prevalent to the north and west. This difference is easily visible. In other cases, the contrast is more pronounced, with the south-eastern half of the shell featuring large, carefully arranged stone blocks, while the north-western half is composed of smaller, more irregular stones or even lacks a substantial shell altogether. The *mámoa* 5 of Forno dos Mouros da Coriscada exemplifies both of these features, combining differential lithology (as seen in Figure 2) with an asymmetrical architectural approach (Mañana-Borrazás 2005).

Scale 3: a ceremonial enclosure

One of the few examples of non-funerary structures in Galician megalithism can be found at the site of Montenegro. This Late-Neolithic site, excavated in an open-area excavation in the early 2000's, can be found in southwest Galicia in a prominent position at the head of the Moaña Valley. The documentation of a structure, understood as a small ritual enclosure, shows a circular lay-out, incorporating (in its west side) the element of a natural rock outcrop (see Figure 3). The entrance of this small structure, whose inner diameter measures approx. 20m, is facing the southeast. Moreover, a clear division of this half from the north-western half is reinforced by the distribution of lithics, pottery and broken millstones, which are clearly centred in the south-eastern section of the structure, evidencing a dual and asymmetrical organisation of space (Gianotti *et al*. 2011). These aspects (circular form, W-E dissymmetry in the external ditch of the enclosure, shaped by the rock outcrop in the west and a ditch in the rest, south-eastern orientation and the division of space) are assumed as common forms that will be discussed further.

Scale 4: a non-megalithic monument. The simplest materialisation of the structure

A small, non-megalithic tumulus was excavated near Vigo (mámoa 3 of San Cosme; Parcero-Oubiña 1998). Although no radiocarbon datings of this site were published so far, we refer to it as a non-megalithic monument due to the characteristics of the structure. During the excavation, smooth undecorated ceramic material was linked to a first phase of use, and Bell Beaker material to a second use phase. This site did not contain a true megalithic chamber. The funerary

Figure 3. Schematic depiction of the lay-out of a ceremonial enclosure at the megalithic site of Montenegro. In orange and red the dug structure, in grey a natural rock outcrop and in light grey the intentional distribution of different materials (Image adaptation by authors after Gianotti *et al.* 2011).

structure was reduced to a small slab serving as a standing stone in the mound's centre, situated beside a small pit. In spite of differing from the usual megalithic architecture, the complete excavation of this tumulus revealed the same structural asymmetries previously described in the model of megalithic space in Galicia. Both the morphology of the stone shell-extending uniformly over the south-eastern part of the tumulus and reduced to a peripheral ring in the north and west-and the presence of a wide court-like area toward the southeast, the concentration of grave goods in this sector, and the lithological asymmetry of the mound (with a predominance of light-coloured stones in the east, mostly absent in the west and north), reinforce this impression. These findings suggest that even in the later stages of megalithism, after the peak moment of Galician megalithism of monuments built between 4000 and 3500 BC, in use until around 2800 BC (Criado-Boado *et al.* 2001)-this structural model of space remained operative.

However, the most notable discovery was the identification of this structural asymmetry in a highly simplified form within the central standing-stone itself. Its broadest sides were oriented to face north and south, making the narrow sides (barely 30cm wide) face east and west (see Figure 4). What was particularly interesting was that the surfaces of either one of these narrow sides had received a different surface treatment. While the eastern side was smoothed and retouched to a clean and polished surface, the western side maintained its rough, quarried state, even showing intentional marks to emphasise its unfinished appearance. This serves as a remarkable example of the spatial asymmetry we have described, reduced to its minimal expression here.

Scale 5: the Megalithic Landscape

The structure that has arisen in the previous scales, has been proposed by Criado-Boado and Villoch Vázquez at the landscape scale based on the study of the distribution of burial mounds in different areas, particularly in the megalithic necropolis of the Serra da Barbanza (Carrero-Pazos *et al.* 2020; Criado-Boado 1989a; Criado-Boado and Villoch Vázquez 2000) and of the Chans de Amoedo (Criado-Boado 1999).

Barbanza is a peninsular region in Galicia (see Figure 5). The space of its central Mountain Range (Serra da

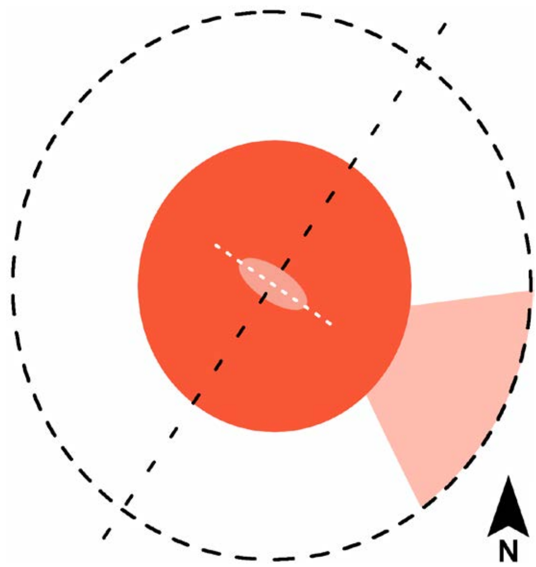

Figure 4. San Cosme mound, in orange the central burial area is indicated, in light orange the south-eastern direction as emphasized by a stone concentration. Central in the burial area is a standing stone, further dividing the space with its characteristics. (Image adaptation by authors after Parcero-Oubiña 1998).

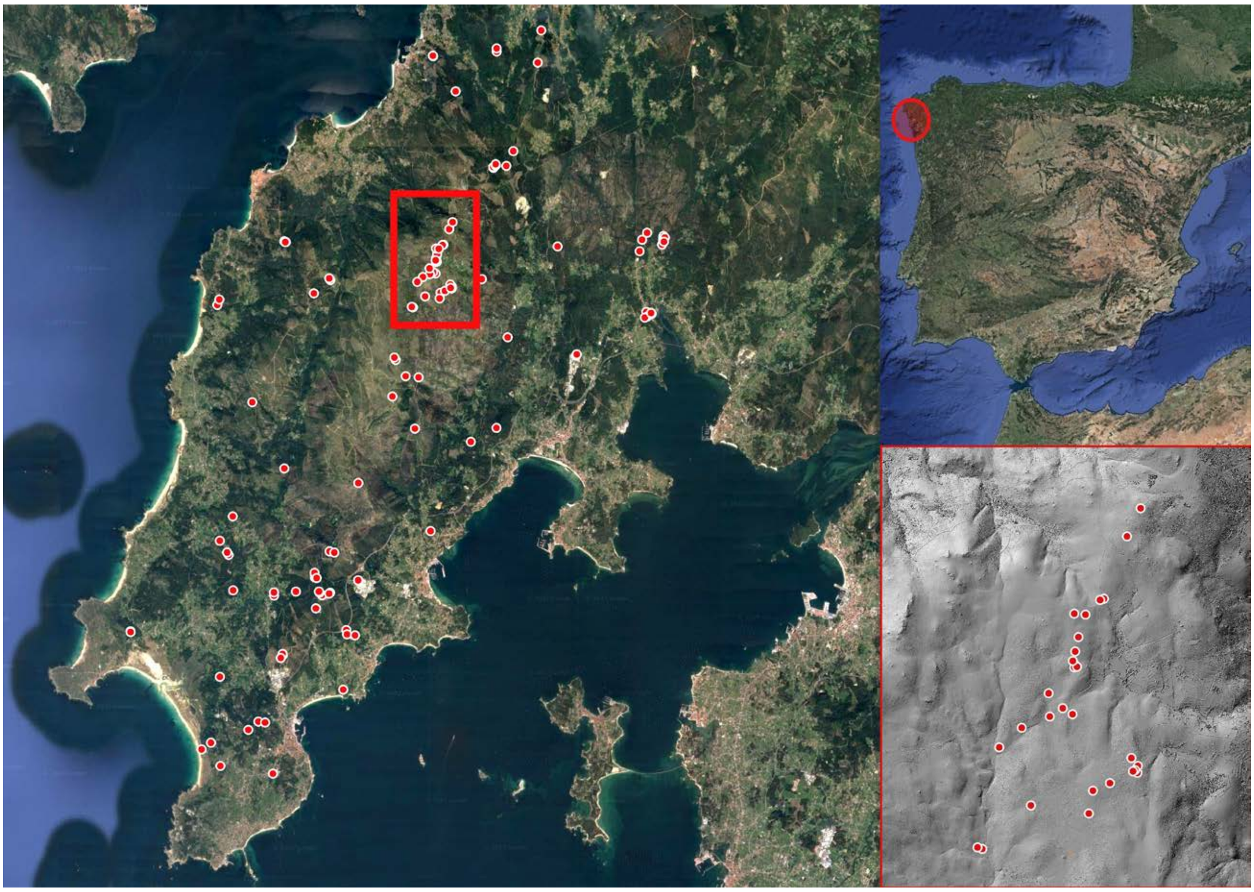

Figure 5. Megalithic distribution (red points) on the Barbanza Peninsula. Red square and detail indicate the Barbanza Mountain Range megalithic concentration.

Barbanza), displays a significant concentration of megalithic monuments; 30 mounds are located in an area of 2km^2 grouped within a central point that organises and distributes movement through not only the Barbanza Mountain Range, but also the entire Peninsula. It is a crossing point of transit routes, especially the ones relevant for navigation on foot, in a society without draught animals or wheeled vehicles. The concentration of mounds configures a circular landscape, the outwards visibility restricted and limited by higher topographic horizons that are formed by the hills. Visually and topographically, the necropolis is shaped like a plate, with a flat and smooth central area that is enclosed by higher hilltops.

The mounds are located in the centre of this circular space, forming an approximately north-south oriented line. This line fits with the main direction of the most efficient transit route. Besides this, some individual mounds are linked to transversal passes crossing this main line. Others are located in lateral extensions of the main route, allowing access, in different directions, to the main areas of the peninsula.

The segmentation of space discussed above, based on the opposition between the E-SE and W-NW halves, is extended to the whole landscape here. As in the corridor the SE/NW orientation indicated the opposition between life and death, in the landscape this is enlarged to become a division between the domesticated and the wild, in that order. This division is put in place on the scale of the landscape in the Barbanza Mountain Range through the placement of the mounds (see Figure 6). Their intentional placement is evidenced through the analysis of the concepts of movement and vision. Already in 2000, Criado-Boado and Villoch Vázquez detailed common characteristics of megalithic landscapes, highlighting their circular, visually enclosed nature, often defined by topographic features within low-lying areas or basins. They distinguished that this pattern is particularly evident for *mámoas* near watercourses but also applies to those on hills, where distant hills frame the view. The edges of the visible panorama tend to be marked by natural elements and artificial monuments, with *mámoas* frequently visible on the horizon. These scenes typically have a central point, usually a *mámoa*, placed on an elevated feature or in the axis of a depression, creating a consistent pattern of enclosed circles with a monumentalised centre (Criado-Boado and Villoch Vázquez 2000).

This pattern has been later reviewed extensively with GIS methods (Fábrega-Álvarez and Parcero-Oubiña

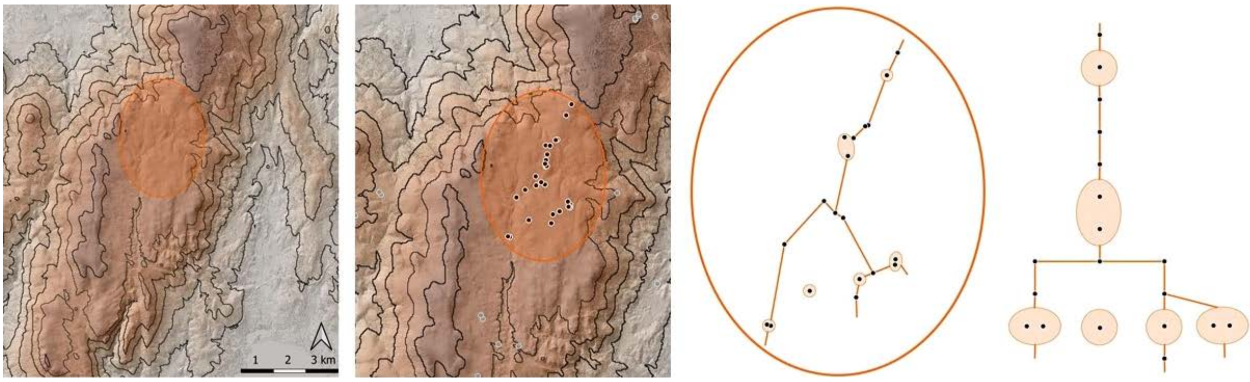

Figure 6. Gradual schematisation of the organisation of space at the megalithic necropole of the Barbanza Mountain Range. a) The circular and enclosed condition of the necropole's location. b) The distribution of the mounds. c) A schematic depiction of the distribution of the mounds, indicating the structure that is formed through movement and visibility between the mounds. d) A depiction of the resulting structure.

2019; Llobera 2015; a comprehensive overview of the GIS studies of Barbanza and their results is in preparation by Verdonkschot, Fábrega-Álvarez, Canosa-Betés, González-García and Criado-Boado). These studies showed both that the mounds were positioned along the routes of easiest transit through the mountain range, and that their placement permits a system of intervisibility that guide one from one 'mark' to the next. Thus, a person navigating this landscape is led from one mound to another while never losing visible contact with them, as the best transit route is thus indicated. This positioning of the mounds in the landscape is associated with natural lines of movement, but also with rocks and significant natural features, previous monuments and supposedly the villages of their builders (Criado-Boado and Villoch Vázquez 2000).

While this system of movement and visibility indicates the optimal navigation of the landscape, it also divides it in the way that was previously discussed. The E-SE part was presumably connected to the domestic sphere, as it is related to the more visible, bright and open characteristics in the landscape, while the W-NW part would be related to the wild and unknown (not to say ritual), being linked to more obscured and closed features in the landscape. Although there are not sufficient evidences to support this claim currently, it is strongly that the areas of agricultural activity and domestic structures would have been located towards the east of the Mountain Range. This is based on the pollen indicators documented in the thus far only palaeo-environmental research carried out in the area (Criado-Boado *et al.* 1986). As further research is currently taking place in this area of study, it might be possible to shed more light on this topic soon.

If we return to the central N-S line of mounds, we notice that it divides the circular space in two halves, roughly an eastern and a western one. These halves present opposing characteristics; whereas the eastern one holds the inner valleys more suitable for human settlement and permanent agricultural use, the western half holds the rugged, uncultivated land. The mounds themselves tend to be located in the area suitable for an extensive use of woodland, bush cultivation and grazing. Due to the placement of the mounds in relation to the upper areas, they are most prominently visible from the eastern half, creating even a balcony effect of sorts as they are lined up with the horizons from this perspective. This is what leads us to state that the mounds are oriented towards the eastern half. Moreover, the north-south line is emphasised through a direct visibility from one mound to the next.

Again, the megalithic structure of space is identified at the landscape scale through a specific order, in which a formalisation of the elements of circular construction, visual limiting and segmented space are evidenced. When dealing with megalithism, we must be aware that its characterisation of 'phenomenon' or 'megalithic society' is elusive. As a matter of fact, we are dealing with an extensive period of time in which several stages of monumental building activity can be identified. According to calibrated radiocarbon dates, the earliest megalithic structures in Galicia can be dated around at least 4400-4000 BC. Galician megalithism reached its peak in another timespan, dated between 4000 and 3500 BC (Criado-Boado *et al.* 2001; Ramírez and Valcarce 2002). Apart from these main construction phases, as observed in radiocarbon datings, we should consider the re-structuring and re-use over a period of time spanning over 1000 years. From this point of view, we may appreciate the order which is continuously shaped, constructed and in some form perpetuated.

A chrono-cultural point of contrast

For a point of contrast, required to reflect upon the previous statements, a brief detour is necessary here to explore another example of Atlantic Megalithism; the well-known Perdigoes enclosure. The Neolithic and

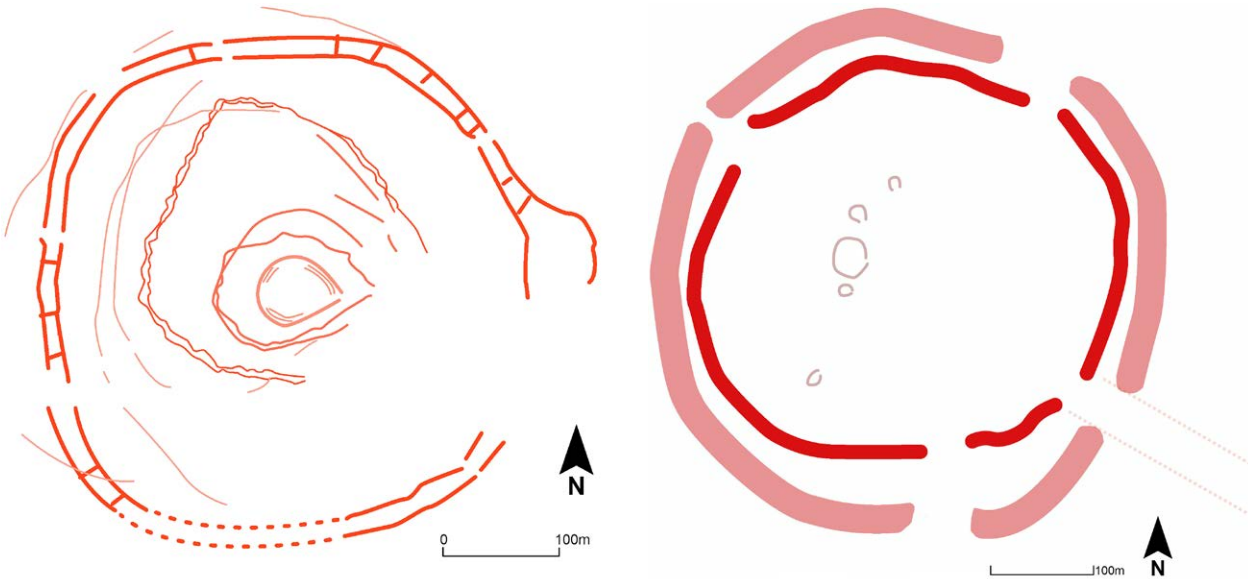

Figure 7. Schematic depiction of the megalithic enclosures of Perdigoes (left) and Durrington Walls (right).

Chalcolithic archaeological site of Perdigoes is located in a lower part of the landscape in the Alentejo inland in the Portuguese Middle Guadiana Basin (Valera 2018), ensuring a delimitation of the space by the surrounding rising horizons. Moreover, as can be seen in Figure 7, the circular form of the structure and southeast oriented entrance are linked with some of the main characteristics of the previously detailed elements identified in the structural model of megalithic space. The orientation of the enclosure, regarding its environment and especially the Monsaraz peak as well as the solar position at the summer and winter solstice is discussed into detail (Jiménez Jáimez *et al.* 2022), corresponding largely to the lines we have previously laid out.

As another example, this time venturing slightly further away, the Durrington Walls henge in England is presented. This megalithic enclosure in the immediate vicinity of Stonehenge shows the same characteristics of a circular lay-out and southeast oriented main entrance (Gaffney *et al.* 2018, 2020). As a matter of fact, these two examples call for further research to test to what extent the Megalithic structural model we are proposing was also operative for the Neolithic enclosures of Atlantic Europe.

Interpretive challenges and future directions

On the different scales of megalithic materiality that we have reviewed here, we found a shared structure of space that conceived this as circular, marked a central focus, enveloped this in a circular arrangement, in turn delimited by an exterior line (either a ring conceived by a positive or negative structure, piled stones or topographic horizon), and delimited the world of the living and the dead. The SE (either a passage, a court or domestic area) built an area of mediation between life and death and guided the observation of a segmented space. The axis of the system is always oriented towards the southeast; pointing to the winter solstice and thus the end of winter and the resurrection of the sun. In this ritual space deposits were made and ritual or domestic activities took place.

Having exposed our examples and reasoning regarding the existence of a model of space, the question that remains to be answered is how this consistent model of megalithic spatial structuring is generated and maintained. How and why it traverses different scales and materialisations of the megalithic phenomenon, and why it persists over time. Based on the initial hypotheses explored in the XSCAPE project, we believe that this is exactly what we should expect and learn to recognise in the archaeological record. The reproduction of culture and the creation of a balanced order between the cultural and the natural require strict and consistent codes. These codes are materialised to enhance their effectiveness, as cultural formalisations rely on familiar codes and structures within each society, which are reproduced to better ensure the continuity of the socio-economic formation.

The XSCAPE project hypothesises that once these codes are materialised, these materialisations inform the cognitive processes of those who engage with them through the impressions and perceptions they generate. These perceptions shape each individual's internal model for cognitive navigation of the world. Because the external, artificial model of reference is consistent for each individual, the internal models within the group are largely similar. In this sense, once the external material model is internalised by the individual and aligns with the internal models of others within the group, the internal model becomes a robust cultural structure, which tends to reproduce and perpetuate itself.

Thus, we move from form and matter to XSCAPE, from the external model to materialisation/formalisation of the internal cognitive structure. Megalithism provides a privileged field of study for this analysis, not only because it allows us to empirically analyse and 'archaeologies' this process, but also because it represents a crucial moment when this phenomenon occurs for the first time on a human scale, based on monumental material culture. However, this process is not unique to megalithism, it applies to any form of early monumentality, with megalithism being merely one manifestation of it.

Conclusions

This article aimed to formulate a nuanced appeal for a structural approach in archaeology, inspired by Lévi-Strauss yet updated with insights from research in recent years. The articulated model of megalithic space organises the elements of circular form, dual and asymmetrical (segmented) space and orientation throughout a set of contexts from the realm of megalithic materialities, that built different versions of this structural model. Through this model, assumptions can be made regarding megalithic thought.

The viability of this approach for archaeological research is consistent through the given examples, and the integration of concepts such as the internal model, embedded normativity and latest developments in research regarding the relationship between thought and materiality. This provides a framework for interpreting the rationality underpinning archaeological contexts, in this case, Atlantic megalithism. The model proposed here does not only align with observed archaeological patterns, but more importantly, thereby enhances our understanding of the processes of thought and normative behaviour of societies.

The demonstrated applicability and potential of the propositions in this article show its suitability for broader archaeological research. Future research on the interplay of materiality and cognition, covered in layers of thought (rationality), meaning and function, can build upon this foundation. At the same time, further efforts into expanding the dataset and continuously incorporating new theoretical insights assure that the model proposed in this article will continuously both structure and be structured, in its further exploration and refining.

Acknowledgements

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Chapter 14
Fathoming megaliths: social proxies and indicators for the study of the dolmens

Gail Higginbottom

Abstract

This chapter primarily explains the theoretical underpinnings as well as the systematic method applied to the research undertaken on the Galician Neolithic for the Horizon Europe project SHoW. It will reveal much of the philosophical reasoning and systemisation that could not be contained within the often statistically based publications that have emerged from this work. Most particularly, it will demonstrate the use and reasoning behind the chosen social proxies and social indicators (qualities of the chosen proxies) to determine something of the relevance of dolmens for their creators. The proxies discussed herein are dolmen location and dolmen architecture. For architecture, the chosen proxy is monument axis and its concomitant social indicator is direction or orientations of the axis (as a measurable indicator). The conclusions arising from the examination of these social proxies are then reviewed through thematic contextual filters. Such filters can act as further social proxies or be physical realities (Laws of Physics). Themes include environmental information where scientific data and ethnographic information act as social proxies. Once the theoretical underpinnings are explained, an overview of the methods and results of this work is given. This chapter clearly demonstrates how such a systematic method can work and offer up rich, thought-provoking interpretations and models to be tested by further field work. Significantly for this chapter, the social position of dolmens in the Neolithic is revealed.

Keywords: Neolithic, Megaliths, Iberia, Materialisation of Culture, Cultural Change, Cultural Proxies, Landscapes, Resource Management, Cosmology, Cultural Astronomy

This chapter primarily explains the theoretical underpinnings of the methods, as well as something of the methods themselves, applied to the research undertaken on the Galician Neolithic for the Horizon Europe project *SHoW*. It will reveal much of the theoretical methodological reasoning that could not be contained within the often statistically-based publications that have emerged from this work (Higginbottom *et al.* 2022, 2023; Higginbottom *et al.* 2025). This work will also reveal something of the new social conclusions uncovered by this project, namely the meaning of dolmens for those who built them.

The clarity of both the data and the results are attributed to their original reductionist origins and are illustrated through explanation and example of the theoretical approach and outcomes. Further, it is the creation of these reduced or elemental data (fundamental constituents) that allows for their entailing within an overall holistic strategy leading to nuanced conclusions about past people and where their activities and belief systems are more easily envisaged (*q.v.* Higginbottom 2020 on the connection between the hermeneutic approach to History and hermeneutic phenomenology).

The archaeological and regional foci of this paper are the dolmens of Costa da Morte, where the latter is one of several case-study regions under examination in Galicia. Much of the other non-statistical archaeological data reviewed, also used as social proxies, are to be found in a larger production (Higginbottom *in preparation a*), as well as works that detailed the place of iconography within the Neolithic and their possible connections to dolmens (Higginbottom *in preparation;* Higginbottom and Santos Estevez *in preparation*). Those proxies primarily include megalithic art and include a review of data and information from several other projects from western Iberia, in particular.

Theoretical underpinnings

The *SHoW* project adopts the view that that we should 'approach architecture as one of the aspects of a culture upon which a society directly imposes its way of being on the world' (Criado-Boado 1999; *q.v.* Criado-Boado *et al.* 1986; Criado-Boado and Mañana Borrazás 2003: 5). Further, this project considers 'the materialisation of ideology as a means to highlight the active process that underlies the creation, dissemination and manipulation of ideologies' (DeMarrais *et al.* 1996). In adopting this same materialist perspective, this paper maintains that people's 'concepts are given concrete, physical form, as part of human interactions with symbol and icons, performances, (and) monuments' (DeMarrais 2012: 11). In this view, the action of making something is both a ritual itself and a materialisation of culture, where 'to materialize culture is to participate in the active, ongoing process of creating and negotiating meaning' (DeMarrais *et al.* 1996). These are all part and parcel of the materiality of practices (Toren 1999: 18). On this basis, like Higginbottom and Criado-Boado

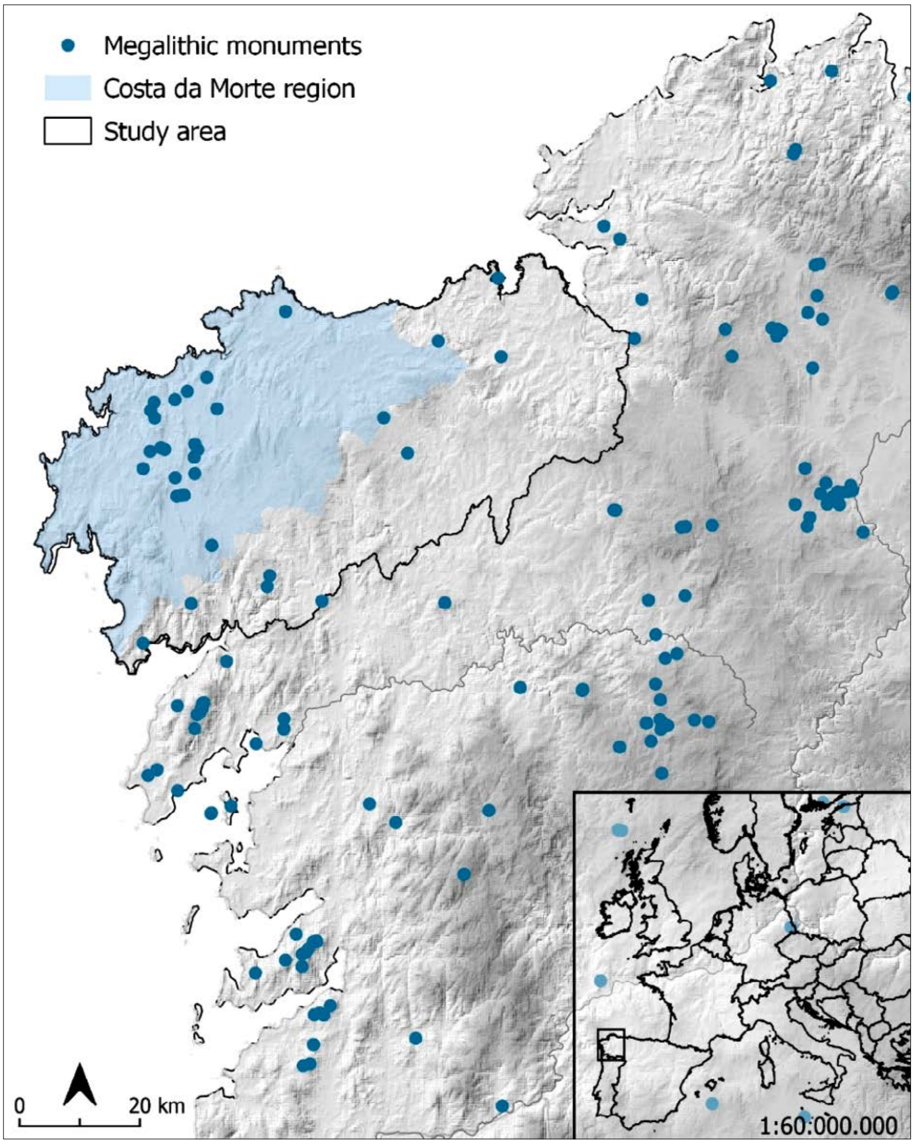

Figure 1. Map of Galicia with study area of Costa da Morte outlined and dolmen locations highlighted (elevation data from http://mapas.xunta.gal/centro-de-descargas). (Created by Maria Gomez Faro).

(Higginbottom *et al.* 2015; Criado-Boado 1999), it is therefore considered possible to reverse-engineer such connections, and thus, by studying the *elements* of material culture and practices we can come to know something of the conceptual belief systems associated with them (also see Criado-Boado and Verdonkschot, this volume).

Thus, we adopt a formal analytical approach that allows us to first to deconstruct and then to describe the resulting elemental cultural phenomena (Criado-Boado 1999; Criado-Boado and Mañana Borrazás 2003). Such deconstruction happens on more than one level and allows for the decomposition of material phenomena or social space (whether that be a landscape or a tomb) to the levels that constitute it (these are *social proxies*, SP; e.g. architectural design), which in turn allow us to (i) identify the basic elements or *social indicators*, that make up the SP (social indicator = SI; e.g. monument axis), (ii) discover their configuration (social indicator qualities, SI-*1…n*; e.g. azimuth of axis) and then (iii) to describe how each of these 'operate' in the *social* context (Hypothetical Concrete Models, HCM; Figure 2 - Strategy Model). Once all of the concomitant Hypothetical Concrete Models (HCM *1…n,* sets of hypotheses)[1] have been produced for each targeted social proxy, the *interpretive assessments* or Ideal Concrete Interpretations (ICI-*1…n*) of the original phenomenon can be attempted. These include meanings and ideologies attached to the material culture and practices (e.g., dolmens and their creation).

[1] Note for our model (e.g. Figure 2) we expressed this as HCM a … *n*, using letters instead of numbers, where a=1, b=2 and so forth.

Whilst Criado-Boado and colleagues do not formalise their steps as clearly as in the current project, to know what the social proxies are and itemise them is an evident advantage. Also, the advantage of identifying specific informative social indicators is that you can carry out, not only narrative descriptions, but those of a statistical nature, both qualitative and quantitative, and the outcomes of each of these provides you with an informative HCM.

Criado-Boado (1999) argues that once this is done a possible *Ideal* Concrete Social Model (ICM), or set of essential belief systems, can be *formed* from the consideration of the outcomes of all the HCM together. At this stage, it is necessary to confirm the validity of all HCM models by seeing how well they and their interpretations (ICIs) dovetail together and the manner in which they do so. For if the interpretation is not internally consistent then they will need to be reviewed. If, upon reflection, an HCM is not fully satisfactory, one does not discard the social indicators attached to that model but reinvestigates them. Further, in recognition of the interwoven and complicated nature underlying reality, namely that social proxies interact to create realities, the current project also combines the analyses of social proxies to create HCMs that reflect this (for e.g., HMC3; Figure 2). This project also expands on Criado-Boado's strategy by allowing for the creation of new HCMs and interpretations (ICIs) by combining the HCMs through the filter or the inclusion of *thematic contexts*. Such contexts, like the immediate natural environment, can be treated as social proxies, where the social indicators can be specific environmental data or other information revealing human behaviour in response to or effecting the natural environment. Thematic contexts can also be physical realities (as in the Laws of Nature or *Physics*, e.g., astronomical behaviour) that offer *contextual information* about the social proxies being examined, thereby providing the possibility of greater accuracy in the creation of ICIs and the final model. Contexts may also include ethnographic material as a reflective tool for the study of prehistory. As well as enhancing the reliability of the ICI models, this approach potentially enriches our considerations and the hypotheses we make for future testing. Further, at a later date, these HCMs and ICIs can be reconsidered through the introduction either of more social proxies or contextual filters (like other archaeological data, such as associated find types – idols – or decorative features of structures – carvings; Higginbottom *in preparation;* Higginbottom and Santos Estevez *in preparation*). Herein will be demonstrated the creation of the ICI models through the incorporation of several related contexts at different stages of the research strategy that includes the quantitative research (See Figure 2). The final ICM, which also includes several archaeological contexts as social proxies, is revealed in Higginbottom (*in preparation*).

By partially adopting Criado-Boado and Mañana Borrazás' materialist perspective, then, the current project 'arrive(s) at a description from the … logic of spaces … and thereby establish(es) the basic form or formal pattern invariant that manifests itself in said construction and from it define(s) a Hypothetical Concrete Model (HCM) of the spatial organisation' (Criado-Boado and Mañana Borrazás 2003: 105; brackets inserted by current author). Once this is done, this author sees that the ICM ideologically manifests through the enfolding of all the information that has gone before, funnelling through the contexts the HCMs and the ICIs altogether.

The current project also differs from that of Criado-Boado 1999 and his later works in an essential way. In those works, Criado-Boado *et al.* focus upon the architectural design of the monument as a first step for investigating common design features and *then* search for possible similar forms in the world surrounding these monuments (such as domestic space or how the land was divided into use or ritual zones and the shape of the occupied land): a kind of inside-to-the-outside approach. This project *begins* with the landscape and then moves to the monument *and then* back again to the world outside the dolmen, as it seeks the possible connections between them. Like Higginbottom and Clay (2016), it upholds that past people knew the world and landscape surrounding them *before* they conceptualised, knew or created dolmens (*c.f.* Criado-Boado and Verdonkschot, this volume).

Basic astronomical information and definitions - cycles

Whilst the Earth rotates around the Sun, in terms of naked eye astronomy, a solar year is the time that the Sun takes to return to the same position in the sky – as viewed from the Earth. Throughout the year, in the northern hemisphere, the Sun's rising and setting positions move more northerly each day as it heads to the summer solstice and then moves more southerly along the horizon, as it heads towards the winter solstice. We call the most northern rising and setting points of the Sun the summer solstice, or more accurately, the most northern rising and setting points of the Sun just prior to its apparent change in direction to head southwards. The most southern, then, are those just prior to the Sun's apparent changing of direction to head northwards, at the time of winter solstice. More strictly, a solar year is the period of time for the Sun to pass from vernal equinox to vernal equinox.

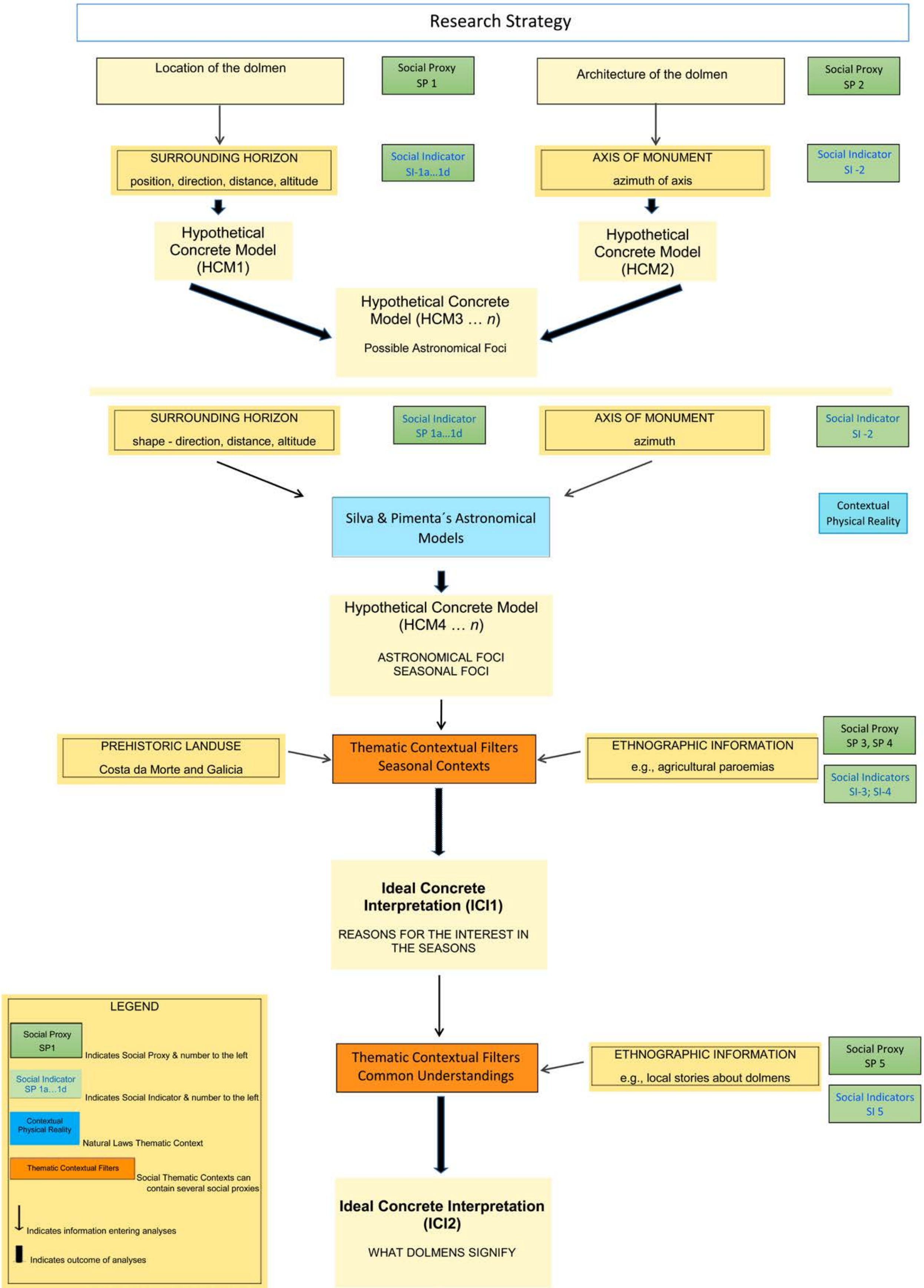

Figure 2. The project's Strategy Model highlighting the chosen social proxies and social indicators along with the outcomes of their application.

Figure 3. Pedra Arca (Regoelle; Casa Dos Mouros) – example of local passage tomb (Photo: Gail Higginbottom).

Instead of a 1-year cycle, the Moon has an 18.6-year cycle which operates similarly to the Sun's annual cycle, where the standstills are the actual most northern or southern points that the Moon may travel, but these can occur above or below the visible horizon. Therefore, one might say the lunistices are the observable maximum northern and southern rising and setting points which occur *closest* to the *time* of Moon's position at the major standstill (greater lunar cycle). The minor lunistice is a more complex matter and is also a phenomenon of the greater lunar cycle and together they are the one-time-only maximum and minimum every 18.6 years. The minor standstill is where the difference in the Moon's most northerly path and its southerly will be at its smallest, and so too, then, the northerly and southerly rising and setting points. The striking visual qualities of this event are that the Moon at this time will always travel between the Sun's extreme northerly and southerly paths, never exiting or crossing the solstice Sun's travels (for a detailed explanation, see Higginbottom 2020: 37-8). Note that, for this work, the terms winter or summer solstice are not 'midwinter' and 'midsummer', but are the first day of winter and the first day of summer, as defined astronomically. The approximate time of this is observable by noting the apparent change in direction of the Sun's rising and setting positions, moving from north to south and vice versa.

This chapter will now proceed simply as follows: (i) background to the Galician tombs (dolmens), (ii) method and methodological considerations (iii) outcomes and (iv) concluding discussion.

A brief introduction to the tombs of Costa da Morte

Costa da Morte is a small region within the municipality of A Coruña. Situated in the most northwesterly corner of Galicia, it is flanked by the Atlantic Ocean on the north and west. This region contains a variety of dolmen forms, but they can be generally divided into the smaller, lower dolmens that are probably earlier in date, and those which are significantly larger in size, usually with passages. Naturally, as one might expect, there are those with a combination of styles, like the small polygonal chamber of Anta Zarramaceda, with its short passage. Generally speaking, the smaller megalithic structures are totally covered by mounds about 50cm to 1m high (like Dombate Antigo) and the larger structures have orthostats up to 4m tall, large capstones, polygonal chambers and long passages, covered by mounds of up to several meters and 20-50m in diameter (Dombate Nuevo). Within Costa da Morte, we have some of the most important Galician dolmens, such as Pedra da Arca, Casa dos Mouros, Pedra Cuberta, and Dombate (Figure 3). There are few absolute dates for the dolmens within our study area and even fewer are high-precision determinations from recent excavations. The general consensus is that dolmens were constructed within the 5th millennium to the late 4th millennium, with some possible new tomb building occurring in the early 3rd millennium. Various necropoleis were likely used from *c.* 4300 BC to around 2000 BC, extending hence over several millennia (Carrero-Pazos *et al.* 2020; Prieto Martínez 2012). Whilst its two phases are not millennia apart in construction, Dombate is a good working example of the incorporation of a previous monument plus the reuse of dolmens for millennia (Cebrián del Moral *et al.* 2011: 167).

General methodological consideration

This methodology will restrict its focus to the three quantitatively based studies of Costa da Morte. In this area, thirty-two megalithic tombs fall within the calculated boundaries for the case-study area (Higginbottom *et al.* 2022; Figure 1). The overall approach initially hinges on the first two social proxies: situation of dolmen (SP 1) and architecture of the dolmen (SP 2), where four social indicators are analysed for SP 1 and one for SP 2.

The SPs, SIs, HMCs, and ICIs

The SP 1 chosen measurable SIs are: (b) direction, (c) distance, and (d) altitude of the surrounding horizon in relation to (a) monument location (SI-1a-d). SP 2 only has one: the azimuth of the dolmen axes as signalled by the dolmen architecture (orientation measurement; SI-2). These orientation values come from Vilas-Estévez's study of orientations in A Coruña (Higginbottom *et al.* 2023; Vilas-Estévez 2016: Appendix; Table 1). Landscape models were created to calculate SIs for SP 1. We used the 25m and 5m LiDAR data from the Galician Xunta and the software *Horizon*, to create a 2D horizon profile and a 3D rendered landscape panorama (viewshed) for each megalithic site. Several files were produced for the 2D horizon profiles, both data and imagery. The main data file contains the location of the dolmen and 4 columns of data for 36,000 rows, where each row indicates a new viewing direction from the monument location starting at zero degrees, with new records every 0.5 degree for: latitude (constant), an azimuth (viewing direction), horizon distance in the direction of the azimuth, and altitude (the relative height of the horizon as viewed from site; strictly, the angle that subtends above the horizontal). The 3D landscape panoramas display the

Name of dolmen	Most close horizon (west=Grp 1; east Grp 2)	Azimuth of dolmen orientation	Possible Target Time	Degrees from phenomena in azimuth	Opposite Azimuth of dolmen orientation	Possible Target	Degrees from phenomena in azimuth
Rabós M1	West	120	**MinLSs**	3	300	**SS set**	0.05
Prado de Mina – (Mina de Folias)	East	94	**Equinox**	2	274	**Equinox**	3
Pedra Moura Carmeo (Carnio)	West	117	**MinLSs**	1.5	297	**MinLS set**	Sits between MinLS (2) SS set (5)
Pedra da Arca (Malpica)	East	122.5	**WS rise**	Between MinLS (3) **WS** (2.2)	302.5	**SS set**	1.5
Pedra Cuberta	West	98	**Equinox**	3.8	278	**Mid-point SS set & Equ**	16.1 & 18 either side *c.* 1° from midpoint
Parxubeira	West	97	**Equinox**	4	277	**Mid-point Equ & MinLSn**	13 & 12.5 either side *c.* 0.25° from midpoint
Mina de Recesindes	West	115	**MinLSs**	4	295	**MinLSn**	0.05
Fornela dos Mouros (Aprazadoiro)	West	128	**WS rise**	Between WS (2.6) MajLS (5.4)	308	**N/A**	X
Dombate New	West	126	**WS rise**	1	306	**MajLS**	Dead-on
Dombate Antigo	West	110	**Mid-point WS & Equ**	15.8 & 16.9 either side 0.5° from midpoint	290	**MinLSn**	1.0
Dolmen Cabaleiros	East	92.5	**Equinox**	1	272.5	**Equinox**	2.5
Caxadas	West	124	**WS rise**	Between MinLS (4) **WS** (2)	304	**SS set**	1.0
Casota de Freans	West	110	**Mid-point WS & Equ**	16.2 & 17.1 either side 0. 5° from midpoint	290	**MinLSn**	1.5 (5 fr SS)
Casa Dos Mouros – Pedra Arca (Regoelle)	West	112	**MinLSs**	4.6	292	**MinLSn**	Dead-on
Arca da Piosa	East	95	**Equinox**	3	275	**Equinox**	5
Aquela Banda	East	124	**MinLSs**	Dead-on	304	**SS set**	0.02
Anta da Gándara de Baiñas 1	West	117	**MinLSs**	Dead-on	297	**Midpoint MinLSn SS**	MinLS (3.8) SS set (4.3) 0.25 from midpoint

Table 1. Dolmen orientations on the Costa da Morte.

topography of the entire landscape surrounding each dolmen from the viewpoint of an 'observer', within 5m of the dolmen to the visible horizon. The data tables generated were used for the quantitative investigation of our first set of SIs (SI-1).

SP 1 and SI-1*a-d* were studied to create HCM1 (landscape choices of the dolmen builders), and SP 2 used SI-2 to create HMC2 (directional preferences for dolmen axes – orientation patterns). The next step was to combine SI-1a and d with SI-2 to create HCM3. The data of SI – 1a (viewing location) and 1d (horizon altitude) are required for the astronomical analyses of the monument orientations (azimuths, and SI - 2). Together, these three pieces of data combine to produce second order data, which are 3D values given to those points on the horizon which are intercepted by the imaginary orientation line extending out from the tombs. Relevantly, this value is equivalent to that given to the paths of the astronomical bodies. Therefore, if the two values are the same, we can say that the dolmen is oriented toward that astronomical body at the horizon. These values are called declinations.

Despite the interesting outcomes as represented by HCM3, it was clear to us that a more powerful explanation was required to better understand the data (Higginbottom *et al.* 2023; also see section below on Orientations of the dolmen axes of Costa da Morte - HCM2 & HMC3). To this end, we combined and re-examined all the social indicators of HCM-1 (horizon altitudes/location) and HCM2 (azimuths of the orientations) through the *contextual filter* of luni-solar event models: the statistical modelling of lunar cycles related to the Sun through time (da Silva 2004, Silva and Pimenta 2012). Inspired by Silva and Pimenta's 2012 work, we created models that provided better 'physical realities of observable phenomena' than our previous tests which were *primarily* based upon solar *or* lunar events as separate events, thus this new work ultimately included astronomical events not yet considered (Higginbottom *et al.* 2025).

Armed with this new astronomical information, the project could more accurately assess which astronomical phenomena might be connected to the dolmens by way of orientation and also re-examine the relationship(s) between the overall horizon shape, astronomical phenomena and dolmen location. From this research, emerged HCM4.

These new HCMs revealed (i) the strength and type of astronomical interest, (ii) an interest in complex seasonality and, strikingly, (iii) that each dolmen alignment targets more than one significant luni-solar event (Higginbottom *et al.* 2025). At this point, these ideas were then considered through the Thematic Contextual Filter of seasonal contexts related to resource management, with the goal of creating the first Ideal Concrete Interpretation (ICI-1). The social proxies or 'contexts' that made up this filter were (i) possible prehistoric land uses (SP 3) and (ii) ethnographic information (SP 4). The concomitant indicators are (i) a collection of palaeoenvironmental data (SI-3) and (ii) a collection of paroemias and historic references about seasons and seasonal activity (SI-4).

By filtering HCM4 through these thematic contextual filters, the first ICI model, ICI-1, demonstrates the *significance* of seasonality for the dolmen builders as well as highlighting *which* seasons were a likely priority and why (ICI-1 – 'Reasons for the Seasons').

The last Thematic Contextual Filter to be presented here is 'common understandings' about dolmens and is used to assist in the comprehension of what dolmens may have signified for the builders who lived with them (IC1-2).[2] The social proxy for this stage of the project was ethnographic information (SP 5) and SI-5 was a collection of stories from local people about dolmens. Combining our understandings from ICI-1, essentially the subsummation of all of the HCMs and the data thereof, through this contextual filter, ICI-2 was composed, announcing the 'Signification of Dolmens'. We now turn to the results overview for the main stages of the model before proceeding to the newer outcomes presented here, namely, ICI-1 and ICI-2.

The landscapes of the dolmens - HCM1

In a previous study (Higginbottom *et al.* 2022), evidence supporting the hypothesis that *very specific* natural landscapes *surround* the Neolithic dolmens of Costa da Morte in Galicia (Figures 4a-b) was provided, effectively demonstrating a Hypothetical Concrete Model of landscape qualities likely chosen by the creators of the dolmens. Thus, regardless of the location within Costa da Morte, the dolmens appeared to be united through similarities of community practices that combined chosen landscape topographies (Higginbottom *et al.* 2022: figures 11, 12, 14). This confirms common forms of landscape for our HCM1, most particularly that the western horizons were consistently higher than the eastern, the opposite to that found naturally, but particularly so for sites with a more distant horizon towards the east than the west (Figures 4a-b). Investigating these possibilities further, it was confirmed that these observed topographical features are not just an effect of the mean horizon profiles but occur at individual sites. More specifically, it was observed that (i) the Sun's path closest to the equinox often sits at the very centre of these ridges, (ii) the

[2] Note that the social proxy of archaeological data (SP 6) is reviewed in a much larger work (Higginbottom in preparation), providing more detailed contexts for the reconsideration of the work herein and that of Higginbottom *et al.* 2025.

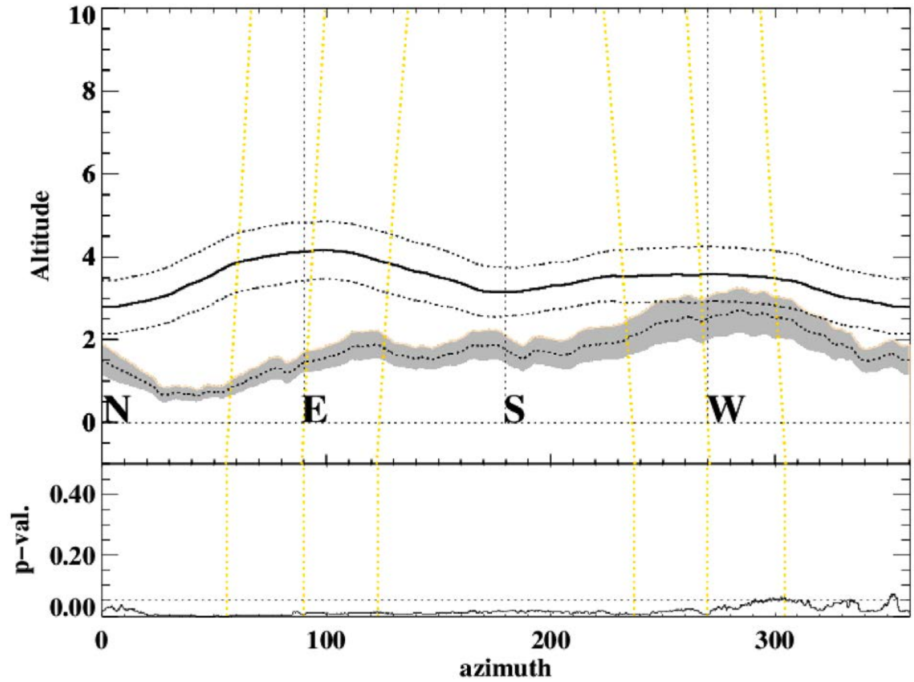

Figure 4a. Direction and Altitude. Top panel illustrates the results of our normality test, which employs the Shapiro-Wilk test under SPSS. Random (solid) and observed (dotted) mean horizon profiles, where the observed profiles are the combined profiles of the Groups A1 and A4 clusters in figure 6 of Higginbottom *et al.* 2022 (n = 21 sites). These profiles explained most of the data. The wavy dotted lines above and below the solid ones indicate the 1-sigma dispersion of 100 random selections of the sample. The grey shaded area around the mean observed profile indicates the standard error of the mean for each direction. Black dashed vertical lines indicate the cardinal directions. From left to right the yellow lines are: Sunrise at the summer solstice, equinox and winter solstice: Sunset at the winter solstice, equinox and summer solstice. The lower frame shows the statistical significance. In this same frame the dashed horizontal line shows the value of p = 0.05. Altitude is the angular height of the horizon as viewed from the monument location.

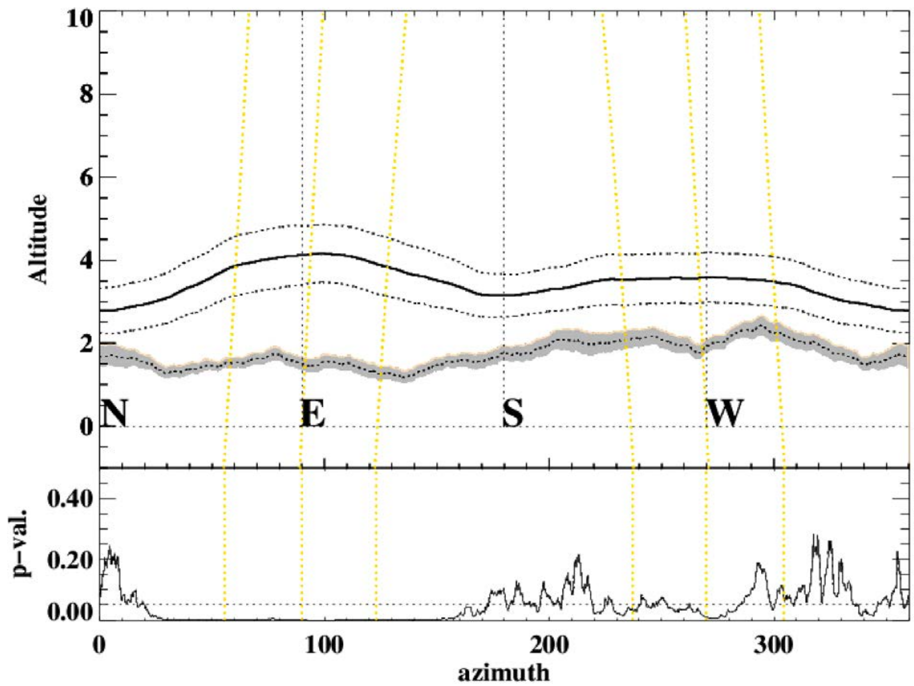

Figure 4b. Direction and Distance. Random (solid) and observed (dotted) mean horizon profiles for the sites with a more distant horizon towards the east than the west (Higginbottom *et al* 2022: figure 9, Group D1). The wavy dotted lines above and below the solid ones indicate the 1-sigma dispersion of 100 random selections of the sample. The grey shaded area around the mean observed profile indicates the standard error of the mean for each direction. Vertical black and yellow lines are as in Figure 4a. The lower frame shows the statistical significance. In this same frame the dashed horizontal line shows the value of p = 0.05. Altitude is the angular height of the horizon as viewed from dolmen locations. For all methodological details see Higginbottom *et al.* 2022.

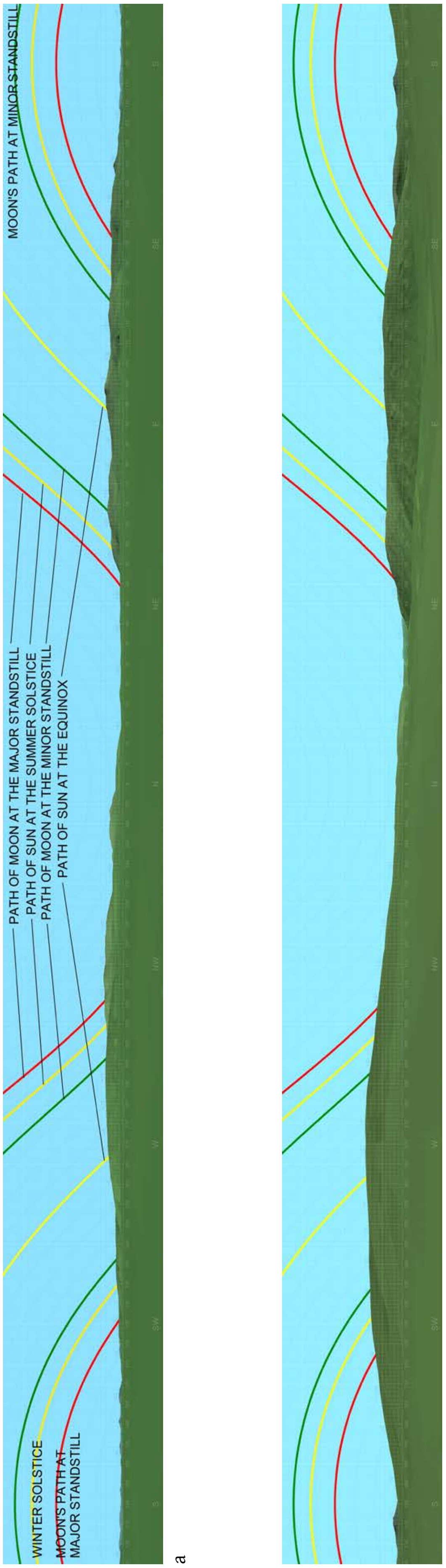

Figure 5. Horizons of (a) Dombate and (b) Pedra Cuberta. (after Higginbottom *et al.* 2023: figures 11a-q).

solstitial paths tend to be towards the inner edges of the tops of these ridges and (iii) the most extreme rising and setting points of the Moon flank the edges or sit on the slopes of these same ridge tops, sitting out further than the Sun (Higginbottom *et al.* 2023). For sites with a most distant horizon towards the east than the west, all lunar and solar events appeared to be contained by the ridges in the east and west. This was the most common pattern, with variability at some sites (e.g. Dombate: Figure 5a).

For Costa da Morte, then, these may indicate a search for a horizon with preferred qualities that connect with the dolmen's orientation preferences.

Thus, HCM1 states that there is a strong and deliberate relationship between dolmen location and specific horizon profiles which themselves contain the rising and settings patterns of both the Sun and the Moon. This can be visualised by the graphic of the landscape surrounding Cuberta (Figure 5b).

Orientations of the axes of dolmens on the Costa da Morte – HCM2 & HMC3

Higginbottom *et al.* 2023 found that, as Figure 6 shows, just by plotting the orientations in both directions of the dolmen axes onto a 360° polar plot, there are two clear orientation preferences towards both the east and the west. In the direction of their entrances, all of the dolmens are oriented from just south of east and towards, but short of, southeast. Thus, there is a clear clustering pattern towards these easterly directions. The opposite directions, as a consequence of the orientations of the entrances, all focus northwest, running from just north of west towards, but falling short of, the northwest. The broader clustering towards the SE/NW could contain more than one group of clustering.

Thus, the simplest HCM for the azimuths or orientations is clear: there is a consistent and unfailing focus towards these regions (HCM2). However, statistical and other analyses were done to determine if there were any astronomical interests, to create a more informative HCM. Firstly, it was determined whether an orientation hit any of the classic solar or lunar targets usually assessed in archaeoastronomy, by observing where the azimuth of each orientation fell along the horizons of each site's 3D panoramic landscape (Figure 5). Building on previous astronomical results (Esteban 2016; García Sanjuán *et al.* 2023; González-García *et al.* 2019; Lozano *et al.* 2014), we investigated two types of orientation: (i) constrained, where a sense of accuracy might have been considered important (within 2° of the target) versus (ii) illumination, where the goal may have been primarily to lighten parts of the interior (within 2° to 4°; see Higginbottom *et al.* 2023 for details). Overall, dolmens could have more than one astronomical target, solar and lunar, but also one of these could be a constrained target and the other could be an illumination. In the east: for 16/17 orientations within the 4° limit, we obtained a probability of 2.23 10^{-5}, excluding chance alignments beyond our significance level. Within 2° of accuracy (9/17), with five possible targets (equinox, midway between solstice and equinox, the Moon's rising or setting closest to the time of the minor standstill (mLS), the solstices and the Moon's rising or setting closest to at the major standstill (MLS), p=0.02, also excluding a chance alignment at the 95% level.[3] Most notably, the western alignments are more accurately aligned, often within a degree or less. Here there are 10/17 constrained orientations (6 lunar, 4 solar) that are within 2° of target, but also there are two calendrical midpoints (between two astronomical targets). So essentially, there are 12/17 constrained orientations. The probability of a chance alignment for the western orientations at 2.83 10^{-5} was excluded.

That orientations in the east and west are meaningful is also supported by the evidence of the HCM1, which demonstrated that the horizon profile 'shapes' in both the east *and the west* were likely to have been deliberately chosen to contain these astronomical events.

The HCM3 model states that this regional group of dolmens shares directional axial orientation preferences that are significantly linked to the astronomical bodies of the Sun and Moon to the east *and* west, and dolmens could even have more than one orientation in the same direction, many of them contained along specified ridgelines. Therefore, the visual scape and architectural elements are connected.

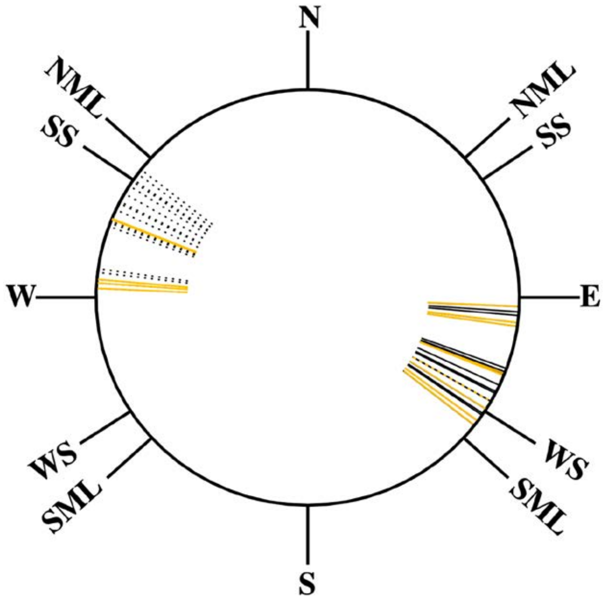

Figure 6. Polar plot of the orientations found in Costa da Morte. N, E, S, W represent the cardinal points: e.g., N = north. SS = the position of the Sun at the summer solstice; WS = the position of the Sun at the winter solstice. NML/ml = northern Major or minor lunistice (see below in caption); SML/mL = southern Major/minor lunistice. All astronomical positions assume the average latitude for Costa da Morte and assume a flat horizon (altitude = 0°) and are therefore approximate. These solar and lunar azimuthal positions would be different when viewed from site to site, as they are dependent upon the local horizon altitude. Constrained orientations (black), illumination form (yellow); yellow-black dashed if both; of these double forms, one is solar and one is lunar.

Next?

Despite all of this testing and resultant knowledge, how the observable dynamics between the astronomical bodies and the horizon were understood by prehistoric people was still beyond our reach. Also, what did it mean to have an interest in these solar or lunar events and why more than one? Further, do we really have so many illumination-based orientations or only many loose or bad alignments in the easterly direction? With such questions in mind, more detailed astronomical information about the behaviour of the Sun and Moon and their timings was sought.

Astronomical targets of the dolmens of Costa da Morte – HCM4

The first step was to take on board the astronomical truth that each orientation *potentially* has a number of *significant* visual options in both directions. This is for several reasons. Predominantly, it is because (i) all orientation points on the horizon are crossed twice a year by the Sun and many times by the Moon (e.g. the Sun travels northwards in spring and half of summer and then reverses to travel south along the same path in autumn through half of winter) and (ii) the Sun and Moon work in concert, where the relative position of the Sun creates *several* Lunar phases, e.g. Harvest and Hunter's Moons. Notably, whenever the Sun is on the opposite side of the sky to the Moon, the Moon will always be Full. If the Moon is on the same side at the same time as the Sun (in conjunction) the Moon is New and cannot be seen by the naked eye, although it can be occasionally 'seen' by the fact that its body occludes certain stars ('occults'). Also, the waxing or waning crescents can be seen on the same side of the sky as the Sun when the timing of their rising or setting is close but staggered; for instance, when the waxing Moon rises after the Sun (doing so before noon, before transiting the meridian before sunset, and finally setting at midnight). Thus, essentially each direction could be part of luni-solar considerations, where the Sun always affects the Moon, and thus it seems sensible that they should be considered together. To do so,

[3] Due to space limitations, astronomical definitions for the lunar phenomena of the major standstill and minor standstill can be found online in the Supplementary Material of Higginbottom *et al.* 2025. In brief, the Moon reaches its greatest altitude in the sky as seen by the observer on earth in the north and in the south, these are *one-time-only maximum events every 18.6 years*—the Moon's full cycle (see also Higginbottom 2020: 37-8).

and to include more detailed information about the behaviour of the Sun and Moon, we chose to consider da Silva's (2004) scheme and Silva and Pimenta's (2012) models about the target possibilities.

In 2004, Marciano da Silva was the first to propose and investigate the concept and relevance of observable lunar crossovers as a way to explain those orientation clusters that repeatedly appeared south of cardinal east, applying his model to the megalithic *antas* in central Portugal and western Spain (Alentejo). He found that azimuths around this cluster of orientations coincided with a series of events centring on the same phenomenon that happens at a slightly different time and place on the horizon each year (here an azimuth is the value of an orientation in degrees as measured from north). In simple terms, the phenomenon was 'a crossover between the rising positions of the Sun and full Moon, which occurs around the equinox' (labelled the equinoctial Full Moon: Silva and Pimenta 2012: 191) coinciding with the Spring Full Moon. This model underwent a series of improvements in the Iberian context (Pimenta and Tirapicos 2008; Silva and Pimenta in 2012), culminating in the 2012 study of Silva and Pimenta (Silva and Pimenta 2012). Of relevance to this current study, whilst such crossovers can occur at any phase of the Moon, Silva and Pimenta expanded the previous model of Full Moons to include phases of preferential cultural interest as reported by ethnographers, especially for rituals, namely Dark or Crescent Moons. This current project also found support for these lunar phases (e.g. Watt 2005; Sims 2006) and Full Moons (Sims and Fischer 2020; Rosales 2021; Silva and Pimenta 2012: 192).

The astronomical and modelling information provided by these authors (Silva 2004; Silva and Pimenta 2012), can be summarized as follows:

(i) The models use declinations, which are also used in astronomical studies in general. It is important to recall that (a) declinations are essentially 3-dimensional values given to the paths of astronomical bodies through time allowing us to determine where their relative positions are in the 'sky' and when; and (b) each dolmen has two declination values for horizon points in each direction as indicated by the dolmen axis, easterly and westerly.

(ii) these authors statistically modelled regular calendrical crossover phenomena, which are significant moments in the luni-solar calendar. Thus, for example, we have the Spring and Autumn Full Moon Crossovers (AFM, SFM) which 'are the phenomenon of crossover when the (full) Moon and the Sun change their positions *on the horizon*, with the Sun going north and the Moon going south during spring, and vice versa in autumn' (Silva 2004). These are the equinoctial Full Moons (EFM), and are located close to cardinal east and west and are chronologically bound to the occurrence of the equinox, but not necessarily occurring at the *same* time as the equinox. The Harvest Moon could be an example of an AFM. The full list of *crossovers* is: SFC and WFC = Summer and Winter First Crescent; SLC and WLC = Summer and Winter Last Crescent; FM = Full Moon; AFM and SFM = Spring and Autumn FM. The last crescent is the phase just before the New Moon. Importantly, Marciano da Silva and Silva and Pimenta's work tells us that, chronologically speaking, events do not always occur on the same dates of the solar calendar (Silva and Pimenta 2012: 196); thus, it is through observation that such events are understood. Silva and Pimenta's model further highlights the *possibility* of multiple targets for the same direction, or the overlapping of targets, where we can find, for example, that the horizon position (declination) of the rising Sun at the time of the winter solstice (WS) is also the most probable position for the setting of the WLC in Silva and Pimenta's models, and the position of the setting SLC is most likely the same as that of the Moon closest to the time of the minor standstill (mLS; Figure 7). So not only do they have the Moon crossing the same points on the horizon several times of year (and the Sun twice per year), they also have the possible coincidence of major astronomical events occurring at the same locations – all linked to significant moments in the luni-solar calendar.

More generally, the Sun's position at these events helps to indicate the time of year and thus the seasons in which they take place. Also, these events occur within a 'range of time' because they can happen at different times each year but *within specific bands of solar time* and they are predictable. Thus, for example, a specific event like the Crossover FM rise could occur any time within a certain number of days of the Equinox, even before, but they are *most likely to occur* in the first week after the Equinox at a certain location (remembering that this location is defined by the variable declination). Silva and Pimenta also modelled, therefore, chronological distributions of particular events for the solar year related to latitude, allowing for the consideration of astronomical phases correlated with the time of year and region. These models highlight there is *a range of potential horizon azimuths and declinations* for such events, for both the Moon on the one side of the sky and for the Sun on the other, where the occurrence of declinations is expressed as a probability. For the Sun, the *bands of solar time* indicate that there is a *range of potential horizon azimuths* because solar time is directly connected to the Sun's position north or south along the horizon and any change in position means the both the azimuth changes and the altitude of the horizon and thus the declination.

Such information has provided the current study with more detailed information about observable

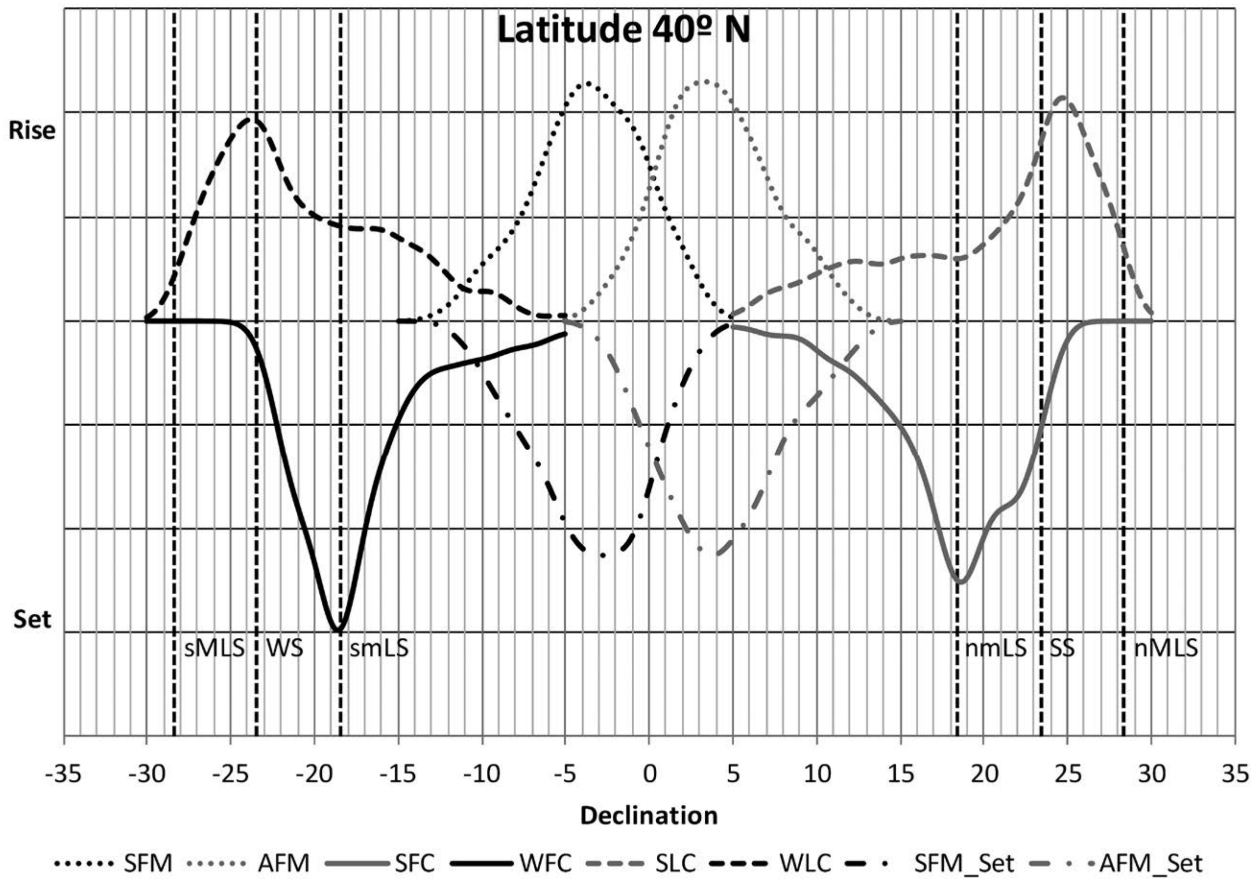

Figure 7. Silva and Pimenta's 2012 Model for solar and lunar behaviour at 40° latitude. All black lines of the graph are part of the model. The model indicates the declination values (x-axis) of the Sun and Moon at the times of their most extreme, and other, paths. These are marked out by the *black* dotted vertical lines: sMLS = southern Moon at the time of the major standstill; WS= the Sun at the time of the winter solstice; smLS = southern Moon at the time of the minor standstill; nmLS = northern Moon at the time of the major standstill; SS = Sun at the time of the summer solstice; nMLS = northern Moon at the time of the major standstill. The top section of the model represents rising phenomena and the lower part, setting. Specifically, this figure contains the declination *models* for *the occurrences of various significant lunar events in relation to their declination* (horizontal wavy lines), highlighting the relative probabilities of their occurrence throughout a luni-solar style calendar. Looking at the first top-left dashed line of the WLC, for instance, we see that its occurrence likely peaks at the time of the winter solstice (WS) *relative* to the time of the Moon at the sMLS and so on. FM = Crossover Full Moon; FC = First Crescent; LC = Last Crescent; SFM = Spring FM; AFM = Autumn FM; SFC = Summer FC; WFC = Winter FC; SLC = Summer LC; WLC = Winter LC. (After Silva and Pimenta 2012: fig. 3, c.f. fig. 6).

astronomical contexts (physical realities) that are astronomically conspicuous.

(iii) From the above, we see that Silva and Pimenta's models express the astronomical event locations by declination (that is, they indicate where it can be seen in the sky – its path – and thus where it crosses the horizon), and, given that the paths of the Sun and Moon, as defined by declination, change throughout the year, and from year to year, they have statistically modelled the most likely paths upon which the Sun or Moon will travel at the times these events occur.

To examine the possibility that the alignments of Costa da Morte might represent elements of such a luni-solar calendar, we first listed the target *possibilities* according to the schemes discussed above (Table 2) and then assessed the possibility that any of the alleged targets in Table 2 might provide reliable explanations to the observed data, using our own implementation of Silva's (2004) scheme and Silva and Pimenta (2012) models. To do so, we computed the relative positions of the Sun and the Moon according to Meeus (1991) for the location of interest, and for 148 years. This includes 8 cycles of 18.6 years. Our modelling procedure compares the longitudes of the Sun and Moon and the lunar elongation to obtain the different relative positions. The final product of each simulation is a number of declination values that are later compared with the measured data for our Costa da Morte megaliths.

For the last modelling step, the different distributions of declinations were plotted in a curvigram. This is a generalisation of the common histogram where each data point is modelled by a Gaussian distribution with a bandwidth equal to twice its estimated uncertainty.

No of sites	**Astronomical Phenomena chamber entrance (east)** Hyphenations indicate that the Sun crosses over the same horizon point twice in a solar year: the 1st season is the first occurrence for that solar year. For the Full Moon, the hyphens reflect the time of the year the Sun (on the other side of the sky) can be responsible for this full Moon.	No of sites	**Astronomical Phenomena back of tomb (west)** Hyphenations indicate that the Sun crosses over the same horizon point twice in a solar year: the 1st season is the first occurrence of that solar year. For the Full Moon, the hyphens reflect the two times of the year the Sun (on the other side of the sky) can be responsible for this full Moon.
3	O Full Moon Start or Early Spring - Late Summer	5	O Full Moon Start or Early Autumn - Late Winter
2	O Full Moon Middle Spring - Middle Summer	2	O Full Moon Mid-Autumn - Mid Winter
6	O Full Moon Late Spring - Early Summer	5	O Full Moon Late Autumn - Early Winter
2	O Full Moon Autumnal Equinoctial	3	O Full Moon Spring Equinoctial
4	O Full Moon @ SS (includes: 3@MinLS)	4	O Full Moon @ WS (could occur:1@MajLS; 1@MinLS)
5	⊙ Start or Early Autumn - Late Winter	3	⊙ Start or Early Spring - Late Summer
2	⊙ Mid-Autumn - Mid Winter	2	⊙ Middle Spring - Middle Summer
5	⊙ Late Autumn - Early Winter	6	⊙ Late Spring - Early Summer
5	⊙ Sun @WS	4	⊙ Sun SS
3	⊙ Sun @ Spring Equinox	2	⊙ Sun @ Autumn Equinox
10	☽ Winter Last Crescent Moon	8	☾ Summer First Crescent Moon
5	O Crossover Spring Full Moon	4	O Crossover Full Moon Autumn
	Total events = 52		**Total events = 48**

Table 2. The possibilities of the cross-over targets for the dolmens in Costa da Morte. In columns 3 and 4, we find the list of all the likely rising astronomical events related to the Sun or the Moon for the easterly (Col. 3) and westerly orientations (col. 4), clearly demonstrating that each alignment has several visual options in both directions linked to the astronomical relationships between the Sun and Moon and the fact that they both pass horizon locations more than once per year (after Higginbottom *et al.* 2025, table 2).

The final curve is the sum of all these Gaussians (see, e.g., González-García 2015 for further details).

Finally, a simple plot that illustrates where each corresponding azimuth sits within the seasons related to the solar calendar is offered. This allows for a closer understanding of the time(s) of year that such events might occur.

HCM4 Results and Model

Together, the data in Table 2 and our models resulting from the consideration of Silva and Pimenta's 2012 work, with the addition of our seasonal polar plot, clearly indicate that the majority of all sites are primarily correlated to phases of the Moon connected to transitioning bands or ranges of seasons, rather than to a specific point at the literal start of seasons (such as the solstices) or an entire or single season.

Specifically, the schematic modelling that tests the possibilities presented in Table 2 indicates that the dolmen orientations *towards the southeast* are strongly connected to the tested rising lunar crossover events in this direction (Figures 8 and 9), namely the Autumnal equinox Full Moon and the Winter Last Crescent; to the point, in fact, where the observed data almost perfectly mimics that of the expected data (Figure 9). To the northwest, comparison of the expected and observed data confirmed that some of the dolmen orientations in this direction appear connected to the lunar crossover event of the setting of the Spring Full Moon (Higginbottom *et al.* 2025: figure 7). The tall peak for the west in Figure 8 probably represents an exceptional interest in the Moon at the minor standstill, the position at which the Moon is most often seen, thus by default, to the Full Moon. The polar plot highlights the time of year, or solar calendar interests, remembering that the position of the Sun affects which phase of the Moon can be observed and when (Figure 10). It is clear that the dolmen alignments themselves tend to indicate astronomical events that occur over a range of times throughout the solar calendar not only those occurring at a single time and place, like the solstices.[4]

[4] These points change in space also over a long period, but the change is incredibly small from one year to the next such that, on a flat horizon, it would take at least 1000-2000 years to make a clear visual difference along the horizon.

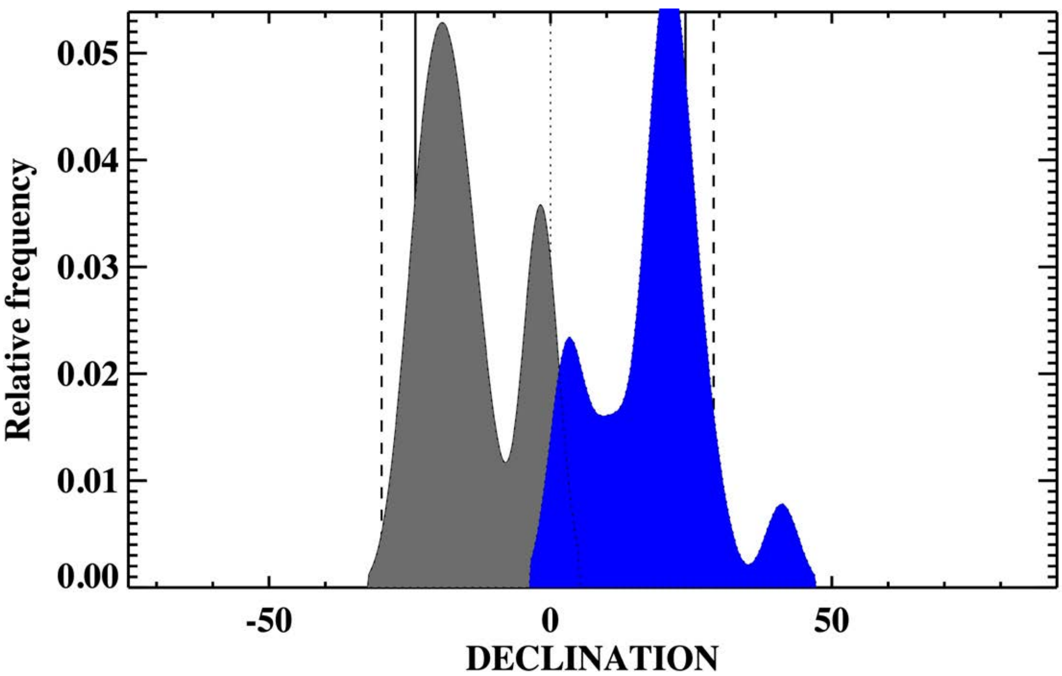

Figure 8. The curvigram of the observed declination data values for our sample where the grey shaded area is for the rising eastern orientations (negative values of declination) and the blue is for the setting western declinations (positive values). Dotted vertical lines indicate the equatorial declinations that correspond to the equinoxes for the solar values. Vertical solid lines indicate the winter (*c.*-24º) and summer (24º) solstices respectively. The dashed vertical lines indicate the northern and southern lunar extreme positions. The east values (grey shaded) present two concentrations at values that peak for -19.5º and -3º. All values are inside the lunisolar range. The west values (blue shaded) present to concentrations at values 18º and 3º; there is one value outside the lunisolar range. (after Higginbottom *et al.* 2025: fig. 5).

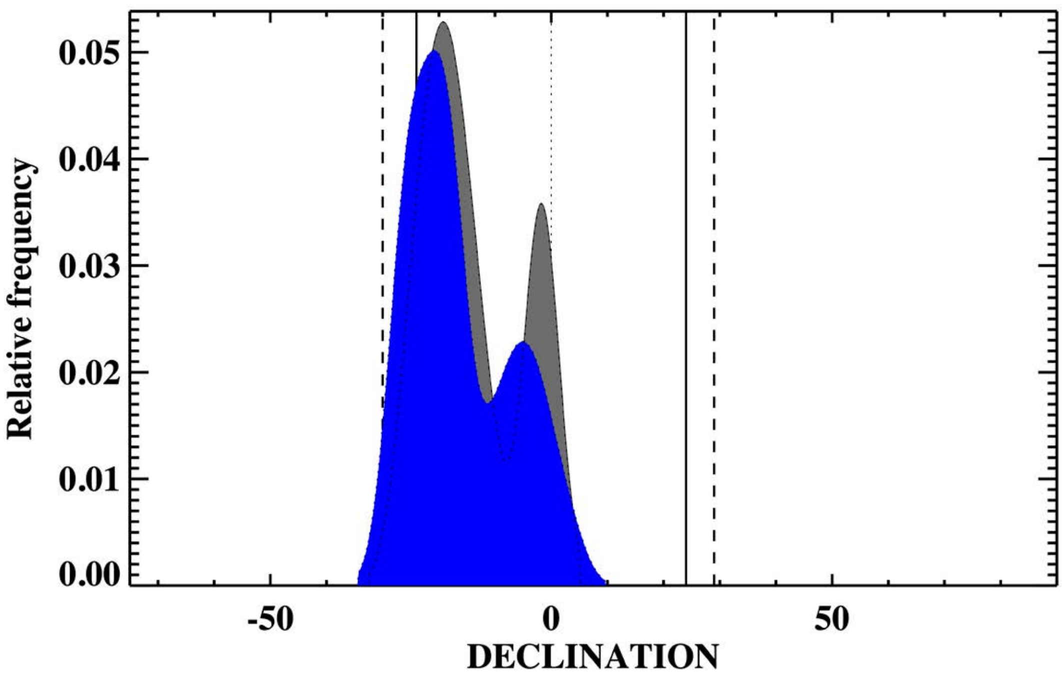

Figure 9. Here we have two models for both the observed (gray shaded area) and expected curvigram (blue shaded area) for the eastern orientations: the equinox Full Moon (left peaks, closest to zero declination) and the Winter Last Crescent (right peaks). The extremely close fit of these models supports the conclusion that the easterly orientations are principally oriented towards and near the most probable range of occurrence for the crossover rising equinoctial Autumn Full Moons and the rising of the Winter Last Crescent. (after Higginbottom *et al.* 2025: fig. 6).

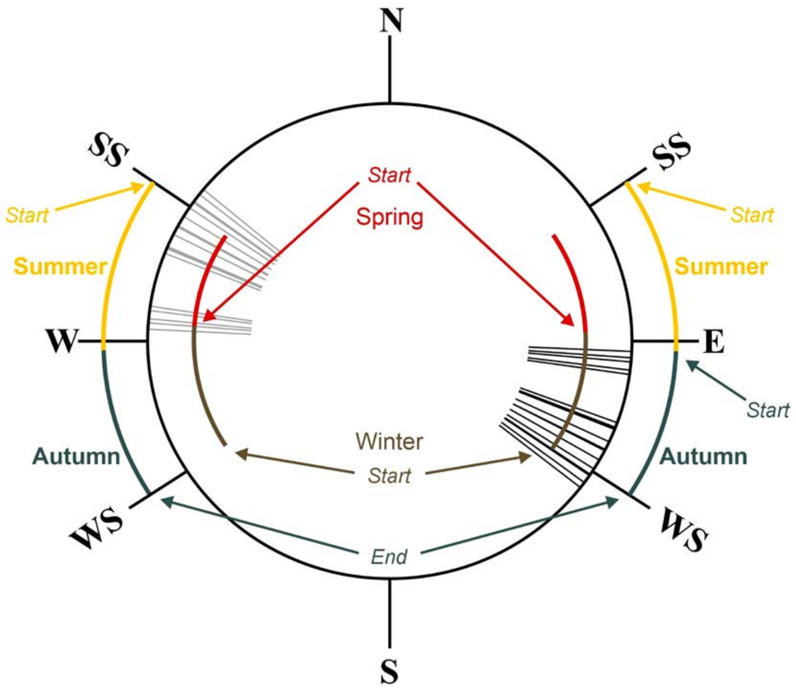

Figure 10. Polar plot of the orientations in both directions and their associated seasons found in Costa da Morte (assuming a flat horizon, altitude = 0°). The coloured lines indicate the paths of Sun and approximately where the Sun is at the beginning and end of seasons. The beginning and end positions around east and west are exaggerated to illustrate the point that the astronomical beginnings and endings of seasons occur a little before or after these cardinal points. N, E, S, W represent the cardinal points: e.g., N = north. SS = the approximate position of the Sun at the summer solstice; WS = the approximate position of the Sun at the winter solstice; all assuming a flat horizon.

Further, the timing of these crossover lunar occurrences is variable, and they tend to *straddle seasons*. Thus: the Crossover Spring Full Moon rise can occur in early Spring *or even 10% just before* in late summer (Paschal FM; 90% coincidence, González-García *et al.* 2010 and Silva and Pimenta 2012). Silva and Pimenta's modelling also found that the most likely *seasonal* time for the Winter Last Crescent Moon rise is from late Autumn to the first half of Winter (model simulation 1 – SIM1), or peaks in early winter (SIM2, Silva and Pimenta). In terms of declination, it is most often closer to WS than the end of Winter, 50% less at MinLS. Whilst we have not modelled timing specifically for our area, the general rule remains true (González-García *et al.* 2010): these events are cross-seasonal, marking out the crossing over from one season to another. With this, we are put in mind of Silva and Pimenta's comments that that such phenomena could be ritual and observable, and they are defined empirically by observation (Silva and Pimenta 2012). The interest in the setting minor lunar standstill at our sites highlights the regard for the Full Moon in the later months of autumn and the earlier part of Winter, a phenomenon providing light on those nights before deep winter moves in.

The data in Table 2 show how the annual orientations might work at the Costa da Morte dolmens such that, for instance, the early or late eastern spring horizon targets become the early or late eastern summer targets later in the year, and the three eastern Spring Equinox targets become autumnal targets. We also have instances of major astronomical phenomena sharing the *same rising position* on the horizon (therefore one orientation can equal up to several astronomical interests), but where events will not happen at the same moment in time, but some can happen on the same day: for example, the axis orientation of Rabós M1, towards the east: Winter Last Crescent Moon and the Sun at the winter solstice; Full Moon at the summer solstice (SS); mLS Full Moon at the SS and the Sun at the SS (Table 2)**;** remembering too, that the Sun on one side affects the lunar phases on the other. These are examples of the luni-solar calendar and how a dolmen's single alignment can pull this together.

The HCM4 model states that 'overall, there are distinct solar and lunar targeted times, where the relative positions of each of these bodies (Sun and Moon) naturally create the lunar phases, and all of the targets nominate *phases of transiting seasonal times*, like the coming of spring or early autumn or the end of winter. These are quantitively supported and exemplified by the fact that the dolmens are principally oriented towards and near the most probable range of occurrence for crossover events, which most often occur at or near the changing of the seasons (e.g. Figure 9; Figure 10; Higginbottom *et al.* 2025; Silva and Pimenta 2012: 179, 199), and where there are multiple potential targets for each dolmen in both directions.' Figure 11 illustrates the positional links between orientations, seasons and the astronomical options.

The importance of HCM1

That there are natural astronomical dynamics which allow for a variety of significant phenomenal pairings on the opposite or same sides of the sky is clear (which may or may not happen at the same time of year). However, such *event* pairings that 'face' each other across the sky (e.g., SFC Moon in the west opposite

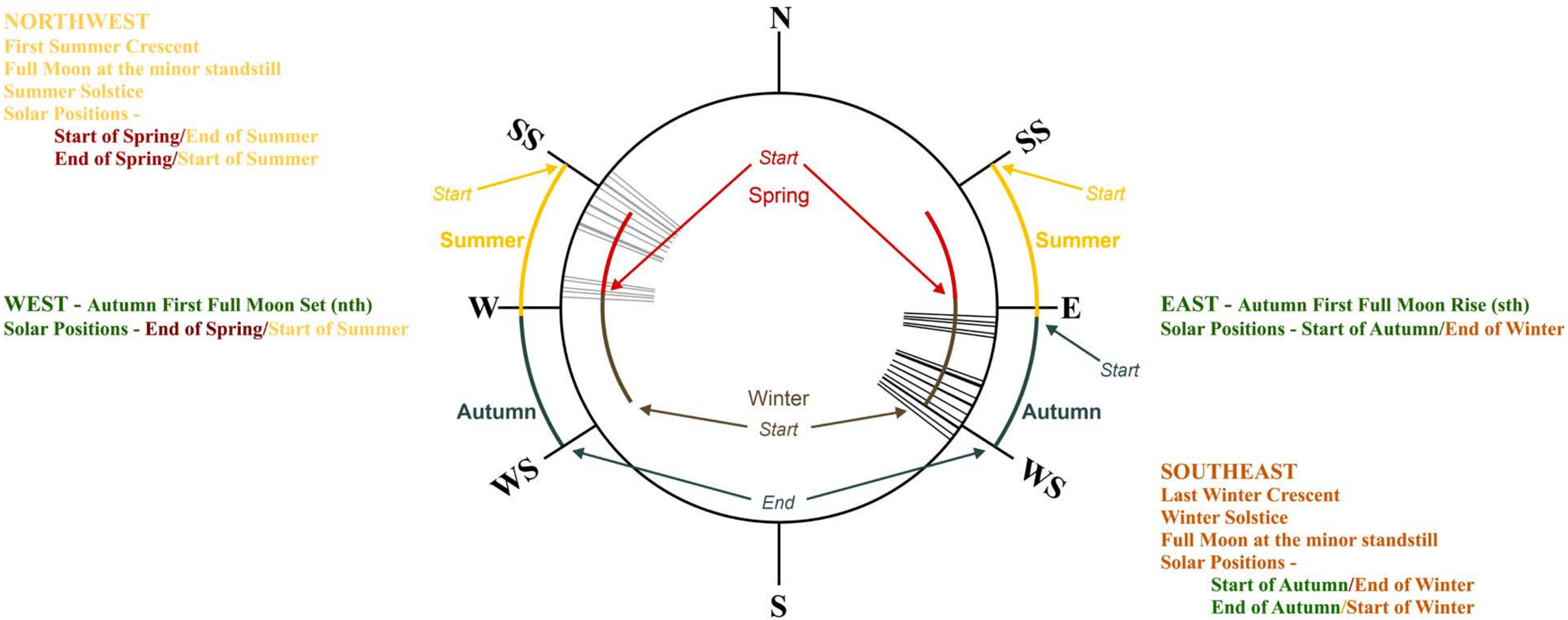

Figure 11. Polar plot of the orientations in both directions along with their associated seasons and potential associated astronomical (Costa da Morte). Details as for Figure 10.

the WLC Moon in the east; rising solstitial Sun facing the setting Moon at the mLS) *cannot happen* unless the horizons on the opposite sides of the viewing point both have very particular altitudes. Even when a phenomenon can appear at a variety of horizon locations along a specified length of a horizon, like the rising crossover SFM, the location of its entire rising range *will not be automatically mirrored* by the setting of the crossover AFM. That is, a horizon of a particular height in a particular direction must be assured. Even assuming a theoretical flat horizon on both sides, the best we can hope for is some kind of natural overlap where they could face each other. Thus, the deliberate landscape choices discovered for HCM1, of distinct ridges in specific directions, further support HCM4.

The reason for the seasons ICI-1

Thematic Contextual Filter – Seasonal contexts related to resource management

As proposed above, the majority, if not all, of the orientations found in Costa da Morte are linked to the end and/or beginning, the transitional times, of the seasons, or even the first half or the second half of a season (due to behavioural possibilities of the astronomical phenomena that we are considering). Further, it is possible that some orientations designate an entire bracket within a transitional solar time between seasons, for instance where a single orientation equals two points in the calendar that bookend these ranges of conjoined seasons, e.g. from Late Autumn to a point in Early Winter (Figure 10). It is important to re-emphasise, that we only have four sites potentially associated with *astronomical* mid-winter or mid-summer, the middle of the astronomically indicated seasons, within Costa da Morte.

Several examples of the contextual social indicators of palaeoenvironmental and ethnographic studies of Galicia, and neighbouring Portugal, related to seasons and resources/resource management have been collected by this project. The collections were created to comprehend the possible reasons behind the seasonal focus identified above and ultimately illustrate how the seasonal times targeted by the dolmens match with likely resource management activities (Higginbottom *et al.* 2025, Higginbottom *in preparation*).

These studies also contain information or results relating to palaeoenvironmental or ethnographic information taken from other work on dolmens in western Iberia, some of it including in previous archaeoastronomical papers (e.g. González García *et al.* 2017; Hoskin 2009; Senna-Martinez and Socorro López 1998; Silva 2004; Senna-Martinez and Quintã Ventura 2008; Silva 2013; Silva and Pimenta 2012; Scarre 2019; Vilas-Estévez 2016). Other social archaeological studies of western Iberia contain the same such evidence (e.g. Carvalho *et al.* 2017; Carvalho and Tente 2023).

Social Proxy 3 Prehistoric land use

SI-3a Palaeoenvironmental data

In terms of likely plant resources for Galicia and northern Portugal, whilst several crops were grown in southern Iberia with the arrival of the Neolithic agriculture (Peña-Chocarro *et al.* 2018: 369), by the time it begins to appear in the northwest the list has dwindled. The plants grown from the early Neolithic through to the Late Neolithic include broad beans, poppies and barley (Peña-Chocarro *et al.* 2018). Significant evidence for the potential past environment in Costa da Morte comes from Campo Lameiro in Galicia. As Costa da Morte's topographical and geological landscape is very similar to that of Campo Lameiro, including the altitude range, we can hypothesise that the information is relevant for this study. The evidence from Campo Lameiro supports the early increase of herd animals on the upper slopes of the undulating landscapes of the fifth millennium B.C. (via faeces proxies - coprophilous *Sporormiella*-type fungal spores are particularly strong evidence of dung deposition (Currás *et al.* 2012 in Kaal *et al.* 2013). Considering this data more sharply through the specific lens of altitude, we see for those altitudes of 290 m.a.s.l. and 260 m.a.s.l. at Campo Lameiro, which are comparable to the dolmen locations found in the coastal mountains of Costa da Morte (Muñoz Sobrino *et al.* 2005: 382, fig. 1), that during the Holocene Thermal Maximum (wet and warm), there is 'a firm body of evidence of an enhanced period of fire/*grazing*/erosion from ca. 5.9 to 4.8 ka cal BP … (an) important moment in landscape evolution' (Kaal *et al.* 2013: 1523). At these altitudes, the area is seen as 'a mosaic of pasture, open woodland and deciduous forest, the former being concentrated on the upper part of the hill, *probably driven by proximity to human activity focal points* (current author's emphasis; Kaal *et al.* 2011; Kaal *et al.* 2013: 1523). There are records of legumes as part of scrubland replacing forest. The creation of small, and later more significant pasture lands could also imply herding strategies and the evidence for overturned soil may well be the results of the combination of both herding and gardening or small-scale cereal cropping activities. It is possible then, to assume the concomitant farming strategies of sowing and reaping, even if initially this was done on a small scale (Mighall *et al.* 2006).

As part of the introduced plant economy's appearance, there is evidence of cereal pollen dated to *c.* 4500-4000 BC, (*Sierras Septentrionales*: Ramil Rego and Aira Rodríguez 1996a, 1996b). This, along with the evidence for the earliest agricultural herding or faunal management, seems to coincide with the majority of earliest dolmen construction (Kaal *et al.* 2013: 1522;

Mighall *et al.* 2006; Prieto Martínez *et al.* 2012; see interpretive fig. 2, '*Galicia in Anexo Listado de Dataciones C14*' in Prieto Martínez 2012; Schulz Paulsson 2016). Thus, as argued by Scarre for the 4th millennium chambered tomb of Anta da Lajinha in Portugal, lifestyle in Galicia may have been, even partially at least, related to mobile pastoralist economies where large farming villages were not a dominant feature of this period and individual settlements were small in scale (Scarre 2019: 215). This also fits in with the study of Penedo dos Mouros at 435 m.a.s.l., (rock shelter, Gouveia, Portugal: Carvalho and Tente 2023). The main implications for the current study are: clear evidence of ungulates as a new resource in the region and the inclusion of swine as part of subsistence life-ways of Neolithic groups (sheep *Ovis aries*: Carvalho *et al.* 2017), other *Ovis/Capra* sheep/goat, *Sus* species pig/wild boar (*q.v.* Carvalho and Tente 2023), which, when combined with faeces proxies and possible grazing evidence, suggest a mixed economy that included either mobile pastoralism or transhumance activities at the lower altitudes. Most particularly, and very relevant for this work, these fragments 'were attributed to the 5th-4th millennium BC transition (between the end of the Early Neolithic and the beginning of local megalithic monumentality; Carvalho *et al.* 2017 in 2023: 14). Despite discussion around transhumance, the final conclusions upheld that the evidence from Penedo dos Mouros is more consistent with pastoralism than semi-permanent transhumance.

From the evidence and ideas above, it is likely that at the time of the dolmen construction in Galicia there were: (i) mixed economies, (ii) cultivation of broad beans, poppies and barley (iii) animal grazing and pastoralism of some form. From this, it is possible to suggest a plausible link between domesticates and/or agricultural activities with the times of year indicated by the dolmen orientations. For instance, one of the main crops – broad beans – *regardless of the month*, are usually sown from *Late Autumn to early Winter*, and by the *end of Spring* they are usually ready for harvesting. Note, too, that an interest in *early Autumn* can coincide with the usual time for harvesting cereal and other crops. Pastoralism, too, of whichever format, is guided by times of seasonal change – moving out of one into the next, as observed below from ethnographic evidence.

Social Proxy 4 Ethnographic data about seasons

SI-4 Historical accounts and Galician and Iberian paroemias

Critically, the ethnographic examples of the differing ways people chose to apply pastoralism or transhumance, or other activities, can reveal connections to events related to particular *parts of seasons.* For instance: for Montemuro and the coastal plain of the Beira Litoral province, 16th century documents record which herds were kept on the mountain *from May* to September, which then moved to the plains *in October* until April (Carvalho and Tente 2023: 23, fig. 5, itinerary 7). Whilst the records 'say' months, the *actual* events occur in Late Spring and again in Early Autumn (mountains) and then again from the end of Early Autumn until end of Early Spring (plains).

Crucially, then, whilst some *historical records* or verbal accounts might use months, the actual activities are clearly tied to the transitional times between seasons. Further, actual hands-on management is more nuanced, tied to current and immediate environmental circumstance. That is, activities begin in relation to natural events *within the 'partial season' for that micro-region*. Thus, when will it be warm enough to travel to a or b? Usually in March but perhaps not until early April. If warmth is the condition upon which the activity is premised, no-one knows exactly which day, in advance. For these kinds of decisions, Iberian refrains or *paroemias* act as mnemonics for just this sort of seasonal resource management, revealing the level of understanding of local, *cyclic* environmental events linked to resource regimes. Thus, an observable 'natural event occurs' = 'right temperature' = 'right time to act'. For instance, we find the following extract from Benítez Rodríguez (2024), which is essentially a type of *paroemia* or 'saying' (other examples in Higginbottom *et al.* 2025: table 3).

In fact, past and present Galician and Iberian *paroemias* make up much of the collection of Iberian ethnographic data created for this project (e.g., Higginbottom *in preparation:* a large collection from various sources; Higginbottom *et al.* 2025, table 3 from Benítez Rodríguez 2024). The project also found relevant Galician church decorations (Figure 12). Together, these social indicators provide evidence for an interest in significant transitional seasons within the luni-solar calendar from both agricultural and ceremonial origins known to be inextricably intertwined in Galician society since early medieval times. Upon examination, these social indicators correspond to the transitional seasonal ranges connected to the dolmen orientations above (Higginbottom *et al.* 2025). Significantly, note that '(t)he proverb, like the calendar, ... alludes to what **must** happen' (Coira Pociña 2013: 132). Here is a sample related to swine management and nut gathering. Whilst it is acknowledged that 'the determination of (swine's) domestic or wild status' is as yet indeterminate for the Neolithic in the west (Carvalho and Tente 2023: 20), it is clear that swine were part of a mixed economy by the time of dolmen construction, as supported by the specimens found by Carvalho and Tente (2023). Also, pollen and charcoal records now support the occurrence of sweet chestnuts in prehistory in Galicia (Krebs *et al.* 2019; Roces-Díaz *et al.* 2018). In the examples, seasonal

No of sites	**Astronomical phenomena related to seasons-timing** For allocation to its most probable time of seasonal occurrence, the phenomena from the first half of table are folded into the second half of the table below the thick black dividing line (in the green brackets; based on Silva and Pimenta 2012 (S&P). See *SM 1*).
5	○ Crossover Spring Full Moon rise = early Spring; or even 10% just before (not Paschal FM); 90% coincidence (GG et al 2010 & S&P 2012). Seasonal markers in temperate climes, as in Costa da Morte (S&P 2012:179.
4	○ Crossover Full Moon Autumn set = early Autumn (distribution max 10 days after equinox S&P 2012: 199)
8	☾ Summer First Crescent Moon set at the crossover (Spring or Summer) with a peak at MinLS (in terms of declination); most likely *seasonal time* from last half of Spring to first half of Summer (model SIM1), or peaks late Spring & very early Summer for SIM2; S&P 2012)
10	☽ Winter Last Crescent Moon rises at the crossover. In terms of declination most often close to WS, 50% less at MinLS. The most likely *seasonal time* from late Autumn to 1st half of Winter (model SIM1), or peaks early winter for SIM2).
10 (14)	Early Autumn - Late Winter; plus, Crossover Autumn FM = 4
4	Mid-Autumn - Mid Winter
10 (20)	Late Autumn, Early Winter; plus, Winter Last Crescent Moon rise **=** 10
6	*Start of Spring* Equinoctial
4	*Start of Autumn* Equinoctial
6 (11)	Early Spring - Late Summer; plus, Crossover Spring FM rise= 5
4	Middle Spring – Middle Summer
12 (20)	Late Spring - Early Summer; plus, Summer First Crescent Moon set **=** 8
8	*Real Start of Summer* **SS**
9	*Real Start of Winter* **WS**

Table 3. Astronomical phenomena related to seasons.

range and management strategy are indicated first, followed by time of year and then the *paroemias,* plus other relevant information:

(i) Early Autumn (first half of Autumn) – pastoral/ transhumance – Albarella *et al.* 2011 state that pigs are moved usually Oct-Nov and left free to roam. More specifically, Erias Martínez demonstrates that October is associated with taking pigs to the forests to eat ripened acorns (Erias Martínez 2004: 426), Proverb: 'Before slaughter the piglet has to fatten the pigs' wings. To do this, *take them to the mountain,* where they feed on oak acorns or holm oaks (on the Plateau and beyond), which he himself pulls from the trees.'

(ii) Late Autumn – ceremonial and gathering strategies – St Martin's Day 11th Nov**,** is the same as the day for celebrating Magosto (chestnut ripening festival) and for pig slaughtering. Medieval proverbs from Ourense in southern Galicia include: 'Every pig gets its St. Martin' (M); 'In *the month of the dead* kill your pigs'; (C); (Figure 12 below); 'November, the month of chestnuts, acorns and walnuts' (C); Coira Pociña 2013: 149).

The St Martin's religious festival has multiple connections and connotations. People collect and store several varieties of nuts in early Autumn, a time of plenty, as well as celebrating this glut, which is done on *Magosto* for the ripening of chestnuts (on the same day

Figure 12a. One of the twelve statues representing the seasonal activities set out and agreed upon at the level of local diocese. Represented here is the Pig Slaughter of November (© Antonio Garcia Omedes 2024: Romanico Aragones, http://www.romanicoaragones.com; http://www.arquivoltas.com/21-LaCoruna/01-BetanzosSantaMaria.htm, see figures 10 and 11. Reproduced with permission.

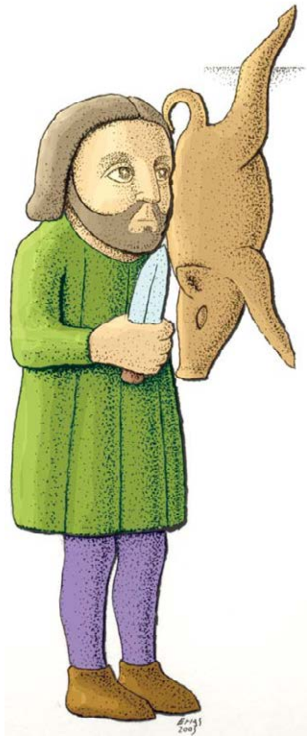

Figure 12b. *Novembro Matarife.* A rendition of the image in the photograph to re-create the statue as it was (artist © Erias Martínez, from *Anuario Brigantino* 2004, 27: 429). Reproduced with permission.

as St Martin's). This glut also fattens specific animals which are then slaughtered in *mid-Autumn* on the night of 'All Hallows Eve'; some of which are consumed and the rest prepared for consumption during Winter's scarcity ('In the month of January the pork is already in the pot': Coira Pociña 2013: 132). Historically and ethnographically speaking, this night is the in-between time when the barrier between 'Worlds' is weakened, and for remembering the dead (Correll 2023; Kupisiński 2020), heading towards the darkness of Winter. Somehow, this time of plenty and celebration, plus rituals for the dead/spirit world, are connected. It seems possible, then, as some of the dolmens are oriented to these seasonal moments which are connected to the basic need for survival and resource management, and are literally where the dead have been placed, ritualised and remembered, that there were similar connections at the time of a Neolithic containing megaliths. We are certainly reminded of the Late Neolithic events at Durrington Walls in Britain where the *en masse* slaughtering of pigs outnumbered cattle 10:1 (Parker Pearson *et al.* 2011: 86; Wright *et al.* 2014) and there was a killing peak during the *first autumn and winter* (of animal's life), followed by steadier killing *between* seasons during the second year (Wright *et al.* 2014).[5]

It is clear that the Social Proxy of resource management, with its concomitant Social Indicators of palaeoenvironmental and ethnographic information (3a and 3b), support the following interpretation:

> *The series of transitional luni-solar milestones indicated by the dolmen orientations are of primary concern and are likely linked to ongoing seasonal management activities of both wild and domesticated resources. In a way that we do not yet understand, the dead are connected to resource management (ICI-1).*

What do dolmens signify? IC1-2
Thematic Contextual Filter – common understandings

Social proxy 5 – ethnographic information about dolmens

To summarise, historic stories about the dolmens centre on their creator(s) and their sometime resident – a fertile mother or goddess or woman, who possesses supernatural powers (*mouras*, *q.v.* Higginbottom *in preparation*, list of stories in Supplementary Material). These stories exist in Galicia, Portugal and Malta (there are also stories about other magical women in other parts of Iberia).

SI-5a - local stories about dolmens

In the Galician stories, the 'witch-woman' is breast-feeding her child whilst flying and carrying the final

[5] Note there is often emphasis on winter in conclusions by both ethnographers and archaeologists when in fact both the ethnographic and archaeological evidence points to these activities starting in Autumn moving into Winter! Further Winter is not November and begins on the solstice of December. Sometimes people might use one word to mean both seasons or reference to the colder climes of the year in resource management: e.g., *'winter areas' for* Senna-Martinez and Quintã Ventura seems to mean both Autumn and Winter (Portugal, Senna-Martinez and Quintã Ventura 2008: 324).

Seasonal times/indicators	Refrain/paremia
Los vaqueiros trashumantes deben subir a la alta montaña	A.3b [ast] *L'abedul floríu, el vaqueiru yá pue pasar el ríu.* [El abedul florido, el vaqueiro ya puede pasar el río]. *The flowering birch, the cowboy can now cross the river.* [The flowering birch, the cowboy can now cross the river].

Table 4. Extracts of seasonal sayings from Benitez Rodriguez 2014 Appendix II. (https://cvc.cervantes.es/lengua/biblioteca_fraseologica/r5_benitez/anexo_02.htm, in Higginbottom and González-Garcia 2024: SM4 Table 1).

capstone on her head (Alonso Romero 1998: 14-15). Significantly, in the Portuguese versions, the *breast-feeding* mother, has *gifted the dolmens* (Frazão and Morais 2009 in Lindström 2014: 86) and folkloric tales 'tell how the *mouras* (or The *Moura*) came to the area in the beginning of the time and shaped it – its hills and valleys and rivers, dolmens and menhirs and red paintings on the rocks, and gave birth to children, who possibly became the ancestors of the community' (Lindström 2014: 89). Ultimately, even more striking is that these women can be essentially interpreted as being responsible for the Neolithic 'revolutions (sic)' for they taught people the most central skills and knowledge connected to the Neolithic way of life: e.g., weaving and spinning (Lindström 2014: 89).

Also critical, in terms of interpreting the meaning of the dolmens, are the *gifts they contain placed by the Moura*, and then given directly to individuals. Costas Goberna *et al.* (2008) state that 'Mar Llinares quotes the first bibliographical reference of a *moura* who keeps an enchanted treasure from the 17th C: 'she ordered him to go and dig the hillock of the megalithic chamber tomb in Segade and there he would find a treasure for him and all his generation' (Llinares, Mar 1990 in Costas Goberna *et al.* 2008: 22). Significantly, in the Portuguese versions, the breast-feeding mother, who has gifted the dolmens (Frazão and Morais 2009 in Lindström 2014: 86), also *delivers the gift of legumes*, the largest non-cereal crop of the Iberian Neolithic (Peña-Chocarro *et al.* 2018: 372). In a subsistence society, beans are likely a form of wealth.[6] Traditionally speaking, too, 'broad beans (fava) and other legumes are most often sown (from) late autumn (onwards to midwinter), a period that can be considered an agricultural new year because of the annual regeneration (Pasqualone *et al.* 2020: 4) Ultimately, then, legumes and dolmens have strong association in folktales where there are: 'legends about *mouras* fill(ing) the dolmens with beans and figs and treasures, which all are thought to symbolize fertility' (Frazão and Morais 2009 in Lindström 2014: 119). In some ways, these stories about dolmens have reinforced the idea that the dolmens are connected to resources. In O Folón, Galicia, at the end of the twentieth century, some people left a hen at the entrance of the place where the enchantment appeared as an offering to ask several favours to the *moura*: '*abundant harvest*, to avoid the evil eye ...' (Rodríguez, A. 2004 in Costas Goberna *et al.* 2008). Further, the *Moura* provided blessings of pregnancy and survival for both mother and child (Quintía Pereira 2015). These stories tell us that through their association with powerful spirits, dolmens are linked to the fertility and survival of both the land and the people: they hold the blessings of survival. It is clear that dolmens are seen to be tightly connected to significant resources and that *the Moura* is responsible for both. Finally, *moura* also have a magical ability to kill people, especially those who did not treat them well, and so contain the emblematic power of both life and death. In fact, SI-4 demonstrates that, locally at least, dolmens are considered '*The Touchstone*' to the past and contains possibilities for future (re)generations.

It seems plausible that the dolmen builders, not unlike those who have since lived with the dolmens, had, and continued to create, cosmological ties to the monuments, ones which combined ideas of death, fertility, and good luck (gifts of food/wealth/survival), which all relate to the cycles of living connected to sustenance and *caring for the social group*; especially given the archaeological context of people being buried *together*. Here, we can see a supportive link for these ideas in ICI-1, which also highlights the relevance of seasonal *food resources.* These stories, then, are a useful tool for reflections on prehistory, providing an opportunity to create interpretations/hypotheses for future testing.

Thus, this Social Proxy with its concomitant Social Indicator of ethnographic stories (SI-4) combined with ICI-1, supports the following *interpretation*:

> *Dolmens are linked to the cosmological ideologies of their builders; they signify ideologies incorporating the supernatural, death, fertility, sustenance and the importance of the local group (ICI-2).*

[6] As an aside, in parts of Italy today broad bean meals are the ritual food of the wake and beans are thrown on the funeral procession. They are also made into biscuits, or biscuits are made in the shape of a broad bean, to be given as gifts, especially to a female elemental, on 'All souls night'.

Final discussion

Many of the points presented in ICI-2 are not new for Iberian dolmen archaeological research, e.g. (i) the importance of identifying as a member of the local group and the importance of that group (Lillios 2008; Bueno Ramírez *et al.* 2022) and (ii) fertility (Gomes 2002; Senna-Martinez and Quintã Ventura 2008; q.v Higginbottom in preparation). However, it is highly relevant and necessary to find support for theories on multiple levels, using different forms of data and ways of thinking to ensure that our ideas are robust and can be improved.

Thus, the forms of evidence for the relevance of a community as a considered group and concepts of fertility so far stem from different bases. For instance, in relation to the first, the occurrence of idols most particularly within the burial context has added weight to the idea of the significance of the communal ties between individuals (Žorž 2008), having already been implied by multiple burials within single tombs. From the point of view of this work, the concern of creating communal entombing structures, the architecture of which contains information about the way Nature works – astronomical cycles and by default the surrounding ecological cycles, be they wild or domestic – supports the idea of the provision of knowledge for the survival of the group. Perhaps, too, this survival is not ensured only through knowledge but by the sympathetic magical impact that results from the creation of dolmens that include such astronomical alignments.

The arguments for the connection between dolmens and fertility are varied, e.g. dolmen=cave=womb as proposed by Eliade (1970; Senna-Martinez and Quintã Ventura 2008). Most archaeoastronomical works, or archaeological works that include such considerations, tend to discuss connections between seasonality and dolmens rather than fertility. Their evidence is usually a set of dolmens that appear to be pointing to a single solar event (WS), a star(s) or a 'season' (most often winter), indicating a potential time of hardship or 'plenty' and/or the possible connection to pastoral or transhumance regimes (Carvalho *et al.* 2017; González-García *et al.* 2017; Senna-Martinez and Quintã Ventura 2008; Silva 2014). Thus, their forms of evidence are related more to resource management than to fertility. However, despite this current project being heavily based upon seasonal data, its outcomes have significantly increased the amount and strength of indirect evidence for a relationship between dolmens and fertility and it is the project's direct evidence of an interest in complex seasonality via dolmen orientations that is responsible for much of this. Essentially, the archaeoastronomical evidence, with its high number of indicative times relating to seasonally active resource management events throughout the year verges on being able to provide the strongest testament from prehistoric evidence so far. Whilst clearly about resources, the breadth of this focus implies the continued promise of fertile outcomes – a fertility focus. Interestingly, too, the social indicators SI-3b and SI-4, whilst not evidence, support these notions. The palaeoenvironmental evidence indicates the activities in which people likely engaged at the time of dolmen construction.

In Galicia, there is a clear materialisation of ideology through the placement and architecture of the dolmens, as well as their creation as a monument that entombs the dead. Studying these structures as social proxies via their indicators and through the filters of cultural contexts highlights the active processes of resource management, community bonds and living within Nature, ideas that underlay dolmen creation. Thus, by studying the *elements* of material culture and practices through a formal analytical approach, we have come to know something of the conceptual belief systems associated with them, where our series of theories to date are represented by the HCMs and ICIs.

It seems plausible and strongly supported by both the approach and the data analysed in this project, that the cosmological ideology expressed through the existence of the dolmens entails the greater themes of fertility, sustenance, life and death, where each dolmen was the *local* omphalos of this world view, connecting each family group to these core themes. In these ways, dolmens are anchors. Their status, then, if it may be expressed as such, is not *primarily* about Territoriality but about *Existence* (*contra* Senna-Martinez and Quintã Ventura 2008: 340).

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Chapter 15
A reappraisal of megalithic orientations from Iberia and beyond: towards models of interpretation

A. César González-García

'One of the most striking aspects of megalithic constructions is their astronomical orientation…'
(Garrido Pena *et al.* 2012: 157)

Abstract

Data gathering work and methodological analysis by Michael Hoskin, Clive Ruggles and several other researchers across Europe led to the overall acceptance of the possible astronomical orientation of megalithic constructions. The main result from these works, especially those of Hoskin for Iberia, is that the megalithic monuments of a specific area and of a certain typology present a characteristic orientation pattern that, in several cases, can be related to astronomical events such as sunrise at certain times of the year.

In the last two decades, these seminal works have been expanded and revised. First, new research carried out in collaboration with archaeologists have expanded the areas and objects where it was originally studied. New data has allowed us to ratify, correct, or nuance some of their conclusions. It also has revealed other ways of demonstrating the intentionality of astronomical orientations, like diachronic studies. Other studies have dug out further into the data to find the possible existence of intentionality on the one hand, and links to other areas in the other.

Also, these new data, together with further critical studies including contextual information, allowed for the interpretation of those possible astronomical relationships. Such may come from the material remains within the excavations, from studying the interaction of light with the megalithic art and/or through a deep understanding of the elements at work in deciding the location of the megaliths. The image resulting from the new contributions opens new questions to be answered in the future and at the same time they allow us to show a richer and more diverse image that brings us closer to interesting aspects regarding the mentality of the builders of the megaliths and their conception of space and time.

Keywords: megaliths, Iberia, archaeoastronomy, orientation, space, time

Introduction

Although there was work on the orientation of megalithic monuments in the Iberian Peninsula and the Balearic Islands before the studies of Michael Hoskin (e.g. Font Cot 2005; Vivanco 1981; López-Plaza *et al.* 1992), the above statement by Garrido Pena *et al.* is based on the intense work of data gathering and methodical analysis by Hoskin and his collaborators for almost two decades (Hoskin 2001).The main result from his works is that the megalithic monuments of a specific area and of a certain typology present a characteristic orientation pattern.

Over the last two decades, the idea that the orientation of megalithic monuments is a measurement worth recording has gained importance among archaeologists, especially in particular areas of Europe. Thanks to the works of several dedicated studies on the orientation of megalithic monuments across Europe and the Levant (e.g. Belmonte *et al.* 2013; Clausen *et al.* 2008; González-García and Costa-Ferrer 2003; González-García *et al.* 2009; Lomsdalen 2014; Prendergast 2011; Ventura and Hoskin 2015; Zedda 2015) it has been shown that particular groups of monuments with a consistent typology, chronology and material culture, appear to display also similar orientation patterns, indicating that such characteristics may tell us something fundamental about the ideas of the builders of such structures.

One clear possibility to account for the coherent orientation of monuments across wide geographic areas is an astronomical motivation, as in most cases other possibilities do not account for such coherence.

However, in a thought-provoking paper presented at the 'Oxford IX' meeting celebrated in Lima (Ruggles 2011), Clive Ruggles explored the idea that perhaps we are running around the same circles once and again in Cultural Astronomy. When dealing with the orientation of megalithic monuments, we may speculate over the possible meaning of the orientation of singular monuments, but Ruggles argued that we were not going to gain any further insight on the meaning of such orientations if we do not connect such with the contextual data. In other words, we must always take into account the cultural context in which such orientations might have been meaningful. To do so, one needs to consider the material culture found in the megalith we are studying, but also the surrounding landscape including here not only the natural formations but other artificial elements from the same or other periods.

Michael Hoskin's work on the Iberian Peninsula, summarized in his book Tombs, Temples and their Orientation (Hoskin 2001), was likely the stepping stone for present-day archaeoastronomy in Iberia. However, the field has evolved significantly since then. This evolution first came from new concepts and theoretical considerations. It also arose from extending Hoskin's sample in different areas, introducing new approaches and methodologies, and considering new ideas about orientations in relation to the overall landscape.

In this chapter, I will summarize the improvements made over the last two decades since Hoskin's work. I will also present a state-of-the-art overview of the Iberian Peninsula, with thoughts on its possible future developments.

New ideas, new methodologies?

Cultural Astronomy is a term that was defined, in various ways, at the beginning of the 1990s (Iwaniszweski 1991; Ruggles and Saunders 1993). As such it appears as the field of research devoted to the understanding of how past societies comprehended the sky and its phenomena and how they incorporated such into their daily lives, into their culture. As part of this field, a number of what we may call sub-disciplines appeared.

One is ethnoastronomy, devoted to understanding this human relationship with the heavens in contemporary societies as part of the culture of a given human group characterized by given traits or 'habitus', socially built (Bourdieu 1997). As such, ethnoastronomy should be defined as an 'anthropology of astronomy' (López 2016), using to develop this task the epistemology, tools and methods of ethnography and anthropology.

Another area is that known as archaeoastronomy, devoted, according to Ruggles (1999: 145), to the study of the practice and use of astronomy. This is particularly achieved through the material record of archaeological sites and using social theory to provide viable interpretations (Ruggles 2011).

In the last decades, cultural astronomy and particularly archaeoastronomy has been struggling to cope with the new waves of post-processualism, interpretative archaeology, phenomenology, and the ontological turn, to name but a few. At the same time, it had to deal on the one hand with the suspicion in certain sectors of academia of its lack of professionalism, often on the verge of fringe science, and on the other with the gap between archaeology and archaeoastronomy. Such gap apparently grew wider due to the recourse of (mostly European) archaeoastronomers to gross mathematical arguments to back up their finds but omitting the overall social theories to go beyond pure data analysis (see e.g. García Quintela and González-García 2009).

Works such as those by Clive Ruggles (1999), Michael Hoskin (2001) or Juan Belmonte (2012), helped, in certain areas of archaeology and in particular countries, to a change of ideas regarding the usefulness of archaeoastronomy to the archaeologist, and as such several archaeological studies now include a review of the orientations and the concept of the heavens from the start of the projects themselves. This is not always and everywhere the case, but things seem to be improving. One of these fields is the study of the megalithic phenomenon.

The methodology of data acquisition for megalithic tombs, and passage graves in particular was largely devised by Michael Hoskin himself (Figure 1). As most passage graves seem to display a symmetry with respect to an axial line, the idea would be to measure the orientation, the angle with respect to true north, of such line from the inside out. This may encounter a number of practical problems in the field, and this is not the place to go into the details. To correlate such measurement with any heavenly body one needs to record another two magnitudes, the latitude of the site and the angular altitude of the horizon as seen from that site in the direction of the orientation (Prendergast 2015).

This way of measuring the orientation, together with the associated uncertainty inherent in the measurement process itself, with the state of preservation of the remains and with the determination of the axis, was nuanced in several cases by different authors. Belmonte and Hoskin (2002) indicated, for example that in several cases one should not only look from the inside out, but consider the other direction, that on occasions might have been of relevance. Silva (2014) proposed the concept of 'window of visibility' and that the whole span of the width of the passage as seen from inside the chamber should be considered equally relevant. This concept was expanded by González-García (2018) to the 'window of illumination' particularly for those cases where sunlight entered the chamber.

The more varied ways of data acquisition have run in parallel with the use and introduction of new methods

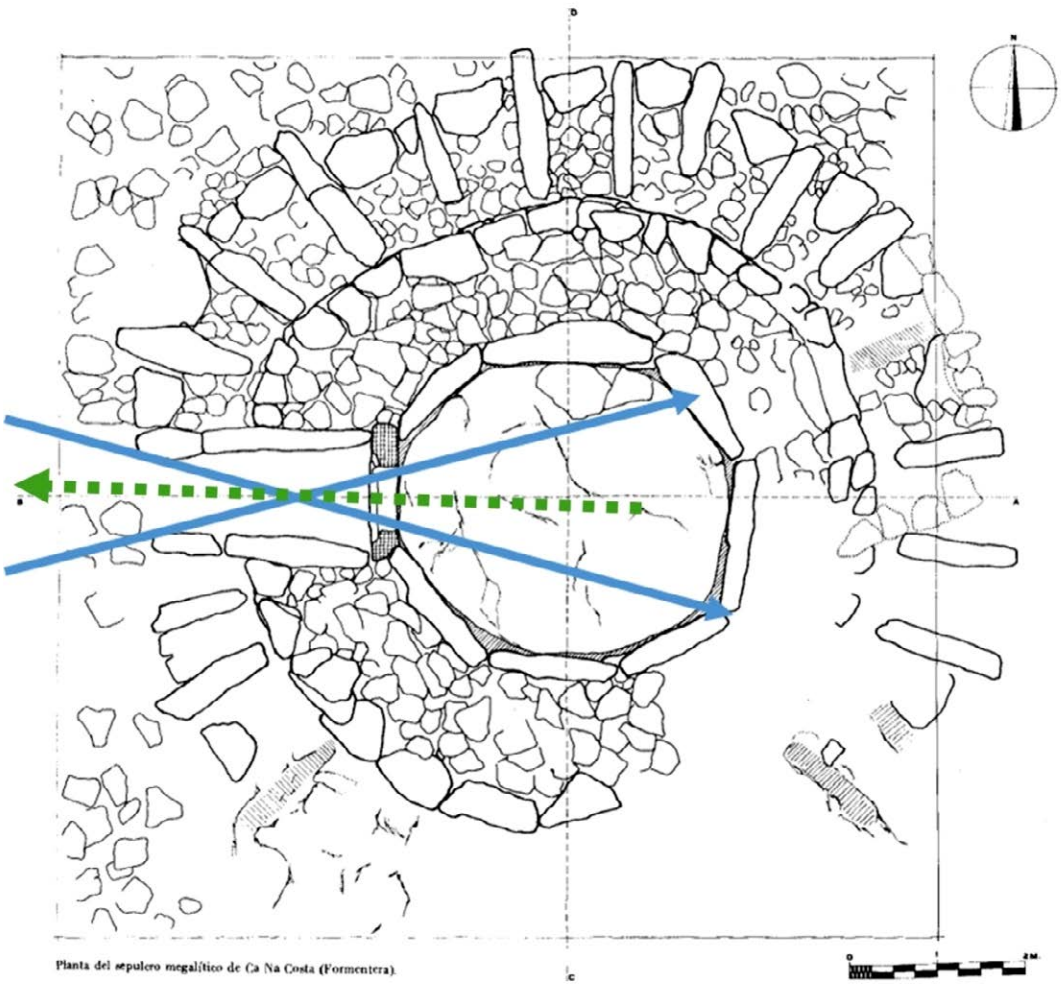

Figure 1. The usual methodology for data gathering is illustrated using the plan of the megalithic chamber of Ca na Costa in Formentera (Balearic Islands). The green dashed line indicates the symmetry line normally considered. The blue arrows indicate the window of visibility or window of illumination. These ranges indicate either the range of the horizon visible from the inside or the dates when the sun could illuminate the back of the chamber.

to delve into the data in new ways so that we can try to extract more information from them. This has been specially the case using several statistical tools. On the one hand, several methods have been explored to verify if a given concentration of orientations are indeed significant, in statistical terms (see e.g. González-García 2013; González-García and Sprajc 2016; González-García *et al.* 2021; Silva 2020). On the other hand, the groups of data gathered have been compared to see whether there appear similarities in the orientations across broad regions (more on this below).

Finally, apart from the traditional way of data gathering by field work, either using magnetic tools, or through theodolite/total station, new ways of collecting data have been implemented. These are based on the rise of the high-resolution digital terrain models (DTMs). These models help in the reconstruction of the landscape surrounding the megalithic monument, although in several cases they have inherent problems due to the improper use of these models without considering the uncertainties derived from the resolution of the models themselves. However, these models with the new visualization tools (i.e. computer programs such as Horizon (Smith 2020) or Stellarium (Zotti 2016)) have helped to incorporate the sky in 3-D reconstructions of environments that have expanded the capabilities of the interpretation of past skies.

On a more theoretical level, to try and bridge the gap with archaeology indicated above, Silva (2015) introduced the concept of skyscape archaeology. Skyscape, a term traditionally associated with a particular type of paintings, is defined as 'a part of the sky with outlined terrestrial objects that can be comprehended in a single view'. Silva proposed this term because it was not loaded by preconceived western ideas as 'astronomy' might be, defining thus skyscape as the way a particular society engages with the sky (Silva 2022). Skyscape archaeology, therefore, would be the study of such engagement through the methods of archaeology.

The term has gained momentum with a growing number of studies in the last years using the definition (with varying success: see Silva 2022) and even a new *Journal for Skyscape Archaeology* was founded. Despite this, the term archaeoastronomy is still widely used today (see e.g. González-García and Belmonte 2019).

Completing data collection in new and old areas

A review of the areas covered by Michael Hoskin over almost two decades of fieldwork reveals that his studies were exhaustive, but particular regions were left out of the initial exploration. To these, we must include the new megalithic tombs that on-going archaeological explorations have brought into light since Hoskin's book was published.

For decades, some areas in central Iberia were deemed to be almost empty of megalithic monuments (Delibes 2010). This picture has been changing in the last decades, and even if the density is still low, these areas are no longer considered as devoid of megaliths. Singularly, some of them appear to be possible transition zones, where local building traditions, not previously considered 'megalithic', are being explored (Tejedor 2018). Other areas, in high mountain zones, are being explored now they are recognized not as peripheral and therefore marginal areas, but as integrated in a complex network of interactions with many other zones: lowlands, mountain passes and river fords (Alday Ruiz *et al.* 2012).

For low density regions Gil-Merino *et al.* (2008, 2018), González-García and Belmonte (2010) and González-García *et al.* (2024), obtained measurements for the northern plateau, while Silva (2010, 2013, 2014) covered central Portugal. In general, these monuments present orientation patterns similar to those already shown by Hoskin for Salamanca (1992), with orientations close to sunrise at the winter solstice.

Soon after Hoskin's publication, Font completed a PhD dissertation centred on the analysis of the orientation of several types (passage graves and Catalan galleries) of megalithic monuments in the Catalan areas, specifically in regions close to the Pyrenees (Font 2007, 2009). He included more than sixty new megalithic monuments that were not previously included in Hoskin's work. Also, while he concluded that the overall results of Hoskin within this area were correct (see below), with most orientations towards the second quadrant of azimuths (with a strong concentration between 135º to 180º), this appears to be clearer for the passage graves while it seems rather more diluted for the Catalan galleries. However, among these, the Large Catalan galleries stand out as they seem to be more connected with the sunrise.

More recently, these samples were completed with new data from mountain areas such as the Pyrenees in Huesca (Belmonte and González-García 2012; González-García and Canosa-Betés 2021) and the Iberian Mountains in La Rioja (González-García 2021; Figure 2, above). The last work includes a diachronic study of orientations in the Iberian northeast, demonstrating how orientations in this area were maintained during the Neolithic period in non-megalithic as well as in megalithic structures. However, there are still areas to explore further, like the dolmens of Asturias where preliminary studies are being carried out today.

González-García *et al.* (2017) explored further the dolmens of Galicia, where Hoskin's original sample of 32 monuments was expanded to more than 70, showing that a clear pattern of orientations appears where all passage graves are within the luni-solar range, with a concentration of orientations near winter solstice (Figure 2, above).

For central Portugal, Fabio Silva (2013, 2014) endeavoured to obtain new data for several passage grave tombs, by also applying a new methodological approach considering the whole aperture of the passage as possibly significant for the megalithic builders. In doing so, he proposed that the cluster of megalithic tombs near Carregal do Sal appeared to be connected to the heliacal rising of Aldebaran. Stellar orientations are rare among the Iberian dolmens, but not completely absent; the dolmen of Valencina de la Concepción (Seville) is allegedly also oriented towards the rise of Sirius (Belmonte and Hoskin 2002).

In Southern Iberia, it is worth mentioning the research of Benítez de Lugo Enrich *et al.* (2021; Figure 2) in Córdoba. This new cluster of megalithic monuments appears to display orientations that are in agreement with those already measured by Hoskin, with a singular difference from those found in the northern part of Iberia, as can be seen by comparing the diagrams of Galicia and Cordoba in Figure 2. Another study worth mentioning is that of the monuments of Montelirio, near Seville, by Esteban (2016). Here, Early Bronze Age *tholoi* have been excavated uncovering an elaborate deposition ritual in a tomb with only female bodies, accompanied by lavish grave goods that included ochre painting and an upright stela in front of the elongated passage that was illuminated at particular times of the year, perhaps indicating the correct moment to perform funerary rituals.

Also of note is the recent discovery of a new megalithic tomb in Antequera, next to the Peña de los Enamorados,

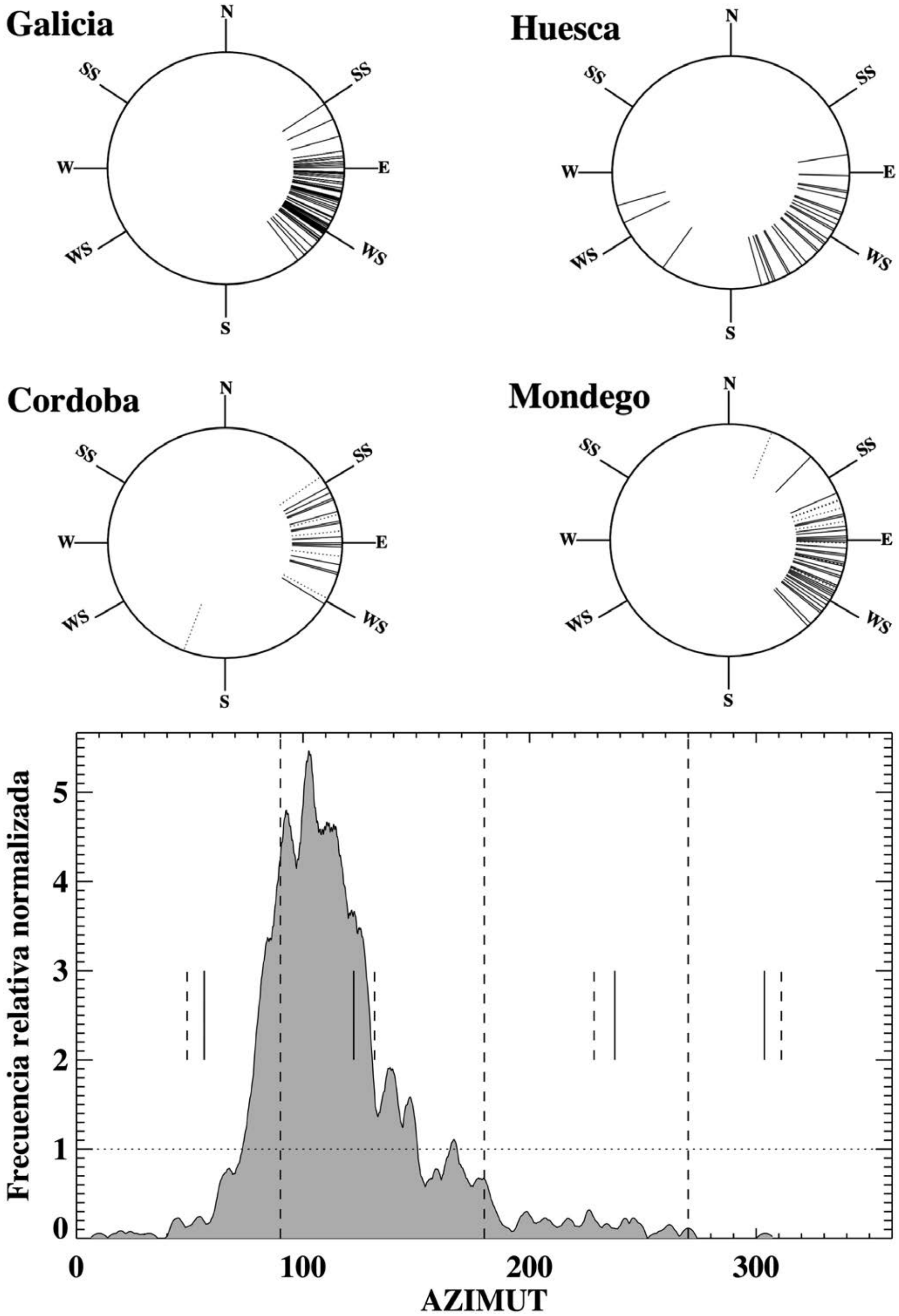

Figure 2. Above: orientation patterns in the new areas studied. The outer lines indicate the cardinal points and the limits for positions of the sun. The orientations are indicated by lines within the circle. The solid lines indicate the measurements of Michael Hoskin (except in Huesca) and the dotted lines the new measurements. Below: azimuth curvigram of 1300 megalithic monuments of the Iberian Peninsula and Balearic Islands. Dashed long lines indicate the cardinal directions, short solid lines the sunrise azimuth for the solstices at a mean date of 3000 BCE and a latitude of 41.5º. The short vertical dashed lines indicate the lunar extreme azimuths for the same date and latitude.

with an identical orientation to Menga (45º), but where a beam of light at summer solstice sunrise illuminated the back stone through a side opening (García Sanjuan *et al.* 2023). The site was excavated recently, and the data indicated a extended period of use of the megalith, with different phases that included the deposition of a couple (male and female) at a position that was at odds with the general orientation of the tomb, but was coincidental with that of the illumination indicated above.

Finally, in the Balearic Islands, research has also continued, especially expanding the study of the Taulas on Menorca (Riudavets González *et al.* 2023), some of the first megaliths to be explored in Spain by Hoskin, and in the Mallorcan Talayots (Aramburu-Zabala and Belmonte 2002). For the Taulas, Riudavets González *et al.* (2023) explore the possibility of illumination effects inside the megalithic enclosure. Such effects might stimulate new hypotheses apart from the stellar one proposed by Hoskin, who linked the orientation towards south of these monuments with the visibility of the Southern Cross in the skies of the Balearics at the time of construction (see recently, Cristofaro 2021). In the light of new chronologies, these monuments appear younger than previously thought, and such an observation is now deemed dubious, as precession brought the asterism towards southern declinations, making the observation impossible at the later times.

It is worth considering here some studies on peculiar structures found at individual megalithic monuments that have also been connected to astronomy. One such case is the structure found in Rego da Murta dolmen I, where a few quartz blocks were located below the level of the orthostats (Figueiredo *et al.* 2018). These stones present orientations consistent with that of the passage and chamber, marginally consistent with the moon, but according to the authors more consistent with a stellar hypothesis. A similar case, where structures are present that allegedly could have been used to set the orientation of the megalithic structure, was proposed for the Huerta Montero tholos near Almendralejo in Extremadura (Blasco Rodríguez 2000).

In short, most of these works show that the sample taken by Michael Hoskin is still valid, confirming that, indeed, most megalithic monuments of the Iberian Peninsula open to the east (93% of the nearly 1300 measured so far) while 78% are oriented inside the luni-solar rising range (Figure 2).

Comparative analysis

Hoskin (2001) indicated the differences between megalithic monuments in the eastern and western half of the Iberian Peninsula, mostly based on a by eye impression of the difference between such groups.

Font Cot (2007) performed a similar comparative analysis which indicated a number of small dissimilarities between the coast and the mountains in his analysis of Catalonian monuments.

González-García and Belmonte (2010) aimed at comparing the orientations of different areas of megalithic monuments in the Iberian Peninsula by specific applying statistical tools for the first time. To do so, they took most of the data in Hoskin (2001), complemented by a few new measurements for particular areas in the central part of Iberia. The conclusion of their work was that there appear to be a number of large orientation families, and they highlighted the one in the western part of the Peninsula that they termed the 'Atlantic façade family'.

This study motivated the extraction of new data in the Spanish central Pyrenees (Huesca: Belmonte and González-García 2012; González-García and Canosa-Betés 2023), and other areas indicated above (e.g. González-García 2021). They also expanded such comparison to other central Mediterranean areas (González-García *et al.* 2014).

Here we will apply these tools to the more complete data now available, also by dividing our data in smaller groups to see if the new data allows to derive a nuanced picture from it.

To do so we have divided our data in the Iberian Peninsula in 37 groups. For each group of data we have the azimuth, altitude of the horizon and declination data for each megalithic monument obtained from the various bibliographic sources indicated above. From such, we extract six observables that define the distribution of orientations, following the scheme devised by González-García and Belmonte (2010): the mean and median azimuth, the standard deviation, the maximum and minimum azimuth, and the peak azimuth of the main concentration and the second concentration. With these six values we build the matrix of our input data.

We then build the dendrogram by applying a nearest neighbour approach iteratively. In this way we can build the distances among the different groups and using such distances as a proxy, draw the dendrogram illustrating the overall pattern of distances among the different groups.

The results of the analysis can be seen in Figure 3. The small inset to the right illustrates the dendrogram, but a more visual outcome is apparent if we apply a cut off at a given value of the y-axis in that figure, and group together everything that is below that value. In that way, we may identify five groups of similar orientations.

The first of such families is concentrated in the western part of the Iberian Peninsula and corresponds to that identified as the 'Atlantic façade family' (light yellow in Figure 3). A second family, closely related to the first, appears overall in the northwest of the Peninsula (dark yellow in Figure 3). A third group is concentrated in the southern area, mostly in Andalusia and southern

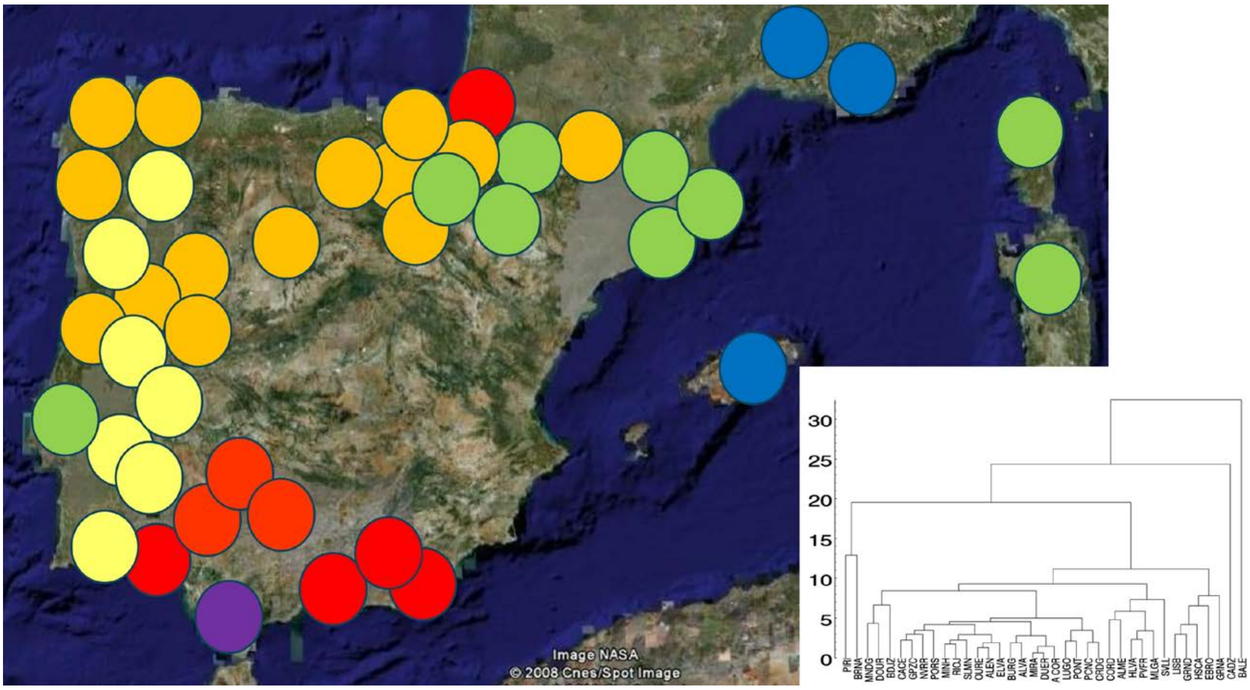

Figure 3. The 37 groups of Iberia and nearby areas group together in supra-regional clusters. The right inset shows the dendrogram resulting from our analysis. If we cut off at a given value in the y-axis we may find 5 grand families: the light-yellow one appears mostly in the eastern façade of the Peninsula. The dark yellow appears overall in the northwest, the red in the southern areas, the green mostly in the northeast and the Ebro valley, while the blue appears in the south of France and the Balearic Islands.

Extremadura (red in Figure 3). A fourth group is in northeast Iberia, composed mostly by the megalithic monuments in the Pyrenees and the Ebro valley (green in Figure 3). Finally, the megalithic monuments of the Balearic Islands still seem to be more closely related to those of the southern coast of France (blue in Figure 3; see González-García *et al.* 2014). The megaliths of Cadiz appear as an isolated group (purple) possibly due to numerical artifacts of the modelling.

A way to visualize the meaning of such families is by grouping the azimuths inside those families and plotting a curvigram for each family. This is presented in Figures 4 to 8. The first family, the Atlantic Façade family, appears to display orientations mostly inside the solar range, but with a spread of orientations concentrating between the equinox and the winter solstice sunrise, with the largest concentrations at azimuths of nearly 100º. It is interesting the absence of a concentration on orientations close to the solstice.

The northwest family presents a similar range of orientations to the previous family, but the largest concentration now appears closer to the winter solstice sunrise. It is interesting that the shape of the concentration in this family is very similar to the one we would expect if the orientations were connected to sunrise at any day between autumn and spring equinoxes, i.e. with the range of sunrise orientations in the cold part of the year.

The southern family, again, presents a similar range to the Atlantic one, with the majority of orientations in the range between due east and the southeast, but in this case with two significant concentrations at roughly the equinox and winter solstice sunrise.

The orientations in the eastern part of the Peninsula seem at odds with that of the western half: the northeast family (Pyrenees + Ebro valley), presents a range mostly outside the lunisolar range with maxima from winter solstice to due south. Meanwhile, the Balearic family presents orientations towards the western part of the horizon.

With this we may nuance the interpretations given in previous studies.

The whole area of western Iberia (including the Atlantic façade, the northwest and the Andalusian groups) appears to be relatively systematic with orientations mostly within a range between slightly north of due east and southeast, with 75% of the orientations facing a solar rising (85% inside the lunar range). Interestingly, there seem to be differences between the three families that appear to justify the different treatment in orientations: while the northern group appears to be highly consistent with a general lunisolar hypothesis (172 monuments measured so far, with 72% of orientations consistent with the sun; 92% with the moon), that seems to imply a fairly loose

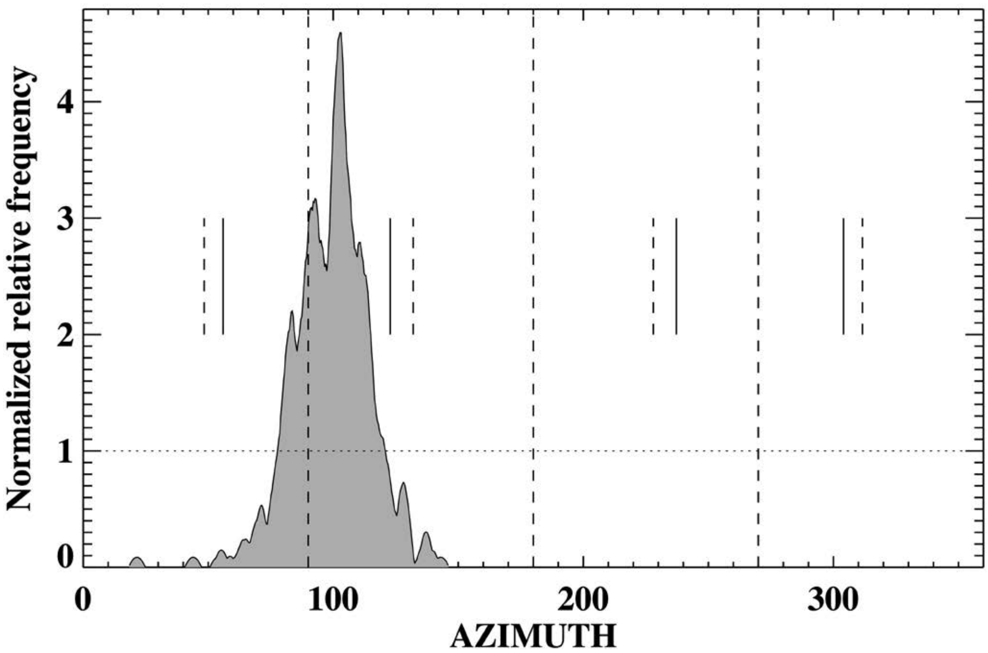

Figure 4. The Atlantic façade family displays a range of orientations heavily concentrated towards the eastern part of the horizon, with most orientations within the solar range. It is interesting to note the absence of a concentration near the winter solstice line. Lines are as in Figure 2 (below).

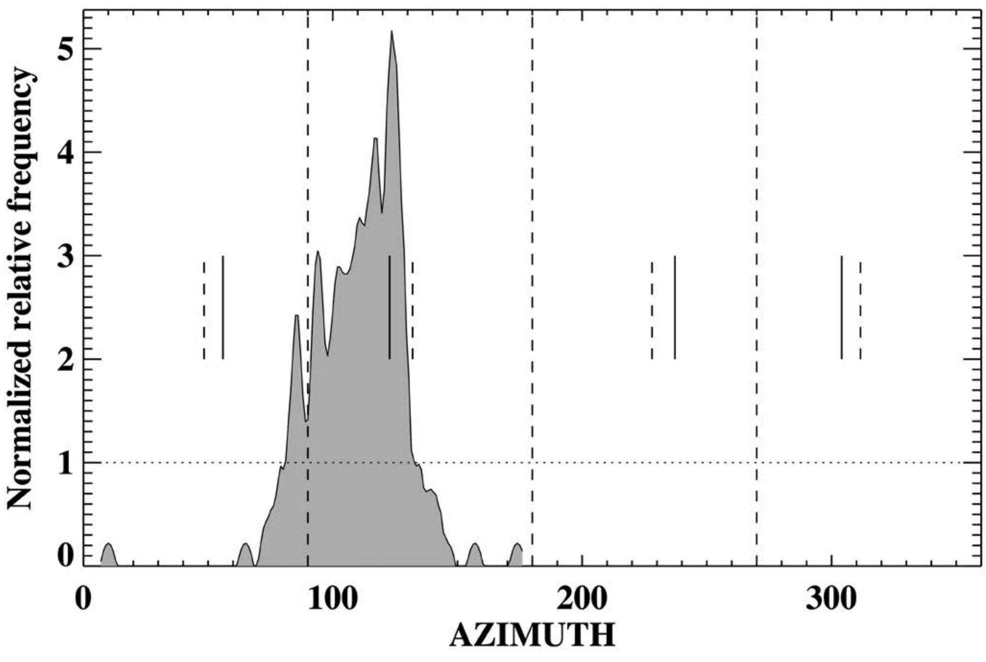

Figure 5. The northwest family presents a range of orientations similar to that of the Atlantic family, but the shape now is heavily skewed towards the southern extreme risings of the sun and the moon.

connection with specific moments of the lunisolar cycle, and instead rather a general association (in the sense indicated by González-García 2013). This would indicate that the orientations, and if we assume a ritual character attached to them, the dates of celebration were not dictated by specific moments in the solar or lunar cycles such as the solstices or equinoxes. The concentrations appear to indicate that the orientations had to follow any one of these two heavenly bodies at particular ranges of epochs (cold part of the year for the sun) but not at specific dates (i.e. equinoxes or solstices).

A similar conclusion might be drawn from the Atlantic façade group (93% solar; 98% lunar), but coherence with the lunisolar hypothesis in this case

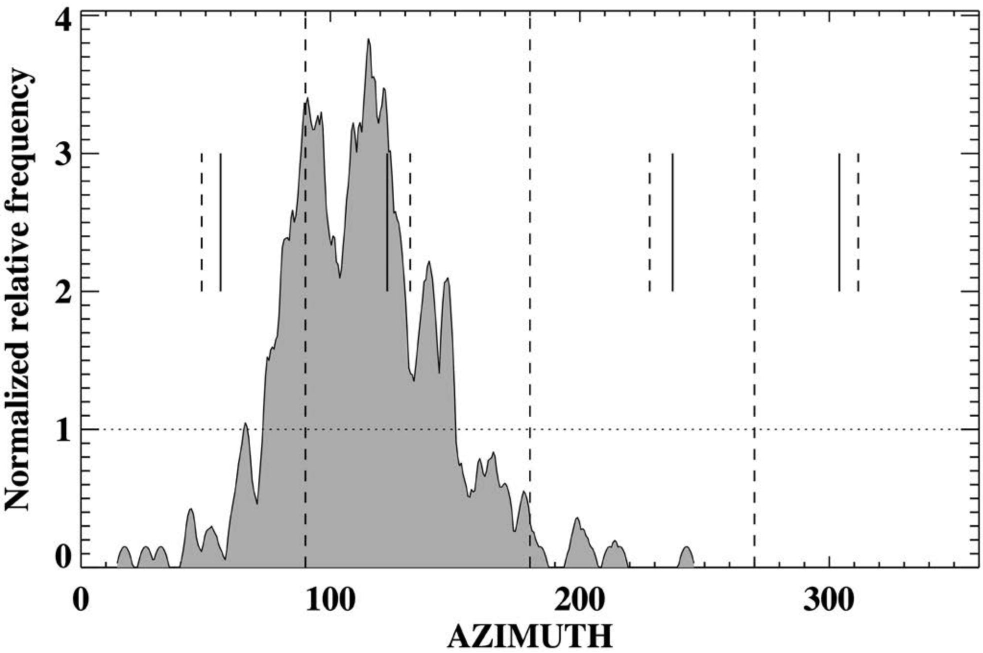

Figure 6. The southern family presents a range of orientations similar to that of the Atlantic family, but less concentrated inside the luni-solar range to the east, and with two broad concentrations towards the east (equinox) and the southern extreme risings of the sun and the moon.

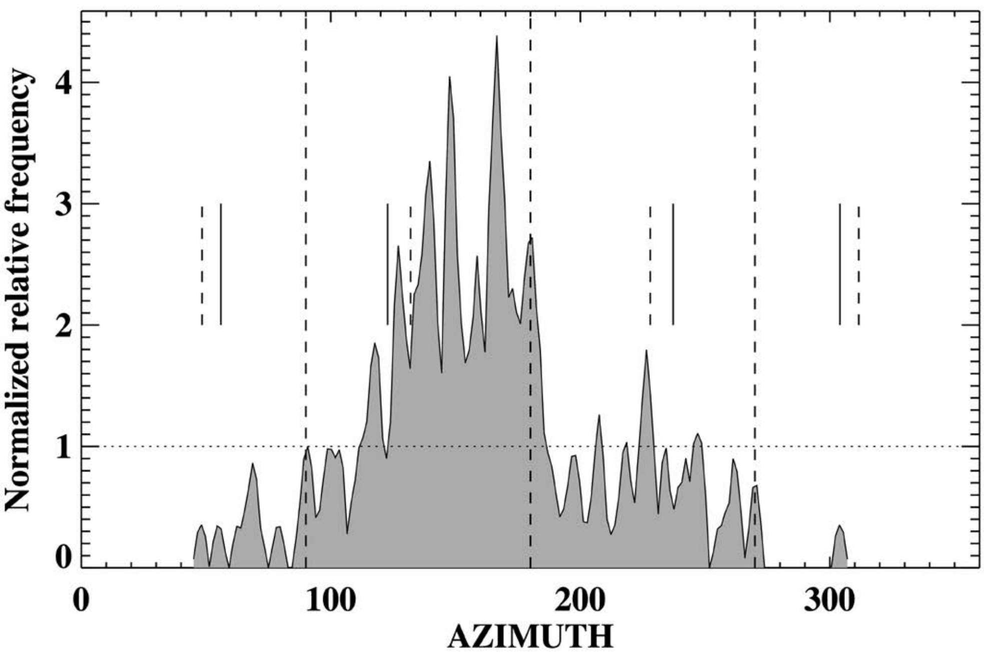

Figure 7. The Ebro valley family (northeast Peninsula) presents a range of orientations at odds with those in the east of the Peninsula. The range is mostly outside the rising and setting positions of the sun or the moon. Most orientations are within the range from winter solstice sunrise to due south.

seems even stronger, with practically all megalithic monuments consistent with the lunisolar hypothesis. Remember this group includes the Alentejo dolmens (177 monuments), but also includes many others in a large region of Portugal and western Spain (333 monuments in total), highlighting the coherence within this group.

The southern group seems to present a larger scatter (342 megaliths measured, 61% consistent with sunrise at any time of the year; 72% with a moonrise) with orientation values from practically north to the southwest, but with clear concentrations close to equinoctial orientations and the winter solstice values, as indicated above.

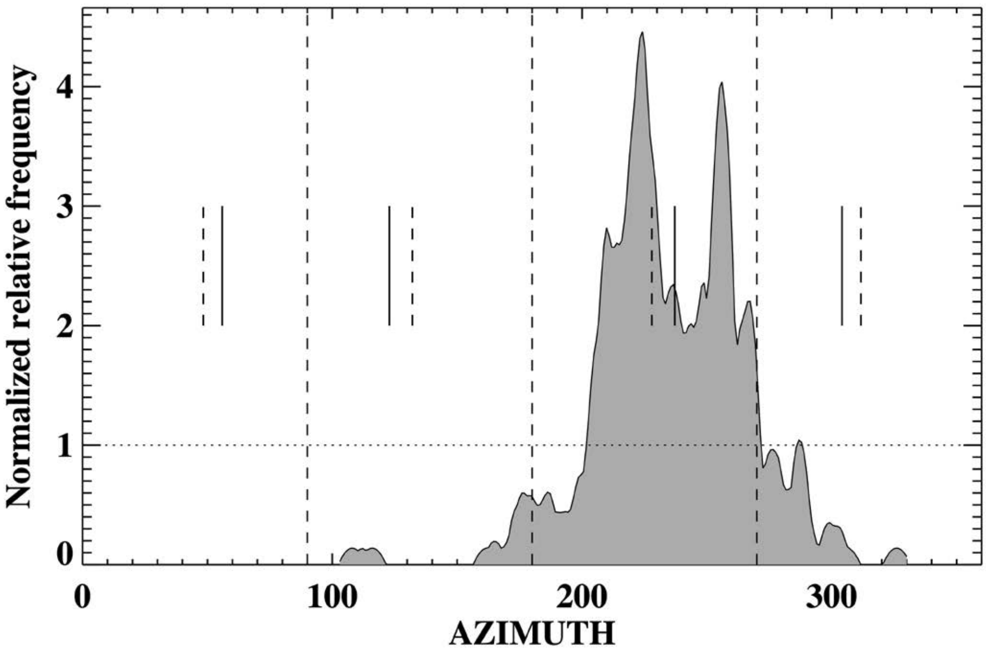

Figure 8. The Mediterranean family appears to be the only one with orientations restricted to the west and mostly inside the setting luni-solar range.

The Ebro valley appears to be a complex area, with interactions with the mountains to the north. The megalithic tombs present orientations generally outside the lunisolar ranges (229 measurements with only 16% of orientations inside the solar, and 23% inside the lunar range). Even if this points to the absence of a link with any rising solar or lunar positions, it may indicate an avoidance of such; hence although there is no direct link with the rising of either of the two main astronomical luminaries, it may indicate that the orientations were dictated by avoidance of such directions. One possibility is that in this way the entrances to the graves did not face the main winds in the area (Cierzo). It must be noted that such a possibility has been proposed for the Taulas in Minorca, where a possible stellar orientation was used to obtain an orientation that would avoid the prevailing winds (Urrutia-Aparicio and Belmonte 2021).

Finally, the Balearic Islands and southern France are the only group with orientations directly open to the western half of the horizon (222 megaliths measured): 44% of monuments have orientations inside the solar range, basically towards the setting sun, and 54% inside the lunar range. This latter could be linked with the visibility of particular lunar events, such as the first crescent observation that occurs on the western horizon (see below). This group presents two main concentrations, one towards the southernmost setting of the moon and a second within the lunisolar range at an azimuth of nearly 260º.

In this first approach we have not yet considered the stars. Of course, in most cases we could name several stars that might relate to the main orientations. In some cases, mostly at individual tombs or small groups, some stars have been advocated as possibly linked to the orientations or the range of views possible from inside the chamber (see e.g. Belmonte and Hoskin 2002 for Valencina and Sirius, or Silva 2013, 2014 for the Carregal do Sal dolmens and Aldebaran). A possible stellar connection was explored also for the Ebro passage graves by González-García (2022), but without reaching a plausible explanation for all of them. This does not preclude the possibility of stellar orientations. In fact, the Ebro valley orientations may provide an interesting case to explore this possibility further in the future.

Towards models for intention

Once intentionality was established, Hoskin proposed a model of motivation (Hoskin *et al.* 1995). To do so, he applied the parsimony principle (or Occam's razor approach) concluding that the sun should be the object of interest for such orientations, either at the time of its sunrise (sunrise, SR) or slightly later (sun-climbing; SC).

This simple scheme was harshly criticized (Iwaniszweski 2009; Silva 2014). We must highlight that Iwaniszweski does not criticize the collection of archaeoastronomical data itself, but the conclusions of Hoskin's scheme that fall too short to account for the various societies that populated the Peninsula at the time the megalithic phenomenon developed. Trying to explain them all by a single simple scheme may seem too reductionist and does not provide enough clues to understand the orientations within the specific cultural context of each case.

These criticisms could be well based, but still the interpretation by Hoskin holds as a valid one for many archaeologists. It is in this way that we can understand the citation at the beginning of this chapter (Garrido Pena *et al.* 2012). In fact, the case of the Alentejo passage graves is often understood as one of the first unmistakable proofs of astronomical orientations precisely because of the consistency of the orientations with respect to the solar hypothesis. In this case, for instance, the economy of the people who built and used these monuments, possibly herders, could be in accordance with this interpretation. However, as we will see in a moment, other possibilities such as a lunar association could also be advocated, not only for explaining the orientations equally well (or even better, if we consider the whole range of orientations and the shape of the distribution), but because they could also include in the interpretation the decoration of the plaque-idols placed mostly in the passages of these passage graves at later times (Belmonte and Hoskin 2002).

Various alternatives to Hoskin's scheme have appeared in the last two decades that try to get closer to this sociocultural perspective. For example, in the case of the *antas* of central Portugal and Extremadura, first Roslund *et al.* (2000) but especially Marciano da Silva (2004) proposed that the orientations could be interpreted by lunar observations, of the spring full moon. Da Silva (2004) introduced the concept of lunar cross-over to consider the orientations that appear to be close to the equinox, but deviate from it by a few degrees. The key element for this scheme is that the sun and the full moon appear in areas of the sky nearly 180º opposite each other. This means that if we take into consideration the position of sunrise during summer solstice, for example, the full moon at that moment would be setting almost at its southernmost position, opposite the sun. The next evening, the moon would rise close to its southernmost rising. As the months pass, the rising sun travels south while the full moon is travelling north, and at a moment close to the equinox but not necessarily coincidental with it, the two bodies appear to cross at the horizon. The cross-over would be the 'ideal' point of such a crossing, but the crossing itself is not directly observable. We should recall that such a position involves the coherent observation of the sun and the full moon over the passing months. This possibility may also accommodate the findings referred to above on the geometric decoration of the plaque-idols that seem to imply a solar and lunar reckoning. Silva and Pimenta (2012) expanded this scheme to other instances of crossing over by the sun and the moon, offering a range of possibilities for other orientations.

Another lunar explanation was explored by González-García *et al.* (2007). These authors proposed that the orientations towards the west found at several megalithic monuments in southern France and the Balearics could be connected to the observation of the first lunar crescent. That is indeed well attested both historically and ethnographically as a culturally relevant reckoning point in any lunar time-keeping system, and is often considered the start of the lunar month.

González-García and Belmonte (2010) also find that lunar models seem better than solar ones to explain the orientation patterns of the Alentejo monuments, something supported by Pimenta *et al.* 2009 for other monuments in the area and by Silva 2016 for other Portuguese tomb groups. Such a lunar interpretation opens up very interesting interpretative possibilities for the understanding of time by the pastoral societies that may have built and used these megalithic tombs.

As indicated earlier, in 2014, Clausen re-examined the orientation of the monuments in central Alentejo and the surrounding area. Inspired by the similarities between Danish and Swedish passage tomb orientations and those in the Alentejo, Clausen found that the lunar model that best fitted his findings (applying the concepts of cross-over full moon proposed by da Silva 2004, 2010; see also Silva and Pimenta 2012) included all the full moons of summer, excluding the time of the standstills, i.e. the southernmost full moon (Clausen 2014).

Besides solar and lunar orientations, a small number of monuments have been linked with stellar orientations. Silva (2013: 2014) connects the orientations of the dolmens close to the Sierra da Estrela (one of the groups belonging to the Atlantic façade group) with the visibility from the chamber of this mountain range and the star Aldebaran, indicating that this could be a reason for the use of this name for the mountain range. Also, observation of the heliacal rising of the star on top of the mountain would coincide with important moments for the herding economy of these communities.

Several monuments, especially Mediterranean ones – e.g. the Taulas – have been associated with the Southern Cross. As regards the exploration of the stellar hypothesis, a general overview of the role of the Milky Way in Iberia and elsewhere was presented by Cristofaro (2021). She indicates the relevance of this asterism in ethnographic accounts worldwide, and proposes a scheme to understand why at widely varying latitudes there are orientations that could be consistent with the Southern Cross and the Pointers (α and β Centauri).

Finally, a small number of works have dealt with the possibility that the orientation of megalithic monuments could be connected to more than just a single heavenly body. These dual observations, proposed by Sims (2006) for the English stone circles, where explored by González-García (2022), indicating some instances where such could be the case.

From this evidence, then, we may see how some stars and notably the Moon are being considered as possible keys to better comprehend the intention behind the systematic orientations. The somewhat systematic observance of these heavenly bodies may indicate a ritual need that was fulfilled by their rhythms and appearances. However, to get the full picture we still need to ask the following question: How did they get the orientations right?

As indicated above, interest in the orientation of megalithic monuments has led to attention on the peculiar arrangement of certain features in archaeological excavations that in other circumstances would not have been given such importance. Such is the case with the discovery of what have been interpreted as the footprints of post holes in Huerta Montero, possibly prior to the erection of the megalithic structure (Blasco Rodríguez 2000). They have been interpreted as markers of the orientation necessary for the passage of the megalithic structure. A similar case has been found at Rego de Murta, in Portugal (Figueiredo *et al.* 2018), pointing to the planning of those orientations. This means that prior to the actual erection of the megalithic structure, the sites had been scrutinized and the horizon explored to verify the correct orientation needed.

Another issue to consider is that megalithic monuments and the cemeteries are places with a long history. They were not built in one go, used and abandoned, but in most cases, the monuments begin with a given form. Instead, that initial form evolves through time and in some cases achieves monumental proportions. Finally, in several cases, the megalithic structure appears to be ritually closed, once the use of the burial structure has finished. This, however, does not preclude the use by other communities later in time, as the various uses during the Chalcolithic, Beaker and other times attest in several cases.

An evolution of this kind may be seen for example at Dombate, in Galicia (belonging to the northwest group). In this case, before the erection of the large megalithic chamber, a smaller simple dolmen was built with an orientation slightly different to that of Dombate. The early chamber has a mean orientation towards values of *c.*110º but the shape of the megalith, with a wide chamber and short passage, allows the light during all the cold months of the year (from autumn to spring equinox) to enter the chamber. We may speculate that at first it was not that important to pinpoint a particular moment, such as the winter solstice. However, we may consider that this was needed later, for reasons of which we are unaware, and a large chamber was built with an orientation towards Winter Solstice sunrise, and in such a way that the megalithic mound of the new monument entirely hides the old one. This may perhaps be a case of trial and error, or better, of an evolution in the ritual needs leading to an increased interest in the extreme positions of the sun and/or the moon (see e.g. Hensey 2015 for a similar case in Ireland and the Irish passage graves, and González-García *et al.* 2024 for another example in central Spain).

One element to consider alongside the orientation of many passage graves in the Iberian Peninsula is megalithic art. This can take the form of both engravings and paintings. Significantly, the largest concentrations of this kind of art inside the chambers appear in Portugal (Bueno Ramírez *et al.* 2016). That has been interpreted in various ways but what might be of particular interest here is the interaction of this art with light.

In fact, one possible concern in the planning of these orientations is the interaction of light with the interior of megalithic monuments (González-García 2018). Dombate is again a paradigmatic case where the light of the rising sun near the winter solstice illuminates only the part of the chamber decorated with red and white geometric paintings on the back stone, so that it can be seen from the entrance, marked by a series of anthropomorphic idols, while the areas with engravings are all in darkness (González-García *et al.* 2019). Other notable cases recently investigated are the dolmens of Burgos (Gil-Merino *et al.* 2019) or Huerta Montero in Almendralejo (Pro *et al.* 2017; González-García 2018). The internal structures in the dolmens of Alberite and Soto block and collimate light so that at times close to the summer solstice (Alberite) or the equinox (Pozuelo 4 or partially that of Soto) the sunlight directly illuminates the rear of the monument (Lozano *et al.* 2014). This use of light and shadow may link the orientations further with the ritual realm at specific times, therefore providing clues to understand the social understanding of time.

How light interacts with megalithic art may tell us something fundamental about the ritual use of these monuments. It has been proposed elsewhere that this use could be an outcome of the evolution of typologies in the megaliths and of beliefs within society. This is a field requiring further exploration in the future. The lack of large chronological samples for the megalithic monuments of the Iberian Peninsula precludes further speculation on the possible evolutions. However, in a few cases the evolution within a single site – as at Dombate described above – can be envisioned and

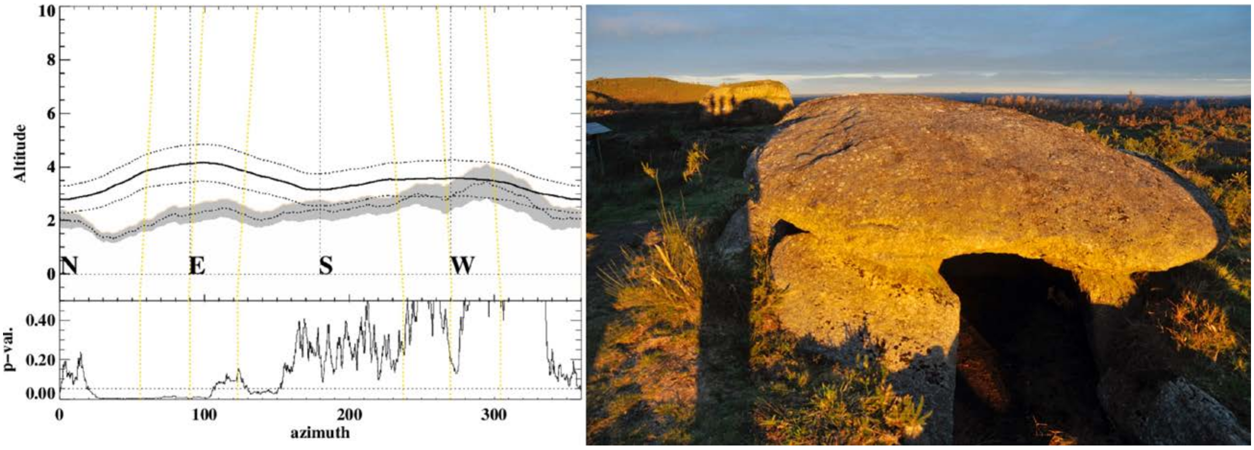

Figure 9. Left: diagram showing a comparison between the horizon that we should expect from a random sample of sites in the Costa da Morte megalithic area in Galicia (indicated in the figure by the heavy solid line and the two dashed lines above and below) compared with the horizons observed from the actual positions of the megaliths (indicated by the grey shaded area). The second is systematically lower than expected for the eastern half of the horizon, precisely where the passages of the dolmens open towards. Right, the dolmen of Forno dos Mouros, located next to a natural route across a sierra in central Galicia, opens towards winter solstice sunrise. Only at that time would the paintings in the chamber have been directly lit by the sun. Finally, its location is such that the shadow of the mound and megalith projects onto a large natural boulder behind it.

might provide important clues although these are difficult, however, to extrapolate to all monuments in different areas of the Peninsula.

Further, the location of the megaliths in the landscape must also be considered. Megalithic monuments appear in areas connected to physiographic constraints (availability of raw materials; Criado-Boado 1981), to transit routes (Llobera 2015) or to areas of greater or lesser visibility in the landscape (Carrero Pazos 2018). And although it is very likely that there will be combinations of all of them (Criado-Boado 2012: 307-313), it has been noted that megaliths appear in areas with particular astronomical characteristics. González-García *et al.* (2017) have shown how the dispositions of megaliths can, at the same time, show a location on best access routes, and in areas of astronomical relevance, perhaps related to transhumance movements. Something similar has recently been noted in the Chabola de la Hechicera group (González-García 2021), applying a diachronic scheme to generate interpretative frames in the structural framework proposed by Criado-Boado (2012; González-García 2013).

These interactions between orientations and landscape are currently being investigated in the Costa da Morte area in Galicia (Higginbottom *et al.* 2022, 2023). There they find that the monuments are in locations that seem to offer specific horizons, which are not the most common in the area (Figure 9). This may indicate a deliberate selection of the building site dependent on whether one could see the rising or setting of astronomical events, and seems to open up a new window that promises to be very fertile for interpretation in the coming years.

In summary, a wide range of interpretations is available, but the rather simple scheme proposed by Hoskin (2001), has been complexified in several ways. On the one hand, this included other astral possibilities, which, even if they break the parsimony principle, appear in several cases to be closer to a social understanding of the sky as a relational field, with actors that influence each other and with a *habitus* that evolves and perhaps is reflected in differences in the orientations displayed by the megalithic monuments. On the other hand, considering the interaction of those orientations with light, art and the location in the landscape, we may see how the picture gets more intricate, but at the same time the interpretation appears richer and more elaborate.

Conclusions

The work of Michael Hoskin consolidated the idea that the orientation of megaliths provides relevant data when interpreting the spatial, temporal, and ritual dimension of those monuments. Data that, put in context (archaeological, social, cultural), and integrated together with other cultural information, allow us to build more fertile interpretations of the past.

In addition to the orientations, we argue that other features such as the location of the megalithic monuments themselves or the illumination of the megalithic art, indicate that the sky and its rhythms were incorporated into the mentality of its builders, with common trends but peculiarities in different regions. As Criado-Boado says, ‘Megalithic architecture builds a model of thinking about the world that is also a way of inhabiting it, of being in it’ (Criado-Boado 2012: 312).

With the new data and the new empirical and theoretical approaches we can try to complexify such models, moving away from the simple schemes proposed early on. In several cases, the most obvious and simplest explanation to account for the regularities in orientations is the sun, but in many cases, those regularities are better linked with the moon or even the stars. In any case, all these interpretations appear to identify specific times likely to have been connected to the ritual and economic spheres of those societies.

It is very likely, in certain areas, that the model was not a static one, but continued to evolve from the Middle and Late Neolithic to the Chalcolithic and Bronze Age, as did the megalithic typologies. Although in most cases there seems to be an overlap in chronology between the simpler chambers and the large ones, as at Dombate, this same example appears to suggest a first stage with simpler chambers displaying a loose connection to the heavens, while later, the large chamber displays a sharper relationship to specific times. Indeed, this is something to explore further in the future.

A megalithic model in which light (from the sun, the moon, or the stars) and layout (orientation, location, and its relationships with the sky and landscape) played an important role, helps us understand the way of inhabiting space and dealing with time that characterised the builders and users of those megaliths.

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Chapter 16
Monuments of the dynasties – monuments of the people? Megaliths in Europe

Johannes Müller

Abstract

Different social formations are sometimes reconstructed for European societies according to interpretations of megalithic tombs. One example is the postulate of 'Neolithic dynasties' as the background of the large Irish megalithic tombs in contrast to more egalitarian societies associated with the construction of smaller megaliths. Such a contrast can also be observed in recent ethno-archaeological studies, e.g., in Sumba, Indonesia.

However, although a thorough comparison of the size ratios of megalithic tombs in different European regions confirms the diversity of architectural development, a structured comparison of existing palaeo-genetic studies negates any evidence of stratified Neolithic groups that erected megalithic tombs, as does an approach to supposed dietary differences. Instead, we can probably assume in all cases that these were not 'monuments of the dynasties', but rather 'monuments of the people'.

Introduction

In recent decades, Neolithic and Chalcolithic European societies with megalithic tombs have often been associated with societies of very different social differentiation (cf. Cassidy *et al.* 2020; Müller 2019; Wunderlich 2019; Wunderlich *et al.* 2024). The predominant idea is that the groups that constructed megalithic tombs were acephalous farming societies that erected communal monuments as collective burial sites for group representation as part of a cooperative ideology. Internal developments, such as an assumed mutual competition in contrast to the basic anthropological constant of sharing (cf. Widlok 2017), are held responsible by some authors for the fact that locally observable graves of different sizes were also erected over time, depending on the economic and demographic power of the groups involved (Gebauer 2014).

In current studies, the question of the social interpretation of societies with megaliths has also found its way into a palaeo-genetic study. Based on the findings of incest, a 'dynastic elite' is postulated for the Irish megalithic: the incest case at Newgrange could be interpreted as an indication of a ruling, closed 'social elite' (Cassidy *et al.* 2020). In contrast to general incest taboos, there would always be only closed ruling groups, such as the medieval European nobility or the pharaohs, in which incest would have been partially promoted. The transfer of this observation to Neolithic Ireland was underpinned by additional arguments: dimensional differences in the megalithic architecture, further genetic kinship structures and observed dietary differences between the interred in different types of megalithic tombs, were intended to identify the corresponding 'elite'.

In the following, we will discuss this approach argumentatively in order to contribute to a perhaps new assessment of the social development of European Neolithic societies with megalithic tombs. Ethno-archaeological research results on recent traditional societies that erected megaliths serve as a basis. Against this background, the size development of Neolithic European megalithic tombs, a comparison of palaeo-genetic ancestral line (pedigree) reconstructions from 24 megalithic sites in Europe, and the reconstruction of the diet of individuals from megalithic tombs are presented.

Ethnoarchaeological background

Ethno-archaeological investigations and ethnographic case studies often help in the interpretation of archaeological contexts. In our case, this covers the question of the role of megalithic architecture in societies, the identification of burial rules and the evaluation of the topic of 'inbreeding'.

Architecture

As part of a research project on social differentiation in recent and sub-recent societies, which we conducted in 2015-2019, it was discovered that on the island of Sumba, under similar topographical, climatic, ecological and demographic conditions, 'megalithic' societies classify themselves socially in very different ways (Wunderlich 2019). In West Sumba, societies tend to exist without social stratification, with numerous megaliths scattered throughout the villages on the village squares. In East Sumba, in comparison, there are considerable differences in size between megaliths in highly stratified societies, with the graves for 'royal' families being spatially agglomerated.

In 1805, megalithic tombs were recorded in detail on the island of Sumba. Their distribution in settlements and the surrounding landscape was documented and interviews were conducted in 20 villages on the construction and significance of the megalithic tombs. On Sumba, the aforementioned very different recent 'megalithic phenomena' can be observed between West and East Sumba. In West Sumba, there are differences between various types of megalithic tombs, but their size is relatively normally distributed. They are located within the settlements on sites that are mostly surrounded by ancestor houses of different clans

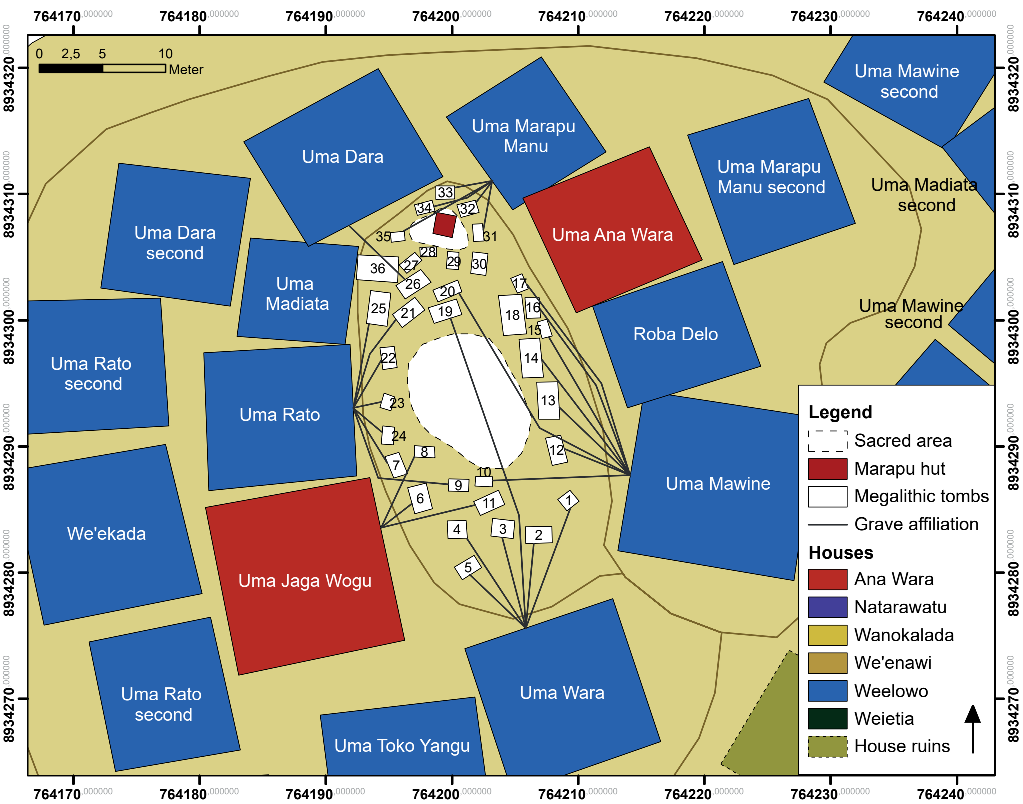


Figure 1. The central area within Tarung, Sumba. The example of a West Sumba village with megalithic tombs of similar size indicates the close relation between ancestors (in the tombs) and the living. The surrounding houses are the ancestral houses of clans in Tarung (from Wunderlich 2019: 79, figure 21).

(Figure 1). The individual enclosures are assigned to these houses and thus to specific clans. This contrasts to East Sumba, where there are several 'royal clans', each of which is dependent on different villages. The clan structures in West Sumba are characterised at most by quantitative differences in wealth, but not by institutionalised social differences. In short, the society of equals in West Sumba is also characterised by a dispersed distribution of relatively many and relatively equally large megalithic tombs. It is also the case in West Sumba that, in principle, all inhabitants (should) be buried in a megalithic tomb. However, the size of a megalithic tomb depends on the economic potential of the family or clan:

> actually there is a rules to make the megaliths. For example, now I also make an example with you [laughs]. Sorry. [laughs] You want to have a tombstone, megalith. But he cannot make by himself. Even he can make by himself in Sumba we need to try to find someone. Because later we need to (...) we need to exchange things and we need to throw the negative spirits from all the things. So, if you want to have one megalith he needs to choose two of the men. And then they discuss about the price. How much until finished. (...) And then the two will make this tombstone. But depending on what size you want. So for example if you want, okay, I like to have this size. But also depends how much (...) Ah, buffalo, pigs and chicken do you have. And how (...) many family all take, participate for these things also. So if whole family, they participate, then you can make bigger (Wunderlich 2019, supplement).

This is also reflected in the statistics. In addition to differences in type and decoration (Figure 2), the size differences in the megaliths of the different clans reflect the different economic and demographic potentials of the individual clans. If a clan is less economically potent, new constructions of megalithic tombs are less frequent and the number of burials in the megalithic tombs is higher than for other, economically more potent clans. To summarise: in West Sumba, there are no pronounced social differences and the construction of and burials in megalithic tombs are not restricted to a specific population group.

The situation is different in East Sumba. Here, particularly large and elaborate megalithic tomb types can be found, which are often enhanced in their

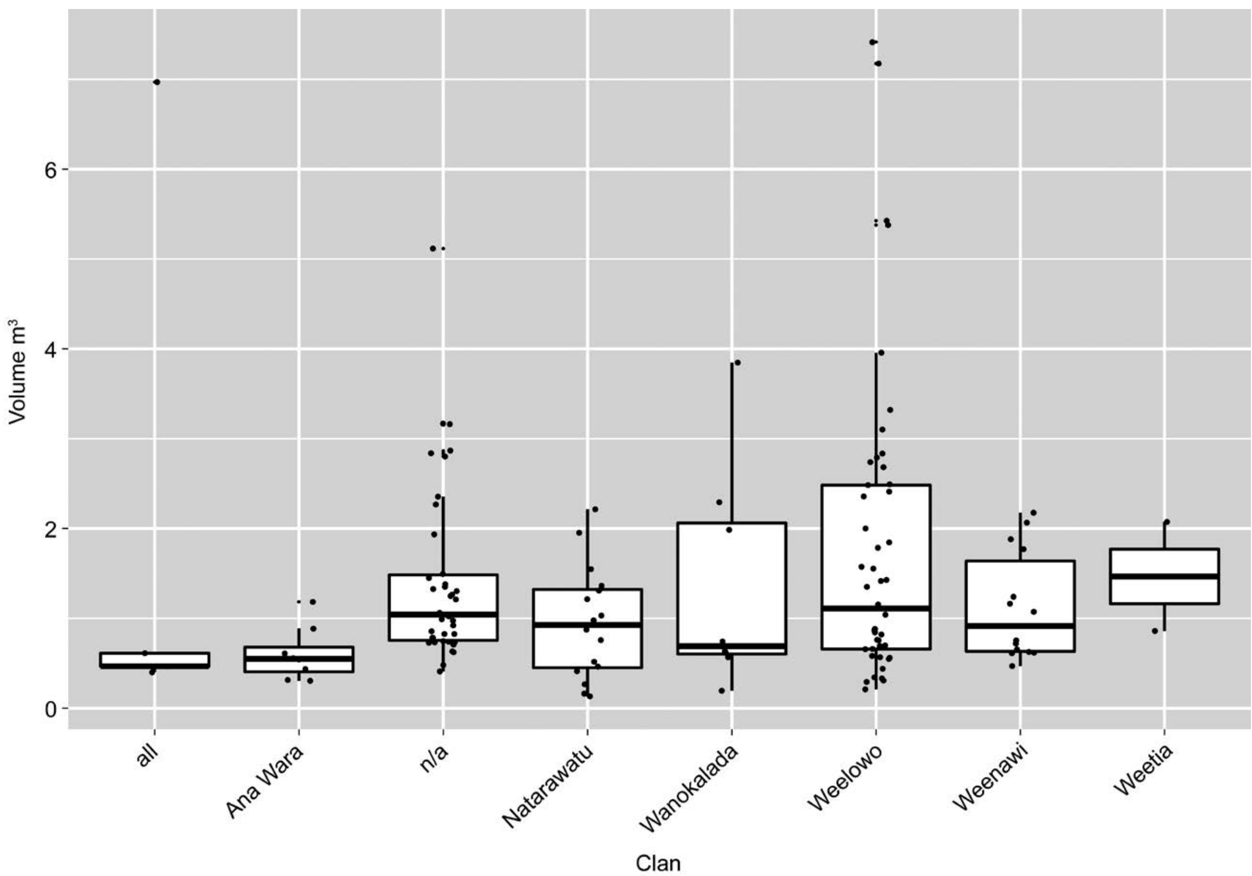
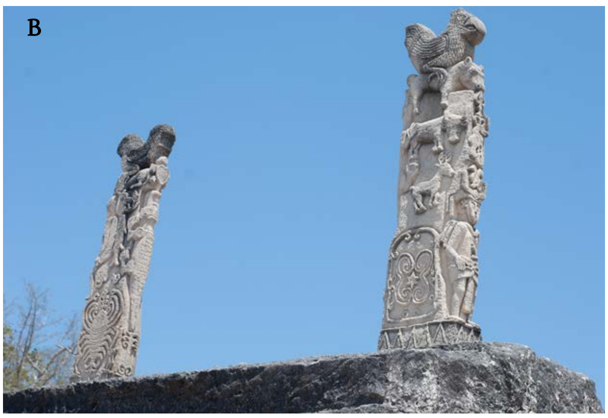


Figure 2. Boxplot of the volume (m³) of the tombs in Tarung (West Sumba) with consideration of the clan affiliation (from Wunderlich 2019: 88, figure 32). The size differences do not display institutionalised social differences, but differences in wealth related to economic and demographic potentials.

thickness and significance by panels (Figure 3). This can be seen in the village of Uma Bara (Wunderlich 2019: 154-62). The differences in size between the houses are striking – in the north, the floor area for houses of the descendants of former unfree people measures from 115-185m², whereas in the south, the floor area of the houses of the descendants of former 'royals' measures from 344-474m². These differences are expressed in the megaliths as well: simple tombs vs. large open dolmen graves. The large open dolmens, some with stelae, may only be built for the 'royal' family. The differences in size between simple gravestones and large open dolmen graves are immense. The 'royal' large dolmens with slabs on pillars have a volume of approx. 5-25m³, whereas the other graves have only 0-3m³ (Figure 4).

In summary, in East Sumba we recognise a restrictive separation between grave types of different architecture and size, which reflect the power of the 'royal' families with their control over goods and resources. In West Sumba, it is rather individual prestige expressed in the megaliths, linked to the individual frame of reference. It is striking that very different social and political systems have developed in two neighbouring and ecologically similar regions and that the megalithic tombs are used in very different ways to represent the social order.

Figure 3. "Royal" megalithic tombs in the village of Uma Bara (A) and Praiyawang (B) (East Sumba). Smaller tombs are visible in between the monuments (photos: Johannes Müller).



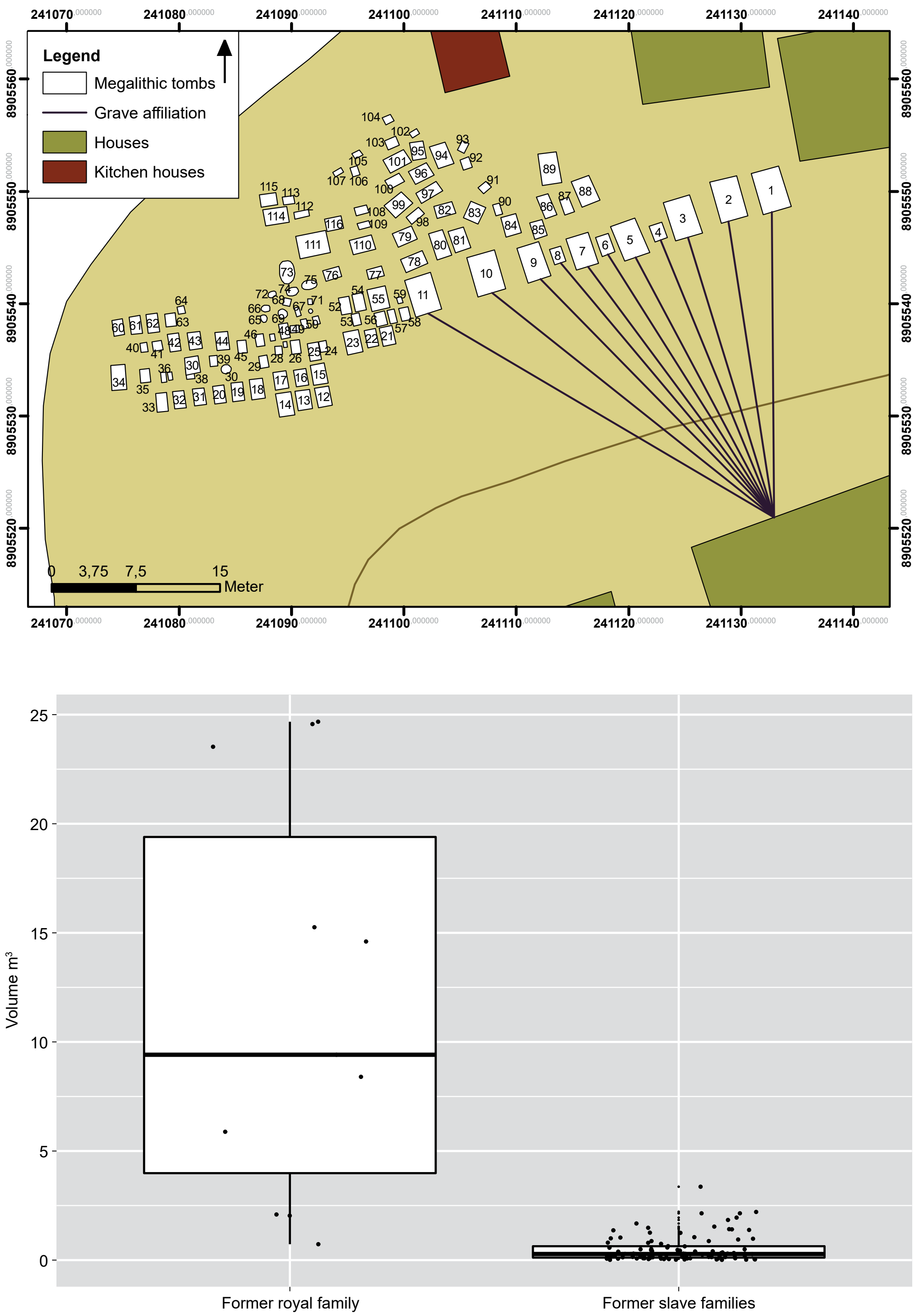


Figure 4. The central area of the village Uma Bara (East Sumba) with large "royal" and small other megalithic tombs and a boxplot of the volume (m³) of the tombs with consideration of the family affiliation. In contrast to West Sumba, institutionalised social differences are visible in the tombs (from Wunderlich 2019: 155, figure 115; 160, figure 122).

The dispersed distribution of smaller megaliths in West Sumba contrasts with the concentrated distribution of 'royal' megalithic tombs in East Sumba.

We were able to observe something similar in Nagaland during our ethnographic field research. In the villages of Central Nagaland, megalithic monuments are erected in a dispersed manner and in varying sizes (Jamir and

Müller 2022; Wunderlich *et al.* 2021; Wunderlich *et al.* 2019; Wunderlich 2019). They are linked to acephalous traditions, in which the economic and demographic potential of individual families and clans varies, but in which there are no institutionalised social differences. In Northern Nagaland, in contrast, we have strongly stratified societies in which the megaliths are located in a central 'agglomerated' monument near and under the control of the *anghs* house, i.e. the central royal family.

Such bipolarity was recently emphasised by Amborn (2019) as characteristic of the historical development up to the middle of the 19th century, and in the meantime, it was also partially attempted to transfer this observation to European prehistory (Jeunesse 2019). Consequently, the ethno-archaeological results point to the possibility that 'megaliths' can be used to express social conditions in societies with very different social structures.

Relationship

In addition to the sociologically relevant architectural differences and those in the localisation of the megalithic tombs, observations on kinship may also be relevant. In most villages – regardless of whether in East or West Sumba – there were certain rules regarding the succession of generations in the megalithic tombs. The interviews in West Sumba revealed that not every generation is buried in a megalithic tomb, but that a generational sequence is usually 'skipped' (Wunderlich 2019: 120, 129, 149). Complex rules therefore ensure that the same family or clan is distributed across several megalithic tombs used at the same time. If genetic lineages are concerned, a documentation of a detailed pedigree for three 'royal' tombs of East Sumba enables further observations (Jeunesse 2019; Jeunesse *et al.* 2021). For example, in the situation of several productive partnerships with one partner, only one of the women is buried in the same megalithic tomb per generation (Jeunesse 2019). Consequently, we should pay particular attention to the 'missing' individuals in pedigrees from megalithic tombs and recognise them as archaeological evidence.

Inbreeding

With regard to the basic assumption described above that inbreeding is a phenomenon of kinship-based dominant groups of societies, ethnographic observations are available to assess such an assumption. Ethnographic surveys documented quantitative results as early as the last century, when there was a certain scientific interest in this topic (Goggin and Sturtevant 1964): eight non-stratified societies were documented, in which sibling marriages have been allowed for everyone (e.g. Calusa). In 35 stratified societies, sibling marriages were only allowed for some high-status individuals as an exception to local incest rules. 18 cases of royal-full sibling partners were documented, but only in one case of royal full-sibling partners are the offspring of a full-sibling marriage. Accordingly, we can conclude that institutionalised sibling marriages are not restricted to stratified societies; incest has also been documented for many non-stratified societies (Trobriand Islands). As a consequence, the incest case in Newgrange cannot serve as an argument for 'Neolithic dynasties'.

Based on these ethnographic and ethno-archaeological observations and consequences, we will now follow the line of argument with some archaeological data (Figure 5).

Megalithic architecture: size comparisons

If we follow our ethnographic examples, we can use simple measurements of megalithic tombs to determine different size groups during different European megalithic times as well.

Ireland and Britain

Due to the research tradition, the studies analysed in Britain and Ireland to date have primarily focussed on Ireland and the Northern and Western Isles.

If we follow the Irish dating and recorded sizes of megalithic tombs, an older phase around *c.* 3500 BC can be distinguished from a younger one around 3000 BC. In the younger phase, we recognise a distinction between megalithic tombs in the Boyne Valley with mound diameters of approximately 10-30m, but then those with mound diameters of >80m (Sheridan 1986). In older megalithic cemeteries, e.g. in Loughcrew, Carrowkeel and Carrowmore, there are also such differences, but not of this dimension. There is also no correspondingly strict separation of two size groups (Figure 6 A-B); Sheridan 1986: 20 figure 8). If we relate our illustrations to a supposed development of megalithic tombs in Ireland, the differentiation in size becomes clear. One seems to recognise a change in that a new Late Neolithic size class begins to exist.

In other regions of the British Isles, size comparisons are available, for example, for parts of Scotland (Fraser 1983; Müller 1988: 31-36, figures 18-19). An increasing differentiation in size, which amounts to two separate sizes of megalithic tombs, is only found on Orkney, while on the Outer Hebrides or the Shetlands size classes develop that are not clearly distinguishable from one another. The Orcadian development, in particular, indicates that we are dealing here with a phase contemporaneous with Boyne, in which primarily large megalithic tombs of the Maes Howe/ Quonterness-Quoyness type, possibly also of the stalled

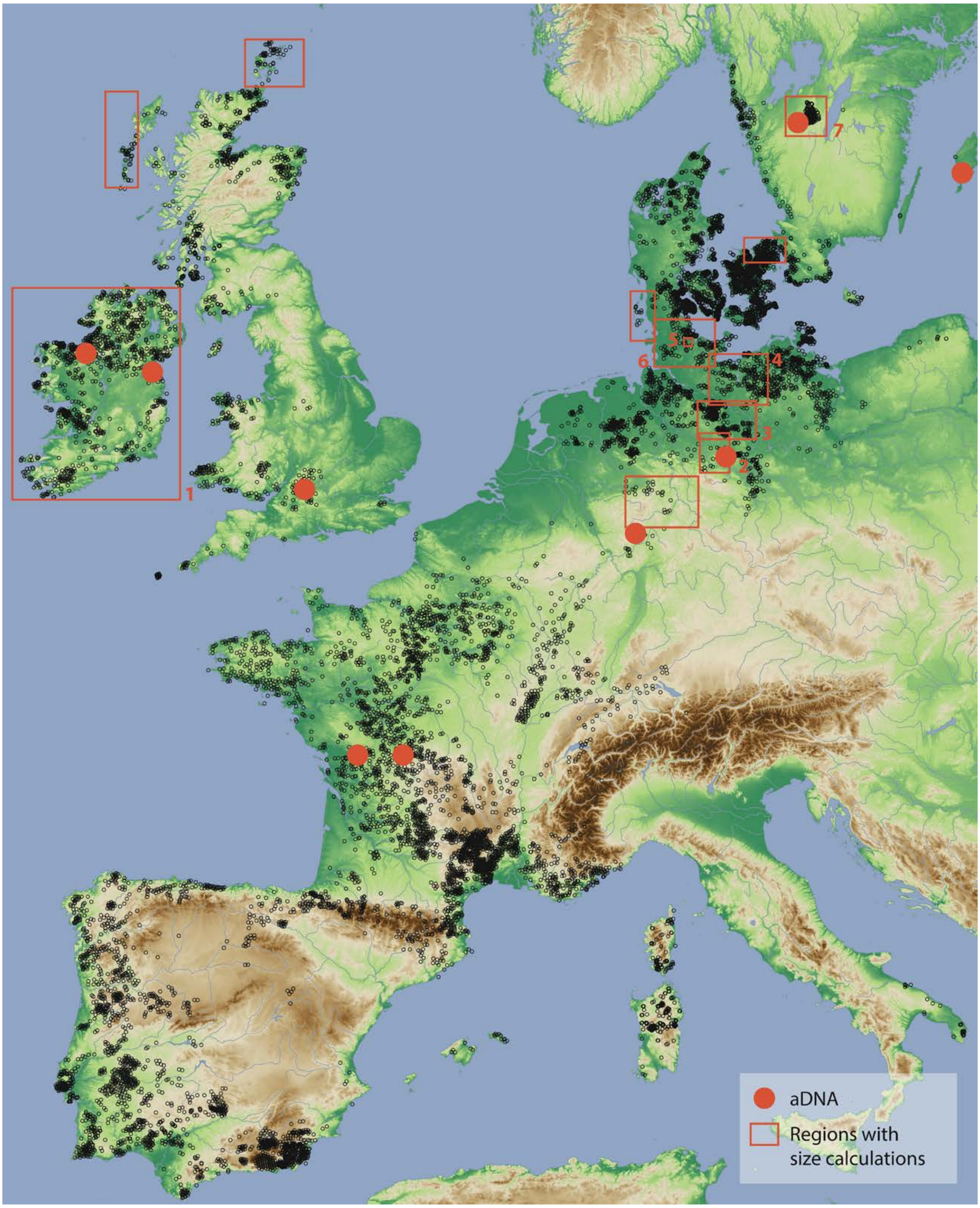


Figure 5. The distribution of megalithic tombs in Europe. Megalithic bone assemblages with palaeogenetic analyses as well as areas that were used in the article for size comparisons of megaliths are marked. Numbers indicate the regions from which data has been used for size calculations in this article (graphic: Agnes Heitmann; distribution of megaliths: Müller *et al.* 2023).

type, were constructed (Bayliss *et al.* 2017; Fraser 1983). Basically, we recognise an increase in both the ground area of the mounds of the megalithic tombs and the floor area of the created chambers. This means that both the visibility of the monuments as well as their capacity for the burial of a larger number of deceased individuals was increased. The increase in the size of

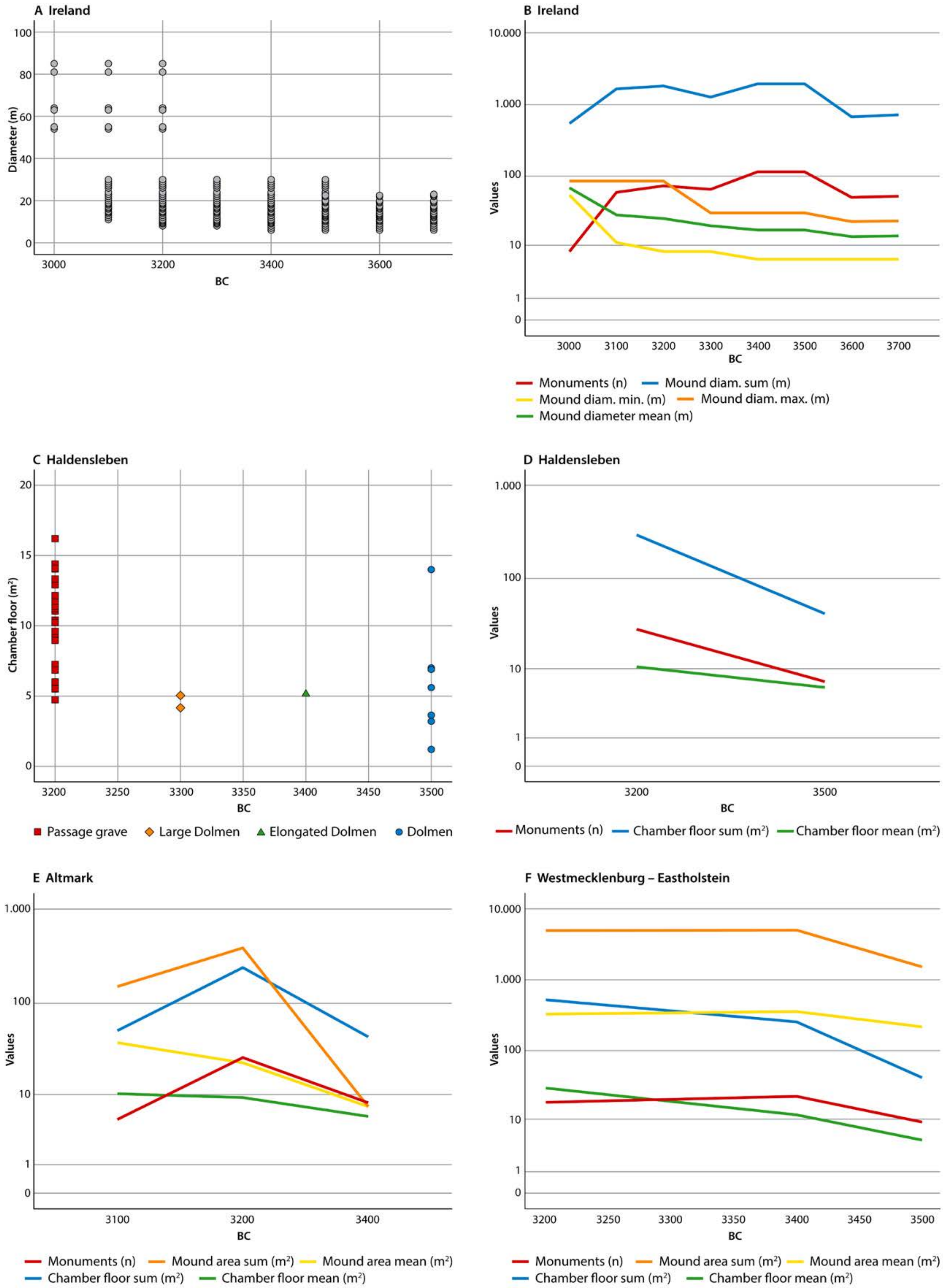


Figure 6. Size calculations of megalithic tombs in Europe. (A) Scatterplot of the Irish megaliths according to their use time per hundred years (based on Sheridan 1986). (B) Size developments of Irish megaliths. (C) Scatterplot of chamber sizes of Haldensleber megaliths (based on Rinne 2019). (D) Size developments of Haldensleber megaliths. (E) Size development of Altmark megaliths (based on Fritsch 2006). (F) Size development of megaliths in West Mecklenburg/East Holstein (based on Wunderlich 2019).

the cairns is accompanied by a reduction in the number of chambered cairns (Müller 1990).

North Central Europe and Scandinavia

If we compare the situation with the North Central European lowlands or Southern Scandinavia, the overall assessment of the size ratios of the megalithic tombs is more difficult due to the poorer source situation caused by more intensive industrial agriculture. Nevertheless, some observations can be made. Here we concentrate on the small regions of Haldensleber Forst, Altmark, West Mecklenburg/Ostholstein and Falbygden, as both the archaeological research and the source situation allow appropriate conclusions to be drawn.

The Haldensleber Forst is one of the densest megalithic tomb regions in Europe with 117 known megalithic tombs covering an area of approximately 20km² (Rinne 2019). Based on typochronological considerations, a general chronological tendency can be assumed from dolmens first erected in the west and later passage graves, which exhibit an expansion of the base area in the landscape to the east of the Haldensleber Forst. Chronologically, we are dealing with the period from *c.* 3600-3100 BC. A comparison of the architectural elements first reveals a reduction in the size of the capstones (probably due to a shortage of building materials), secondly, however, an increase in the size of the burial chambers and thirdly an increase in the number of graves (Figure 6 C-D). There are few dolmens but numerous passage graves from the Altmark (Fritsch 2006). Here, too, an enlargement of the chamber and the base area can be observed with an increasing number of graves (Figure 6 E).

In Westmecklenburg/Ostholstein, the development is somewhat different. Although the statistical comparisons show an increase in the size of the burial chambers and mounds, the number of monuments has decreased slightly over time, in contrast to the Altmark and the Haldensleber Forst (Wunderlich *et al.* 2024; Wunderlich 2019: 281-97). We associate the considerable rate of increase around 3400 BCE, both in the sum of the chamber areas and the mound areas, with a certain population growth. The size of chambers and mounds also increased for individual monuments (Figure 6 F).

An increase of chamber size with the introduction of passage grave architecture can be demonstrated particularly impressively for the extremely well-researched megalithic cemetery of Flintbek near Kiel (Figure 7 A). Of 27 megalithic tombs, 23 could be dated absolutely in their construction period (Mischka 2022: 670, figure 6.40). Between 3650-3400 BCE, 17 dolmens with a chamber floor area of 4-5m² on average were erected, and between 3400-3200 BCE, 7 passage graves with a chamber floor area of approx. 6.5-8m² were built. A corresponding development can also be seen for the North Frisian Islands (Müller 2011). Similar to the Flintbek cemetery, a large number of graves were initially erected. Their number was reduced to a few passage graves, in which more energy was invested.

For the whole of Schleswig-Holstein, an overall increase in the diameter of the mounds, but also in the size of the burial chambers, can be demonstrated for 96 megalithic graves. At the same time, the relative number of megalithic graves decreases in the late phase of megalithic grave construction (cf. Rinne 2011: Figure 7 B).

A similar development also appears to have been observed in Southern Jutland and on Zealand (Schülke 2019). The development in Falbygden in Sweden is different (Figure 7 B-D). Starting from a small number of dolmens, a boom in passage graves that tended to be erected later is noted here (Sjögren 2003; Sjögren *et al.* 2023). This is a pattern that we know in a very similar way from North Central Germany. We recognise a different development in the Hessian-Westphalian gallery graves. Here, larger collective graves were erected first, while the more recent ones tended to be smaller complexes (Drummer 2022).

If our observations are correct, different developments can be observed in different Funnel Beaker regions. In most regions, the number of megalithic tombs decreases, but the size of the tombs increases. However, such an extreme qualitative difference in size as is observed in the Boyne Valley, for example, does not occur elsewhere. In other areas, e.g. in North Central Germany or in Falbygden, the number of sites even increases.

Summary

The observations on the chronological development of the number and size of megalithic tombs in Britain, Ireland and in Northern Germany/Southern Scandinavia show that in many, but not all areas, a reduction in the number of tombs and a simultaneous increase in their size is visible. In contrast to Ireland and Orkney, however, there is no differentiation into two qualitatively distinguishable size classes: diameters of 80-90m, as we know them from Ireland, are not achieved anywhere else. In consequence, this means that we should obviously differentiate qualitatively between social landscapes: (A) in which a large number of smaller monuments are created, (B) in which there is an addition or even a reduction to fewer sites that stand out from the rest in terms of design and size, (C) in which a few particularly large megalithic tombs are created that dominate the rest of the social landscape, and (D) in which there is a constancy or increase in

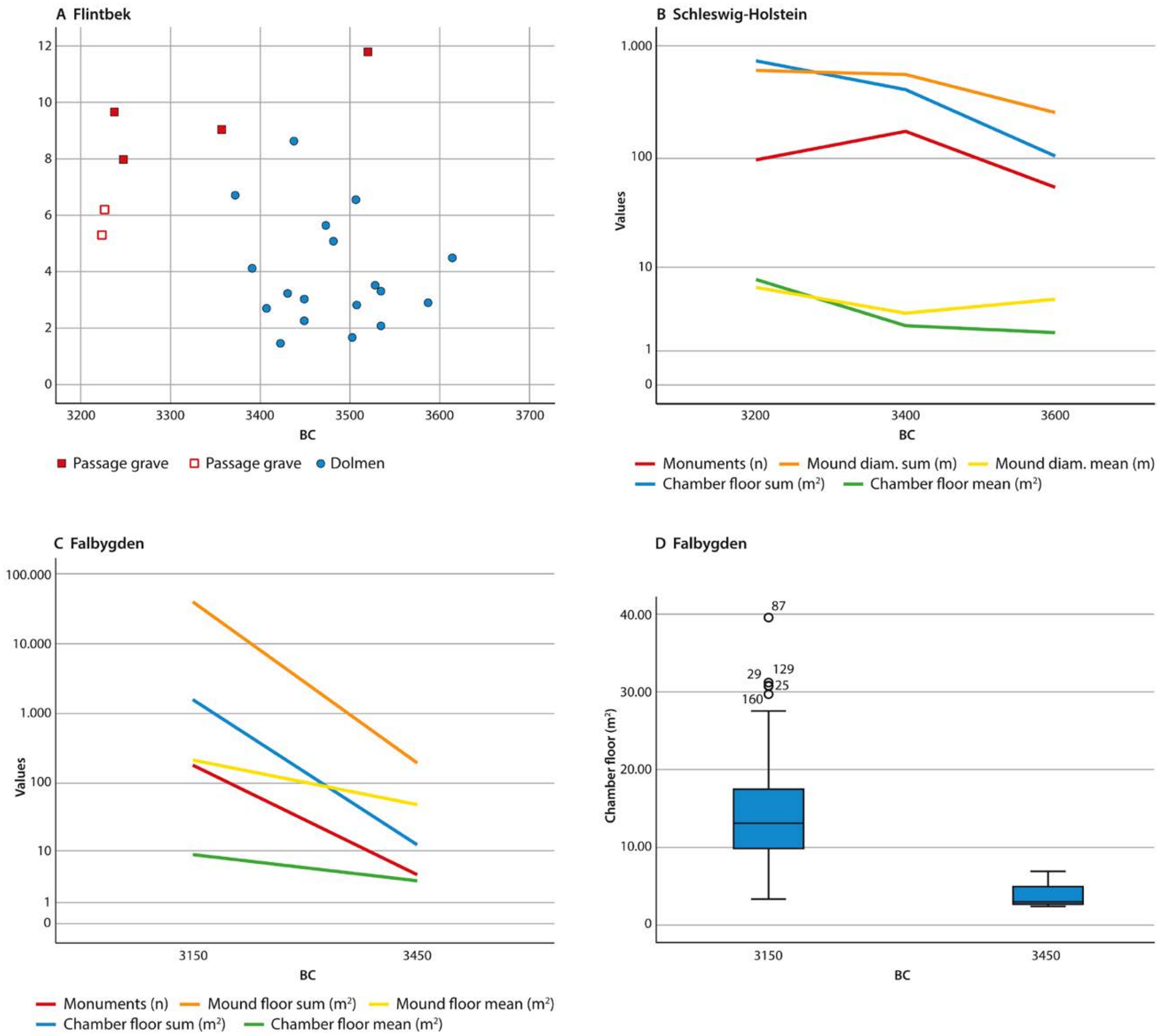


Figure 7. Size calculations of megalithic tombs in Europe. (A) Scatterplot of directly dated Flintbek megaliths (based on Mischka 2022). (B) Size developments of megaliths in Schleswig-Holstein (based on Rinne 2011). (C) Size development of Falbygden megaliths (based on Sjögren 2003). (D) Comparison of Falbygden megalithic chamber sizes.

the same or larger sites. The development from A to B can be observed in most of the presented megalithic landscapes (Ireland, Hebrides, Orkney, Shetland, Flintbek, Westmecklenburg/East Holstein, North Frisia, Jutland, Zealand), and from B to C in only very rare cases (Ireland, Orkney). D can only be observed in other cases (Haldensleben, Altmark, Schleswig-Holstein, Falbygden).

We can thus recognise social landscapes in which a dispersed distribution of qualitatively equal megalithic tombs points to segmented groups, while the construction of larger sites, in contrast to the many smaller ones, demonstrates a centralisation of the use of human energy and of political power. Such a spatial centralisation of power does not necessarily have to be interpreted in terms of social hierarchical developments, but can of course also mean a grouping on the basis of equality. In order to find method-independent arguments here, we should look at both the palaeo-genetic and the nutritional aspects of burials from megalithic graves.

Pedigrees from megaliths

In order to assess whether there are different access rights for the population between the megalithic tombs of Europe, palaeo-genetic studies can increasingly be included alongside the investigations of physical anthropology. Even if the number of studies in which several individuals from a megalithic tomb have been successfully palaeogenetically determined is still limited due to the limited quality of the sources and the methodological orientation of aDNA research, the number is steadily increasing. There are now at least 24 megalithic sites with corresponding data (Figure 5; Supplement 1).

Firstly, it is important for us to compare whether closely related individuals, i.e. first or second-degree relatives, were buried in megalithic graves over several generations. The existing palaeo-genetic genealogical reconstructions provide evidence of such family trees. In addition, in all studies there are some individuals who do not show any close relationship to other individuals within the grave. On closer examination, one could hypothesise that there are both graves in which burials are based on kinship and others in which other causes are responsible for whether an individual is buried in a megalithic grave, in addition to non-related individuals coming from outside for marriage.

However, a statistical comparison shows that the relative proportion of related individuals is strongly dependent on the success of the genetic evaluation (Figure 8): the relative proportion of first- and second-degree related individuals tends to increase with an increasing proportion of genetically determined individuals. In the ideal case of a complete genetic survey of the burial community of a megalithic grave, approximately 20% of unrelated individuals can be expected.

Accordingly, we postulate that megalithic tombs are primarily burial sites for one or more families. Evidently, several families in one megalithic tomb have so far been found in Frälsegården, Hazelton North, Landbogarden, Oberbipp, Aesch and Champ-Chalon B, whereas individual families were found in Bougon F0, Rössberga, Primrose, Ansarve, Niedertiefenbach, Altendorf and Kierzkowo (Cheronet *et al.* 2022; Furtwängler *et al.* 2020; Immel *et al.* 2021; Lösch *et al.* 2020; Rivollat *et al.* 2020; Sánchez-Quintoa *et al.* 2019; Seersholm *et al.* 2024; Silva *et al.* 2023; Susat *et al.* 2024; Vai *et al.* 2021). These genetically recognisable lineages are always joined by a much smaller number of individuals that are not genetically related to the 'majority burials'. It is possible that these are further members of a lineage that is fundamentally not a biological but a social institution (cf. Sahlins 2012).

The reconstructed family trees provide additional indications of the role of male and female individuals in the social structure of these lineages, whose rules are primarily responsible for both the biological and social reproduction of the societies (Figure 9). With one exception, all female productive partners lack ancestors in the local pedigrees – these mothers were 'married in' (only related by marriage) (Supplement 1). In

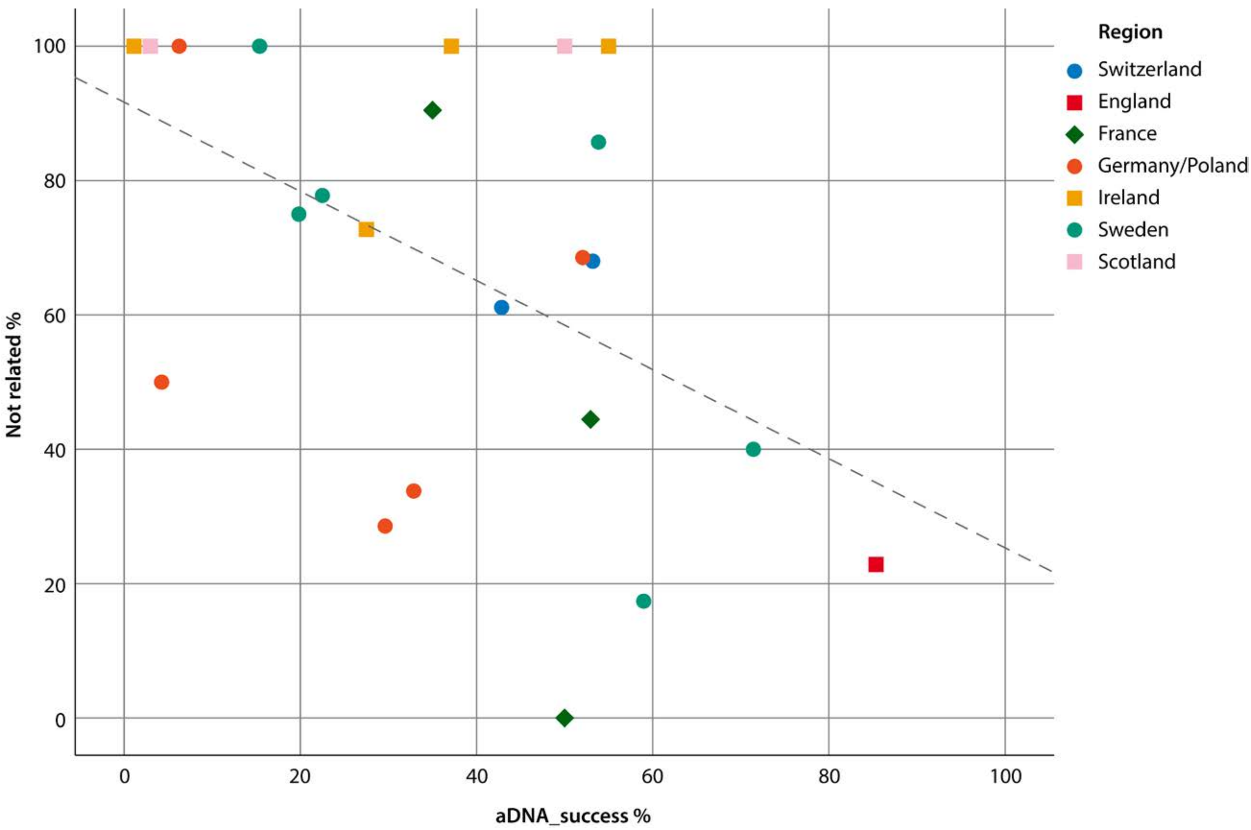


Figure 8. The relative proportion of first- and second-degree related individuals within the successfully palaeogenetic analysed individuals tends to increase with an increasing proportion of genetically determined individuals of the buried population (cf. Supplement 1).

Partnerships in pedigrees

site	♂+ ♀	♀ +♂ + ♂	♂ + ♀ + ♀	♂ + ♀ + ♀ +♀+ ♀	♀ +♀ + ♂*+ ♂* + ♂*
Hazleton N	6	3	0	1	1
Frälsegården	12	0	4		
others	10	0	1		
n	28	3	5	1	1

* cousins

Individuals in pedigrees

Individuals in pedigrees	Missing individual	Mother without ancestor	Father with ancestor
♀	29	22	14
♂	20	1	41

Figure 9. Individuals and partnerships visible in the available pedigrees from megalithic tombs. Productive partnerships that are dominant are mainly monogamous, patrilineal/virilocal partner practices (cf. Supplement 1).

contrast, the vast majority of female individuals without descendants traceable in the respective megalithic tomb have ancestors in their pedigree. These are childless women or girls.

For male individuals, the number of male productive partners with ancestors is higher than the number of male productive partners without ancestors in the pedigree of the local megalithic tomb. We can therefore assume that, on the one hand, there is a patrilineal orientation of the kinship rules. On the other hand, in addition to the 'married-in' women, we also find, to a lesser extent, men who obviously 'married-in'. Among the male individuals without children who were buried in the respective megalithic tomb, the ratio of those with and without ancestors is comparable to that of the females.

The above observations are confirmed in the two most successfully reconstructed pedigrees presented to date from Hazleton North, Southern England and Frälsegården, Central Sweden (Fowler *et al.* 2022; Seersholm *et al.* 2024). In Hazleton North, in addition to six apparently monogamous partnerships, three partnerships of female partners with two male partners and one of a male partner with four women were found among the productive partnerships. The intermarried women are just like those in the monogamous relationships without ancestors buried in the megalithic tomb. In Frälsegården, in contrast, it is in fact the other way around: here, in addition to 12 monogamous partnerships, we know of four productive partnerships of male partners with two women each, in which the married-in partners are found without ancestors. From other megalithic tombs, ten reliable monogamous partnerships and one of a male partner with two female partners (Bougon F0) have been reconstructed to date. In principle, therefore, the present structures show pedigrees that indicate a patrilineal line, although matrilineal elements may be evident – i.e. a mixture of both.

The number of female and male individuals from the respective pedigrees *that cannot* be palaeogenetically identified in the megalithic tomb can hardly be explained meaningfully so far. Nevertheless, it is noticeable in Hazleton North that with the exception of the founder generation only one female was buried in the grave in each of the four subsequent generations and the other female partners were obviously buried elsewhere (Fowler *et al.* 2022, figure supplement). Coincidentally, this corresponds to a recent example from Sumba, where only one woman per generation was 'allowed' to enter the megalithic tomb and the others were buried in other megalithic tombs used at the same time (Jeunesse *et al.* 2021). In this context, the previously published cases from Primrose/Carrowmore and Frälsegården/Hjelmars rör (Sánchez-Quintoa *et al.* 2019: 9472, figure 3; Seersholm *et al.* 2024: figure 3) are noteworthy, in which the deposition of close relatives in neighbouring megalithic tombs has been palaeogenetically proven over a distance of two and eight km, respectively. Accordingly, archaeological evidence for the simultaneous use of several megalithic tombs by the same kinship groups is likely to increase. The 'missing' individuals in the family trees of the local megalithic tombs can certainly be partially explained in this way.

In addition to the palaeo-genetic kinship structures, the positional relationships of the individuals in the

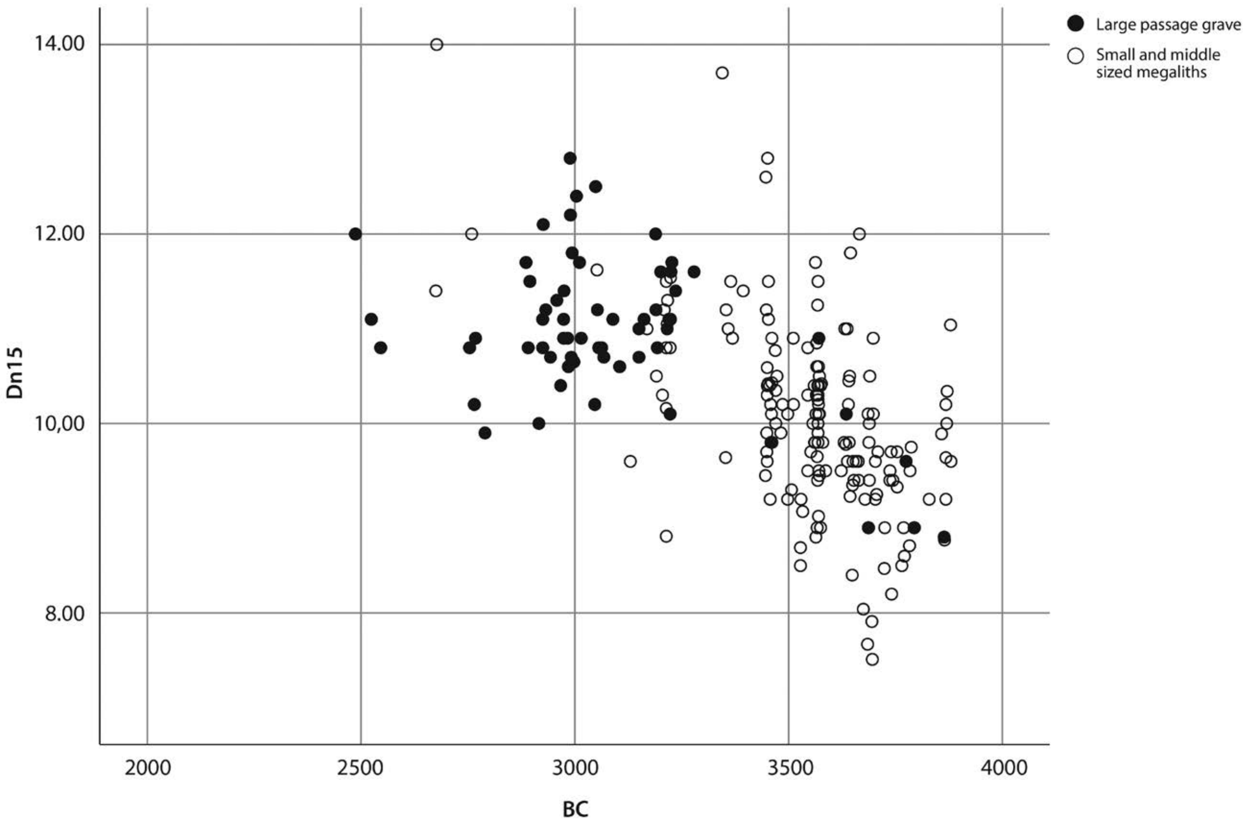


Figure 10. The indication of N15-values that have been derived from human bones of megaliths in Ireland and Britain was used to indicate a difference in nutrition between individuals from large passage tombs (black dots) and smaller megalithic tombs (open dots). The chronological distribution displays a chronological, not a social difference. This might be due to a general increase in animal proteins and/or an increase in manuring practices (data from Cassidy *et al.* 2023, supplement).

megalithic tombs are also important. It has already become clear in various megalithic tombs that close relatives were often buried close together. This was demonstrated early on for Benzingerode in the Harz Mountains (Meyer *et al.* 2008) and was the case for Frälsegården (Seersholm *et al.* 2024), where one family was primarily buried in the left burial chamber and the other primarily in the right burial chamber of the passage grave. This was also the case at Hazelton North, where the position of the 4 mothers of the founding generation determined the spatial distribution of their descendants in the two burial chambers (Fowler *et al.* 2022).

Overall, there is no indication that the burial community in the large Irish megalithic tombs behaved and buried differently than was the case in the rest of Europe. The case of inbreeding from Frälsegården also shows how this can 'occur' in a 'normal' megalithic community in a normal-sized grave – which confirms the ethnographic observations already mentioned. The documented case of 1st degree incest from a Mediterranean Cardial Burial (Gazel, Sallèles-Cabardès, Aude, dating 5200-5000 BC; cf. Arzelier *et al.* 2022) supports our view that the known Neolithic and Chalcolithic inbreeding cases were randomly and not institutionally produced. Furthermore, closer relationships between the prominent megalithic tombs in Ireland have not yet been established. In this respect, with the current state of research, we must assume that the buried individuals of the Boyne-type megalithic tombs did not differ from the other aspects of social organisation that have been uncovered.

Nutrition

Without going into the reconstruction of the diets of individuals from megalithic tombs, we will only refer to the distribution of N15 values. In numerous publications, the increased N15 values are associated with an increased proportion of animal products. The compilation of N15 values from European megalithic tombs generally shows a chronological increase in N15 levels between 4000-2000 BC (Figure 10). In this respect, no differences can be observed between those buried in large and small megalithic sites. It is safe to assume that there were dietary differences between individuals, but detailed comparisons, e.g. within uncovered kinship groups, are still pending.

Consequence: ... the people and the megaliths

The approaches for the interpretation of the social background of megalithic tombs from the European Neolithic presented here have primarily addressed the question of whether megalithic tombs provide evidence of social differentiation processes in prehistoric societies. In particular, the question was asked whether the differences in size and specific palaeo-genetic investigations were helpful.

Our own hypothesis, expressed several times, is that European megalithic tombs are basically the social manifestation of groups that promote the cultivation of peaceful social relations within the framework of a common megalithic tomb construction with principles of 'sharing'. Regardless of the size of the cooperative activities, the amount of work and the required coordination, we believe that any society with a participatory approach is capable of doing this without necessarily developing institutionalised social differences.

This approach is initially contradicted by the ethnographic and ethno-archaeological observations described above. In the example of recent megalithic tombs on Sumba, different types and size distributions of megalithic tombs can be correlated with differences between stratified and non-stratified communities. Size comparisons of Neolithic megalithic tombs in different regions confirmed that there are also very different size ratios in individual regions of the European Neolithic. Although this suggests a similar differentiation to that seen in the ethnographic example, further investigations were unable to find any evidence of different social models that would apply to the megalithic tomb landscapes with different size classes. Families are buried in all megalithic tombs – no selective choice of individuals can be recognised. Inbreeding is not only found in the large megalithic tomb at Newgrange, but also in a 'normal' passage grave at Frälsegården. It does not *per se* – even from an ethnographic point of view – indicate socially segregated and self-contained population groups. The differences in diet can also be reconstructed in a chronological sequence, but not between supposed coeval social groups.

Consequently, according to our interpretation of the architectural, palaeo-genetic and diet-related data, megalithic tombs in the European Neolithic – whether as small or large communal works – are fundamentally cooperative sites that served all the actors of the respective society. According to the current state of research, they are not installations of institutionalised ruling groups, i.e. 'monuments of the dynasties', but serve as a reflection of the acephalous conditions as a whole, as 'monuments of the people', so to speak.

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BCE_old	BCE_young	BCE_mean	site	reference	region	individuals	aDNA_analyzed	aDNA_success	related_1_2	not_related	not_related_male	not_related_female	missing	missing_male	missing_female	Mother_with_ancestor	Mother_without_ancestor	Father_with_ancestor	Father_without_ancestor	non_productive_male_without_ancestor	non_productive_male_with_ancestor	non_productive_female_without_ancestor	non_productive_female_with_ancestor	aDNA_success_indiv_relative	not_related_indiv_relative
3300	3200	3250	Niedertiefenbach	Immel *et al.* 2021; Drummer 2022; Schierhold 2012	Germ	171	89	89	28	61	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	52,05	68,54
3250	3100	3175	Altendorf	Silva *et al.* 2023; Drummer 2022; Schierhold 2012	Germ	235	15	10	5	5	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	4,26	50,00
3350	2900	3125	Warburg sammel	Susat *et al.* 2024; Silva *et al.* 2023; Drummer 2022	Germ	216	71	71	47	24	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	32,87	33,80
3200	2750	2975	Rimbeck	Silva *et al.* 2023; Drummer 2022; Schierhold 2012	Germ	160	10	10	0	10	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	6,25	100,00
4700	4000	4350	BougonF0	Cheronet *et al.* 2022; Schwegler 2016	France	17	9	9	5	4	#NULL!	#NULL!	4	2	2	0	1	0	0	0	3	1	1	52,94	44,44
4100	3800	3950	Champ-Chalon B	Cheronet *et al.* 2022; Schwegler 2016	France	22	22	11	11	0	#NULL!	#NULL!	7	2	0	1	3	3	1	1	2	1	1	50,00	0,00
3200	2900	3050	Pierre-Virante	Cheronet *et al.* 2022; Schwegler 2016	France	60	22	21	2	19	#NULL!	#NULL!	1	0	1	0	0	0	1	0	1	0	0	35,00	90,48
3695	3620	3658	Hazeldon North	Fowler *et al.* 2022	England	41	35	35	27	8	5	3	15	7	8	0	7	6	2	0	13	0	2	85,37	22,86
3700	3400	3550	Primrose	Sanchez-Quintoa *et al.* 2019	Ireland	40	11	11	3	8	7	1	1	0	1	0	0	0	1	1	2	0	2	27,50	72,73
3850	3550	3700	Poulnabrone	Sanchez-Quintoa *et al.* 2019	Ireland	35	13	13	0	13	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	37,14	100,00
3700	3570	3635	Parknabinnia	Sanchez-Quintoa *et al.* 2019	Ireland	20	11	11	0	11	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	55,00	100,00

Supplement 1. Palaeo-genetic data from European megaliths.

BCE_old	BCE_young	BCE_mean	site	reference	region	individuals	aDNA_analyzed	aDNA_success	related_1_2	not_related	not_related_male	not_related_female	missing	missing_male	missing_female	Mother_with_ancestor	Mother_without_ancestor	Father_with_ancestor	Father_without_ancestor	non_productive_male_without_ancestor	non_productive_male_with_ancestor	non_productive_female_without_ancestor	non_productive_female_with_ancestor	aDNA_success_indiv_relative	not_related_indiv_relative
3100	2950	3025	Newgrange	Cassidy *et al.* 2020; Buckley *et al.* 2017	Ireland		2	2	0	2	2	0	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!		
3200	2600	2900	Carowkeel	Sanchez-Quintoa *et al.* 2019	Ireland	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!
3050	2900	2975	Frälsegården	Seersholm *et al.* 2024	Scand	78	54	46	38	8	2	6	21	7	14	0	6	9	5	8	10	0	4	58,97	17,39
3200	2950	3075	Rössberga	Seersholm *et al.* 2024	Scand	121	25	24	6	18	#NULL!	#NULL!	1	0	1	0	0	0	1	1	0	2	1	19,83	75,00
3020	2980	3000	Landbogården	Seersholm *et al.* 2024	Scand	14	17	10	6	4	1	4	4	2	2	0	1	0	1	0	3	0	1	71,43	40,00
3200	3000	3100	Hjelmars rör	Seersholm *et al.* 2024	Scand	26	23	14	2	12	9	4	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	53,85	85,71
3350	3250	3300	Hunnebostrand	Seersholm *et al.* 2024	Scand	13	3	2	0	2	1	1	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	15,38	100,00
3400	2900	3150	Ansarve	Sanchez-Quintoa *et al.* 2019	Scand	40	9	9	2	7	4	3	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	22,50	77,78
3100	2600	2850	Isbister	Sanchez-Quintoa *et al.* 2019	Scotla	338	10	10	0	10	7	3	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	2,96	100,00
3500	3100	3300	Holm of Papa Westray	Sanchez-Quintoa *et al.* 2019	Scotla	8	6	4	0	6	3	3	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	50,00	100,00
3900	3600	3750	La Mina	Sanchez-Quintoa *et al.* 2019	Spain	#NULL!	6	4	0	4	2	2	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	100,00
3094	2500	2797	Aesch	Lösch *et al.* 2020; Furtwängler *et al.* 2020	CH	47	25	25	8	17	10	7	4	2	2	0	2	0	2	0	3	0	1	53,19	68,00
3350	2800	3075	Oberbipp	Lösch *et al.* 2020; Furtwängler *et al.* 2020	CH	42	42	18	7	11	6	5	4	0	4	0	0	2	1	2	2	0	0	42,86	61,11
3050	2830	2940	Kierzkowo	Vai *et al.* 2021; Müller 2023	Germ	27	9	8	5	2	#NULL!	#NULL!	1	1	0	0	2	0	1	1	2	0	0	29,63	28,57

Supplement 1. Continued.

Shining a light on some of the most interesting research results on megalithic cultures, as well as their contemporaries, these 16 papers from the European Megalithic Studies Group symposium (Santiago de Compostela, Spain), cover monuments from Scandinavia, moving down the Atlantic Facade, across to Ireland, and then back to the Western Mediterranean. Key issues under discussion include temporality and mobility (both at the broad scale and at the local scale), social organisation and settings, and external relationships. The methods used to investigate these themes are various: bio-molecular and isotopic analyses, typo-chronology, targeted excavations and radiocarbon dating, material cultural analyses, 3D models, ceremonial and funerary/burial practices (including osteometrics), and large-scale prospection. New methods researching the materiality and symbolism of monuments are also presented; some incorporate the role of the natural world. Alongside them are other contributions focusing on the key characteristic of megalithic monuments – the skilful and purposeful arrangement of large blocks of stone – and their interpretation. Discoveries include the intriguing return of large and complex ceremonial timber circles in active megalithic areas, presenting a significant contrast to what was considered the main funerary expressions in South Portugal. Ultimately, through the application of new, or differently applied, technologies and ways of thinking, this volume offers a series of studies that remove some of the mystery that surrounds these mementos of another time.

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