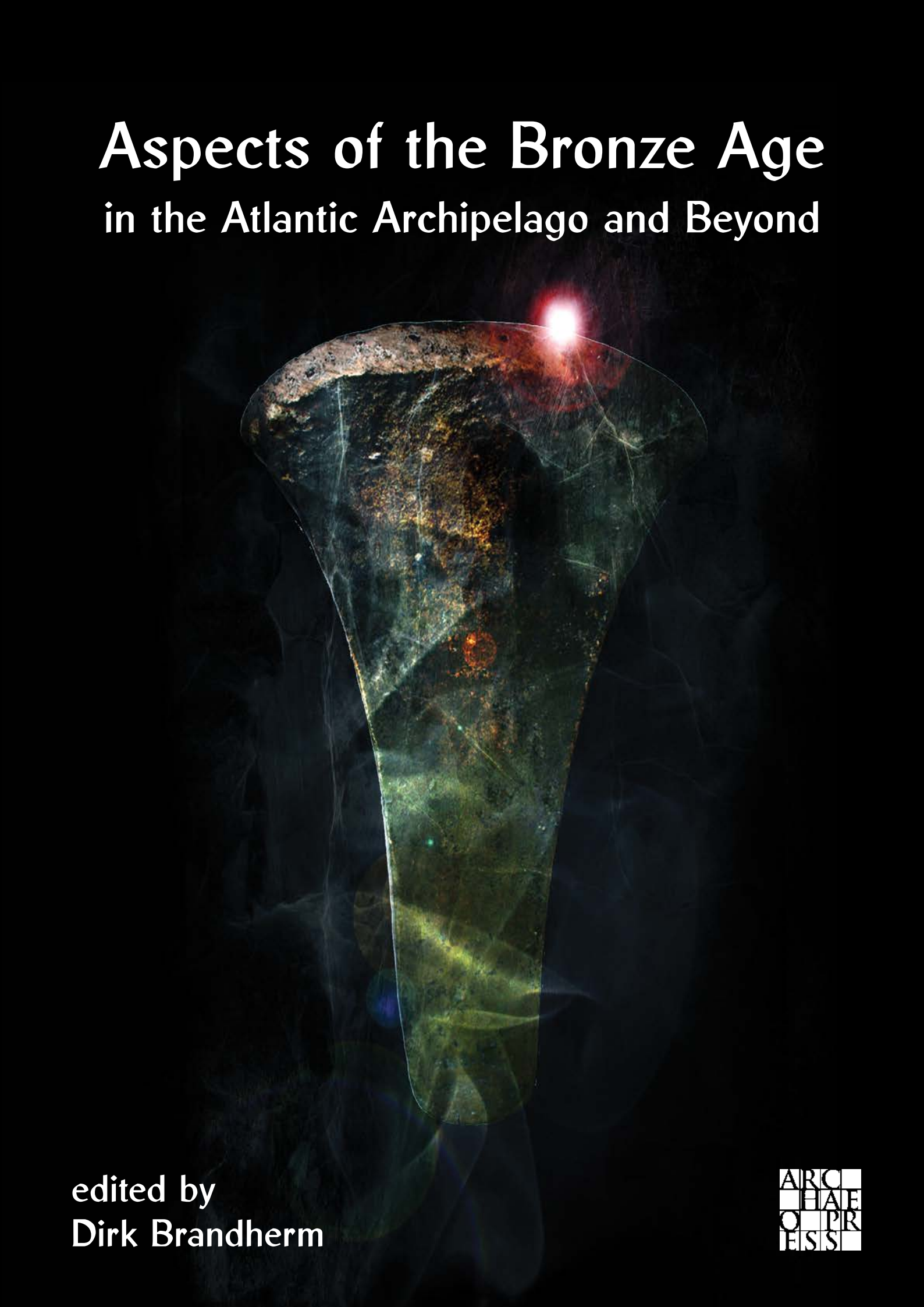
Aspects of the Bronze Age
in the Atlantic Archipelago and Beyond



edited by
Dirk Brandherm

ARC HAE O PR ESS

Archæologia Atlantica – Monographiæ III

Aspects of the Bronze Age

in the Atlantic Archipelago and Beyond

Proceedings from the Belfast Bronze Age Forum 9–10 November 2013

edited by
Dirk Brandherm

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Editor's note and acknowledgements

The majority of contributions to this volume were originally presented at the Belfast Bronze Age Forum conference in November 2013. While it has not been habitual for published proceedings to come out of the biennial Bronze Age Forum meetings, the high standard and the overall thematic coherence of the presentations and posters given at Belfast provided an impetus to produce the present volume. If it took much longer than originally envisaged, both by the editor and the authors, to bring this project to fruition, this publication still appears timely, bringing together important advances across a range of interrelated fields in Insular Bronze Age Archaeology and beyond. Some of the talks and posters presented in Belfast subsequently underwent substantial transmogrification, and not all talks and posters found their way into the present pages, as a comparison between the table of contents and the original 2013 Bronze Age Forum programme, included here among the appendices, will readily reveal. On the other hand, a number of contributions have been added that were not presented at the conference, either to fill some very specific gaps or because of their immediate relevance to topics covered at the Belfast meeting. All contributions to the present volume have been peer-reviewed by at least two anonymous reviewers.

As editor I would like to express my gratitude first and foremost to the authors, for their contributions and patience, to the peer reviewers, who provided invaluable feedback, to my colleague Gill Plunkett, who co-hosted the Belfast Bronze Age Forum with me, and last but not least to the team of student volunteers who helped make the event such a success. Thanks equally go to the graphics talent involved in the production of this volume: to Libby Mulqueeny for bringing many of the illustrations found throughout its pages to publication standard, and to Rebecca Enlander and David Withers for designing both the artwork used in advertising the 2013 conference and the cover of the present volume, which is based on that original artwork. Acknowledgement is also due to Joanna Brück and Stuart Needham, who originally launched the Bronze Age Forum series of conferences that have since become not only a regular calendar fixture, but a crucial platform for presenting current research on all matters Bronze Age in Britain, Ireland and the Near Continent.

The 'Aspects of the Bronze Age' formula is not derived directly from the Belfast Bronze Age Forum conference but adapted from the title of a lecture given by Colin Burgess to the Prehistoric Society in January 1964: 'Aspects of the Bronze Age in Wales and the Marches'. This volume is dedicated to his memory, as well as to the memory of other eminent Bronze Age scholars who, like him, had been prevented from attending the Belfast meeting by deteriorating health or who passed away while preparations for the Belfast Bronze Age Forum were underway.

Colin Brian Burgess *1938 – †2014

Ian Arthur Colquhoun *1954 – †2013

Jay Jordan Butler *1921 – †2014

Margaret Anne Brown (neé Smith) †2011

Non Cum Corpore Extinguuntur Magnae Animae

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Almost lost between the lines: the concept of the Atlantic Bronze Age

Dirk Brandherm

Since its inception in the 1930s, the concept of an Atlantic Bronze Age has repeatedly undergone considerable change. Different authors have conceptualized it along very different and sometimes diametrically opposed lines, not least because hardly any explicit definitions have ever been put forward. Some scholars evidently conceptualized it purely in geographically and temporally circumscribed terms, while others perceived it very much as a culturally defined nexus. The old conundrum of viewing Britain either as apart from or a part of Europe also had to play its role in this. While until relatively recently the majority of British scholars used to envisage the Insular Bronze Age as something quite distinct from the Bronze Age of Atlantic Europe, the default perspective in Continental scholarship has always been to situate the Atlantic Archipelago at the heart of the Atlantic Bronze Age nexus.

Introduction

The concept of an Atlantic Bronze Age was first formulated by Adolf Mahr in his 1937 presidential address to the Prehistoric Society.[1] He used the term 'Atlantic' not merely as a generic geographical reference, but as a label for what he saw as a distinctive cultural sphere, and it is perhaps no coincidence that it was someone who had spent his formative years working on Continental Bronze and Iron Age archaeology to first discern the specific character of the Bronze Age on Europe's Atlantic façade, with Britain and Ireland perceived as constituting an integral part of a wider European Atlantic sphere. For scholars brought up primarily on a diet of Insular Bronze Age archaeology, it was naturally much less of a concern to try and characterize the distinctive features setting apart the Bronze Age of the Atlantic seaboard from Bronze Age cultures elsewhere on the Continent.

Also subsequent to Mahr's seminal synthesis, it continued to be mainly Bronze Age archaeologists working in Iberia, France, Belgium, and the Netherlands, ie in regions where Atlantic and Continental Bronze Age cultures share common land borders, who felt the need to conceptualize the differences – and, by extension, commonalities – between the Atlantic and Continental spheres. Symptomatically, the only two major international conferences dedicated explicitly to conceptual issues surrounding the definition of the Atlantic Bronze Age were organized by French and Portuguese institutions respectively.[2]

Obviously, the conceptual parameters used to characterize the Atlantic Bronze Age have changed quite considerably over the years. If Mahr had based his vision of the Atlantic Bronze Age as a culturally defined entity mostly on its distinctive metalwork industry and other elements of portable material culture, the focus has since shifted to also include settlement features and funerary practices.[3]

It is not without a certain irony that Mahr saw the Early and – particularly – Middle Bronze Age periods as the heyday of the Atlantic Bronze Age, when most later scholars used this label quite specifically to refer to the Late Bronze Age.[4] The historical reasons behind this fundamental shift in its conceptualization – which strangely seems to have escaped the attention of most authors subsequently working on the subject – will be explored further below.

For Mahr, the Atlantic Bronze Age effectively ended with what most of his predecessors and contemporaries perceived as evidence of a veritable invasion of the Atlantic Archipelago by bellicose Celtic-speaking 'sword bearers' originating from Urnfield lands around the western Alps or further east,[5] bringing the Bronze Age cultures of Britain and Ireland in line with Continental developments and thereby diminishing their distinctive 'Atlantic' character.[6] In contrast to the then mainstream view, however, Mahr's model was considerably more nuanced, in that he rejected the simplistic notion of a uniform Urnfield people and insisted that the Atlantic Bronze Age, as he conceived it, was brought to an end by 'a vigorous cultural, not […] racial expansion'.[7] While he still saw the epicentre of that expansion in central Europe, it was its knock-on effects on the Urnfield periphery along the Middle and Lower Rhine, in eastern and northern France, and beyond, that in his view would have brought about the cultural transition from the Middle to the Late Bronze Age in Britain and Ireland.[8]

A lot has changed since Mahr's original conceptualization of the Atlantic Bronze Age. We now know that many of the typo-chronological tenets that underpinned both the original notion of an 'Urnfield invasion' and Mahr's more

[1] Mahr 1937, 397

[2] Chevillot and Coffyn 1991; Oliveira Jorge 1998

[3] cf Burgess and Miket 1976; Gibson *et al*, this volume

[4] eg Gibson *et al*, this volume, who quite explicitly place the Early and Middle Bronze Age on Europe's Atlantic façade 'before the emergence of the so-called "Atlantic Bronze Age"'. A rare exception in this respect is Craddock's (1978) examination of Atlantic Bronze Age metallurgy, which chronologically included Chalcolithic to Late Bronze Age material under this umbrella term; it is probably quite telling that this came from a materials scientist rather than from a cultural archaeologist

[5] Crawford 1920, 27–8, Peake 1922, 130–1, Evans 1930, 157–71; Macalister 1935, 54–87; Dunlop 1938, 472; *eadem* 1939–40, 37

[6] Mahr 1937, 397

[7] *ibid*

[8] *ibid*, 401

sophisticated alternative model were false, eg that Deverel-Rimbury pottery is by no means a provincial Urnfield derivative and indeed considerably predates the beginning of the Late Bronze Age, that carp's-tongue swords do not originate in the western Alps and that they date to the later part of the Late Bronze Age rather than to its beginning. This is not to say that the onset of the Late Bronze Age on Europe's Atlantic façade was not characterized by a notable increase in elements whose origin can be traced back to central Europe, specifically where metalworking is concerned (eg leaf-shaped swords, cauldrons and other sheet-bronze objects),[9] and there is also evidence to suggest that we are not only looking at the arrival of new ideas and technical skills but also of people,[10] but today we tend to think very differently about the social and economic framework within which these changes took place.

However, the general tendency to equate the Atlantic Bronze Age only with the Late Bronze Age period, in contrast to Mahr's original conceptualization, has little to do with changing perspectives on the mechanisms driving cultural change, but is mainly due to Julio Martínez Santa-Olalla's hijacking of Mahr's label and conceptually turning it on its head. In the broad-brush overview of Iberian prehistory which Martínez Santa-Olalla presented in his 'Esquema paletnológico de la Península Hispánica', he used the labels 'Bronce mediterráneo' (Mediterranean Bronze Age) and 'Bronce atlántico' (Atlantic Bronze Age) to refer to a generic binary division within the Iberian Bronze Age sequence, a division to which he attributed both cultural – and by extension ethnic – as well as chronological significance, whereby the Mediterranean Bronze Age corresponded to an earlier (Chalcolithic to Middle Bronze Age) phase, during which the author had all of Spain and Portugal inhabited by a population of Ibero-Saharan stock, whereas the Atlantic (Late) Bronze Age saw the arrival of Indo-European speakers to the Iberian Peninsula.[11]

Thus, in contrast to the more nuanced model Mahr had developed to explain cultural change at the Middle / Late Bronze Age transition in north-western Europe, Martínez Santa-Olalla's broad-brush approach once again used migration as the only device to explain any significant change in the archaeological record. Its monolithic outlook, equating individual chronological phases with specific archaeological cultures and trying to apply these equations across the whole of Iberia, regardless of any regional variations in the archaeological record, subsequently went on to become a stumbling block that would take Iberian archaeology several decades to overcome.[12] In neither of the two editions[13] of his scheme did Martínez Santa-Olalla include any reference to Mahr's 1937 presidential address or otherwise credit Mahr with the original conceptualization of the Atlantic Bronze Age, but given the close collegial ties between the two men,[14] it is quite inconceivable that Martínez Santa-Olalla should not have been aware of Mahr's authorship of this concept.[15]

Only a few years after the publication of Martínez Santa-Olalla's 'esquema', Hubert Savory re-introduced the notion of an Atlantic Bronze Age into Anglophone archaeology, now based entirely on its equation by Martínez Santa-Olalla with the Late Bronze Age of the Atlantic façade.[16] Also Eoin MacWhite, in his seminal study of the Atlantic relations of the Iberian Peninsula from the end of the Neolithic to the end of the Bronze Age, published a few years later, in essence stuck to the concept of the Atlantic Bronze Age that his doctoral supervisor Martínez Santa-Olalla had presented in his scheme.[17] However, in contrast to the very coarse approach employed by the latter, MacWhite painted a much more granular picture of regional developments, introducing the notion of a 'Proto-Atlantic Bronze Age' for north-western Iberia, which during the Early and Middle Bronze Age would have existed alongside Martínez Santa-Olalla's south-eastern Mediterranean Bronze Age.[18] This, of course, was still radically different from Mahr's original conceptualization. In Anglophone archaeology the concept of a Proto-Atlantic Bronze Age only ever seems to have been adopted by Richard Harrison.[19] It did not gain any wider acceptance, and in consequence, when John Koch several decades later again made a case for the notion of an Atlantic Early and Middle Bronze Age, he did so oblivious of Mahr's and MacWhite's earlier attempts.[20]

In retrospect it is not entirely clear if references to Mahr's original concept of an Atlantic Bronze Age are lacking from almost all subsequent studies employing that label because Mahr formulated it on the periphery of a much wider-ranging overview of Irish prehistory, or if authors approaching the subject matter in the aftermath of World War II may have chosen to minimize references to Mahr's work because of his objectionable political leanings and his wartime role as a propaganda operative with the German Foreign Office.[21]



[9] Jockenhövel 1975, 140–7; Gerloff 2010, 334–6; Brandherm 2011, 43

[10] Brandherm 2013, 148–50; *idem* 2017, 414

[11] Martínez Santa-Olalla 1941, 152–4

[12] cf Tarradell 1950; 1965; 1969

[13] Martínez Santa-Olalla 1941; 1946

[14] cf Brandherm and Mederos forthcoming

[15] The first edition of the scheme (Martínez Santa-Olalla 1941) was published entirely without any bibliographical references, while the second edition (*idem* 1946) came with the benefit of a bibliography which, however, amounted to no more than a concise list of further readings

[16] Savory 1948, 158; *idem* 1949, 128; *idem* 1968, 221–7

[17] MacWhite 1951

[18] *ibid*, 59

[19] Harrison 1974, 52. In Hispanophone archaeology, MacWhite's notion of applying the Atlantic Bronze Age label also to the Early and Middle Bronze Age periods had a somewhat more lasting impact, but here as well, subsequent authors seem to have been unaware of Mahr's original conceptualization; eg Ruiz-Gálvez 1979, 151; Almagro 1997, 219–21

[20] Koch 2013b, 120

[21] cf Mullins 2007; the first study in several decades crediting Mahr with first having developed the notion of an Atlantic Bronze Age seems to be Gerloff 2010, 24. While Martínez Santa-Olalla's political leanings were not at all dissimilar from Mahr's (Vera 2009), his profile in this respect – to an Anglophone archaeological readership at least – would likely have been less prominent

The Atlantic Bronze Age as metalwork industries

Following the excessive reliance on population movements as an explanatory device in prehistoric archaeology over previous decades and the abuse of ethnic interpretations of the archaeological record for political purposes during the interwar period and World War II, most authors touching upon the Bronze Age on the Atlantic façade from the mid-1940s onwards fell back either on more abstract interpretative frameworks or on detailed chrono-typological studies.[22] As a consequence of this, and to some extent also because of the general dearth of funerary evidence characterizing most of Europe's Atlantic seaboard from the Middle Bronze Age onwards, subsequent discussions of the Atlantic Bronze Age for several decades tended to revolve mostly around the subject of metalwork typologies, and to a lesser extent also around metalwork depositional practices.

It is worth pointing out that initially most of those discussions centred on the Insular and on the Iberian evidence, while – with the notable exception of Savory's reconsideration of the sword-bearer issue[23] – Atlantic France was only brought into the picture from the mid-1950s onwards. There is a variety of reasons for this. Firstly, other than Martínez Santa-Olalla, it was scholars based in Britain or Ireland, but with a keen interest in Peninsular prehistory, who initially developed and embraced the concept of an Atlantic Bronze Age. Secondly, French Bronze Age archaeology by the mid-twentieth century had not advanced a very great deal beyond the state of affairs set out by Joseph Déchelette in his seminal 'Manuel d'archéologie préhistorique, celtique et gallo-romaine' forty years earlier,[24] which identified the Late Bronze Age population of all of mainland France as Proto-Celts. This, together with the national doctrine of 'nos ancêtres les Gaulois' and the suppression of regional identities under the French Third Republic left little room for acknowledging any significant dichotomy between Continental and Atlantic Bronze Age cultures, let alone the possibility of different ethnic identities in the Late Bronze Age, within the national territory of Metropolitan France. Even Margaret Dunlop in her insightful survey of the French Bronze Age, despite identifying three separate cultural traditions within that territory and interpreting these as evidence for distinct ethnic ('racial') groups, had felt compelled to attempt and reconcile her interpretation with that official ideology, by describing those traditions 'as a unique example of unity in diversity in the history of Europe'.[25] A final reason for the somewhat belated inclusion of northern and western France in the conceptualization of the Atlantic Bronze Age may have been that the rich register of Bronze Age metalwork from Atlantic France at the time remained relatively poorly published, with few systematic attempts to remedy that situation.[26]

Things in this respect only started to change after Wolfgang Kimmig[27] had brought an outsider's perspective to French Bronze Age studies and a new generation of French prehistorians set out to break the existing stasis. At the 1956 Congrès Préhistorique de France, Jacques Briard introduced the notion of the 'Bronze atlantique' as a culturally conceptualized entity into Francophone archaeology, referring to an Atlantic 'facies' within the French Bronze Age that was clearly distinct from the Continental Urnfield cultures.[28] While Briard evidently recognized that the geographical distribution of many Middle Bronze Age types remained very much limited to France's western seaboard, he envisaged the formation of what he perceived as a specifically Atlantic cultural facies only during the developed stages of the Late Bronze Age.[29] Arguing along very similar lines to Briard, in her survey of French Late Bronze Age cultures Nancy Sandars distinguished between an eastern and western French sphere, equating the latter with the 'important Atlantic province of metallurgy'.[30]

Soon after his contribution to the 1956 Congrès Préhistorique de France, Briard initiated the systematic publication of Breton hoard assemblages through the 'Travaux du Laboratoire de Anthropologie de Rennes' which would significantly expand the published corpus of Atlantic Bronze Age metalwork readily accessible to an international readership.[31] By 1963 Jacques-Pierre Millotte was using the label 'Bronze final atlantique',[32] subsequently to become standard parlance, and two years later Briard's seminal monograph 'Les dépôts bretons et l'âge du Bronze atlantique' established a much more detailed chronological framework for Atlantic Bronze Age metalwork than had previously been available.[33] Despite the fact that in focusing largely on the metalwork industry it followed a very traditional approach, Briard's study opened up a new chapter not only in French Bronze Age archaeology, but through its subdivision of the Late Bronze Age of Brittany into three distinct chronological phases would also exert significant international influence.

In Britain, the chronological insights offered by Briard's study were much more readily absorbed than the conceptual implications of his work. Colin Burgess, in his influential attempt to align metalwork sequences on both sides of the English Channel, drew heavily on Briard's chrono-

[22] eg Hawkes 1948; Savory 1949; Sandars 1957; Harbison 1967; Burgess 1968a; 1968b

[23] Savory 1948

[24] Déchelette 1910

[25] Dunlop 1939–40, 38

[26] eg Marsille 1913; 1921; 1937; Coutil 1921; 1922; Bénard Le Pontois 1929; Giot 1949

[27] Kimmig 1951; 1952; 1954

[28] Briard 1957, 315

[29] *ibid*

[30] Sandars 1957, 261. The text of this volume was very much based on Sandars' B.Litt thesis, completed several years before Briard presented his contribution to the 1956 Congrès Préhistorique de France (M Tomlinson pers comm). Both scholars thus seem to have applied similar concepts independently from each other. An isolated reference to the 'Atlantic Middle Bronze Age' in one of her figure captions (Sandars 1957, fig 14) appears purely as a geographical indicator, rather than conceptualizing a cultural epithet

[31] Briard 1958; 1961; 1966

[32] Millotte 1963, 175

[33] Briard 1965. At the centre of this study was Briard's attempt to devise a chronological reference framework for the Bronze Age hoards of Brittany that was separate from, but aligned with, French Urnfield chronology (cf Hatt 1961). It would be another twenty-five years until Gomez de Soto (1991) demonstrated the existence of a chronological setoff between Hatt's Urnfield phases and Briard's Breton hoard record phases

logy but interestingly, like John Coles before him,[34] did not view the Insular Bronze Age as an integral part of the Atlantic sphere.[35] Where he used the label 'Atlantic', Burgess invariably referred to the Continental Atlantic façade, viewing it as a region of origin for influences he considered 'exotic' within the British Bronze Age and that exerted little influence beyond south-east England.[36] This was not only diametrically opposed to Mahr's original concept of the Atlantic Bronze Age, but also stood in stark contrast to Briard's conceptualization of the Atlantic sphere, which explicitly included Britain and Ireland as one of its 'provinces'.[37] Throughout the 1970s and into the 1980s, most subsequent British authors engaging with the subject would follow very much in the same vein, using 'Atlantic' as convenient shorthand for 'Atlantic Europe', but implicitly excluding Britain and Ireland from that notion.[38] With some notable exceptions, it was only in the wake of the Beynac and Lisbon conferences,[39] from the 1990s onwards, that British and Irish scholars began to conceptualize the Bronze Age of the Atlantic Archipelago not as something to be distinguished from, but as a constituent part of the Atlantic Bronze Age sphere.

Prior to this, the focus particularly of British scholarship considering the links between the Insular Bronze Age and that of continental western Europe, for the most part had been on transmanche connections rather than on wider Atlantic relations, with the English Channel rather than the land borders between the Atlantic Bronze Age sphere and neighbouring Continental Bronze Age culture areas perceived as the more significant interface.[40] This shift of perceptions ties in with an increasing realization both of regional variability within the Bronze Age along the Continental Atlantic façade and of the existence of distinct registers with different social and geographical reach within the metalwork record.[41] Even during the heyday of Atlantic Bronze Age metalwork commonalities, truly pan-Atlantic types remain limited almost exclusively to the registers of warrior equipment, feasting paraphernalia and metalworking implements, eg swords, spearheads, cauldrons and special-purpose anvils. More mundane object types, such as axes, are generally associated with distribution areas which in geographical terms remain much more narrowly circumscribed, and it is either on those latter types or on objects from the final phases of the Late Bronze Age, when the Atlantic Bronze Age had ceased to function as a unified interaction sphere (see below), that the attention of scholars conceptualizing the Late Bronze Age of Britain and / or Ireland as distinct from that of the Continental Atlantic façade was generally focused.

Beyond Britain and Ireland, Briard's tripartite subdivision of the Atlantic Late Bronze Age, despite having been developed almost exclusively based on material from Brittany and never explicitly having been intended by the author as a template for chronologically structuring the material from other Atlantic regions, quickly became just that. More specifically, Marisa Ruiz-Gálvez[42] and André Coffyn[43] during the 1980s attempted to apply Briard's Breton chronology also to Atlantic Iberia, which at that point was still largely lacking a functioning chronological framework for its metalwork industries.[44]

One significant issue with these attempts was that they did not question or test the applicability of Briard's chronological scheme to the Iberian material, despite the much smaller number of closed assemblages from Iberia and obvious differences in the composition of the latter when compared to the hoards from Brittany. Rather, Ruiz-Gálvez and Coffyn used the Breton chronology as a ready-made chest of drawers into which they proceeded to sort the Iberian material, with varying degrees of success. As might be expected, this generally worked well enough with types shared between Atlantic France and Iberia and firmly tied into the Breton hoard sequence, but less so with others. Problems resulting from the attribution of some of those latter types to one or the other of Briard's chronological phases based on mere conjecture, from unrecognized chronological setoffs between episodes of hoard deposition north and south of the Bay of Biscay and from the lumping together of different and chronologically diverse types under the same undifferentiated label, eg 'carp's-tongue' swords, were only realized and addressed much later.[45] Nevertheless, the studies by Ruiz-Gálvez and Coffyn constituted major advances compared to the previous state of affairs, which had remained largely static since Martínez Santa-Olalla's and MacWhite's work.

As already emphasized above, Briard's work on Breton metalwork assemblages, along with Hawkes earlier scheme for the British Bronze Age,[46] was also hugely relevant for Burgess' influential attempt of aligning the Insular and northern French metalwork chronologies with each other. Here again, while this endeavour was largely successful, some misalignment between individual metalwork assemblages on both sides of the Channel was not recognized until much later.[47] On the back of Briard's and Burgess' work, subsequent studies by Albrecht Jockenhövel[48] and Sabine Gerloff[49] went on to introduce further chronological detail and to establish a much better defined temporal correspondence between the Continental and the Atlantic Bronze Age sequences.

[34] Coles 1959–60, 22, where the author rejects an Atlantic source for Wilburton swords and argues for their British origin instead

[35] Burgess 1969

[36] *ibid*, 3, 16

[37] Briard 1965, 196

[38] On the odd occasion, both conceptualizations can be found side by side, used by different authors within the pages of the same volume; eg Taylor (1978), conceiving Britain as separate from Atlantic Europe, and Craddock (1978), including Britain and Ireland in the Atlantic Bronze Age sphere, both in the proceedings of the 5th Atlantic Colloquium

[39] Chevillot and Coffyn 1991; Oliveira Jorge 1998

[40] eg Burgess 1968b; 1987; O'Connor 1980

[41] Brun 1991

[42] Ruiz-Gálvez 1984

[43] Coffyn 1985

[44] cf Kalb 1980; Monteagudo 1983

[45] Brandherm 2007, 10–15; Milcent 2012, 47–51

[46] cf O'Connor and Gerloff, this volume

[47] Burgess 2012

[48] Jockenhövel 1975

[49] Gerloff 1980–81

BC	PHASE		BRITAIN HOARDS/FINDS	MILCENT 2012	NW FRANCE	SW FRANCE	IBERIA
1300	LBA1a	APPLEBY	Appleby	Bfa1 anc.	ROSNOËN Chailloué		ISLA DE CHETA Foios Stela
1200	LBA1b	PENARD	Penard Ffynhonnau	Bfa1 rec.	Abbeville Grigny		LOS CASCAJOS La Era
	LBA2a	LIMEHOUSE		Bfa2 anc.	ST BRIEUC Kerguérou	ST-DENIS- DE-PILE	ALHAMA DE ARAGÒN
1100			Mickleham	Caix	Combon		Catoira
	LBA2b	WILBURTON	Guilsfield Skidby West	Bfa2 rec.	BRÉCY St Nazaire Canteleu	CÉZAC Braud-et- St-Louis	HÍO San Esteban
1000			Isleham				
	LBA3a	BLACKMOOR	BROADWARD Waterden Llancarfan	Bfa3 anc.	LONGUEVILLE		HUELVA Camino de Santiago
900	LBA3b	EWART PARK	Boughton Malherbe	Bfa3 rec.	VÉNAT Nantes c-t swords	Cubzac- les-Ponts	SAFARA Fiéis de Deus M.S. Idda c-t swords
			Thames swords				
800	IRON 1 Ha C1	LLYNFAWR	Gündlingen swords	1er Fer a1	Gündlingen swords BRANDIVY Armorican axes		Ocenilla

Fig 1 The Atlantic Late Bronze Age sequence (modified after Burgess 2012, table 2)

Save for some later adjustments,[50] these works established the general outline for a relative chronology of the Atlantic Bronze Age that still operates today, and which in recent years was synthesized authoritatively by Pierre-Yves Milcent,[51] providing a more nuanced vision than Briard's earlier studies, and by Lothar Sperber,[52] building on Jockenhövel's and Gerloff's attempts at aligning Continental and Atlantic Late Bronze Age chronologies (Fig 1).[53] This did not prevent some authors from perceiving the long-standing focus on metalwork studies as rather unproductive, to the extent of writing off the Atlantic Bronze Age as a meaningful concept altogether.[54]

The Atlantic Bronze Age beyond metalwork

While until the 1980s most studies employing the concept of the Atlantic Bronze Age had been concerned primarily with metalwork, this was not the only type of evidence considered in its conceptualization. The funerary record also has been called upon to provide diagnostic criteria for characterizing the Bronze Age on Europe's Atlantic façade, mostly stressing the dearth of archaeologically visible burials compared to Middle and Late Bronze Age cultures in other parts of Europe.[55] For the Early Bronze Age this contrast is less pronounced, but the extensive flat cemeteries typical of many continental European Early Bronze Age cultures are largely unknown on the Atlantic façade.

Other than the lack of extensive flat cemeteries and, from the Middle Bronze Age onwards, the altogether dwindling numbers of archaeologically detectable burials, there is relatively little in the funerary record that would provide a common denominator across all of Atlantic Europe. Those commonalities that do exist remain largely limited to the Early Bronze Age, and include burials in stone cists and under cairns or earthen barrows. None of these, however, are ubiquitous throughout the Atlantic sphere, and none of them are exclusive to the Atlantic Bronze Age.[56]

Over the last few decades, in line with more general shifts in Bronze Age archaeology, other sectors of the archaeological record have increasingly been called upon to complement the picture offered by the artefactual and funerary registers when it comes to characterizing the Bronze Age

[50] Gomez de Soto 1991; Burgess 2012; Brandherm and Moskal-del Hoyo 2014

[51] Milcent 2012

[52] Sperber 2017

[53] cf Gerloff and O'Connor, this volume

[54] eg Bettencourt 1998, 29–30

[55] Coles and Harding 1979, 468–84

[56] Brandherm 2002

on the Atlantic façade. Interest in land-use, settlement and subsistence patterns in particular has increasingly gained ground,[57] and it was not least this shift in focus which led some authors to advocate a coarser chronological periodization, distinguishing only between an earlier and a later – rather than Early, Middle and Late – Bronze Age.[58] Initially devised primarily with a view towards the Bronze Age in Britain and Ireland, this binary division in recent years has come to be applied to the Atlantic Bronze Age more widely.[59]

One of the settlement features cited most often as a diagnostic element of the Atlantic Bronze Age, and indeed diachronically of the Atlantic sphere throughout most of prehistory, has been the roundhouse, vis-a-vis a predominance of different architectural layouts in other parts of Europe.[60] However, this holds true only for some of the regions along the Atlantic façade: Britain, Ireland and north-western Iberia in particular. In most of Atlantic France and much of Atlantic Iberia other than the Northwest, roundhouse architecture remains very much the exception rather than the norm, and land-use patterns – where not dictated by elevation and surface geology – vary widely between regions and over time.[61]

In the wake of earlier megalithic connections,[62] specific motifs and stylistic features of Bronze Age rock art have long been identified as providing another diagnostic link between different Atlantic regions, specifically north-western Iberia and Ireland, and even between areas as far flung as western Iberia and Scandinavia.[63] Incidentally, Martínez Santa-Olalla, despite his championing the idea of a culturally defined Atlantic (Late) Bronze Age, rejected Bronze Age rock art as admissible evidence for long-distance connections along the Atlantic seaboard.[64] More recently, the notion of Bronze Age links between Iberia and Scandinavia has seen a revival, and rock art has once again been called upon as a key witness.[65] However, even more than with roundhouse architecture, the distribution of Atlantic rock art remains limited to specific geographical areas within the wider Atlantic sphere, and this is clearly not just because of regionally different surface geologies.[66] As a further complication, rock art remains notoriously difficult to date, and while most Atlantic Bronze Age rock art conventionally has been attributed to the Early Bronze Age, there is now increasing evidence that many of the more distinctive 'Atlantic' motifs date to the end of the second or even to the early first millennium BC.[67]

So, while some regions along the Atlantic façade certainly share similar architectural layouts and a common style of rock art, these elements are by no means ubiquitous throughout Atlantic Europe. They are really only found together in north-western Iberia and parts of the Atlantic Archipelago. In comparison to Atlantic Bronze Age metalwork then, their distribution is much more limited, and for the most part they do not offer the same chronological resolution. Consequently, while funerary and settlement evidence, along with rock art provide crucial context, when it comes to identifying the geographical reach of Atlantic exchange networks and for detecting changes in the direction and intensity of contacts along the western seaways, metalwork still provides the best indicator. Beyond culturally diagnostic typological features of metal objects, metalwork deposition practice can also offer insights into shared cultural traditions.

On the other hand, we must not forget that this particular sector of the archaeological record is only accessible to us through the filter of intentional deposition, which in itself did not remain constant over the course of the Bronze Age. Even within the relatively limited time frame of the Atlantic Late Bronze Age, it is now becoming increasingly clear that hoarding practice at a regional level is best understood as an episodic rather than a continuous phenomenon, and that the untested assumption that multi-piece metalwork deposition was a more or less continuous practice, at least from the later phases of the Middle Bronze Age onwards, lay at the heart of many of the problems encountered in the course of trying to build relative chronological frameworks from metalwork assemblages.[68]

Diachronic change also needs to be taken into account when considering the geographical delimitation of the Atlantic Bronze Age sphere.[69] While changes between the Early, Middle and Late Bronze Age in this respect have generally been recognized, few authors have considered territorial fluctuations within these individual periods. One notable exception is a study of changing culture-area boundaries in Late Bronze Age France undertaken by Patrice Brun and co-workers, based on an extensive database of culturally diagnostic metalwork finds and complementary settlement data.[70] Their study not only identified shifts in the territorial delimitation of the Atlantic culture area between different phases of the Late Bronze Age, but also defined an interface zone along its borders where transit between the Atlantic and Continental spheres along riverine corridors was controlled by gateway communities centred on major hillfort settlements.[71]

[57] cf papers in Burgess and Miket 1976 and Barrett and Bradley 1980a

[58] Barrett and Bradley 1980b, 9; González *et al* 1992, 102–6; Bradley 2007, 178–81

[59] Driscoll 2008, 199; Gibson 2013, figs 3.3, 3.6, 3.7; Joy 2014, 341

[60] Moore and Armada 2012, 38–9; Bradley 2012, 52–61, 195–203; Bradley *et al* 2016, 175–95; Ruano forthcoming

[61] cf papers in Mordant and Richard 1992 and Richard *et al* 2002

[62] cf Eogan 1990

[63] eg Obermaier 1925; Norden 1925, 154–61; cf also Enlander, this volume

[64] Martínez Santa-Olalla 1942, 142

[65] Ling and Uhnér 2014

[66] Bradley 1997, 49–79

[67] Santos 2008; Santos and Seoane 2010

[68] Burgess 2012; Brandherm and Moskal-del Hoyo 2014

[69] Some authors have explicitly adopted a static geographical rather than dynamic cultural approach in defining what is and what is not 'Atlantic', occasionally to the extent of using the terms 'Atlantic Europe' and 'western Europe' synonymously, and even subsuming France's and Spain's Mediterranean seaboard under the 'Atlantic' label (eg Moore and Armada 2012). While a purely geographical approach is of course entirely legitimate, any definition extending the 'Atlantic' label to regions beyond Europe's Atlantic watershed seems hardly justifiable on geographic grounds

[70] Brun 1993; Brun *et al* 1997

[71] Brun *et al* 1997



Fig 2 Spatial extension of the two separate Atlantic Bronze Age domains during LBA 3; continuous lines indicate approximate culture area boundaries during LBA 3a; discontinuous lines indicate approximate culture area boundaries during 3b; the inclusion of Shetland only in the latter is not necessarily due to a shift in culture area boundaries but to the lack of diagnostic evidence allowing a definite ascription prior to LBA 3b

The subject of geographical boundaries also raises the issue of the dynamics of internal divisions within the Atlantic Bronze Age, and these likewise were very clearly subject to diachronic change. From the metalwork record in particular, it is evident that, if we understand the Atlantic Bronze Age as a nexus of inter-regional relations translating

into a cultural interaction sphere, the intensity of those relations, as measured through the exchange of objects and technical as well as ritual knowledge, appears to increase from the thirteenth to the eleventh century BC, but dramatically drops off soon thereafter.[72] After the turn of the millennium, the wide-ranging nexus of inter-regional relations underpinning the Atlantic Late Bronze Age quickly starts to disintegrate. By the late tenth century BC, we really are no longer dealing with a single interaction sphere comprising all of the various regions girdling Europe's Atlantic façade. Instead, we now observe what effectively amounts to a breakup of the Atlantic Bronze Age nexus into at least two separate domains.

The driving forces behind this development are still imperfectly understood, and they are clearest for the processes that unfold on the southern flank of the Atlantic Bronze Age sphere, where the arrival of the Phoenicians to the shores of southern Iberia triggers a realignment of trading networks towards the Mediterranean that removes much of south-western Iberia from the Atlantic Bronze Age nexus.[73] Less clear are the dynamics behind changes affecting inter-regional relations further north along the Atlantic façade, where the relative cultural unity that existed during the earlier stages of the Late Bronze Age, as expressed in its metalwork industry and concomitant depositional practices, from the tenth century onwards gives way to two increasingly separate interaction zones.

Centred on Atlantic France, but extending into southern Britain on the one hand and into western Iberia on the other, we now witness the emergence of the Boughton–Vénat complex,[74] while in Ireland and in Britain north of the Thames valley and Bristol Channel axis, the Dowris and Ewart Park industries form very much a distinct metalwork province, not just in terms of object morphology, but also with regard to the composition of assemblages and to some extent regarding the peri-depositional treatment of objects.[75] In southern Britain, these two provinces overlap, but there can be little doubt that the Atlantic Bronze Age as a single socio-economic interaction zone had begun to disintegrate at least two centuries before the Bronze Age / Iron Age transition in north-western Europe, reversing the general trend towards increasing integration seen during the earlier stages of the Late Bronze Age (Fig 2).

This is a very different picture from that envisaged by earlier generations of scholars, who generally tended to view the final phases of the Late Bronze Age as the apex of the Atlantic Bronze Age.[76] It is also a very different picture from that presented by Brun[77] in his map of cultural divisions for the final phase of the Late Bronze Age, LBA 3b, at the Beynac conference (Fig 3). Arguably, the divisions outlined in his otherwise well-informed mapping exercise reflect the state of affairs during the preceding stages of the Late Bronze Age much better than they do for its very end, which mainly serves to illustrate the significant advances made in the relative chronology of Atlantic Bronze Age metalwork industries over the last couple of decades.

In any case, Brun very much deserves credit for having offered the only systematic attempt so far at teasing out the internal structure of inter-regional relations within the Atlantic Bronze Age nexus, and his map is a poignant reminder that the relevant networks operated at more than one geographical level, within a broad socio-economic interaction zone composed of a range of different and on occasion overlapping territories and maritories[78] joined by the western seaways.

There is no doubt that maritime connections within this nexus were important, but they were not necessarily always more important than links with inland communities. This is demonstrated not only by the wide-ranging adoption of Urnfield technologies and cultural practices at the beginning of the Late Bronze Age,[79] but also by the movement of objects and ideas in the inverse direction towards the end of this period.[80] Therefore, while the coastal communities inhabiting Europe's Atlantic seaboard during much of the Bronze Age may well be viewed as facing the ocean,[81] this should by no means be taken to imply that those communities had turned their backs on their landlocked neighbours.

The Atlantic Bronze Age as a Proto-Celtic *koiné*?

Traditionally, theories of Celtic language spread have envisaged a westerly expansion from an area extending – in broad geographical terms – between the western Alps, the upper Rhine and the Paris Basin. Conventionally this expansion was assumed to have taken place during the Hallstatt and / or La Tène periods, although its beginnings have also been sought in the Late Bronze Age.[82] Where maritime trajectories along the Atlantic façade have been considered as part of this process, they were mostly relegated to a complementary role, in order to help explain the presence of Celtic languages in Britain and Ireland at the dawn of the historical period.[83] However, in recent decades the Atlantic Bronze Age nexus has increasingly been called upon not only as a network of inter-regional relations that contributed to the spread of Celtic languages along Europe's Atlantic seaboard, but as providing the geographical and historical context for the original formation of Proto-Celtic.[84] This idea has further been fuelled by John Koch's identification of Celtic personal names in inscriptions found on south-west Iberian Early Iron Age stelae.[85] Not least based on that particular line of

[72] cf Bettencourt 1998, 25

[73] Burgess and O'Connor 2008, 56–8

[74] Brandherm and Moskal-del Hoyo 2014, 24–37; for non-metalwork-related cross-Channel commonalities in this phase see Marcigny and Talon 2009

[75] cf Coles 1959–60; Eogan 1964; Burgess 1968a; Eogan 1983; Burgess 2012

[76] eg Briard 1957, 315; Ruiz-Gálvez 1984, 293–4; Coffyn 1985, 213; Ruiz-Gálvez 1987, 258; Coffyn and Sion 1993

[77] Brun 1991, 16–20, figs 3, 4

[78] cf Needham 2009, 13

[79] Brandherm 2013, 148–50

[80] Milcent 2009, 466

[81] Cunliffe 2001

[82] cf Brandherm 2013, 147–8

[83] eg Monteagudo 1983, 377–8 note 13; Cunliffe 1997, 154–6

[84] Almagro 1992, 8–20; *idem* 1994; Ruiz-Gálvez 1998, 348–59; Cunliffe 2001, 109–58; *idem* 2010; 2018, 58–60

[85] Koch 2011; 2013a; 2016; Gibson *et al*, this volume

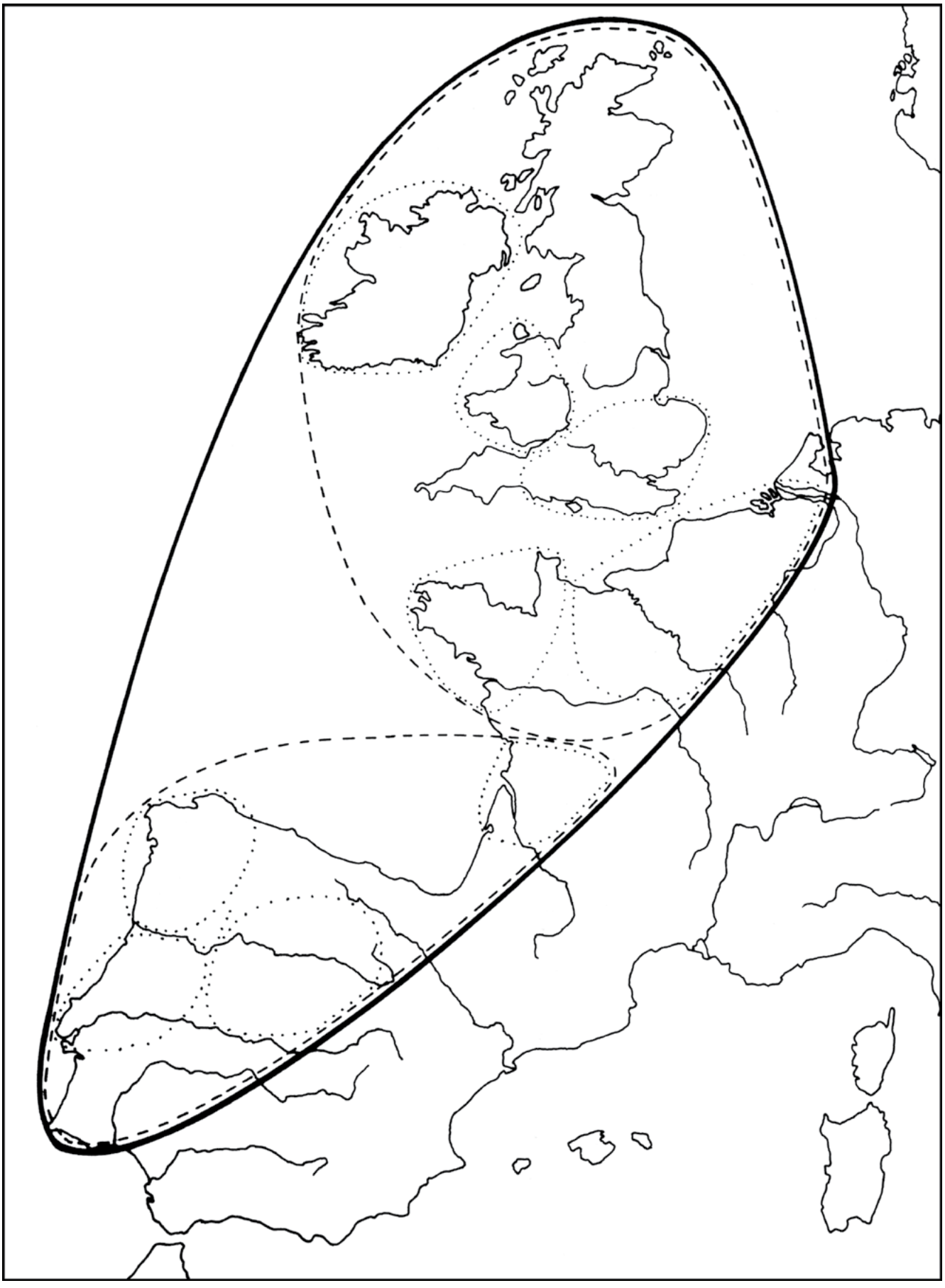


Fig 3 Spatial extension of the Atlantic Bronze Age sphere during LBA 3b according to Brun (after Brun 1991, fig 4)

evidence, the notion that Celtic languages originated on the Atlantic façade and subsequently spread eastwards into continental Europe has most recently triggered what one might be tempted to call a new Atlantic Celtomania.[86]

There undeniably are long-standing issues with the conventional Hallstatt-La Tène model of Celtic language spread, particularly in relation to the presence of Celtic languages in both the Atlantic Archipelago and in the Iberian Peninsula at the beginning of the historical period, when there is little archaeological evidence to suggest any significant population influx into either over the course of the Iron Age.[87] The situation is further complicated by the fact that in both cases we are dealing with the presence of more than one Celtic language in the respective areas, and that the languages concerned differ in a range of features which are usually taken to reflect different stages of language development. Prehistorians in the past have attempted to tackle this issue by proposing multi-wave Celticization models for both the Atlantic Archipelago and Iberia, and by pushing back the beginning of this process into the Late Bronze Age.[88] However, while there now seems to be at least some limited archaeological evidence for Urnfield incursions deep into the Iberian Peninsula,[89] the same hardly holds true for Britain and Ireland, as Mahr had already recognized.

Things evidently were more complicated than envisaged by past generations of scholars. Most recently, the 'Atlantic Europe in the Metal Ages' project has begun to pull together a copious amount of evidence in trying to overcome the limitations of previous models, and the argument that the presence in the Iberian Peninsula of archaic Celtic alongside other Indo-European languages, specifically Lusitanian, which share some significant developments with the Celtic branch of the Indo-European language family, is exactly what one would expect to find close to the epicentre of the emergence of Proto-Celtic certainly makes sense.[90] That said, while simply reversing the direction of language spread assumed by the conventional Hallstatt-La Tène model might solve some of the long-standing issues relating to the presence of Celtic languages in Atlantic Europe, and particularly in Iberia, it does create exactly the same kind of problems in other parts of the Celtic language area.

If the early development of Celtic languages took place on Europe's western seaboard, and Celtic only subsequently spread eastwards into the heartland of the Hallstatt and La Tène cultures, we are very much left struggling to explain the close relationship between the Celtic and Italic branches of the Indo-European language family.[91] In the 'Celtic from the West' scenario, the Celtic and Italic languages during the early stages of their development from late Proto-Indo-European would have been separated from each other by a broad zone of non-Indo-European languages, primarily Iberian.[92] Even if one viewed the shared linguistic innovations of Celtic and Italic as motivated by close contact rather than by having gone through a common Italo-Celtic stage of language development, the fundamental difficulty they pose for any 'Celtic from the West' scenario remains very much the same.

There is also the case of Lepontic, an archaic Celtic language first attested in north-western Italy in inscriptions dating from the sixth, possibly even seventh century BC onwards, ie only marginally later, if at all, than the south-west Iberian Early Iron Age inscriptions in which Koch has identified Celtic personal names.[93] We have absolutely no evidence to suggest that Lepontic was introduced from the Far West just before the first inscriptions in that language appear. Quite the opposite: the area from which early Lepontic inscriptions are attested corresponds closely to the Early Iron Age Golasecca culture, which shows a remarkable degree of cultural continuity from its predecessor, the Canegrate group, harking back to the beginning of the Late Bronze Age. Because of its sudden appearance and the great similarity of Canegrate objects with the material culture of early Urnfields north of the Alps, the Cangegrate group is generally seen as the material fallout of an intrusive population crossing the Alps from the Swiss Plateau around the Middle / Late Bronze Age transition.[94]

Finally, the assertion that only the Iberian Peninsula presents the kind of linguistic patchwork map that one would expect to find close to the epicentre of the emergence of Proto-Celtic is simply incorrect. If the close relationship between Hispano-Celtic and Lusitanian is to be taken as an argument to suggest that Celtic languages emerged around the general area in which these two coexisted, one has to accept that more or less the same argument can be made for other parts of the Celtic language area, for example the northern reaches of the Paris Basin, based on the relationship between Gaulish and the language(s) of the 'Nordwest-block', the latter, like Lusitanian, retaining pre-Celtic /p/, and also showing a number of other features that in comparison to Celtic appear rather archaic.[95]

So, while the 'Celtic from the West' hypothesis may seem to offer a convenient fix to some old and inconvenient problems, trying to relocate the original homeland of Proto-Celtic to Europe's Atlantic fringe and simply reverse the direction of Celtic language spread does create at least as many and no less inconvenient problems as it promises to solve.[96]

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[86] Incidentally, prior to the current bout of Atlantic Celtomania, Ruiz-Gálvez (1990) had fervently argued for the introduction of Lusitanian to its historically documented confines as the *lingua franca* of the Atlantic Late Bronze Age; cf also Senna-Martinez 1999

[87] But see Lenerz-de Wilde (1991, 208–9) for the possible influx of small groups of Celtic speakers across the Pyrenees into Iberia during the Iron Age, and Mac Eoin (2007, 123) and Schrijver (2015, 206–12) for linguistic scenarios envisaging the introduction of Celtic into Ireland during the Iron Age

[88] Mahr 1937, 389–402; Bosch Gimpera 1942, 8–43

[89] Brandherm 2013; 2017

[90] Gibson *et al*, this volume

[91] cf Watkins 1966; Kortlandt 2007, 149–80; Schrijver 2016

[92] cf Gorrochategui 2013

[93] Lejeune 1971; Eska 1998; Uhlich 1999

[94] Sperber 1987, 91–2; De Marinis 1991

[95] Kuhn 1962, 127–8; Meid 1986

[96] This is why some authors have come to suggest that the genesis of the Celtic languages should be pushed back further, into the Bell Beaker period of the third millennium BC (eg Almagro 2004, 95; Brun 2006, 30; Cunliffe 2010, 34). However, this would not only require an extremely condensed succession of multiple linguistic changes from Proto-Indo-European to Celtic within a very short period of time, but also imply that relatively little linguistic development occurred over the subsequent two millennia (cf Mallory 2013, 27–30). The notion of

This evidently does not mean that a form of Proto-Celtic could not have been spoken by some of the communities forming the Atlantic Bronze Age nexus, but the evidence at hand certainly does not suggest a simple 'Atlantic Bronze Age = Proto-Celtic *koiné*' equation. If the linguistic map of the Atlantic seaboard at the end of the Iron Age is anything to go by, we should expect a much more complex situation, with perhaps an early form of Lusitanian spoken along the shores of central Portugal, and Vasconian languages current along the Atlantic coastline between Cantabria and the mouth of the Garonne.[97] For the Late Bronze Age, an even more diverse picture seems likely, based not only on classical sources pointing in that direction,[98] but also on the possibly non-Indo-European character of the matrix language documented in the south-west Iberian inscriptions.[99]

Conclusions

In these pages we have attempted to trace the development of the concept of the Atlantic Bronze Age, from when it was originally formulated by Mahr to the present day, when it is once again being imbued with cultural – and even linguistic – significance that goes far beyond a mere distribution area of certain categories of metalwork objects, to which it had temporarily been reduced. We have tried to show how the changing conceptualization of the Atlantic Bronze Age was informed by broader intellectual trends and diverging conceptual reference frameworks, often underpinned by different national traditions of scholarship, without always making those reference frameworks sufficiently explicit.

One of the main difficulties with which almost all authors have struggled is that we are not dealing with an archaeological culture in the conventional sense, but with a nexus of inter-regional relations that translate into a broad socio-economic, and by extension cultural, interaction zone, held together to a large extent by maritime contacts along the western seaways. The tale of the Atlantic Bronze Age is, however, not a tale of geographical predetermination, in which diachronic variation only arises from advances in maritime technology. That we are dealing with much more complex dynamics, in which the relations of Atlantic communities with their landlocked neighbours had an important part to play, is borne out not least by the changing boundaries of the Atlantic Bronze Age sphere over time, from the Early Bronze Age onwards, and its breakup into two largely separate geographical domains at the height of the Late Bronze Age.

A side effect of the strong focus on inter-regional relations in most research invoking the concept of the Atlantic Bronze Age has been that the internal social dynamics of Bronze Age communities on Europe's Atlantic façade have received little attention as a potentially significant factor in wider processes of change. This is despite the evident limitation to very specific social registers of the key artefact groups underpinning the notion of the Atlantic Bronze Age nexus. The existence of distinct registers with different social and geographical reach within the metalwork record certainly seems to indicate unequal access to material as well as ideological resources, with the concomitant potential for social friction and conflict, whose effects rarely remain confined to individual regions within a wider interaction sphere. Without a better grasp of the internal dynamics of Atlantic Bronze Age societies at a regional scale, our understanding of wider processes must inevitably remain both fragmentary and biased. That grasp will only come with a more systematic and integrated analysis of the different registers comprising the archaeological record, and with a significantly improved chronological resolution of that analysis.

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cumulative Celticity (Hawkes 1973, 617–23; cf Waddell 1995, 159–61) does little to provide a satisfactory solution to the issues raised by such a scenario. It of course goes without saying that all language development is inherently cumulative. The crucial question here is if the defining characteristics which set the Celtic languages apart from the other branches of the Indo-European language family could plausibly have been in place before the end of the third millennium BC. If the answer to this question is negative, then evidently it does not really make any sense to try and associate the carriers of the Bell Beaker phenomenon with Celtic, be it Proto-, Para- or otherwise (cf Falileyev 2015)

[97] This seems to be the main reason why Koch (2016, 434, fig 15.1) excluded the coastal areas between Cantabria and the Garonne from the Atlantic Bronze Age sphere. The incidence of Atlantic Bronze Age metalwork depositions in comparison to most other Atlantic regions here is indeed relatively low, but the same holds true for other parts of the Atlantic façade, to which the same criterion is not applied

[98] eg Strabo III.1.6

[99] For the pertinent debate see Eska 2014; Koch 2014a; 2014b; Prósper 2014; Valério 2014

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A Scheme for the British Bronze Age by C F C Hawkes

Sabine Gerloff and Brendan O'Connor

We publish here for the first time the summary of C F C Hawkes's 'A scheme for the British Bronze Age', prepared to accompany his lecture to a Council for British Archaeology conference in December 1960. The Scheme was not, as originally intended, published in Antiquity, following disagreement over a rejoinder that Hawkes submitted to criticism by F R Hodson of Hawkes's Iron Age Scheme; we also reproduce the text of that rejoinder.

Introduction

The Neolithic and Bronze Age Research Committee of the Council for British Archaeology held a conference on the Bronze Age, entitled 'Problems of the British Bronze Age' at the University of London Institute of Archaeology from 16 to 18 December 1960.[1] The centrepiece of this conference, like its Iron Age equivalent two years earlier,[2] was its opening address, 'A scheme for the British Bronze Age', a lecture given by Christopher Hawkes, Professor of European Archaeology in the University of Oxford.[3] In this opening address he set out a revised and expanded version of his earlier chronological scheme, published in 1948.[4] The revision of the Late Bronze Age sequence was perhaps prompted by sub-divisions of Paul Reinecke's Late Bronze Age Hallstatt phases (Ha A and B) recently published by Hermann Müller-Karpe,[5] to which a chronological table shown at the lecture (Fig 1) and manuscript notes and draft tables dated 1960 in Hawkes's archives in the Bodleian Library, Oxford, refer. Hawkes's revised Scheme introduced two Copper Age phases and a third sub-phase of the Middle Bronze Age (MBA 3), as well as a later absolute date for the start of the Late Bronze Age. It also included Bronze Age metalworking 'industries', described in the Scheme and figuring in the chronological table (see Fig 1). Hawkes appears to have devised these 'industries' in 1960 while working on his Scheme, as his dated notes and drafts of chronological tables suggest. A typescript summary was prepared for his lecture, but received limited circulation and has never been published, although it was explicitly and implicitly influential on subsequent work.[6] We take the opportunity to remedy that omission here; our priority is accordingly the Scheme itself, not its genesis or significance.

The proceedings of the 1958 Iron Age conference were published[7] and Hawkes's paper on the ABC of the British Iron Age[8] appeared also in *Antiquity*.[9] The editorial of the December 1959 issue of *Antiquity*[10] mentioned 'Professor Christopher Hawkes's scheme for the British Bronze Age' among articles intended for publication in 1960. At its meeting on 2 December 1959 the CBA Research Committee, aware of this forthcoming publication, agreed to hold a Bronze Age conference a year later and invited Hawkes to deliver the opening address.

It was intended that his Scheme should appear in the December 1960 *Antiquity*, just before the conference, and that a report on the conference should appear during 1961. However, in June 1960 *Antiquity* published in their *Notes and News* critical comments on Hawkes's Iron Age Scheme by F R Hodson.[11] Hawkes was sent the proofs of Hodson's comments by Glyn Daniel, the editor of *Antiquity*, and he requested the addition of a postscript to Hodson's note in which he announced a reply for the next issue,[12] as he felt that '*your* [Antiquity*'s*] *readers will like to be enabled to look forward confidently to a bit of a rejoinder*'.[13] Hawkes's reply was accordingly entitled '*The British Iron Age – A Rejoinder*'. The editors of *Antiquity*, however, declined to print it because '*your* [ie Hawkes's] *criticism did not deal constructively with the main points he* [ie Hodson] *made*' and they asked Hawkes to change it, which he felt unable to do.[14] *Antiquity's* rejection of his *Rejoinder* was thus the major reason why Hawkes withdrew the planned publication of his Bronze Age Scheme. His *Rejoinder* was never published, nor had Professor Hodson ever seen a copy or known of its present existence.[15] It was identified among Hawkes's Papers in the Bodleian Library by SG in 2015 and because of its relevance to the non-publication of the Bronze Age Scheme (in addition to its historical significance for Iron Age studies), it is presented here as an appendix. The correspondence between Hawkes and Hodson in the Bodleian and other letters kindly provided by Professor Hodson in 2015 show that, although there were academic 'differences of opinion' between the two at the time, these were soon resolved and their professional and personal relationship was friendly and amiable. Indeed, Professor Hodson now sees his *Reflections* as 'perhaps a bit of youthful bravado'.[16]

[1] *Antiquity* vol 34, 222; CBA 1960, 19; *idem* 1961, 16
[2] Hawkes 1959; Cunliffe 2005, 17–18
[3] Harding 1994
[4] Hawkes 1948, 216–18; see also Bradley 2013
[5] Müller-Karpe 1959
[6] Harding 1994, 333; Díaz-Andreu and Price 2009, 6; Roberts *et al* 2013, 25, fig 2.2
[7] Frere 1961
[8] *ibid*, 1–16
[9] Hawkes 1959
[10] *Antiquity* vol 33, 240
[11] Hodson 1960, 138–40; see Collis 1994, 122–7
[12] Hodson 1960, 140
[13] Letter from Hawkes to Daniel 23 April 1960, Hawkes archives, Box 9, Bodleian Library
[14] Letter from Daniel to Hawkes, 3 August 1960, Hawkes archives, Box 9, Bodleian Library
[15] F R Hodson, pers comm (December 2015)
[16] pers comm

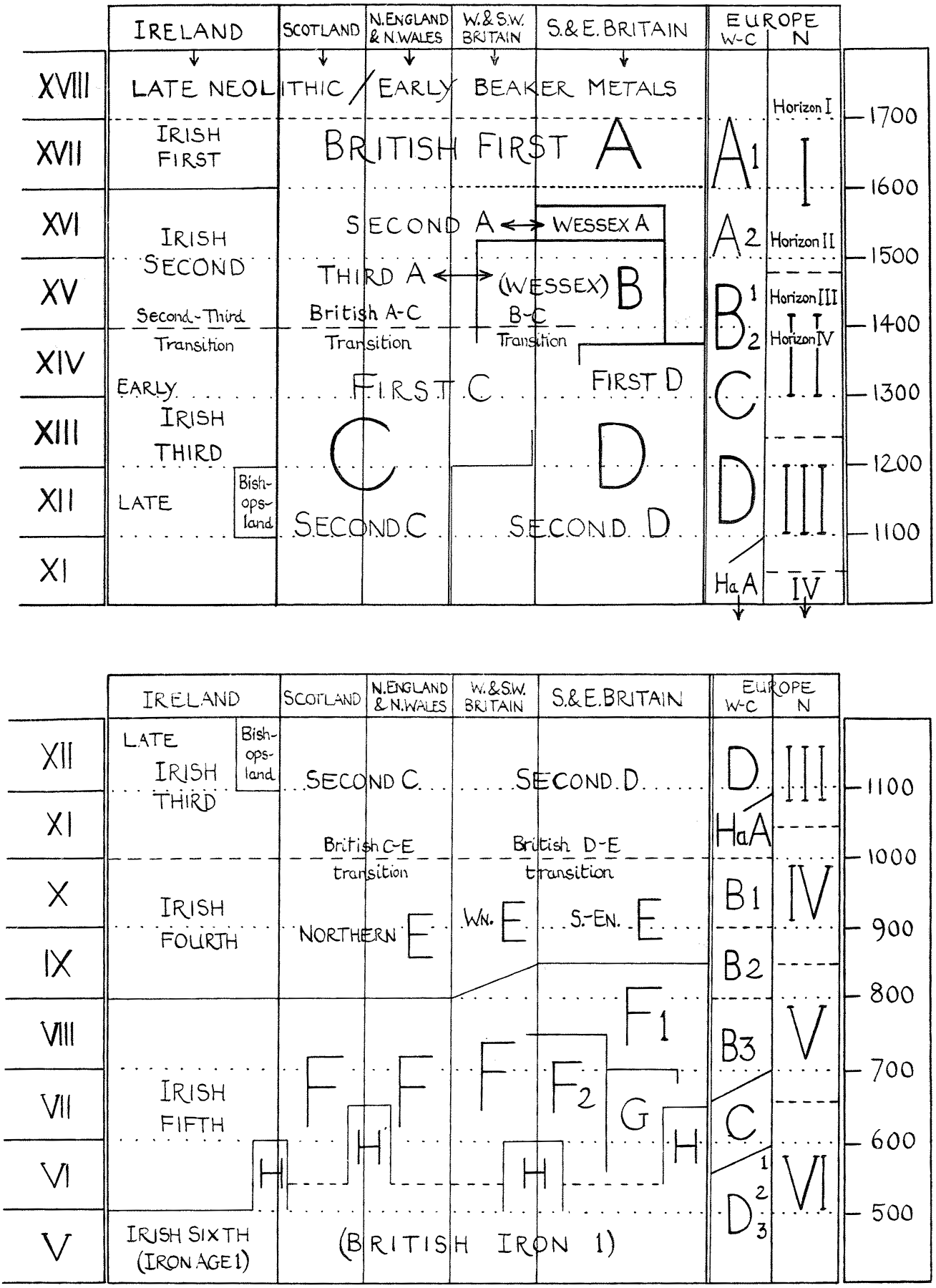


Fig 1 Chronological table prepared for Hawkes's lecture 'A Scheme for the British Bronze Age', 16 December 1960 (deposited in Box 96 of C F C Hawkes Papers, Special Collection, Bodleian Library, Oxford)

	Hawkes 1960	**Burgess 2004**
End Copper Age/beginning of Bronze Age	1650/1600	2354/2345
End of EBA/beginning MBA1	1400	1700/1500
End of MBA1/beginning MBA2	1200	1400
End of MBA2/beginning LBA1 (old MBA3)	1000	1300/1250
End LBA1/beginning LBA2 (Wilburton)	900/850	1100
End LBA2/beginning LBA3 (Ewart Park)	750/700	950
End LBA3/beginning LBA4 (Llynfawr)	650/600	800

Fig 2 Comparison between absolute dates attributed to British Bronze Age phases by C F C Hawkes in 1960 and C B Burgess in 2004 (after Burgess 2004, table 11)

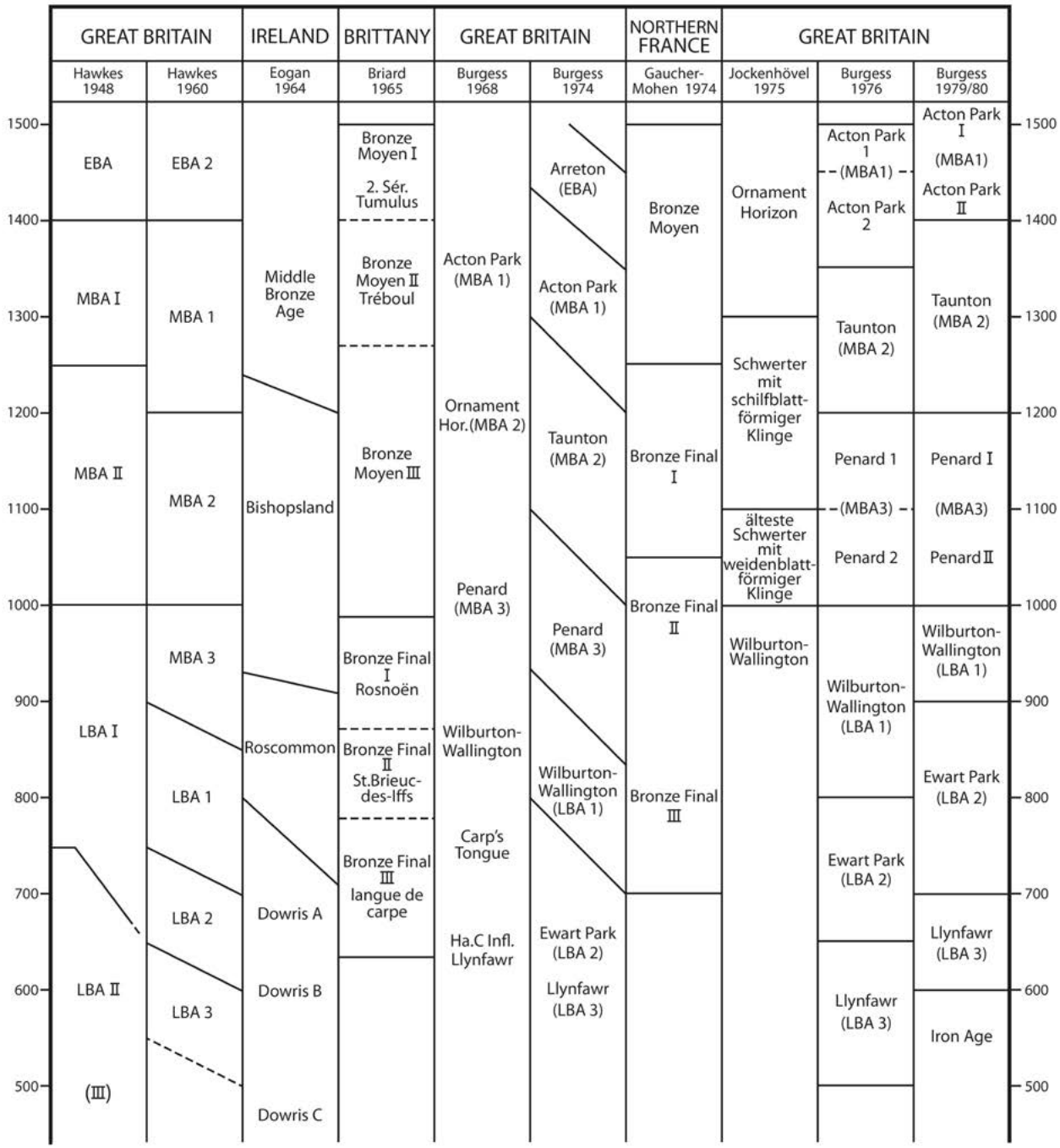


Fig 3 Changes in the Bronze Age chronology of the Atlantic Archipelago and the Near Continent from 1960 to 1980 (after Gerloff 1980–81, table 1)

As Hawkes's contribution to the Bronze Age conference was not to appear in *Antiquity*, the CBA subsequently agreed to publish it,[17] but although the papers of the 1960 conference were summarized and reported in *Antiquity*,[18] neither the proceedings nor Hawkes's Scheme ever appeared. However, some of the papers, as well as references to the Scheme, did appear in print. Stuart Piggott's paper on British Beaker cultures, '*Abercromby and after*', was the basis for his contribution of the same title to Cyril Fox's *Festschrift*,[19] while J B Calkin's summary of Deverel-Rimbury and the Dorset region was published subsequently in the *Archaeological Journal*, where he states that he has taken account of the chronology propounded by Hawkes at the conference.[20] Hawkes's own contribution to the Fox volume includes several references to the Scheme and its intended publication as a CBA Research Report.[21] John Coles, who reported on the conference, mentioned the Scheme in his paper on Scottish Late Bronze Age metalwork published in 1962, but did not adopt it.[22] Coles also spoke at the CBA conference and a few weeks earlier had delivered what was presumably a similar lecture entitled 'The Late Bronze Age in Scotland' to the Society of Antiquaries of Scotland.[23] Hawkes himself referred to imminent publication of his Scheme during 1961 in an addendum to his contribution to the proceedings of the 1958 International Congress on Pre- and Protohistory.[24]

There has never been a published monograph on the whole British Bronze Age and Hawkes's unpublished Scheme formed the basis for syntheses of the period over the decades following 1960, especially through Colin Burgess, who incorporated the Scheme into his own work.[25] As late as 1988 Burgess included a sequence developed from Hawkes's Scheme in a chronological table for the Bronze Age in Britain.[26] In his memoir of his researches, he highlights the importance of the Scheme and compares its chronology with that current in 2004.[27] We reproduce Burgess's table here as Figure 2, with a comparison of British and Continental chronology including Hawkes's 1948 and 1960 schemes compiled by SG in 1980 as Figure 3. George Eogan used Hawkes's sequence for southern Britain in the chronological table for his classic article on the Later Bronze Age in Ireland.[28]

Both the present writers have referred to the Scheme in print,[29] and BO'C had used his copy in 2003 while preparing a paper on the earliest metalwork in Scotland, to record that Hawkes had recognized a Copper Age.[30] So when a German colleague, who had heard of it but never seen a copy, asked SG about the Scheme, the idea of publishing it arose, partly in homage to the memory of perhaps the foremost student of later British prehistory during the twentieth century and partly to fill a conspicuous gap in the history of research on the Bronze Age.

The text we reproduce here covers just over six pages of cyclostyled foolscap, part of which is reproduced as Figure 5. The copy used was given to BO'C while he was an undergraduate at Nottingham University in 1972 by his tutor, Jeffrey May, who had received his copy while he was a student of Christopher Hawkes at Oxford. This original was dated 29.11.1960 – Paul Ashbee, Colin Burgess and Anthony Harding all kindly confirmed the date – so was produced before the conference. However, copies do not seem to have been distributed to the whole audience at Hawkes's lecture: he was not accustomed to provide such aids. The original was re-typed in Nottingham, as was necessary in those days before photocopiers, to make further cyclostyled copies. The text is reproduced as set out there, subject to silent correction of a few typing errors.

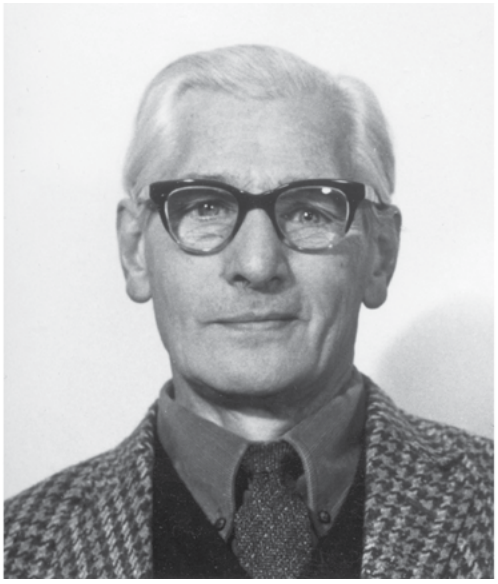


Fig 4 Christopher Hawkes (1905–1992) in a passport photograph from 1969 (photo reproduced courtesy of the School of Archaeology, Oxford)

Acknowledgements

We must thank Christopher's son, Nicolas Hawkes, for kind permission to publish his father's work, Roy Hodson for his support and comments, Dennis Britton for providing additional information and Mike Heyworth for access to the CBA's archives, also Colin Harris for access to the Bodleian's Special Collection and for supplying scans of Hawkes's chronological table, presented above in Figure 1 and the *Rejoinder*, reproduced further below.

[17] CBA 1961, 16; *idem* 1962, 20
[18] Coles 1961
[19] Piggott 1963
[20] Calkin 1964, 2–3
[21] Hawkes and Clarke 1963, 194 no. 2, 216 no. 2, 236 no. 6, 239 no. 2, 248
[22] Coles 1959–60, 17 no. 1
[23] *Proc Soc Antiq Scot* vol 93, 260
[24] Hawkes 1961, 382
[25] Burgess 1969a, 22 no. 1; *idem* 1969b, 3 no. 6; *idem* 1974, 167 no. 9; *idem* 1980; 2004; Schmidt and Burgess 1981, 12
[26] Wright 1990, 178, table 8.6
[27] Burgess 2004, 341–2, 348, table 11
[28] Eogan 1964, fig 20
[29] O'Connor 1980, 9; Gerloff 1980–81, 186 no. 27, table 1; *eadem* 2007, 122–4; *eadem* 2010, 27
[30] O'Connor 2004, 205

C.F.C. Hawkes, 1960

SUMMARY

1. LATE NEOLITHIC AND COPPER AGE

(a) Our Neolithic, Early and Middle for over a thousand years, becomes Late around 2000 B.C. Among its cultures, the Peterborough (Mortlake and Fengate groups) is British/North-European, the Rinyo-Clacton (southern and northern) is British/West-European, though still obscurely. Ireland has now a southern-based culture from France, with Wedge megalithic tombs and flat-based pottery (Lough Gur II', cf. Seine-Oise-Marne or Horgen). Elements of all persisted to the Bronze Age. But the metal first introduced and then found and smelted here was not yet bronze (copper/tin alloy) ut simply copper. The Late Neolithic, with its mass of non-metal equipment, thus in its metal-using aspect becomes a Copper Age.

(b) The Beaker peoples, moving on the Continent around 2000 and after, all knew copper. Those reaching Britain first, from Netherlands, had Cordzoned beakers; the next, c.1800 from Middle Rhine, had 'classics Bell beakers (and archer's bracer, barbed and tanged flint arrowbeads), found with their crouched burials, under not much mound, sometimes with copper tanged flat dagger(awl, small knife too). Some crossed to S. Ireland, mixed with Wedge-tomb people and worked local sulphide copper-ores: there and in Britain, the copper analysed is partly Continental but partly British or Irish. Irish notably are thick-butted flat axes (Continental primary type already); in Britain too, though rarer, Initial metal-using phase: Copper 1, c. ? 1850-1750.

(c) Copper 2, c. 1750-1650/1600. Further incomings: motive partly the copper, and even first tales of Irish (Wicklow) gold. Those with Necked beakers (and slightly different arrowheads), mainly Bell-beaker origin on Continent; so their ornament (beakers, rarer bowls), but Long-necked form suggests mixed group from there (? beyond Rhine). Spread from S. Britain,some corssing from Bristol Channel to Ireland, to make a fresh formation there (below), and from E. Britain.

(d) They appear here widely commingled with Battle-axe people, from N. European Plain or Elbe: origin mixed local and Black Sea, whence crouched burial (sometimes in shaft) under prominent Round barrow, and cord-impressed pottery. But in Britain graves either with no pottery, or with our Long-necked beaker (seldom with sign of the corded type), yet along with their typical stone battle-axes.

(e) The fresh formation in Ireland; graves not with beakers now but bowls, primarily ornamented likewise; with these Irish Bowl 'food-vessels' no Battle-axe element. Typical Irish weapon instead is copper halberd (may occur with thick-butted axe); origin, Mediterranean/Central Europe/beyond Rhine, so likeliest brought thus into Ireland, while inhibited in Britain by battle-axe. Irish gold lunula had same background; gold prototypes, Denmark-Brittany, suggest this now brought in too, though examples rare till Early Bronze Age, when fine-traced ornament began. Any earlier ornament on gold is repoussé ribbing (early sun-disc, basket earrings).

(f) Short-necked beakers were brought into Britain from Netherlands (Veluwe: no Battle-axe mixture); this element spread to north-east Scotland, but also variously combined its beaker form with the Long-

Fig 5 Reduced reproduction of the first page of the Scheme typescript (from copy given to BO'C by his tutor, Jeffrey May, at Nottingham University in 1972)

A SCHEME FOR THE BRITISH BRONZE AGE

C. F. C. Hawkes, 1960

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(f) Short-necked beakers were brought into Britain from Netherlands (Veluwe: no Battle-axe mixture); this element spread to north-east Scotland, but also variously combined its beaker form with the Long-necked. Latter at times is cordoned; has related handle forms; might combine with Bell; Bell persists also by itself; in SE is squat and bulbous; others are impressed with spirally-wound cord. Copper thin-butted axes now appear, some laterally bevelled, all short, and riveted flat daggers (enlarged from knife) with slender rivets. Also perhaps now in copper (rare) are disc-headed pins, disc-ended bracelets, tubular sheet beads from necklaces, and possibly basket earrings (best in Irish gold). Origins here seem from upper Danube (Straubing), by Rhine to Netherlands and thence following the Short-necked beakers, not after 1650/1600; the axes anyhow suggest copper worked now in various British Highland districts and England.

(g) In 17th century also Short-necked Beaker folk from Scotland entered Ireland (with these axes?), their beakers becoming sharp-shouldered now as Irish Vase 'food vessels'. Probably already and independently, Battle-axe people had also gone there (N.E. and E.). Whatever the mutual relations of these and Vase and Bowl folk, the Battle-axe element is specially significant here as in Britain. Ethnically different from all primary Beaker groups, it had come from east of them, about the Elbe. Elbe and Saale flow from Middle Germany, rich in metals, with pyritic ores of copper and with tin. No later than this, before West or upper Danube, production had thus gone onto Bronze. Britain and E. Ireland, made known on Elbe by Battle-axe movement, now open to natural quest for further such sources. Wicklow in E. Ireland, with attraction of gold, had also pyritic copper ores, and tin anyhow enough to start with. Hence a prime factor in our Early Bronze Age.

2. THE EARLY BRONZE AGE

(a) Late Neolithic cultures could live through immigrant admixture or overlay: in Ireland, if the northerly (Court Cairns) declined, the southerly lived on (Wedge tombs presently reduced to 'portal dolmens'); the Boyne culture, roughly between, was penetrated by immigrants, as its Passage tombs may show (intrusive single burials or cemetery; elsewhere were made new 'cemetery-cairns'). But Boyne religion and its art had evident prestige, which carried its tombs through these centuries; their bone pins and rusticated 'Lough Crew' ware have British Late Neolithic counterparts (skewer-pins, and rusticated ware which has Beaker contexts). Peterborough vessels, tripartite 'Mortlake' or bipartitite 'Fengate', meanwhile took flat bases, but forms and some decoration (including their cord-impressed) survived. Mainly Southern, simple vase 'food vessels' in some graves may show some impressed ornament, and Rinyo-Clacton plastic, though mainly plain.

(b) Ditched Henge enclosures for Neolithic religious observance could already by Beaker people be enhanced by Stone Circles (otherwise found unditched), sometimes with an outlying Standing Stone (others occur alone) and more rarely Stone Avenue, all of arguable Atlantic origins. Henge-like ditches were combinable also with round barrows (Bronze Age sequels here in S.); new Henges with two entrances (Avebury four) were imposing, Stone Circle or no. Circles with Recumbent Stone (N.E. Scotland) seem adapted by Beaker folk from older stone-ringed megalithic tombs (Highland). A novel tendency in graves, was burial in posture relaxed or extended; suited to (?boat) tree-trunk coffins, which could last later, even with cremations. Cremation more generally, indeed, perhaps had Neolithic inspiration (cemeteries in some henge enclosures, etc.), but similar coffins across North Sea suggest connexions that way. Known better from metal-work; but metal trade only gradually ousted flint and stone, and took its route from stone axe traders.

(c) Early Bronze 1: 1650/1600–1550/1500

Thin-butted axes elongated (firmer hafting), though cast in stone single-matrix moulds so still flat not flanged like those of Middle Germany, are yet of bronze, knowledge of which came thence (above). Its hardness served also decoration (incised with hard tracer): 'Knipton cuff wristlets; Irish gold lunulas and Irish axes too (style partly from old Boyne art); these and bronze halberds exported, reaching Elbe and N. Europe. The producing industries Irish First A. British First A industries, various mainly Highland Zone locations: axes, awls, slender-rivet daggers and ornaments as already mentioned for ? copper, and bracelets, cylinder armlets, all cast first flat; thus foreign influence still somewhat remote.

(d) Tin supply still precarious (Germany far, Wicklow scanty). Enterprise from Germany (existing trade-route) found tin with the copper (and gold) of Brittany. Brittany then invaded thence, towards 1600: first single graves, bronze flat axes, elongated daggers with 6 slender rivets (datable type, Germany), British 'Bush Barrow' daggers, similar, most also bronze, show invasion extended to Wessex; also stone battle-axes modified from Brittany double axes, small Breton 'grape-cups', etc., all in rich graves of new Wessex I culture, from c.1600. First tin in bronze likeliest Breton; traded to Ireland, brought back Irish gold (much in same graves); copper, tin, gold all desired in Aegean; connexions thither suggested by rare sceptre-mounts, by features of now re-built Stonehenge, and by Aegean and Wessex sharing of same plentiful Danish amber, notably in necklaces with same complex-perforated spacer-plates – adapted from simpler Danish type, giving shape like gold lunula. Native side of culture too; tripartite, etc., pots, Bell barrows formalised from Henge-ditched (above). Spread from Wessex in certain 'colonies'; rare daggers even farther; but phase was short-lived and axes everywhere still not flanged unless by hammering.

(e) Amber in less amounts won already by Irish axe trade, had contexts still Beaker in Yorkshire, with rare gold: trans-Pennine-Irish-North Sea route. Coast invites invasion too: to beakers in graves succeed Yorkshire Vase 'food vessels', spreading west presently into Ireland, converse of Irish Vases or Bowls and ornament variously in N. Britain. Yorkshire vase had foreign elements: cord ornament sometimes double-plaited as in German 'corded ware'; stops on shoulder, at first perforated as on 'corded amphoras'; but shouldered form not German, in Britain already. New bronze daggers too: Parwich type, plug rivets now. Spacer-plate bead necklaces in N. and E., much as in Wessex, but of British jet: pointillé ornament (cf. traced on lunulas); in Scotland a spacer-plate faced in bronze, with tubular sheet beads, adaption of same necklace type. But Boyne art rare (Folkton chalk idols); N. British cup-and-ring designs on grave-buried stones and rock outcrops, foreign to Boyne, await fresh study.

(f) Early Bronze 2: 1550/1500–c.1400

Abundant Cornish tin, discovered hardly before, exploited for bronze from little after 1550 by new B industry. From or soon after start, local control by new people, Trevisker group; pottery again corded and handled, so bespeaking (though British in its biconical cremation-urn form) origin from Germany, with required craft skill, and with ogival grooved daggers (plug rivets) of type there dated now. The B industry and its custom located primarily in concurrently new Wessex II culture. Its typical graves may have now either Bell or (for women) Disc barrows, more Henge-like than that or other forms; 'Aldbourne' small cups have French antecedents, but other pottery is native (shouldered, collared, cord-impressed), especially the cinerary urns appearing now: cremation (native itself?) was gradually prevailing. Trade: amber still, and gold (Rillaton cup, Aegean analogies of before 1500); but

both get rarer, while faience trinkets and segmented beads were received from E. Mediterranean; route at first through Germany (pendants like Middle German halberds, bronze pins of S. German types) but after 1500/1450 a western sea-route – best for the Cornish tin, now as later – avoided the disturbance of Central Europe then caused by advent of new Tumulus culture. The B industry also worked, in good part with imported foreign copper, and showed foreign-derived skill, using double-matrix moulds (not stone); ingenious pins; tools, knives, flanged axes, spearheads tanged and then with core-cast socket (eventually looped). Hoards, graves, distributions show quite far-flung Wessex II 'colonies' and 'spheres of influence'; one in N. Wales, on route for Ireland, had also copper, to be used presently against failing foreign supply. These extensions spread the culture in its native not only its exotic aspect, notably its cremation practice and urn-forms (below).

(g) Elsewhere, continuing First A output may be datable now as Second A influenced from the south and also Ireland. As well as the British arose an Irish B industry (also beside a Second A): daggers varied from the Wessex (two, four rivets); halberds gave place soon to socketed spearheads (looped, varied from the Wessex type); more quickly, flat to flanged axes, often decorated; these traded over N. and all E. Britain, also to France, joining Wessex sea-route, while influence of gold lunula, sun-disc, reached Spain, Portugal (Galicia also has cup-and-ring rock engravings; for this Atlantic route, compare double-looped axes, cauldrons, in Middle and Late Bronze times). Our Early Bronze Age ended industrially about 1400; new cultural balance then attained in general.

3. THE MIDDLE BRONZE AGE

(a) Middle Bronze Age 1: c.1400–1200

Neolithic and Copper Age inheritance and Early Bronze innovation now blended, producing throughout Britain a single Insular Bronze culture, and the like in Ireland. Conservatism of this: little to divide into I, II, III (by the time-phases M.B. 1, 2, 3). Ireland (I) still had Bowls, and Vases, and its first cinerary urns (below); doubtless still with plain ware from the Late Neolithic. Britain has five geographic Provinces, all likewise practising cremation, with features (I) as follows:

Lowland: Collared or Overhanging-rim urns, cord-impressed or incised (Neolithic origin), Tripartite; others Bipartite (ditto); in south, also Biconical urns (cf. shouldered 'food-vessels', above), with restricted plastic ornament (ex southern Rinyo-Clacton?); settlement-pottery in east has this rustication, or is cord-impressed anywhere.

South-western: mainly Trevisker urns, and similar settlement-pottery or (e.g. Dartmoor) different.

Western: (Galloway to Bristol Channel): Collared urns, Tripartite again, or Bipartite or 'Enlarged Food-Vessel' types, and Encrusted urns spread from the northern, which also enter Ireland.

Pennine-Eastern: Tripartite and some Bipartite. (Here and in West and North, true 'food-vessels' may linger).

Northern: the same, with 'Enlarged Food Vessel' and Encrusted urns (ex northern Rinyo-Clacton).

Everywhere Tripartite and some Bipartite urns, as primarily of southern (Wessex) inspiration, are the most often accompanied by small 'pigmy' cups (above), or these may appear alone. Graves: still simple or slab-cist; any barrow or cairn (rare in North) is of bowl shape, ditched only in Wessex

neighbourhood (Bell, Disc, etc.). In 'Pond' barrows there, or variously otherwise, may appear cremation cemeteries, distinct from simple secondary barrow-graves and of likely Late Neolithic origin (cf. Henge cemeteries above). Grave-goods: normally poor or absent, with few splendid exceptions (Mold, with amber and sheet-gold cape; Lansdown, large sun-disc; Winterslow, amber etc.); beads rarer (sometimes still faience); knife rarer; weapon very rare; oval bronze razor rare, but parallels those of Tumulus culture abroad. Settlements, stock-enclosure, evidence for agriculture (barley) only rare in our present knowledge: culture not really poor. Bronze: First C industries, using steatite double-matrix moulds; basal-looped leaf spearheads; socket-looped mostly Irish and kite-bladed; dirks (lengthened from Irish dagger); haft-flanged axes (short flanges, Irish origin); the south has lost leadership to Ireland and Highland Zone. But in S.E. (from c.1400: foreign hoards) appears true palstave, work of foreign-based First D industry, with bigger future.

(b) Middle Bronze 2: c.1200–1000

Insular culture changing little and internally only (II) with Tripartite urns modified to cask-shaped cordoned urns, in Northern and Western provinces generally, in Peninne-Eastern entirely. Encrusted urns continue; Ireland now has both types. But in S. of Lowland province, this was replaced by 'Deverel-Rimbury' culture, progressively from S. (c.1200): settlements, stock-enclosures, linear ditches, field systems; cremation in old or new (low) barrows, cemeteries; settlement-pottery and urns either Globular (most novel), Barrel, or Bucket derived from old Biconical; tooled and plastic ornament ousts cord-impressed; contrast with Insular, Primary districts (1) Bournemouth-Cranborne Chase, (2) Dorset W. of Stour, (3) Sussex; secondary, variously up to line Gloucestershire-Lincolnshire (eastern has rusticated ornament). Intimacy with South-western Province (Trevisker). Bronze: Second D industries, palstaves (SE and SW), first socketed axes, spear-heads still looped, button sickles, tools, pins, torcs, bracelets, bifid A razors; still tin-rich bronze; extension to N. Wales (copper), and by trade to Ireland (Bishopsland). Insular culture has Second C industries, wing-flanged axes, rapiers, little other change, but second D in influence (in Ireland too); gold torcs, from Ireland to Britain and N. France. At end of phase, Continental swords in SE (? colony on Thames estuary).

(c) Middle Bronze 3: c.1000–900/850

All existing cultures continue with only internal changes (III). Bronze: in Insular cultures, Third C industries: rapiers still, spearheads still looped (? some already lunate or plain leaf, riveted); bifid B razors adopted; question of tools, knives, sickles; and of shields. Gold torcs still, plain bracelets, solid earrings. In British Lowland and South-west, the E industry: palstaves becoming 'transitional', razors developed, socketed sickles invented; knives, tools, spearheads presumed, but evidence suffers from rarity of hoards. The swords in SE were locally developed, and thence arose those of L.B.1.

4. THE LATE BRONZE AGE

(a) Late Bronze 1: 900/850–750/700

In Ireland, there was presumably still late 'food-vessel' and urn pottery, and also plain ware descended from Late Neolithic. In Britain, urns of the Middle Bronze Age sorts seldom survived: decline of the 'Deverel-Rimbury' and virtual end of the Insular culture. Bronze: now alloyed with lead; cast in clay moulds; in Lowland Britain founders' hoards. Everywhere the First F industries: late palstaves, more socketed axes, sickles, tools, knives, spearheads, lunate (and barbed?), 'protected' or late

basal-looped (as Nettleham) or of plain leaf type, tubular spear-butts, swords, with sharp shoulders, long chapes, rings, horse-gear; hoards often either mainly of axes (Stuntney) or of weapons (Wilburton, Blackmoor, Guilsfield). Reflexion of continental 'Urnfield' culture without its pottery or urnfields: rare cremations, plain coarse pots. The new Isleham 'workshop' hoard (with such a pot) marks transition to next phase.

(b) Late Bronze 2: 750/700-650/600

Sheet bronze vessels and their techniques were introduced: Atlantic cauldrons (type A and then B; prototypes Mediterranean); 'Urnfield' (Kurd) buckets, whence Irish-British buckets; these made by the second F industries (below). In Ireland, contact with Scandinavia: Irish bronze sunflower pins and trumpets, concentric ornament on gold sheet (discs) as well as repoussé (gorgets). But also gold hollow earrings (imitated in France), and 'Covesea' gold bracelets, adopted through continental influence. In British Northern province, their recipients included new settlers in north-east Scotland, with own plain coarse pottery etc. (Covesea); the Western shows influence variously Irish, Lowland, Northern or Pennine-Eastern. Bronze in the Second F industries was abundant; late palstaves, socketed axes regionally standardized (e.g. Irish, 'Yorkshire'), swords with less prominent shoulders (Irish Dowris, British Ewart), spearheads mostly plain. Hoards in the North and Ireland, (when not 'workshop' as Duddingston or Dowris) are 'personal', with more weapons in Scotland than Ireland; most founders' hoards are Lowland, often with tools in great variety, and at times with buckets or cauldrons or their parts, cart-parts or horse-gear (e.g. 'phaleras'). Lowland socketed axes might in South-east already now be 'wing-ornamented' (imitating median-winged Continental type); further to these, however, a restricted SE district has end-winged axes, and other continental types, including tanged sickles, and carp's tongue swords (W. Mediterranean-Atlantic-Somme), whereby a G industry may be recognised (otherwise identical with most of Lowland Second F, with rare novelties, as socketed swords). This is explained by new SE settlers, from before 700, with pottery including shouldered and other Continental forms (ex 'Urnfield'). Meanwhile in S. Wales the F socketed axe production had reverted to stone moulds. This and much other F metal production might last from Late Bronze 2 to 3 unaltered; where this is known or expected, the name to use is simply 'Late F'.

(b) Late Bronze 3: 650/600-550/500 or later

The Late F industries in this phase made few innovations ('Third F': e.g. B2 cauldrons, or socketed axes of Llyn Fawr type). It is mainly distinguished by the intrusion of groups of Continental Hallstatt people, using bronze yet knowing and sometimes already working iron. Their 'Hallstatt I' bronze swords, winged chapes and single-bladed razors (more rarely swan-neck pin or conical phalera) are found sparsely in Lowland Britain, the swords (and chapes) also rarely near the more northerly east coast (one inhumation at Ebberston N.R. Yorks.), whence their flangeless hilt-form influenced some Late F swords in the north and Ireland. Iron copies of bronze forms (socketed axe, spearhead, sickle) occur sparsely likewise, and in the Llyn Fawr find in S. Wales with Late (or 'Third') F native bronzes and a local-made iron Hallstatt sword. In Ireland, another iron and more Hallstatt I bronze swords point to similar invasion. The Irish Iron Age I so introduced was equipped still largely in bronze, and shown no further or Late Hallstatt settlement. In Britain, however, the Hallstatt I intruders opened the way for a hundred years or more of Late Hallstatt colonisation, from the south and east and probably west coasts, which created in the 6th and 5th centuries the First A cultures of the British Iron Age.

Appendix:
Hawkes's unpublished *Rejoinder* in reply to Hodson's critique of his *ABC of the British Iron Age*

Reproduced from typescript deposited in Box 76 of C F C Hawkes Papers, Special Collection, Bodleian Library, Oxford.

THE BRITISH IRON AGE – A REJOINDER

In Antiquity for June[1] Dr. F.R.Hodson had words to say about my lately-suggested British Iron Age system[2]; I thank the Editor for asking me to reply.

Dr. Hodson finds it 'algebraical'. I have forgotten my algebra, but expect he means somehow clumsy. Honestly, I prefer it to my original one of 1930. He thinks that was bad enough – the Daniel and Wheeler references (his footnotes 2–3) should be looked up here – but this one, 'if anything', still worse. To name cultural entities by letters, as they both do – A, B, C – is 'most unusual'. But all the great systematists, Reincke and the rest, have used letters if not numbers – and precisely for cultural entities (Hallstatt A, La Tène B, etc.), apprehended from standard combinations of material types. And I have followed Childe in using numbers for the Periods through which the cultures run, and trying to fix their duration in absolute time. So I am puzzled to know how this can seem 'quite contrary to accepted practice'; but I see that he wants the cultures named from type-sites, as of course is often done where possible, and relatively dated. My Periods, 1-2-3, he discusses (footnote 5) as an 'unnecessary complication'. By cutting these out of my system, he may make it seem easier to assail. Too easy, really; shouldn't he dismiss no part of it, but demolish all? To my mind, the Periods are a great convenience; and the more so, the more absolutely-dated. Instead of 'some time between the middle 4th and middle 2nd centuries B.C.', I want to say just 'Period 2'. And I think grown men are right to like short speech.

Admittedly, Dr. Hodson has the further objection that my dates are mostly wrong. If he would say how wrong, I could perhaps improve them. But we must not forget that he wants no periods at all. He would use the cultural entities as time-entities too, in a relative chronology; that is, measure them with a ruler of their own elastic. I have been supposing, with so much C14 now in the air, that prehistorians liked and wanted absolute dates. And while I know these are difficult to make quite sure of, I do like and want them for my Periods – not to complicate matters, but to simplify. He is quite right to call them most often termini post quos: so do I. Archaeological dates very often are!

Dr. Hodson also mistrusts my Provinces and Regions. But these are areas of physical geography, bounded by well-known scarp-lines, marsh or heath or forest tracts. Cultural frontiers, of course, did not all 'remain fixed' throughout the Iron Age; but where they moved, they had to move across this chessboard. Sometimes, by the end, Region units got partitioned, e.g. the Oxford region (my 6) between Catuvellauni and Dobrunni, each with their version of C cultures: in the later phases anyhow, frontiers must be seen in terms of power. Yet whether seen in those or in the simpler terms of compactness among primary settlements ('men of the wolds', or 'men of the Trent'), they do naturally tend to rest on mayor physical divides – and often just on my Provinces or Region borders. Locally, they will of course be vague in places; who minds that? 'Concordant distributions of type-fossils' are surely much harder to draw a line round everywhere. As for the affinity of the early south-east with the Eastern Province, I may even know more of it than Dr. Hodson: it extends to Yorkshire. But my purpose in all this is simply to insist on our duty to look through our distribution-maps, back to the bone and flesh of the land the people lived in. And this talk of 'a barrier to progressive interpretation' shows I am insisting none to soon.

1. pp. 138-40
2. Antiquity, 1959 (September), 170 ff.

Lastly, those type-sites. Our Neolithic, which he bids me compare, has some cultures named that way, others not. Our Bronze Age has scarcely any. Why? Because so few sites qualify as type-sites. What then of the Iron Age? For a start, he suggests West Harling – 'early' and 'with good associations'. Yet, the finds were hardly anything than pottery! I date it, he says, too early. But in my system, to date it later, I only need to slide it down a bit. In his, however dated, it must stand as a type-site of pottery only; and that is not enough. Type-sites require good other things as well. Also, they ought to stay inside the phases they are supposed to typify. But bigger sites than West Harling may be important just because they run through several. As type-sites, then, their names must sprout appendages, letters or numbers again! And how choose these? Maiden Castle I–V are earthwork phases, valid only at that site; Maiden Castle A–B–C, as cultures, give no improvement on my system; so where were we? Yet there is worse. Dr. Hodson wants type-sites in 'ever-expanding-series'. How often can he be sure of getting them – real type-sites, with more than pottery – without big digs? Big digs today mean State money, and therefore 'threatened' sites. How many such sites, when Iron Age at all, can be fresh Maiden Castles? Has he a hope?

When I first suggested the A–B–C culture-names, thirty years ago, I did quite think they would pass into higher and better things, presently, in the heavenward steam of archaeology from the earth. We are alive in that dawn no longer. However young now, we shall never see a very heavenly system! Yet we do need one somehow redesigned. Dr. Hodson's design may seem to trail clouds of glory. But it will take another thirty years, at least, to get beyond the drawing-board – if indeed he can fend off the shades of the prison-house so long. I, while my light of common day lasts, still aim at finding more modest new blisses sooner, building my ABC of blocks. They make a hard game, of obstinate questionings. Dr. Hodson has called it naughty. But before he tries throwing my blocks right on the fire, I advise him to think twice.

CHRISTOPHER HAWKES

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Dating the entrance graves and cists of the Isles of Scilly

Katharine Sawyer

This paper considers the dating of the megalithic burial chambers and cists of the Isles of Scilly. It examines attempts to develop a chronology for the sites based on an analysis of the funerary urns found in them and considers the issues relating to this. It then outlines the results of recent Accelerator Mass Spectrometry (AMS) radiocarbon dating of cremated human remains from two sites in Scilly and compares these with radiocarbon dates from other related sites in the islands. Finally it reviews a selection of radiocarbon dates from similar small, stone-built burial chambers in Cornwall and south-west Scotland.

Introduction

The Isles of Scilly form a tiny archipelago comprising more than 200 islands and rocks and lying some 45km west-south-west of Land's End, Cornwall; the islands form the most south-westerly part of the British Isles. Their location is shown in Figure 1 and their layout in Figure 2. The total landmass of the islands is now about 15 sq km but, over the past 10,000 years, sea levels have risen more than 30m, inundating large areas of low-lying ground and dividing what was once a single main landmass of more than 90 sq km into the present-day cluster of islands.[1] The islands were separated from the Cornish mainland, by rising sea-levels, about 11,500 BP.[2] In the second millennium BC the landmass of Scilly was about twice its present size, the sea-level rise over the past 4,000 years being approximately 5m.

The islands have a wealth of prehistoric and later sites which attracted the attention of antiquarians in the eighteenth and nineteenth centuries. In the first half of the twentieth century research was carried out there by a number of leading figures. For example, in the first issue of *Antiquity*, the first paper, by O G S Crawford,[3] concerned the submerged prehistoric field boundaries in Scilly. The next few decades saw relatively little archaeological work there, but the number of projects has increased in recent years.

Comment should be made about the names used to describe the archipelago under consideration. Although, in the past, 'Scilly Isles', 'Scilly Islands' or 'the Scillies' were used as the normal descriptors, the present-day inhabitants prefer that their home is called the 'Isles of Scilly' or just 'Scilly'; these terms will therefore be used in this paper. Equally, several systems of naming or numbering the sites have been developed.[4] The most complete one is that used in the Cornwall and Scilly Historic Environment Record (HER), and the site names from the HER will therefore be followed.

The following sections consider the megalithic burial chambers and cists found in the archipelago specifically with regard to their dating, critically examining previous attempts to develop a chronology for the sites based on an analysis of the funerary urns found in them and outlining the results of recent AMS radiocarbon dating of cremated human remains from two sites in Scilly. These new dates are then compared with radiocarbon dates from other related sites in the islands and with a selection of radiocarbon dates from similar small, stone-built burial chambers in Cornwall and south-west Scotland. Analogies have also been drawn between Scillonian chambered cairns and sites in south-east Ireland,[5] Brittany[6] and the Channel Islands.[7] These considerations are outside the scope of this paper but are addressed elsewhere.[8]

Entrance graves and cists

Entrance graves

Of the prehistoric remains in Scilly, one of the most striking groups is the megalithic burial chambers, generally known as entrance graves. These have small, rectangular chambers, between 2m and 7m in length, 1.3m and 2m in width and 0.3m and 1.5m in height, enclosed in small, round mounds, now ranging from 6m to 22.9m in diameter and between 0.3m and 2.5m high.

The largest stones in these structures are the capstones and the distal endstone of the chamber. The chamber walls may be formed of orthostats or of coursed (and occasionally mortared) smaller stones, with some sites showing a combination of the two. The chambers are often coffin-shaped, with their greatest width being at the centre; some have one straight side wall and one convex side wall to achieve this effect. A typical example, Innisidgen Carn A on St Mary's, is shown in Figure 3 and the plan of the site is at Figure 4.[9]

The entrance graves are usually found in groups of two or three and sometimes in larger clusters. The burial rite is generally cremation; multiple burials in urns have been found at some undisturbed sites. Other finds from the entrance graves include bronze objects, bone points, glass and faience beads, flint tools and a pumice pendant.

[1] Charman *et al* 2016

[2] Pérez Fernández 2013, ii

[3] Crawford 1927, 5–14

[4] eg Hencken 1932; Daniel 1950

[5] Powell 1941; Ó Nualláin and Walsh 1986

[6] eg Hencken 1932, 28; O'Neil 1948–49, 139, 141, 159; Daniel 1960, 107

[7] Ashbee 1982, 3

[8] Aspects of these sites, including typological comparisons, are discussed in Sawyer 2015

[9] Ashbee 1974, fig 10

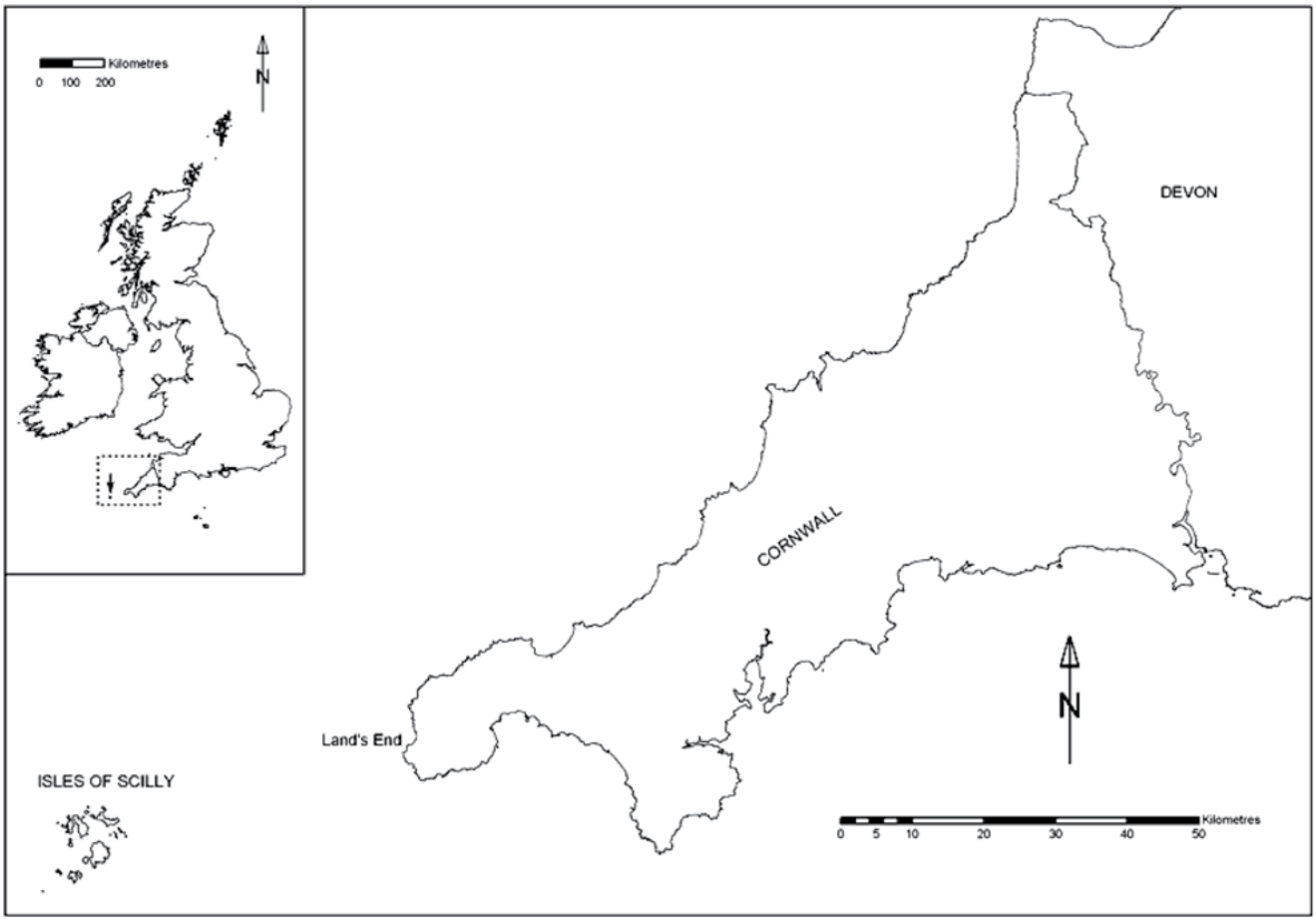


Fig 1 Location map of the Isles of Scilly (after Charman *et al* 2016, fig 1)

Cists

Several types of cist grave, of various dates, also occur in the islands and two will be considered in this paper. Firstly, there are many small, slab-built structures, sometimes covered by a mound as large as those enclosing an entrance grave. These contain a single cremation burial, usually in an urn. Secondly, there are 'megalithic' cists which are similar in size to the smaller entrance graves but have a closed chamber. Both types of cist are often found in proximity to the entrance graves. North Hill H, a fine example of a slab-built cist, is shown in Figure 5.

Density and distribution of sites

The entrance graves occur in unusually large numbers in the islands. Densities of megalithic burial chambers of 0.04 sites per sq km in Arran, 0.27 per sq km in Rousay, 0.47 per sq km in the Channel Islands (with 8.0 per sq km in Herm) and 5.4 per sq km in Scilly have been calculated,[10] suggesting that, across the archipelago, the density of megalithic burial chambers is greater in Scilly than anywhere else in the British Isles. Indeed, Daniel commented that:

> The Isles of Scilly are, of course, a great exception to our generalizations about the paucity and low density of burial chambers in England and Wales. These islands, with an area of between 4000 and 4500 acres (i.e. between 6 and 7 square miles) [15.5 to 18 sq km] have at the present day no less than fifty chamber tombs – between a fifth and a quarter of all the chamber tombs in southern Britain. Yet Scilly is, in point of size, no more than one eight-thousandth part of England and Wales.[11]

Figure 6 shows the distribution of the entrance graves, cists and indeterminate sites in Scilly. Indeterminate sites are burial chambers which are either an entrance grave or cist but where, because of vegetation cover or damage, it is not possible confidently to identify the structure as to type. The areas within the present Chart Datum and 5m submarine contours equate closely to the extent of dry land in the late third and early second millennia BC. At least ninety entrance graves and sixty cists have now been identified. They are typically found on hill-tops or on the upper part of hill-slopes, but two cists have been located in what is now the inter-tidal zone and three others are at an altitude of less than 5m above sea level.

[10] Perry and Davidson 1987; Scarre 2011a; 2011b

[11] Daniel 1950, 29



Fig 2 Map of the Isles of Scilly, showing the main islands (based on 1964 OS map)

Dating the sites from pottery

Pottery, mainly biconical urns, many with impressed or incised decoration, has been found at more than thirty sites, both entrance graves and cists. In most cases only small sherds have survived, but there are complete vessels from the entrance graves of Obadiah's Barrow, Gugh and Knackyboy Cairn, St Martin's. However, the dating of the sites from these ceramics has been complicated by two factors.

Firstly, Scillonian pottery is different in form, fabric and decoration from both mainland and Continental wares. O'Neil said that at Knackyboy Cairn he found 'upwards of four hundredweight [200 kg] of pottery. Yet it is not possible to date it by analogy, because there seem to be no close parallels for the pottery either in the British Isles or elsewhere.'[12] Two of the urns from Knackyboy Cairn, numbers VI and XIII, are illustrated in Figure 7. Urn VI is biconical in shape with impressed decoration and was found on the floor of the chamber, apparently as part of the first phase of deposition, whereas Urn XIII, which is a plain bucket-shaped vessel, is in a stratigraphically later position in the chamber. These two vessels demonstrate some of the changes in vessel shape and decoration which took place during the period of use of Knackyboy Cairn.

[12] O'Neil 1948–49, 96



Fig 3 Innisidgen Carn A entrance grave, St Mary's (author's photograph)



Fig 5 North Hill H cist, Samson (author's photograph)

In Cornwall the typical contemporary wares are Food Vessels, Collared Urns and Trevisker Ware, many vessels being made of gabbroic fabric from the Lizard peninsula. The fabric of the Scillonian pottery is granitic, with no gabbroic ware occurring until the Late Bronze Age. Only one entrance grave site, Porth Hellick Down A, St Mary's, has yielded sherds of probable Trevisker Ware; otherwise all the pottery appears to be of local origin.[13]

The second complicating factor is the suggestion by several authors, starting with Hencken in the 1930s, that two sherds of Neolithic pottery (both now missing) have been found in entrance graves in Scilly. The first is one discovered by Bonsor during his 1900 excavation of Bant's Carn, St Mary's, a site referred to by him as 'Hallangy Tomb'. Hencken states this is 'part of a bowl evidently with a round base like the usual neolithic pottery of Britain'.[14] His illustration of this sherd is shown in Figure 8, where it appears to be the example in the centre of the upper row.

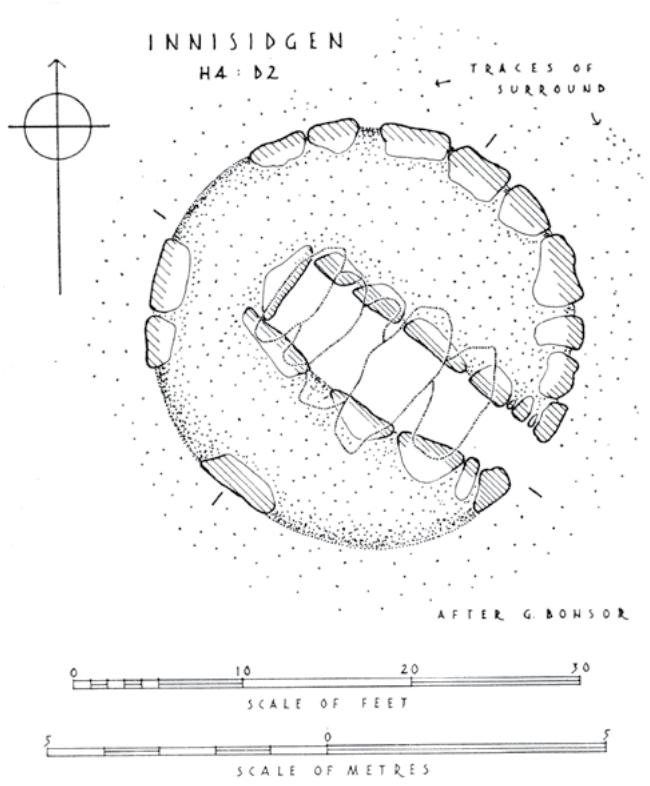


Fig 4 Plan of Innisidgen Carn A entrance grave, St Mary's (after Ashbee 1974, fig 10)

However, examination of Bonsor's hand-written notebook about his work in Scilly in 1899 and 1900[15] revealed a drawing of the sherd from which Hencken's image appears to be taken. The drawing is shown in Figure 9, from which it will be noted that it is captioned 'Hallangy Porth'. This is a settlement eroding from the cliff-face, some 250m north of Bant's Carn, which Bonsor also investigated and from which artefacts from the Neolithic, Bronze Age and Iron Age have been recovered. It appears, therefore, that the sherd illustrated by Hencken is not from the Bant's Carn entrance grave but from a neighbouring site. Bonsor's notes also say that all the urns from Bant's Carn had flat bases.[16]

The second sherd cited as being Neolithic in date was found by Hencken himself at the entrance grave of North Hill E, Samson, which he excavated in 1930. Here he found a large number of sherds, some of which formed part of the side of a vessel, which he described as being 'of the bulging or shouldered kind common in the Scillonian tombs'. However, he also said that it had a 'ledge handle' similar to those found on Abingdon Ware.[17] The sherd in question appears to have a small unperforated lug but, given that this feature occurs frequently on Scillonian urns, there is no reason to believe that there is any connection with Abingdon Ware. It can be concluded, therefore, that there is no reliable evidence for Neolithic pottery at any Scillonian entrance grave or cist.

[13] H Quinnell pers comm
[14] Hencken 1932, 24
[15] Bonsor 1899–1900
[16] *ibid*, 151
[17] Hencken 1933, 27

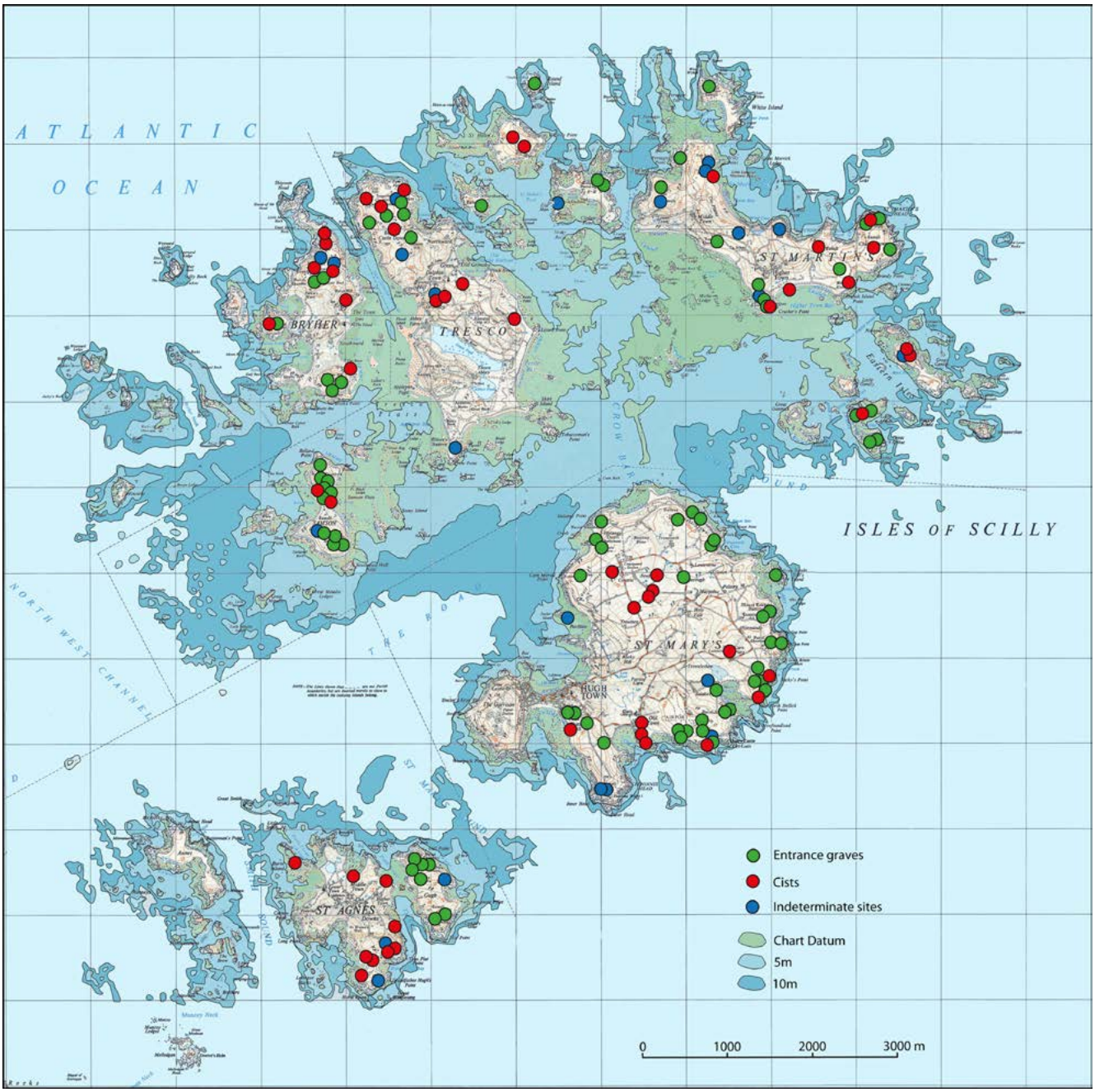


Fig 6 Map of the Isles of Scilly showing Chart Datum (dark green), 5m (dark blue) and 10m (pale blue) marine contours and locations of sites (based on 1964 OS map; marine contours and Chart Datum line after 2011 Admirality chart)

Knackyboy Cairn

Knackyboy Cairn on St Martin's is the most recently excavated entrance grave in Scilly. It was examined by Bryan O'Neil, then the Chief Inspector of Ancient Monuments, during his holiday in the islands in 1948. O'Neil found about 100 urns in the chamber, which had already been disturbed, and others associated with satellite burials in the cairn. Due to O'Neil's sudden and untimely death in 1954, only a preliminary report on the site was ever published.[18] O'Neil's plan of the site was re-drawn by Ashbee and is shown in Figure 10.[19]

Robinson has drawn up a sequence of the construction and deposition at Knackyboy Cairn based primarily on the substantial pottery finds at the site.[20] He argues that the first burials in the chamber at Knackyboy Cairn, which were cremations in comb- and cord-impressed urns, such as Urn VI in Figure 7, took place before *c* 2200 BC. These were followed by burials associated with bronze objects, a star-shaped faience bead and several glass beads, which Robinson dates to *c* 2200 BC to 1600 BC. The final burials in the chamber are in plain bucket-shaped urns, such as Urn XIII in Figure 7, for which Robinson suggests a date of *c* 1600 BC to 1200 BC.

[18] O'Neil 1952

[19] Ashbee 1974, fig 18

[20] Robinson 2007, 54–57

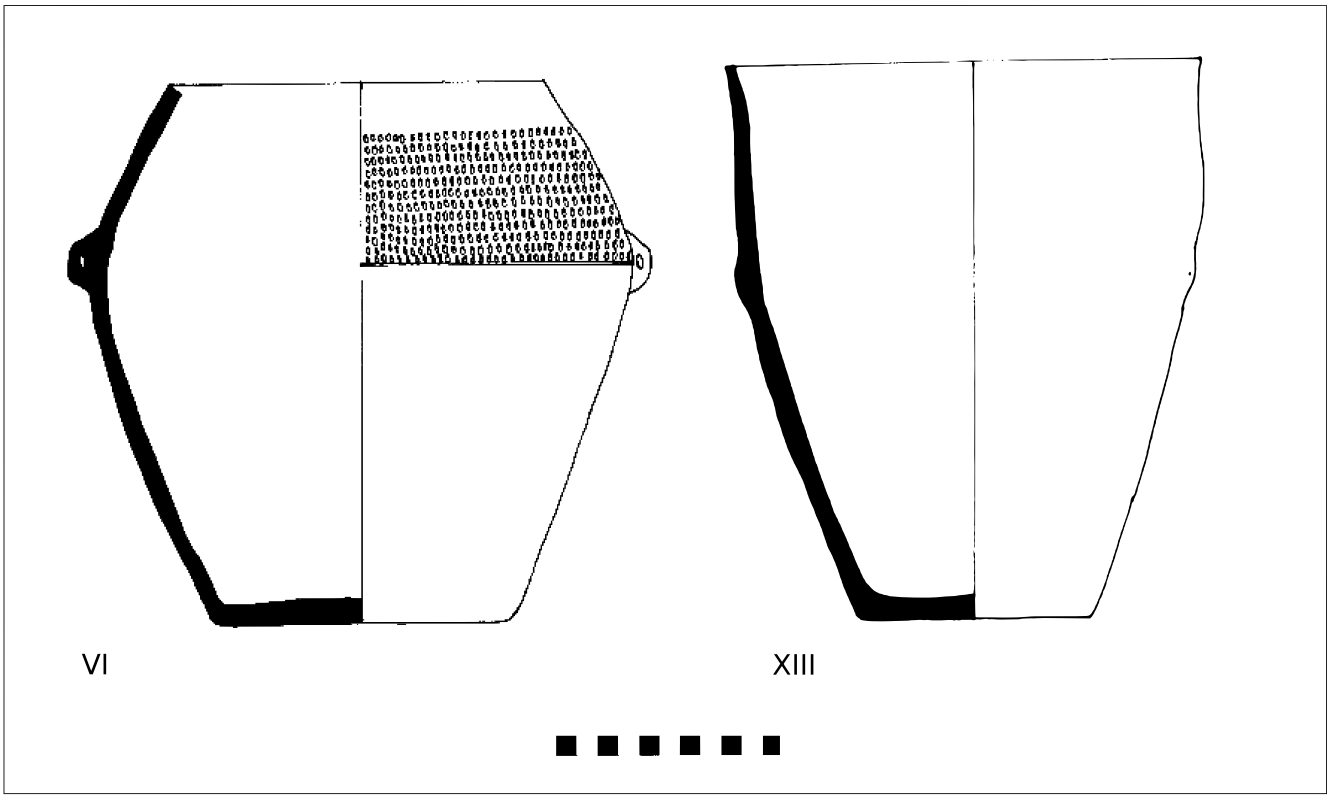


Fig 7 Urns VI and XIII from Knackyboy Cairn entrance grave, St Martin's

These dates are based on comparisons with pottery from settlement sites in Scilly, for which there are radiocarbon dates, and with mainland comparators including Deverel-Rimbury urns. There is uncertainty about some of the proposed dates because of the difficulty in making valid comparisons with pottery from elsewhere. From the Scillonian evidence Robinson has selected the earliest part of the range of a radiocarbon date from the settlement site of Little Bay, St Martin's to support his argument. Here there is a *terminus ante quem* date of 2125–1533 cal BC (HAR-4324: 3490±100 BP) for impressed ware, which Robinson uses to support his view that the impressed ware at Knackyboy Cairn can be dated to between 3000 BC and 2000 BC.[21]

There are also problems in establishing with certainty the stratigraphic sequence at Knackyboy Cairn itself. Robinson argues that the deposit of ashes, which contained the metal, faience and glass objects, was later than the primary urns. However, O'Neil suggested that these ashes 'looked like a secondary filling of material taken from old cremations and put in to level up the area'.[22] If this was the case, the ashes and the objects in them may be earlier than those found in the urns on the floor of the chamber. The sequence of pottery shapes and decoration which Robinson puts forward, from biconical urns with impressed decoration, to more globular vessels with incised patterning, to plain bucket-shaped urns, is supported by the known stratigraphy, although his suggestion that the satellite burials in the cairn form the final phase of use at Knackyboy Cairn cannot be demonstrated stratigraphically.

Although the bronze objects, the faience bead and several of the glass beads were found stratified and in close association with urn sherds and ashes, only a bronze handle and one glass bead were found inside an urn, both discovered lying on top of the cremated bones in Urn XVI.[23]

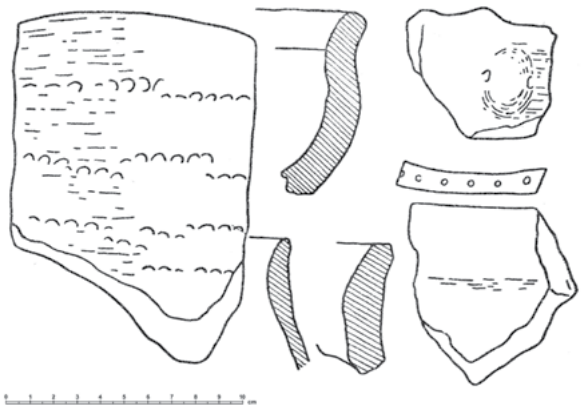


Fig 8 Pottery from Bant's Carn entrance grave, St Mary's (after Hencken 1932, fig 10B)

[21] Neal 1983; Robinson 2007, 55
[22] O'Neil 1948–49, 11
[23] *idem* 1952, 24

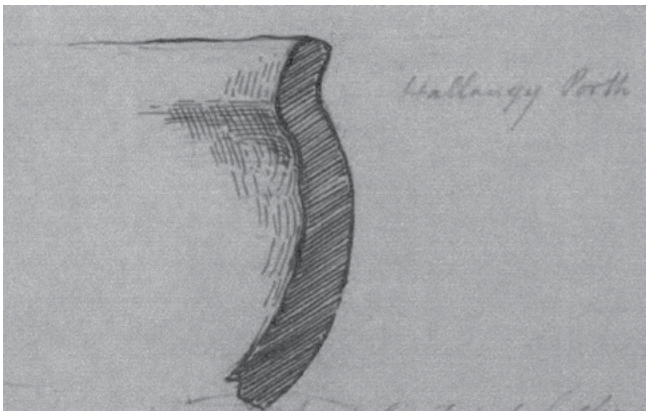


Fig 9 Pottery sherd from Halangy Porth settlement site, St Mary's (after Bonsor 1899–1900, 150)

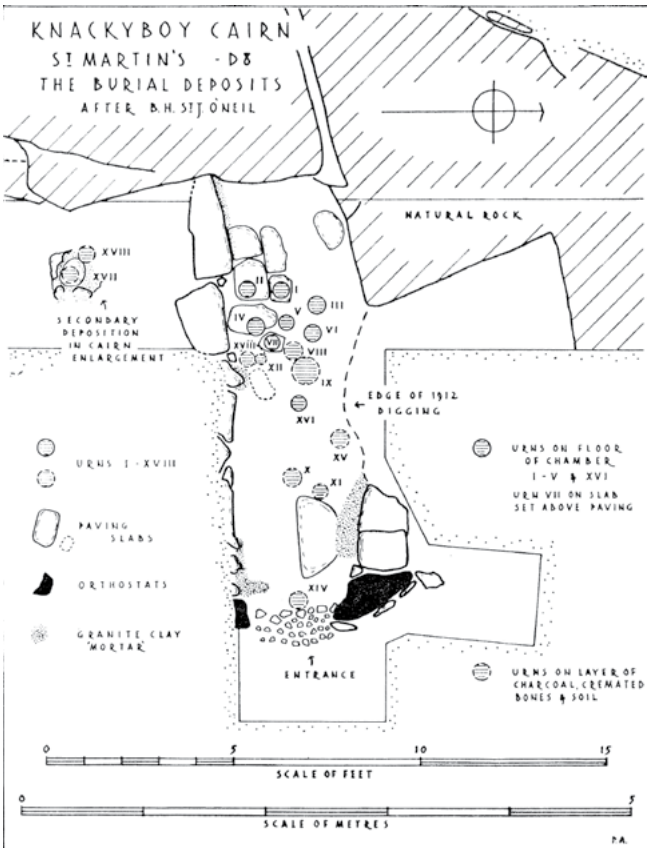


Fig 10 Plan of Knackyboy Cairn; note that the urn numbered XVIII inside the chamber should read XIII (after Ashbee 1974, fig 18)

Radiocarbon dating

Absolute dating offers a different, and potentially more reliable, method of determining the period of use of the Scillonian entrance graves and cists. In this respect, the survival of O'Neil's unpublished notebooks and draft full report of the Knackyboy Cairn excavation has enabled the original locations of surviving bone samples to be established, so that radiocarbon dating could be carried out. This process was greatly assisted by the detail shown in the published plans of the site.[24]

Funding was obtained from the Oxford Radiocarbon Accelerator Dating Service (ORADS) for the dating of a number of samples by AMS. Dates were sought from ten samples from Knackyboy Cairn: seven from the chamber (including cremated bone from urns III, VI, XIV, XV and XVI) and three from satellite burials in the cairn (including bone from urns XVII and XVIII). A sample of cremated bone from Obadiah's Barrow, Gugh (excavated by Bonsor in 1901) and another from a cist at Old Town, St Mary's, which was destroyed during building work in 1964,[25] were also submitted for dating.

Radiocarbon dates

Ten dates were obtained by ORADS from the samples from Knackyboy Cairn. The earliest of these was from Urn III, one of the primary (or earliest surviving) group of urns in the chamber. However, the sample, from which a calibrated date of 2459–2154 cal BC (OxA-26474: 3837±38 BP) was obtained, was identified by ORADS as being burnt rather than cremated bone.[26] Although the date is not as reliable as those from cremated bone, ORADS indicated that the CN of 8.2, suggesting some residual protein, and the quantity (42 per cent) of carbon in the treated sample were encouraging. The date has therefore been included in the table, but some doubt must remain as to its validity.

Eight dates were obtained from cremated bone samples from both the chamber and the cairn; when calibrated, these fall between the eighteenth and fourteenth centuries cal BC. The sample from Urn XIV, the last urn to be deposited in the chamber, which was found just inside the entrance, is calibrated to 1412–1260 cal BC (OxA-26369: 3066±28 BP). The relatively small number of dates and the uncertainty over the relationship between the primary urns and the material around them, outlined above, mean that satisfactory Bayesian modelling is not possible. With the exception of Urn XV, which stratigraphically is a secondary deposit but whose date overlaps with those associated with the primary use of the chamber, the range of dates from Knackyboy Cairn gives a coherent picture of the use of the site.

The cremated bone sample from Old Town cist provided a date of 1893–1702 cal BC (OxA-26373: 3492±28 BP) whilst it proved impossible to obtain a date from the sample from Obadiah's Barrow, where the bones are those of a newborn, probably premature, baby. Details of the dates from Knackyboy Cairn and Old Town cist are shown in Table 1.

Following work carried out by Cornwall Archaeological Unit in 1996, two radiocarbon dates were obtained from charcoal samples from a probable cist at Porth Killier, St Agnes. One of these is from the base of the infill of the cist and is calibrated to 2026–1665 cal BC (WK–5690: 3512±70

[24] *ibid*, pl XV; Ashbee 1974, fig 18

[25] Mackenzie 1965

[26] All radiocarbon dates presented in this paper have been calibrated using OxCal 4.2 and the IntCal13 calibration curve (Bronk Ramsey 2013; Reimer *et al* 2013) and are expressed at the 95.4% (2 sigma) confidence level

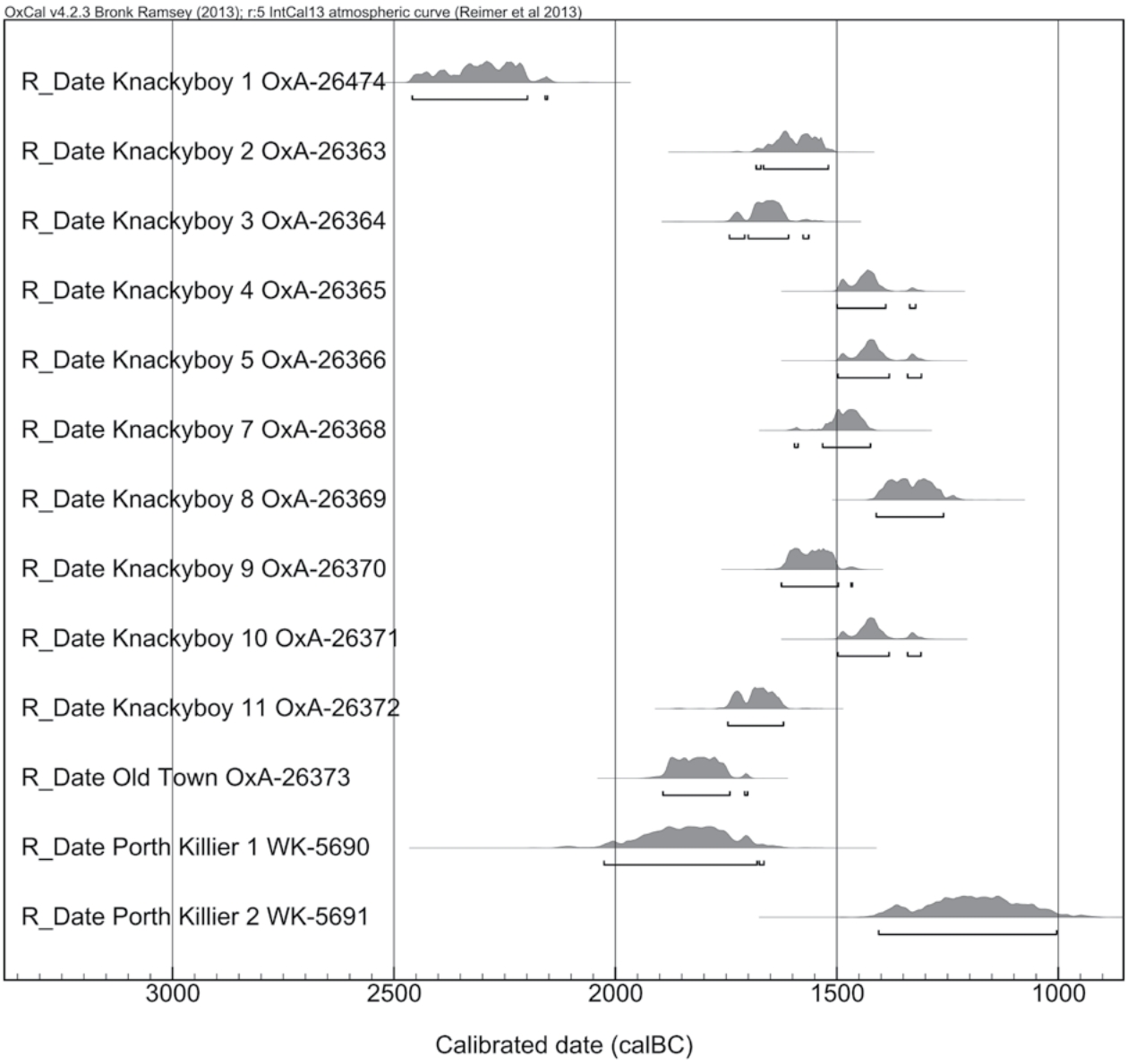


Fig 11 Radiocarbon dates from burial chambers in Scilly

BP), the other is from higher up in the infill and is calibrated to 1406–1004 cal BC (WK-5691: 2973±73 BP).[27] The Knackyboy Cairn, Old Town and Porth Killier dates are shown graphically in Figure 11.

The cremation burials at Knackyboy Cairn span a maximum period of 500 years from *c* 1750 to 1250 cal BC, with the possibility of an earlier, perhaps re-deposited, burial from the later third millennium cal BC. None of the dates, however, relates to the construction of the chamber or the cairn. The dates do demonstrate that the satellite burials in the cairn are contemporary with those in the chamber, rather than being later, as is often assumed.

Overall, but on the basis of very few dates from only three sites (two cists and one entrance grave), the earliest radiocarbon dates from cremated bone are those from the cists. This is contrary to the general view that cists are later in date than entrance graves,[28] although that interpretation is based on the assumption of a general move from communal to single burial at the end of the third millennium BC, a process which does not appear to be evidenced in Scilly.

Where entrance graves and cists occur in clusters together, for example on North Hill, Samson and Kittern Hill, Gugh, the cists are on the highest point of the hill. This may indicate that they were the burial places of those regarded as ancestors or of high status individuals. The cremated remains (now missing) found in the cist of North Hill H, Samson, when it was excavated in 1862, were interpreted at the time as those of a male aged about 50.[29] Such an individual may have been a member of either of those groups.

The interpretation of Bronze Age burial practices in Scilly is complicated by the discovery of burnt, rather than cremated bone at Knackyboy Cairn and by O'Neil's com-

[27] Ratcliffe *et al* forthcoming

[28] eg Robinson 2007, 67

[29] Smith 1863, 52

Ref No.	Sample No.	Location	Material	Activity	Associated artefacts	^{14}C Date (BP)	Calibrated date (cal BC)
Knackyboy Cairn							
OxA-26474	1	Urn III	Burnt bone	Primary use of chamber	Impressed ware	3837±38	2459–2154
OxA-26363	2	Centre of chamber near Urn VI	Cremated bone	Primary use of chamber	None	3319±29	1683–1520
OxA-26364	3	Urn VI	Cremated bone	Primary use of chamber	Impressed ware	3365±28	1743–1564
OxA-26365	4	Urn XVI	Cremated bone	Primary use of chamber	Impressed ware, glass bead	3157±29	1500–1323
OxA-26366	5	Layer of ash between Urns VI and VII	Cremated bone	Primary use of chamber	Bronze, faience and glass beads	3145±29	1498–1310
OxA-26368	7	Urn XV	Cremated bone	Secondary use of chamber	Incomplete urn	3215±28	1596–1425
OxA-26369	8	Urn XIV	Cremated bone	Final use of chamber	Undecorated ware	3066±28	1412–1260
OxA-26370	9	Under Urn XVII	Cremated bone	Satellite burial in mound, first phase	Incomplete urn	3276±29	1626–1466
OxA-26371	10	Under Urn XVIII	Cremated bone	Satellite burial in mound, second phase	None	3146±29	1498–1311
OxA-26372	11	Urn XVII	Cremated bone	Satellite burial in mound, first phase	Incomplete urn	3386±29	1747–1621
Old Town cist							
OxA-26373	13	Urn	Cremated bone	Single burial	Incomplete urn	3492±28	1893–1702

Table 1 Radiocarbon dates from Knackyboy Cairn entrance grave and Old Town cist

ment that 'a few pieces of unburnt human bone, including a piece of skull were found loose in the dark soil'[30] at that site. There are also records of inhumed bones at Bant's Carn, St Mary's[31] and Obadiah's Barrow, Gugh;[32] both these latter finds are, unfortunately, now missing. They may represent evidence of an earlier tradition of inhumation of which only a few traces remain due to the acidity of the soil. It is possible also that these are curated bones, perhaps brought from the mainland by the earliest permanent settlers in Scilly.

Radiocarbon dates from settlement sites

There are also radiocarbon dates from five settlement sites in Scilly, all of which have pottery similar to that from the entrance graves and cists. Some of these dates were obtained some time ago and have large margins of error, and some of them are based on combined charcoal samples. They therefore need to be treated with caution.

The most recently obtained dates are those from the settlements at Porth Killier, St Agnes and Dolphin Town, Tresco. At both these sites cists were uncovered which appear to pre-date the settlements themselves. The radiocarbon dates relating to these settlements are 1664–1304 cal BC (OxA-3647: 3220±70 BP) at Porth Killier[33] and 1416–1133 cal BC (WK-19092: 3045±42BP) at Dolphin Town.[34]

Radiocarbon dates from Cornwall and south-west Scotland

Radiocarbon dates have been obtained from small stone-built burial chambers of the second millennium BC elsewhere in the British Isles. Two areas where the chambers are similar in form to those in Scilly will be examined. The first of these is West Penwith, the most south-westerly part of Cornwall, where the site of Bosiliack was excavated by Thomas in 1984 and recently published by Jones and Thomas.[35] The site is illustrated in Figure 12.

Here two dates, probably from a single cremation burial, were obtained. These calibrate to *c* 1680 to 1500 cal BC (SUERC-15589: 3320±35 BP and SUERC-15590: 3305±35 BP). The only other radiocarbon date from a west Cornish entrance grave is that from Tregiffian. At this site there is a single date, from charcoal, of 1958–1660 cal BC (BM-935: 3489±59 BP).

[30] O'Neil 1948–49, 9
[31] Bonsor 1899–1900, 139
[32] *idem* 1901–02, 225
[33] Ratcliffe *et al* forthcoming
[34] Taylor and Johns 2009–10, 120
[35] Jones and Thomas 2010



Fig 12 Bosiliack entrance grave, Cornwall (author's photograph)



Fig 13 Bargrennan White Cairn, Dumfries and Galloway (author's photograph)

The second area to be considered is the Bargrennan group in Dumfries and Galloway, south-west Scotland. The type site, the White Cairn at Bargrennan, was excavated by Piggott and Powell in 1949. They suggested that it bore a 'surprising resemblance'[36] to sites in south-east Ireland, west Cornwall and the Isles of Scilly. It has subsequently been re-examined by Cummings and Fowler who also excavated another Bargrennan group site at Cairnderry.[37] The White Cairn is shown in Figure 13.

Nine radiocarbon dates were obtained from Cairnderry, all of them from cremated bone. The earliest, which is from Pit 4, is 1946–1701 cal BC (GrA-26514: 3515±40 BP), the latest, from the chamber, is 1427–1231 cal BC (GrA-26551: 3075±40 BP). There are eight radiocarbon dates from the Bargrennan White Cairn, of which four are from cremated bone. The earliest of these, from Pit 4, is 2137–1930 cal BC (GU-13905: 3650±35 BP) and the latest, from Pit 2, is 1890–1693 cal BC (GU-13906: 3475±35 BP). There is also a Neolithic date, from charcoal under the kerb, at the latter site.

Cummings and Fowler argue that all of the late third and second millennium BC dates represent the re-use of an earlier structure but, in his review of their report, Clarke has pointed out that all the significant finds are Bronze Age in date and that three of the Cairnderry dates come from cremated bone in a pit which is partially under the kerb of the cairn.[38] The range of dates from Bosiliack, Cairnderry, Bargrennan White Cairn and Knackyboy Cairn is shown graphically in Figure 14. The broad similarities in time frames in the three areas will be noted.

Conclusions

Much of the literature suggests that megalithic burial chambers are a purely Neolithic phenomenon,[39] so it is useful to recognize further examples of the construction or re-use of such structures in the Bronze Age. In Scilly this follows closely after the first permanent settlement,[40] but this is not the case in Cornwall or south-west Scotland, where Neolithic megalithic structures also occur. In Scilly in particular, more absolute dates are needed and, ideally, some which relate to the construction of the chambers or cairns.

The work reported here has established that the use of entrance graves and cists in Scilly is contemporary, with cists apparently starting earlier, and that entrance graves continued to be used until the thirteenth century BC. The work has also highlighted the value to be obtained from an examination of the manuscript notes of excavators, even when they are more than 100 years old, especially where sites are unpublished.

Acknowledgements

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[36] Piggott and Powell 1948–49, 152
[37] Cummings and Fowler 2007
[38] Clarke 2008
[39] eg Lynch 1997; Scarre 2007
[40] Robinson 2007, appendix M

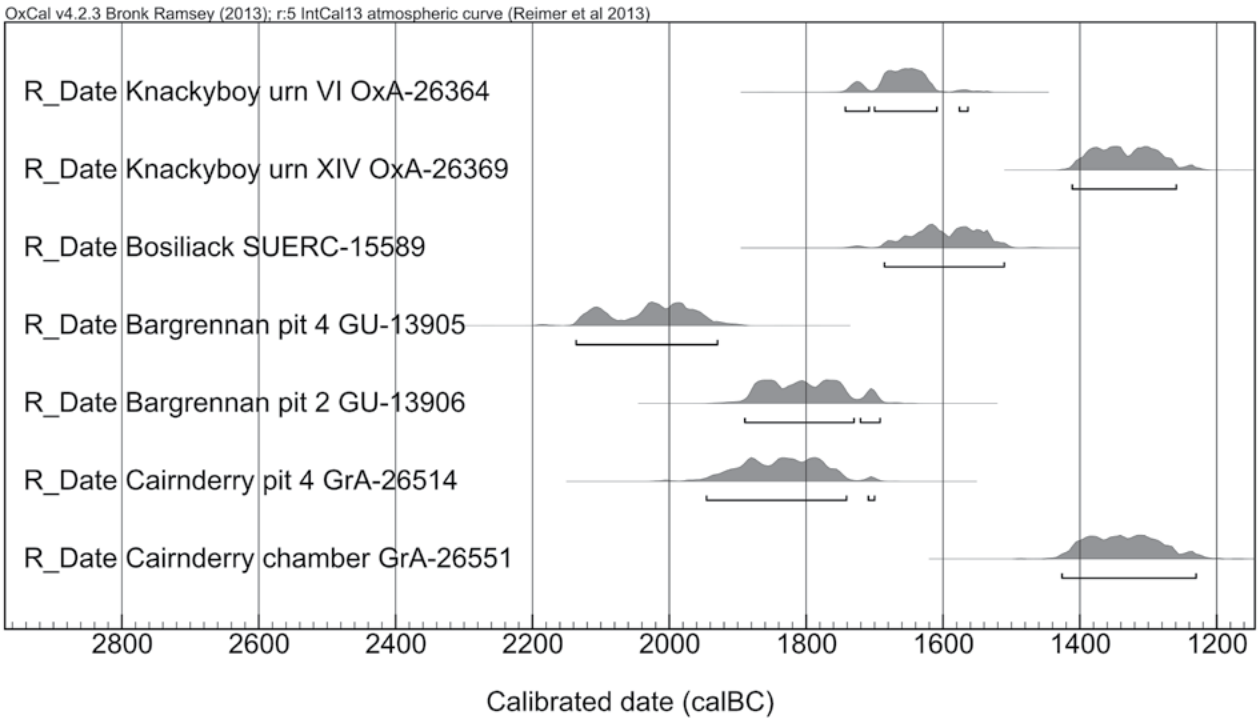


Fig 14 Radiocarbon dates from burial chambers in Scilly, Cornwall, and Dumfries and Galloway

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The emergence of a Bronze Age on the Isle of Man

Rachel J Crellin

A new narrative for the emergence of a Bronze Age on the Isle of Man is presented in this paper. The Ronaldsway Late Neolithic period on the Isle of Man is markedly different from other regional Late Neolithic cultures across the rest of Britain and Ireland. Furthermore, only a single Beaker burial has been excavated on the island. Existing narratives for the period often suggest an isolated Late Neolithic followed by a movement to re-join the mainstream of British practices in the Bronze Age. This paper presents new radiocarbon dates alongside characterization of burial evidence and material culture, to re-consider the emergence of the Early Bronze Age on the Isle of Man. It is argued that copper metallurgy was adopted swiftly, and burials accompanied by Food Vessel Bowls appear to have emerged on the Isle of Man almost synchronously with Ireland. On the basis of this evidence a new perspective is offered on this period: during the Late Neolithic the people of the Isle of Man adopted and adapted aspects of culture (including material culture and practices) from Britain and Ireland, rejected some aspects and also created their own unique practices. In place of a narrative of reconnection at the start of the Early Bronze Age an alternative account is offered, whereby the prehistoric inhabitants of the island continued to adopt and adapt practices from elsewhere, particularly Ireland.

Introduction

The Isle of Man, about thirty-seven miles long and eighteen miles wide, located in the middle of the Irish Sea, is a British Crown dependency. Despite its location, it often escapes coverage on distribution maps and in discussions of British archaeology more generally – something Davey describes as 'Missing Isle of Man Syndrome'.[1] This absence mostly relates to the incompatibility and inaccessibility of archaeological data from the Isle of Man. The island has its own National Heritage body – Manx National Heritage – with its own Historic Environment Record, only 200 sites of which are currently available digitally via ADS. In this paper I discuss the emergence of a Bronze Age on the Isle of Man, arguing that the notion of an isolated Late Neolithic cannot be sustained. There are two excellent existing catalogues and studies of the Manx Neolithic and Bronze Age pottery by Stephen Burrow[2] and Jennifer Woodcock[3] respectively, which form the foundation of any discussion of the periods. In this paper I present evidence to show that the central location of the Isle of Man in the Irish Sea exposed communities to various practices from across Britain and Ireland and contributed to the emergence of distinct practices.

Defining the Ronaldsway Late Neolithic

'*The culture appears to be a new one… In the absence of good parallels in Britain and Ireland one can only suggest that the pottery is the characteristic product of the Isle of Man during a period of isolation, an outstanding example of that insular development of which there have been traces at earlier stages of prehistory.*' Grahame Clark[4]

Piggott described the Manx Late Neolithic as showing a 'notable insular individuality'[5] and named it as one of his five secondary Neolithic cultures. Existing narratives suggest that until the Late Neolithic, the Isle of Man fitted within broader patterns of material culture, mortuary practice and social tradition evident across the rest of Britain and Ireland.[6] Whilst Piggott's other 'secondary Neolithic cultures' have since been questioned and dismantled,[7] the 'Ronaldsway culture' appears to have remained unchallenged. Around 2200 cal BC this 'unique' culture appears to have been abandoned and the island re-integrated into the wider patterns of material culture that defined the Early Bronze Age of Britain and Ireland.[8] This narrative, of difference and re-integration, continues to dominate discussions of the Late Neolithic and Early Bronze Age on the Isle of Man.[9]

The Ronaldsway 'culture' is defined by a mixture of absences and presences. The absence of known henges,[10] pit-circles or indeed any kind of monumental construction, the small amount of Grooved Ware and the single Beaker burial set the island apart from the rest of Britain and Ireland. Secondly, the distinctive types of material culture found on the island, such as Ronaldsway Earthfast Jar pottery, Roughened Truncated Butt axes (hereafter RTB axes) and hump-backed scrapers serve to highlight further differences from the rest of Britain and Ireland.

Ronaldsway Late Neolithic material culture

Two main kinds of pottery are found on the Isle of Man during the Ronaldsway Late Neolithic: Ronaldsway Earthfast Jar pottery and Grooved Ware.[11] The Ronaldsway Earthfast pottery comes in several forms, jars (Fig 1) (which vary in size from *c* 30cm to 1m tall) and the less common smaller

[1] Davey 2004, 130
[2] Burrow 1997a
[3] Woodcock 2008
[4] Clark 1935, 91
[5] Piggott 1954, 351
[6] See eg Burrow 1999, 32
[7] See Thomas 1996a
[8] Burrow 1999, 34
[9] See Burrow 1997a; 1997b; 1999; Darvill 2000a; 2004; Frieman 2008; Woodcock 2004
[10] Although this is disputed by Darvill who identifies a feature at Billown as a mini-henge; see eg Darvill 1997; 1998; 1999; 2000a
[11] See Burrow 1997a; 1997b for detailed accounts of the pottery and an exhaustive catalogue



Fig 1 Cronk Mooar Jar from Colby, approx height 1m (© Manx National Heritage)

bowls[12] and miniature vessels. All vessels are made of a very coarse fabric with large inclusions. Burrow describes them as showing 'little of the finesse'[13] obvious in the Middle Neolithic ceramic assemblage. However, he also notes that the larger vessel size may relate to the coarseness of the ceramics. The vessels have been discovered in two main forms: either as sherds at settlement sites, burial sites and in pits, or as complete vessels, buried within a pit in the ground with only the rim of the vessel showing at the surface. Many of these buried vessels appear to have been covered by removable slate lids. Incised decoration is only evident on the rims, which are the sole parts of the vessels that would have been obvious when they were buried.[14] Whilst some authors[15] have sought comparisons for the Ronaldsway Earthfast pottery, Burrow[16] argues that there are no antecedents of the pottery in the Middle Neolithic period on the island and little evidence that these vessels were strongly influenced by Late Neolithic ceramic styles from elsewhere in Britain and Ireland.

Grooved Ware has been found at three sites on the island: Glencrutchery, Ballacottier and the Ronaldsway 'house'.[17] Grooved Ware never occurs alone in assemblages, but is instead always found alongside Ronaldsway Earthfast pottery. The two types of vessels have notably different appearances – the flat bases of Grooved Ware vessels, absence of overhanging rims, angled sides and the decoration on the body all contrast with the Earthfast pottery. They are also employed differently; there are no known examples of Grooved Ware vessels buried in the earth in the same style as Ronaldsway Earthfast Jars. Burrow argues, however, that the same potters could have made both kinds of vessel and that the 'recipes' for both kinds of vessel and the grit types and sizes are the same.[18] He also notes that when one looks at plain body sherds from Late Neolithic contexts, it can be hard to distinguish whether the vessel is an example of Grooved Ware or Earthfast pottery.[19] The assemblages that Grooved Ware has been found in are notably larger and more diverse than those found at other settlement sites.

The lithic assemblage associated with the Ronaldsway Late Neolithic includes the 'hump-backed scraper', which is considered diagnostic for Ronaldsway Late Neolithic sites, as well as lozenge and leaf-shaped arrowheads, serrated saws, disc cores and hollow scrapers.[20] Hump-backed scrapers are unknown elsewhere in Britain and Ireland, and thought to be associated with only the Late Neolithic period on the Isle of Man, whereas the other lithics are all found in Early and Middle Neolithic assemblages from Britain and Ireland.[21] The only source of flint on the island is beach pebble flint: Moffatt has highlighted the generally smaller size and peculiar shape of the flintwork from the Isle of Man and argued that this relates to a lack of available raw materials.[22]

Stone axes from the Ronaldsway Late Neolithic are primarily identified in two forms: RTB axes and 'normal' polished stone axes. RTB axes (Fig 2) are essentially polished stone axes but with a butt end that shows deliberate pecking, grinding and roughening,[23] meaning that they lack the purity of form, symmetry and shape associated with polished stone axes. Both RTB and non-RTB axes have been found together at the Ronaldsway 'house' site.[24] There is an issue of chronological resolution with these stone axes; polished stone axes could date to any part of the Neolithic period on the Isle of Man, and whilst there are clear associations between RTB axes and Earthfast Jars at sites such as the Ronaldsway 'house', it is possible that RTB axes may have also been in use before the start of the Ronaldsway Late Neo-

[12] See eg B'co12, B'va8 and Gui1 in Burrow 1997a

[13] Burrow 1997a, 24

[14] Darvill and Andrews' 2014 analysis of one vessel from Billown has identified polychrome decoration on the surface; however, this is the only vessel currently to have been analysed, and the authors suggest that cleaning methods used on other jars may have destroyed further evidence of decoration

[15] Bruce *et al* 1947; Megaw and Simpson 1984; Piggott 1954

[16] Burrow 1997a, 26

[17] *ibid*, 24

[18] *ibid*

[19] *ibid*

[20] Burrow 1997a, 21; Megaw 1947; Moffatt 1978

[21] Moffatt 1978, 201

[22] *ibid*, 189

[23] Barrs 2010; Bruce *et al* 1947; Moffat 1978

[24] Bruce *et al* 1947



Fig 2 Roughened Truncated Butt axe from the Ronaldsway 'house' (© Manx National Heritage)

lithic period. This is an issue compounded by the fact that both types of axes are most commonly recovered as chance finds across the island.

Thin-section analysis of RTB axes resulted in the identification of the rock Group XXV. Coope and Garrad[25] went on to tentatively suggest that this was a Manx rock source from either Ballapaddag or Oatland, where basic igneous rocks of this sort outcrop on the island.[26] Forty-three percent of the known RTB axes are believed to be from Group XXV. This means fifty-seven percent of the RTB axes have a probable geological origin outside the Isle of Man. Axes have been identified from sources such as Langdale Group VI, Cornish Group I and Welsh Group VII.[27] This suggests that axes were being brought to the island from Britain. Barrs notes that the roughening of the axes often leaves small patches of polish exposed,[28] suggesting that, at least in some cases, axes were polished before roughening.[29] RTB axes have also been identified in Wigtownshire in Scotland (one case), Yorkshire (two cases), Whiston in Lancashire (one case), Co Limerick and Co Galway in Ireland (one case in each county), and Winchester in Hampshire (one case),[30] and on-going research is identifying further examples of RTB axes from elsewhere in Britain and Ireland.[31]

Ronaldsway Late Neolithic burial evidence

The dominant feature of Ronaldsway Late Neolithic burial practices is the use of cremation.[32] Given that the Ronaldsway Late Neolithic spans much of the third millennium BC, the number of known cremation deposits is low. This is because both identifying and quantifying the burials is difficult. Identifying burial sites is not necessarily as easy in this period as in the Early Bronze Age, as the sites have no upstanding stone or earthen architecture. The majority of sites have been discovered as a result of ploughing, farming, quarrying and construction work,[33] and it is hard to estimate how many sites may have been accidentally destroyed or never identified. Furthermore, in many cases only a few fragments of cremated bone have been recovered from sites. This may be a result of the acidic soils on the island causing poor preservation, cremated remains not being retained at the time of excavation, or because during the period not all of the cremated remains were ever placed in burial contexts that we have discovered. Furthermore, there have been no recent osteological examinations of the excavated cremated remains to determine whether the deposits are of single or multiple individuals (the exception is Ballaharra where communal cremation deposits have been identified).[34]

Cremations were either deposited within pits or scoops within the ground, as at Ballateare,[35] Killeaba[36] and Ballaharra[37] or, less commonly, some fragments of cremated remains have been found in association with buried Earthfast Jars, as at Round Ellan,[38] Scard,[39] Ballig[40] and Ballateare.[41] The dense nature of many of the deposits found within scoops and pits lead the excavators to suggest that the remains may have been held within organic bags.[42] Grave goods associated with the cremations are very rare. There is a cremation from inside a Ronaldsway Earthfast Jar associated with a miniature vessel, a calcined bone pin and polished flint knife from Ballateare,[43] and a cremation associated with a flint knife from Killeaba may also date to this period.[44]

There are some similarities between burial sites but also notable differences, especially in terms of 'architecture'. At Ballateare, Bersu[45] uncovered evidence of a series of postholes that appear to be indicative of some kind of screen.[46] The site of Killeaba[47] is located on a natural glacial mound that contains burials dating from the Middle Neolithic to the Early Bronze Age.[48] At West Kimmeragh, Garrad discovered cremated remains placed within a large cobbled surface.[49]

[25] Coope and Garrad 1988, 67–9

[26] But see Barrs 2010 for a critical review

[27] Barrs 2010, 36; but see Briggs 1976

[28] Barrs 2010, 34

[29] It would be interesting to known whether axes made of Group XXV rock also show polishing beneath their roughening. However, Barrs 2010 does not comment on this

[30] Barrs 2010, 41

[31] K Barrs pers comm

[32] Burrow 1997a, 20; Crellin 2014–15. The site of Knocksharry, where inhumations were found as well as evidence of cremation from the Ronaldsway Late Neolithic, has undergone some re-dating and the inhumations are now known to date to cal AD 1524–1632 (OxA-27057: 376±27 BP); see Crellin 2014. An un-burnt human femur was also found at the Ronaldsway 'house'; however, that deposit is rather exceptional and worthy of separate consideration

[33] For a more detailed discussion see Crellin 2014, 234

[34] D Higgins and P Davey pers comm

[35] Bersu 1947

[36] Crellin 2014–15; Cubbon 1978

[37] D Higgins and P Davey pers comm

[38] Burrow 1997a, 44

[39] Kermode 1902

[40] Burrow 1997a, 38

[41] Bersu 1947

[42] *ibid*, 167; Cubbon 1978, 80

[43] Bersu 1947, 165

[44] See Crellin 2014–15 for discussion on the dating of this burial

[45] Bersu 1947

[46] Fowler 1999, 149

[47] Cubbon 1978

[48] Crellin 2014–15

[49] Garrad 1987

There are no known megalithic constructions in this period. However, at Ballaharra Late Neolithic (and Early Bronze Age) burials were added to the tomb.[50] Whilst these different architectures divide the sites, it is common to find evidence of burning at Ronaldsway Late Neolithic burial sites.[51] The evidence varies from spreads and scatter of charcoal (as at Round Ellan[52] and Ballig[53]) to evidence of burnt soil found within the Earthfast Jars (as at Scard).[54] In some cases the burning evidence takes the form of probable pyre sites where pits and hollows containing layers of dark soil and burnt material have been found.

Ronaldsway Late Neolithic non-funerary evidence

The non-funerary evidence for the Ronaldsway late Neolithic can be characterized by the lack of substantial structures associated with the period and the dominance of sites with evidence of pits, scatters and hollows where broken pottery and lithics have been uncovered. The majority of sites were identified through fieldwalking and then later excavated,[55] and in the main these sites have a coastal distribution with a particular focus on the northern glacial plains of the island. The material uncovered at such sites may be interpreted as the debris of general life: broken pottery, flint knapping debris, abandoned tools and small traces of fires. The pottery assemblages from these sites are always made up of sherds, never the complete vessels, and the assemblages tend to be quite large; Burrow suggests a minimum number of vessels of thirty-two at Ballacottier, seventeen at Ballalheaney and twelve at Knockaloe Beg.[56]

Darvill has argued that the pits excavated at the site of Billown are not directly connected with occupation, nor are their contents deliberately placed deposits; rather he suggests that the act of digging a hole in the ground was important in and of itself in this period.[57] This interpretation is linked to the discovery of approximately 100 shafts at Billown.[58] These shafts are up to 3.5m deep, with earth and charcoal fills. Some are thought to have begun as pits that later had shafts dug into them, and many show evidence of re-working, and some contain deposits of quartz pebbles. Darvill notes that pits are also found at burial sites and has argued for a connection between pits, the natural world and death, suggesting the features may be conduits between the living and the dead drawing.[59]

In addition to sites where hollows, scatters and pits have been found, there are a number of sites where Earthfast Jars have been discovered, often in pairs or small clusters, buried in apparent isolation. Some qualification is needed here: the jars have also been found at both burial and non-funerary sites in association with other features. Many of the Earthfast Jars were recovered as accidental finds during ploughing and construction work, and it is possible that for those discovered in isolation further features in the surrounding area may not have been recovered. Earthfast Jars form a kind of pit-made-material within the earth. They act as an accessible container for materials; one can place something in the jar and then later remove it in a way that is not so easily possible in a pit. These vessels are part of a spectrum of activity that focused on the importance of deposition within the earth, similar to the practices of pit and shaft digging above. I argue, however, that the temporality of interaction with an Earthfast Jar differed from that with a pit – they allowed a more protracted interaction with the earth and materials.[60]

The exception to this characterization of the evidence is the Ronaldsway 'house' site,[61] the type-site for the period, despite its extraordinary nature in comparison to the majority of other settlement sites. The site was interpreted by Bruce *et al* as an 'oblong dwelling',[62] sunk into the ground, with evidence of postholes, floor levels, a central hearth and a thick occupation layer where Ronaldsway Earthfast pottery, Grooved Ware, animal bones, flintwork, coarse stone tools, slate plaques, RTB and polished stone axes were all found. Approximately one third of the site was truncated by mechanical diggers prior to its identification, meaning that the 'oblong' shape is partly conjectured. Bruce *et al* posited that the site was swiftly abandoned and, because of its pit-like nature, quickly filled in.[63] The interpretation of the structure remains difficult.[64] Rather than debate the nature of this site further,[65] I want to simply suggest that the site is exceptional in comparison to other sites of the period and is not most usefully considered as a domestic rectangular house structure but rather, in common with other sites from the period, it seems to encapsulate both what we might term the 'everyday' and the 'ritual'.

The archaeological evidence from the period is far from substantial, and the non-funerary archaeology can be characterized by a focus on digging into the earth. On the whole the evidence may be interpreted as suggesting a mobile community, probably with portable shelters, who repeatedly visited particular sites and parts of the landscape and frequently dug into and interacted with the earth.

Existing narratives for the emergence of a Bronze Age

On the Isle of Man the contrast between the Late Neolithic and Early Bronze Age is arguably clearer than in Britain and Ireland. However, alongside this stark difference there is also an issue of chronological resolution. The latest date for

[50] D Higgins and P Davey pers comm; Fowler 2001; 2002; 2004

[51] Nine of the twelve sites identified as Late Neolithic sites with burial remains in Crellin 2014 (appendix Late Neolithic burials) showed evidence of burning. The three without evidence of burning are sites for which there are no surviving excavation notes of any kind

[52] Burrow 1997a, 44

[53] *ibid*, 38

[54] Kermode 1902

[55] For more detail on the bias associated with the recovery of settlement sites from the period see Crellin 2014

[56] Burrow 1997a, 36–44

[57] Darvill 2004, 49

[58] *idem* 2000b, 70

[59] *idem* 2012, 38–9

[60] For extended discussions of this interpretation see Crellin 2014 and Crellin 2014–15

[61] Bruce *et al* 1947

[62] *ibid*, 141

[63] *ibid*

[64] See eg the differing views of Darvill 1996 and Thomas 1996b

[65] For more detail see Crellin 2014

a Ronaldsway Late Neolithic site is 2429–2033 cal BC and is associated with carbon on a Ronaldsway Late Neolithic pottery sherd from Ballalheaney (OxA-5894: 3775±50 BP)[66] – this is a very wide date range. The earliest Food Vessel date associated with a cremation found within a Food Vessel Bowl from Cottier's Field, Bishopscourt Farm, is 2336–2137 cal BC (OxA-27192: 3792 ±29 BP). With only a single Beaker burial known at present, it is unclear exactly how, and when, the shift from one way of life to another occurred. This period of change could have been quite protracted, or equally, relatively rapid.

In seeking answers and explanations for the changes noted in this period, authors focus on the apparent 're-entry' into more 'broadly held British cultural practices'.[67] This often creates a dichotomy: the Ronaldsway Late Neolithic is about cultural isolation and the Early Bronze Age is about re-connection. Burrow,[68] Woodcock[69] and Frieman[70] create such a dichotomy. The different practices and material culture associated with the Ronaldsway Late Neolithic (eg Earthfast Jars, RTB axes and hump-backed scrapers) are seen as indicators of isolation from the surrounding islands, whereas the similarity of practices and material culture in the Bronze Age (eg Food Vessels, axes, burials) are indicators of contacts and connections.

In an article discussing the end of the Ronaldsway Late Neolithic, Woodcock initially posits a 'significant break in continuity of contact'[71] during the Late Neolithic but later goes on to suggest that 'complete isolation would seem unlikely amongst the maritime people'.[72] Woodcock suggests that during the Ronaldsway Late Neolithic the Isle of Man was essentially self-sufficient with no need for trade.[73] She argues that only when the sustainability of the island became disrupted by events such as disease, population increase or poor harvests, would the island '**need** to look beyond their boundaries to their neighbours'[74] for additional support. Woodcock also argues elsewhere that the isolation of the Late Neolithic may have led to a dearth of 'marriage partners' and a reduction of the gene pool, causing a resumption of contact during the Early Bronze Age.[75]

The economic importance of bronze is also interpreted as driving the changes seen at the beginning of the Early Bronze Age.[76] She suggests that people '*…confident in their own social context do not need to compete with, or emulate, their neighbours and, in the case of the Isle of Man, it seems unlikely that they would aspire to possess the material culture of others*'.[77] However, with the emergence of copper and bronze, which could not be found on the island, she proposes that contact with others communities resumed.[78] Woodcock suggests that those with knowledge of, and access to, bronze would want to expand their own wealth and their spheres of influence and power at the beginning of the Bronze Age.[79] Not only does this dismiss the earlier rich material culture of the Late Neolithic, but it also is predicated on modern western concepts of wealth and power lying in metals, which cannot be upheld.[80]

The debate regarding isolation versus contact is not helpful. Rather, as Darvill has suggested,[81] with reference to the Neolithic of the Isle of Man more broadly, instead of seeing communities as either isolated and insular, or connected and interactive, we need to focus on local identities that are integrated within wider, shared, regional experiences.[82] It is not a case of integration or isolation but rather a productive tension between the two. This paper aims to take Darvill's ideas further, by exploring what they mean for the interpretation of the emergence of the Early Bronze Age and setting them in the context of a re-interpretation of the existing data and new data.

The core problem with the arguments regarding the changes seen in the archaeology of the Isle of Man at the start of the Bronze Age is that they are based upon the notion of an isolated Ronaldsway Late Neolithic, which is not substantiated by the archaeology.

Re-considering the evidence from the Ronaldsway Late Neolithic

The archaeological evidence for the Ronaldsway Late Neolithic period does not substantiate a narrative of isolation. Instead, the evidence paints a clear picture of connection. The material culture of the period indicates not only difference from others, but also connections to them. Communities on the Isle of Man did not simply adopt aspects of Late Neolithic material culture and practice from elsewhere, they clearly acted to adapt it as well: Grooved Ware pottery was made on the island, possibly by the same potters that made Earthfast Jars, and RTB axes were adapted from polished stone axes brought from elsewhere in Britain. Furthermore, RTB axes found elsewhere in Britain clearly suggest that material culture from the island was also finding its way beyond the island's shores. RTBs and polished stone axes are treated in similar ways: they are found at the same sites and are both most frequently found as single finds. Whether communities viewed the two kind of axes as part of the same category of object or as different or, maybe, even opposed remains unclear. As presented above, Grooved Ware was always deposited in the same assemblages as Ronaldsway Late Neolithic pottery – there was clearly no need to keep these two different kinds of material culture, with different uses, forms and meanings, separate.

[66] All radiocarbon dates are calibrated using OxCal 4.3 and are given at 2 sigma
[67] See eg Woodcock 2004
[68] Burrow 1999
[69] Woodcock 2004
[70] Frieman 2008
[71] Woodcock 2004, 214
[72] *ibid*, 215
[73] Woodcock 2008, 57–8, her emphasis
[74] *ibid*
[75] Woodcock 2008, 59
[76] *eadem* 2001; 2004; 2008
[77] *eadem* 2008, 57–8
[78] *ibid*
[79] Woodcock 2001, 382
[80] See eg Brück and Fontijn 2014
[81] Darvill 2004, 52
[82] *ibid*, 48

Find spot	MM accession code	Davey 1999 catalogue no.	Description	Type	Needham chronology
Near Parish Church (Andreas)	792	25	Copper flat axe	Growtown type, Needham's Metalwork Assemblage II	Period I, 2500–2300 cal BC
Beach South of The Cronk	2009-0152 (sometimes refered to as 1383)	n/a	Copper flat axe	Ballybeg/Roseisland type, typologically latest form of copper axe, Needham's Metalwork Assemblage II	Period I, 2500–2300 cal BC
North of island	2009-0035	n/a	Flat axe? Knife-like blade	unknown	Period I, 2500–2300 cal BC
Ballamooar Farm Hoard	2008-250/1	n/a	Bronze knife-like blade	unknown	Period I, 2500–2300 cal BC
Ballamooar Farm Hoard	2008-251/1	n/a	Copper flat axe	Ballybeg type, Needham's Metalwork Assemblage II	Period I, 2500–2300 cal BC
Ballamooar Farm Hoard	2008-249/1	n/a	Copper flat axe	Growtown type, Needham's Metalwork Assemblage II	Period I, 2500–2300 cal BC
Unknown, near Andreas	BM Townley Collection	n/a	Gold disc	EBA Insular group	Period I, 2500–2300 cal BC
Ballachrink	793	2	Bronze flat axe	Migdale flat axe, Needham's Metalwork Assemblage III	Period II, 2300–2050 cal BC
Ballakilpheric, near Ballakelly Cottage	1976,105	27	Bronze flat axe	Migdale flat axe, Needham's Metalwork Assemblage III	Period II, 2300–2050 cal BC
Hango Hill	794	21	Bronze flat axe	Killaha type, Needham's metalwork assemblage III	Period II, 2300–2050 cal BC
Ballawoods	796	15	Large flat axe	Aylesford type, Needham's Metalwork Assemblage IV	Period III, 2050–1700 cal BC
Surbey-beg, East Surby	797	3	Large flat axe	Glenalla type, Needham's Metalwork Assemblage V	Period III, 2050–1700 cal BC
Douglas Head	1979,4	28	Narrow-bladed flat axe	similar to axes from Toome, Co Antrim	Period III, 2050–1700 cal BC
Onchan	945	31	Flanged axe	probably Arreton type, Needham's Metalwork Assemblage VI	Period IV, 1700–1500 cal BC
Peel	lost	10	End-looped socketed spearhead	lost – unknown	Period IV, 1700–1500 cal BC
The Cronk, Upper Lherghydhoo	84,153	11	Bronze fragments (possibly part of a blade)	unknown	either Period III or IV
Peel Hill	lost	12	Small knife or razor	lost – unknown	either Period III or IV
Port-y-Shee	811	32	Tanged double-edged razor	Variant I of Jockenhövel's type 'zweischneidige Rasiermesser mit langovalem Blatt und Griffangel'	either Period III or IV (more likely III)
Corvalley, Ballakoig Brooghs	640	38	Fragments of bronze strip (3)	unknown	either Period III or IV (more likely III)
Ballamooar Farm hoard	2008-0251/2	n/a	Strange hollow copper alloy object	unknown	uncertain
Ballamooar Farm hoard	2008/0250/2	n/a	Slag lump	unknown	uncertain
Ballamooar Farm hoard	2008-0250/3	n/a	Ingot?	unknown	uncertain
Ballamooar Farm hoard	2008-0250/4	n/a	Copper alloy point	unknown	uncertain
Ballamooar Farm hoard	2008-0251/3	n/a	Slag lump	unknown	uncertain

Table 1 Metalwork from the Early Bronze Age on the Isle of Man, typological classifications follow O'Connor 1999

The deposition of material culture in pits and shafts holds much in common with practices that we see elsewhere.[83] Thomas has argued that pits represent a 'key measure of regional diversity in the Neolithic'.[84] The evidence shows that they are found in various forms, with differing deposition practices across Britain and Ireland through the Neolithic.[85] The Isle of Man is no different in this sense from the rest of Britain and Ireland, in that pit digging was clearly widely adopted but regionally adapted. The complete dominance of cremation in the burial record also evidences connections to Britain, where we see evidence for deposits of cremations at sites such as Stonehenge, Duggleby Howe, West Stow and Dorchester.[86] However, a note of caution is needed here, as burial practices are still arguably ill-understood for the Late Neolithic, and it may be that the majority of people did not receive formal burial. It is not the case that the inhabitants of the Isle of Man out-right rejected the practices of the rest of Britain and Ireland; rather, it is the case that they actively selected and adapted practices that fitted with their own.

I argue that the evidence clearly indicates connection rather than isolation. Reflecting on the nature of this connection, in the past we have often found ourselves talking about the movement of materials in the Late Neolithic in a way that perhaps reduces the visibility of people,[87] and this is something that I suggest shifts with the spread of Beaker ceramics, metallurgy and the beginning of the Early Bronze Age. We are happy to talk about explorers and adventurers[88] or Beaker colonists and migrations[89] in these periods. No archaeologist posits a break in contact between Britain and Ireland during the Late Neolithic, and indeed there appears to be increasing evidence for the long-distance movement of animals and people from across Britain to the Wessex

[83] See the papers in Anderson-Whymark and Thomas 2012

[84] Thomas 2012, 2

[85] Garrow 2012, 219–22

[86] Parker Pearson *et al* 2009

[87] See eg work on the axe trade such as Bradley and Edmonds 1993

[88] Needham 2005; Roberts 2014; Sheridan 2008a

[89] Brodie 2001; Evans *et al* 2006; Fitzpatrick 2011; Needham 2007; Sheridan 2008b; Vander Linden 2006

Pottery type	Lab code	^{14}C result BP	cal BC date (2 σ)
Irish Food Vessel Bowl	n/a	aggregate date range after Brindley 2007	*c* 2160–1930/20
Irish Food Vessel Vase	n/a	aggregate date range after Brindley 2007	*c* 2020/1980–1740
Scottish Food Vessels	n/a	aggregate date range after Sheridan 2004	*c* 2140–1620
Cottier's Field, Bishopscourt Farm (Food Vessel Bowl with cremation)	OxA-27192	3792±29	2336–2137
Cottier's Field, Bishopscourt Farm (Food Vessel Bowl with inhumation)	GU-2698	3560±70	2131–1695
Cronk Aust (Food Vessel Bowl with cremation)	OxA-27193	3746±32	2280–2036
Killeaba (Food Vessel Bowl with an inhumation)	OxA-26995	3699±35	2201–1977
Magher Y Clagh (Food Vessel Bowl with an inhumation)	GU-2699	3530±50	2016–1739
The Cronk, Upper Lherghydhoo (Food Vessel Vase with cremation)	GrA-29936	3440±40	1882–1641

Table 2 Dating evidence for the emergence of Food Vessels on the Isle of Man

region.[90] As such, we presume that seafaring and journeying between these isles was constant throughout the Late Neolithic and Early Bronze Age. Indeed, the spread of Grooved Ware designs would seem to hint strongly at heavy use of the Irish Sea.[91] I go on to argue that this level of pre-existing connection was crucial in the early arrival of copper and swift adoption of Food Vessels.

Defining the transition to a Bronze Age on the Isle of Man

Defining the beginning of the Bronze Age of Britain and Ireland is in some ways a difficult task: does the Bronze Age begin with the first use of copper or bronze? Can we date when these materials were first used? Are we better to consider the deposition of Beakers as marking the start of the Bronze Age? Or does the Bronze Age begin with the deposition of Food Vessels? This difficulty is obvious in the volume 'Is There a British Chalcolithic?',[92] where authors debate the relative use and appropriateness of the term Chalcolithic as a bridging term for the period when people were experimenting with and using copper but not bronze.

On the Isle of Man the Beaker evidence is very limited. However, there are at least five examples of unalloyed copper metalwork (Table 1). As such, the emergence of the Bronze Age on the Isle of Man appears to be most readily defined by the deposition of Food Vessels, the changing burial practices associated with them and the use and deposition of alloyed bronze metalwork, primarily in the form of the axe.

Dating the emergence of the Bronze Age

It is not possible to radiocarbon-date any of the metalwork from the Early Bronze Age. Given the lack of clarity over the dating of the Ronaldsway period (discussed above), dating the emergence of the Bronze Age on the Isle of Man is arguably best achieved through the dating of burials associated with Food Vessels. Food Vessel Bowls are widely accepted to have been first made in Ireland and to have spread to south-west Scotland from there.[93] Understanding the dating of Food Vessels on the Isle of Man is crucial when it comes to understanding the emergence of the Bronze Age on the island and exploring how this arrival fits within a wider British chronology.

Table 2 shows Food Vessel dates for Ireland and Scotland alongside all the dates for the Isle of Man.[94] On the basis of the dates we have, the vessels appear to have first been deposited on the Isle of Man shortly after they emerged in Ireland, and it would seem that they continued in use for longer than in Ireland, with a pattern closer to that seen in Scotland. The earliest date from Cottier's Field, Bishopscourt Farm (OxA-27192: 3792±29 BP), is associated with a cremation – perhaps unsurprising given the dominance of cremation in the Ronaldsway Late Neolithic. The date is very early, only partly overlapping with the Irish date range. Brindley comments that the 'evolution of the Early Bronze Age pottery in graves was remarkably consistent throughout Britain and Ireland'.[95] She presents clear evidence that shows there was no 'retardation in the developments [of pottery styles] which occurred on either side of the Irish Sea',[96] and the evidence from the Isle of Man provides further support to this argument. The early date from the Food Vessel Bowl from Cottier's Field, Bishopscourt Farm, is not surprising. This date should not be read as indicating that Food Vessels originated on the Isle of Man; rather, it testifies to their swift arrival on the Isle of Man. This is indicative of the movement of people, material culture and practices and the pre-existing strong connections between the two islands.

[90] Viner *et al* 2010

[91] Thomas 2010

[92] Allen *et al* 2012

[93] Brindley 2007

[94] These dates include new determinations, the first on cremated remains, from Crellin 2014

[95] Brindley 2007, 325

[96] *ibid*



Fig 3 New finds of copper metallurgy from the Isle of Man: top left – copper flat axe from Ballamooar (MNH 2008-251/1), top centre – potential copper ingot from Ballamooar (MNH 2008-0251/3), top right – copper flat axe from Ballamooar (MNH 2008-249/1), bottom left – knife-like blade from the 'north of the island' (MNH 2009-0035), bottom centre – bronze knife-like blade from Ballamooar (MNH 2008-250/1), bottom right – copper flat axe from a beach 'south of the Cronk' (MNH 2009-0152) (author's photograph, with kind permission of Manx National Heritage)

Early Bronze Age material culture on the Isle of Man

Recent evidence suggests that copper metallurgy was adopted swiftly on the island. Since the last published catalogue of Bronze Age metalwork on the Isle of Man,[97] ten objects have been discovered (see Table 1). In particular, these new finds affect the chronological spread of known objects from the Early Bronze Age on the Isle of Man. Three of these new objects are copper axeheads and two are small blades – one of copper and the other of bronze (Fig 3). Previously only a single copper axe was known from the island, and these finds significantly increase the amount of known metalwork from the period 2500–2300 cal BC. Analysis indicates that all the new copper finds have the distinct chemical composition of high arsenic, antimony and silver,[98] which is often referred to as A1 group metal[99] and has been shown to be derived from ore mined from Ross Island in Ireland.[100]

Two of the axeheads and one of the knife-like blades were found in two adjacent fields near Peel and are referred to as being from Ballamooar (Manx Museum accession nos MM2008-249/1, MM2008-250/1 and MM2008-251/1). These three objects are apparently not directly associated with each other, as they were discovered in three separate find spots between September 2007 and February 2008 by a metal detectorist. These three objects may well have been deposited within a relatively short time span, but they do not form a hoard or a single deposit. As well as these axes and blades there are a potential ingot (see Fig 3) and a series of small lumps of copper that were found within this same field. The chemical composition of the small knife-like blade (MM2008-250/1) also appears to indicate a use of A1 primary copper from Ross Island, and the alloying is typical of the very earliest bronze alloys from Ireland.[101] This suggests that it is reasonable to assume that the object was brought to the Isle of Man in this form from Ireland. However, the form of the object is very hard to parallel in Ireland.[102]

The copper metallurgy from the island suggests that copper was part of the Early Bronze Age assemblage on the Isle of Man from an early date. The evidence speaks heavily of links to Ireland in terms of chemical composition. However, O'Connor suggests that the typological links indicate connections with Ireland and potentially Wales;[103] whilst the Ballybeg-type axes are probably Irish in origin, the Growtown types suggest links to Wales, where this form of axe is most common. However, as stated above, the metal itself appears to be from Ireland.

These arguments are also strengthened by the single find of a gold disc on the island. These kinds of gold discs have parallels in Ireland (twenty-one known discs),[104] Wales and

[97] Davey *et al* 1999
[98] Northover 2008
[99] *idem* 1980
[100] O'Brien 2004
[101] Northover 2008
[102] *ibid*
[103] O'Connor 1999, 43–4
[104] Timberlake *et al* 2004



Fig 4 Bronze axe (MNH 1954-797) with thinning and bubbling to the butt of the axe obvious (author's photograph, with kind permission of Manx National Heritage)

the Knowes of Trotty in Orkney.[105] They are hammered very thin and flat, decorated with repoussé work and associated with early metalworking, using similar techniques to basket earrings and lunulae. The disc from the Isle of Man is very similar in form to the disc from Banc Tynddol in Wales. The Banc Tynddol disc was found with a burial, and it has been argued that it may be associated with the copper mine at Copa Hill and can therefore be used to indicate an earlier use of the mine than is currently evidenced by radiocarbon dates.[106] Carlin associates gold discs with supra-regional ideas, given that they have been found in Spain, Portugal and Brittany, as well as in Britain and Ireland.[107]

There are nine bronze axes from the Early Bronze Age (see Table 1) all of which were discovered as single finds.[108] Typologically a range of Irish Sea influences is shown in these axes, which cover Periods II–IV in Needham's metalwork chronology.[109] The Migdale type axes, MM79 and MM1976.105, clearly indicate a connection with Scotland, though as Needham points out,[110] this does not mean the axes necessarily came from there. Rather they indicate the growing influence of the region and style. O'Connor suggests that the Kilaha axe, MM794, is probably an Irish import and that MM1979.4 is best compared to axes from Toome, Co Antrim.[111] The Glenalla type, MM797, suggests links across the Irish Sea, given that this Irish form is also common in north and west Wales.[112] The flanged axe, MM945, is an Arreton type axe; this type of axe is most common in southern and eastern England. However, O'Connor suggests likely links to a scattered distribution in north Wales, north-west England and Ireland.[113] When taken as a whole, this evidence indicates that connections across the Irish Sea between the Isle of Man, Wales, Scotland and Ireland were frequent at this time. I also suggest that the presence of what may be an ingot (see Fig 3) appears to speak of the movement of metals from Ireland to the Isle of Man. We are left to wonder whether the central Irish Sea location of the island would make it a possible node of connection between Britain and Ireland, potentially drawing on existing routes for the movement of material culture, such as axes, from the Late Neolithic.

All the axes from the Early Bronze Age with surfaces suitable for metalwork wear analysis[114] show signs of use, and in some cases very heavy use.[115] Many of the axes are poorly cast: often it appears that too little metal was melted for a complete cast, producing butt ends that are incomplete, with lots of pock marks on the surface resulting from escaping gasses (Fig 4). One could use this lack of metal in the butt ends of axes to speculate about a lack of metal availability on the island. Equally, one could speculate as to whether the lack of metal may have links to the roughening of the butts of stone axes on the Isle of Man. The axes from 2500–2300 cal BC do not show imperfections to the butt. However, from 2300–1500 cal BC five of the seven known axes show imperfections to the butt. I speculate that metalwork wear analysis suggests that axes were deemed more appropriate for deposition on the island when they had been used and were poorly cast. Furthermore, perhaps axes that we see as 'poorly cast', with damage to their butt ends, were actively selected for deposition. The copper and bronze objects from the Isle of Man speak of connections to and contact with Ireland in particular, an argument strengthened by the ceramic evidence from Early Bronze Age burials.

A wide range of ceramic vessels from the Early Bronze Age has been recovered from the Isle of Man.[116] They include Food Vessel Bowls and Vases, as well as a single Beaker from the earlier part of the Early Bronze Age, and later Cordoned, Collared and Encrusted Urns. Food Vessel Bowls are

[105] See Carlin 2012, 261–263; Sheridan *et al* 2003; Timberlake *et al* 2004

[106] Timberlake 2003; Timberlake and Switsur 1998

[107] Carlin 2012, 263

[108] This term is used to refer to so-called 'chance finds' without further contextual associations

[109] Needham 1996

[110] *idem*, 240

[111] O'Connor 1999, 44

[112] *ibid*, 45

[113] *ibid*

[114] Metalwork wear analysis was carried out by the author following the protocol defined in Dolfini 2011

[115] Crellin 2014, 180–96

[116] I follow the typological classifications given in Woodcock 2008



Fig 5 Beaker from Baroose (MNH 1954-21298) (author's photograph, with kind permission of Manx National Heritage)

the most prevalent vessel from the earlier part of the period and most commonly found in Ireland but also, to a lesser extent, in northern England, Scotland and Wales.[117] Woodcock argues that the examples from the Isle of Man show the closest stylistic similarities to those from north and east Ireland.[118]

There are only two Encrusted Urns from the Isle of Man. For both urns only the upper sections have survived and both were uncovered in funerary contexts.[119] Given that only their decoration can be used for comparison to other vessels, Woodcock points out that both are 'strongly suggestive of an Irish origin'.[120] It is unclear if she means that they came directly from Ireland or that local potters were influenced by Irish designs. Brindley has suggested that there is variation in the shape and ornament of Encrusted Urns based on a regional north-south divide in Ireland, along the Meath / Galway axis.[121] Vessels from the north are characterized as having less dense ornamentation, which would certainly tie in with the vessels from the Isle of Man. However, given the lack of information on the body shape of these vessels this is a tentative suggestion. Woodcock points out that the two Vase Urns from the Isle of Man do not have any particularly strong comparators but fit within the broad Irish Sea region.[122]

Nine Collared Urns are known from clear burial contexts on the island, and there are a further six Collared Urns which have very unclear associations and histories. Collared Urns have a wide distribution across all of Britain but are more limited in Ireland, with primary distributions in Co Antrim and Co Down.[123] Woodcock notes that the vessels from the Isle of Man are unusual: whilst their shape and form are easily paralleled, she suggests the limitation of decoration to the collar alone is harder to parallel.[124] This decorative style could be used to argue for a specifically local interpretation of the vessel.

Woodcock suggests there are over fifty-four examples of Cordoned Urns from the Isle of Man. Of these nineteen are clearly associated with Early Bronze Age burials,[125] whilst the majority of the rest are associated with Middle–Late Bronze Age settlement evidence and are excluded from the discussion presented here. Cordoned Urns have a clear distribution in Ireland, particularly focused on the north-east and east, and in Scotland through the south-west and into the south-east.[126] Generally the Cordoned Urns from the island show only minimal decoration, which tends to focus on the area between the uppermost cordon and the rim.[127] Woodcock notes that parallels for the vessels are not always easy to locate.[128] It is notable that there are at least seven examples of Cordoned Urns from the island that have three cordons. Woodcock suggests that such vessels are rare in Ireland but more common in Scotland (she also notes an example from Llanyddyfan, Anglesey).[129] This can be used to suggest a potential shift in the focus of relations.

Early Bronze Age burial evidence

The emergence of the Early Bronze Age marked a significant change in burial practices on the Isle of Man. Burials from the Ronaldsway Late Neolithic were cremations buried within small pits or scoops or within an Earthfast Jar, and burials were rarely accompanied by material culture. The practice of burying a body, either cremated or un-burnt, with a vessel, was therefore relatively novel. In particular, inhumation would have been innovative in the Ronaldsway Late Neolithic context. One-hundred-and-fifty-five[130] Early

[117] Brindley 2007, 11
[118] Woodcock 2008, 43
[119] *ibid*, 75–6
[120] *ibid*, 44
[121] Brindley 2007, 198
[122] Woodcock 2008, 43
[123] Brindley 2007, 132
[124] Woodcock 2008, 46
[125] Crellin 2014
[126] See Bradley 2012, 176, fig 6.8 for a recent distribution map
[127] Woodcock 2008, 45
[128] *ibid*
[129] *ibid*, 46
[130] This figure is built from the comprehensive list of Bronze Age sites compiled in the appendix of Woodcock's PhD thesis (2001). This catalogue lists all the potential known Bronze Age burials on the Isle of Man. My own figure excludes all Middle and Late Neolithic burials as well as all burials where their attribution to the Bronze Age is questionable. Despite this narrowing of the dataset it is possible that some of the burials, particularly those without material culture or radiocarbon dates, could date to a different period. For more details of the burials included and excluded from this number see Crellin 2014

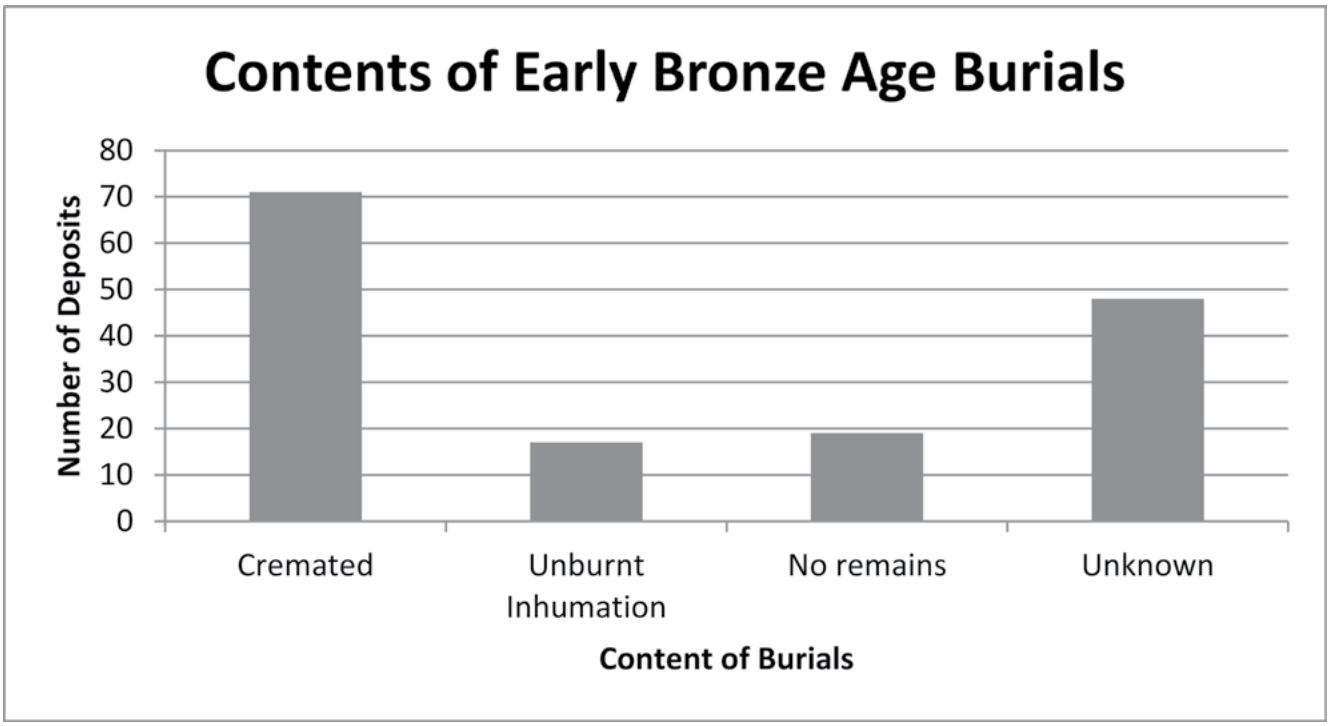


Fig 6 Treatment of human remains from Early Bronze Age burials on the Isle of Man (n=155)

Bronze Age burial deposits have been excavated on the Isle of Man,[131] including burials in cists and pits, and burials within barrows, cairns and flat cemeteries. Some of these burials are accompanied by a range of pottery vessels.

A single Beaker burial is known from the site of Baroose, discovered in 1919 in a cist without a capstone; the vessel was found with some charcoal, a flint scraper and nodule.[132] No skeletal remains were recovered – probably a result of the acidic local soils. This Beaker (Fig 5) is very fragmented and the reconstruction is poor, making comparison difficult. Clark described the influence of the Beaker phenomenon on the Isle of Man as weak, suggesting 'Man [sic] lay definitely in an area peripheral to the main Beaker spread'.[133] Darvill notes that in many ways this is surprising, given the island's prominent position in the centre of the Irish Sea and the occurrence of copper ores on the island.[134] Contra this position, Woodcock maintains that, given the apparent insularity of the Ronaldsway Late Neolithic, it is surprising that any Beakers have been uncovered.[135]

Figure 6 shows the treatment of the remains from Early Bronze Age burials, among which those of cremated remains clearly dominate. The category 'unknown' includes cases where no record of the nature of the remains could be found. The number of un-burnt inhumations is likely to be relatively accurate as a proportion of the known number, as antiquarians appear to have more readily recorded inhumations than cremations. Additionally, records often only state 'cremated remains' rather than an indication of the number of separate deposits uncovered, meaning that the real number of cremations is likely to be higher and possibly a higher proportion of the known number of burials. The dominance of cremation burials perhaps indicates links to Ronaldsway Late Neolithic traditions.

Figure 7 shows the number of pottery vessels associated with burials from the Early Bronze Age.[136] In this figure the 'unknown' number accounts for cases where there is no record of either the absence or presence of pottery vessels, in contrast to the 'No vessel' category, where the absence of a vessel is recorded. Figure 7 indicates the spread of pottery types that were in use at various times during the Early Bronze Age on the Isle of Man and evidences how well networked the island was into broader trends from Britain and Ireland in the period.

Inhumations have only been found in association with Food Vessel Bowls, eg at Cronk Aust (Fig 8), or in burials that contain no pottery. The Early Bronze Age communities on the Isle of Man appear to have adopted the Irish tradition of inhumation or cremation with Food Vessels (though there appears to be a preference for cremation). However, as the kinds of pottery appropriate for inclusion in a burial became more diverse, cremation once again established itself as the norm.

As shown in Figure 9, Early Bronze Age burials have been found in a variety of structures. Figure 10 shows the locations of burials associated with Food Vessel Bowls and Vases only. This demonstrates the marked variety in deposition of burials from the outset of the Early Bronze Age on the island.

[131] Crellin 2014

[132] Quine 1925, 271

[133] Clark 1935, 83

[134] Darvill 2000a, 381–2

[135] Woodcock 2001, 198

[136] Pottery identifications are based on Woodcock's 2008 catalogue of Bronze Age pottery from the Isle of Man and I retain her terms for pottery types

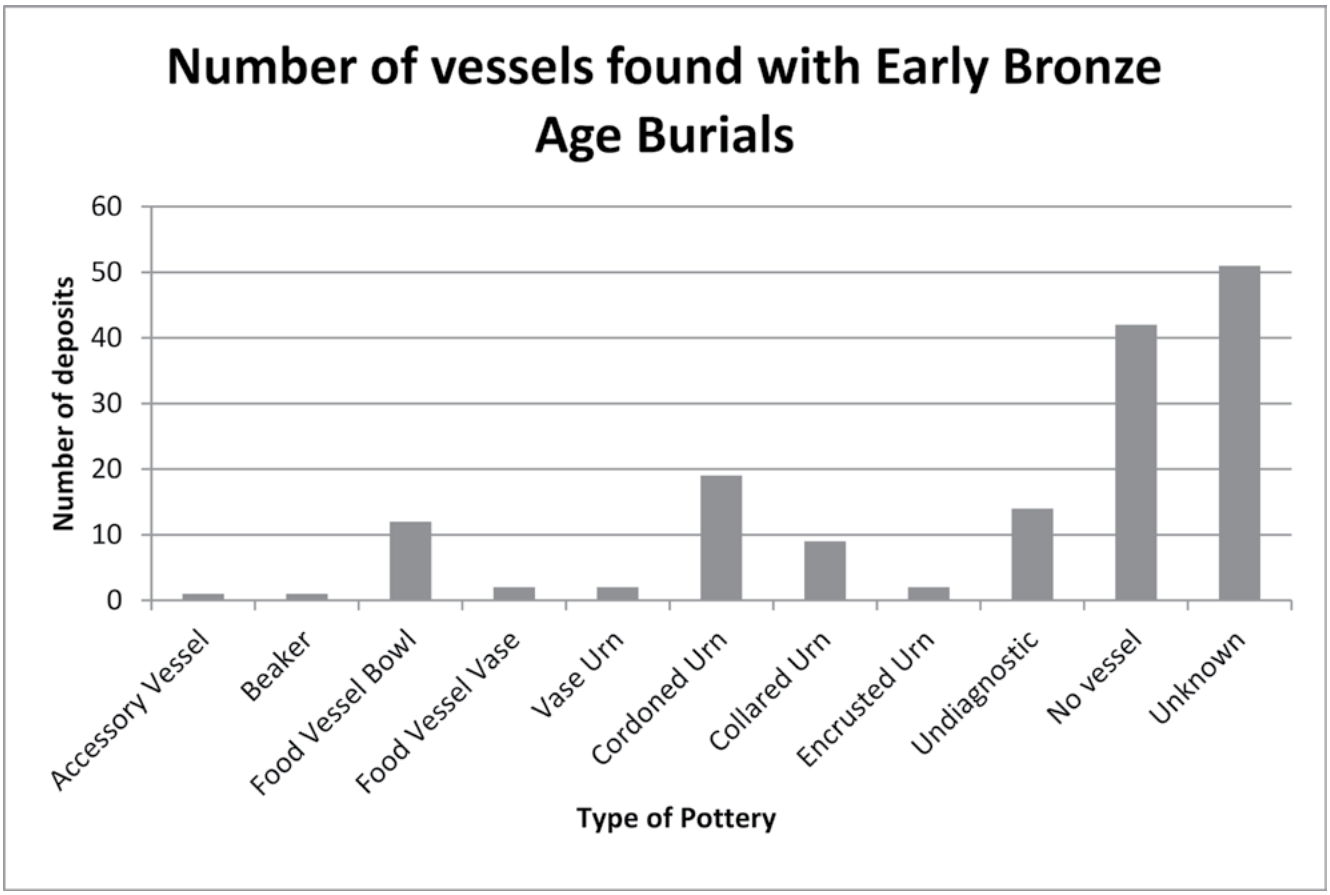


Fig 7 Type of pottery vessels associated with burials form the Early Bronze Age on the Isle of Man (n=155)

Pottery type	Lab code	^{14}C result BP	cal BC date (2 σ)
Irish Collared Urns	n/a	aggregate date range after Brindley 2007	*c* 1850/30–1700
Irish Cordoned Urns	n/a	aggregate date range after Brindley 2007	*c* 1730–1500
The Earliest Scottish Collared Urns	n/a	aggregate date range after Sheridan 2004	*c* 2030–1770
The Earliest Scottish Cordoned Urns	n/a	aggregate date range after Sheridan 2004	*c* 1800–1700
Park Farm (Cordoned Urn)	GrA-29939	3540±40	2009–1751
Staarvey (Cordoned/Collared Urn)	GrA-29940	3515±45	1956–1695
Kerrowmooar Farm (Cordoned Urn)	GrA-29947	3325±40	1731–1507
Kerrowmooar Farm (Cordoned Urn)	GrA-29957	3400±45	1877–1537

Table 3 Dating evidence for Cordoned and Collared Urns from the Isle of Man

The use of cists marks a significant break from earlier practices of the Ronaldsway Late Neolithic.[137] Cists on the Isle of Man are most commonly built of slate (forty-four out of seventy cases), the most readily available rock on the island. There appears to have been a preference for inhumations (which are primarily associated with Food Vessels) to have been deposited within cists.

In the later Early Bronze Age (Table 3) the use of smaller Food Vessel Bowls and Vases gave way to a growth of larger vessels: Collared and Cordoned Urns (Fig 11). At this time the use of cists appears to have declined, as it did elsewhere in Britain and Ireland.[138] Of the twenty known Collared, Cordoned and Encrusted Urns found on the Isle of Man, only four were found in cists and none were found in association with an inhumation. Similarly to elsewhere in Britain and Ireland it appears that cremation comes to dominate the latter half of the Early Bronze Age. Table 4 also indicates the prevalence of the practice of inverting a Collared or Cordoned Urn over cremated remains in the latter half of the Early Bronze Age.

Of the 155 known excavated Early Bronze Age burials on the island, sixty-three contain some form of material culture and of those only thirty-three contain material culture other than pottery vessels. Grave goods from the period include clay, shale, lignite and bone beads (discussed below) as well as fragments of what are presumed to be bronze knives, flintwork and one case of a bronze razor. The trend in Early

[137] See Burrow 1997a, 19–20; Crellin 2014, 233–40

[138] Brindley 2007, 132, 142; Fowler 2013, 234



Fig 8 Food Vessel from Cronk Aust (MNH 1954-1117) (© Manx National Heritage)

Relationship between vessel and cremated remains	Pottery Vessel			
	Food Vessel Vase	Vase Urn	Cordoned Urn	Collared Urn
Inverted over remains	0	1	10	3
Not inverted over remains	2	0	0	1
Unknown whether inverted	0	1	8	5

Table 4 Inversion of Food Vessel Vases, Vase Urns, Cordoned Urns and Collared Urns over cremated remains (n=31)

Bronze Age burials from the island appears to be for few, if any, grave goods in any one grave, which may suggest links to Ireland, where grave goods beyond a pottery vessel are not common.[139] Furthermore, the variety of material culture known from graves is quite limited (see discussion further below).

Early Bronze Age non-funerary evidence

In common with much of Britain and Ireland there are no known settlement structures from the Early Bronze Age on the Isle of Man. If the settlement evidence from the Ronaldsway Late Neolithic is ephemeral, then the Early Bronze Age evidence is almost invisible. There are examples of chance finds of Early Bronze Age flintwork, a few pits which have produced Bronze Age pottery and lithics, and a few sites where Beaker sherds have been uncovered.[140]

Sherds of Beaker pottery have been found in association with settlement evidence at Billown[141] and Port Cranstal.[142] All-Over-Corded sherds were found at the site of Ballachrink, associated with probable Early Bronze Age pottery sherds and both Late Neolithic (hump-backed scrapers) and Early Bronze Age (barbed and tanged arrowheads) lithics.[143] The site consists of an occupation scatter and a series of ill-understood ditches. The majority of the finds came from a disturbed deposit of charcoal-flecked, hard, compact, white-grey sand.[144] The presence of Beaker sherds in settlement scatters is also common in Ireland.[145]

At the site of Crawyn Brooghs worked flint, fragments of pottery and bronze tools have been recorded as eroding from the cliffs in this area for over a hundred years.[146] In

[139] Carlin and Brück 2012, 198

[140] A number of burnt mound sites have been identified on the island; however, their dating remains unclear

[141] Darvill 2003, 18

[142] Woodcock 2001, 198

[143] Burrow 1997a, 32; McCartan and Johnson 1992

[144] McCartan and Johnson 1992, 105–8

[145] Carlin 2012; Carlin and Brück 2012, 196; Cooney and Grogan 1999; O'Brien 2007

[146] Woodcock and Davey 1999

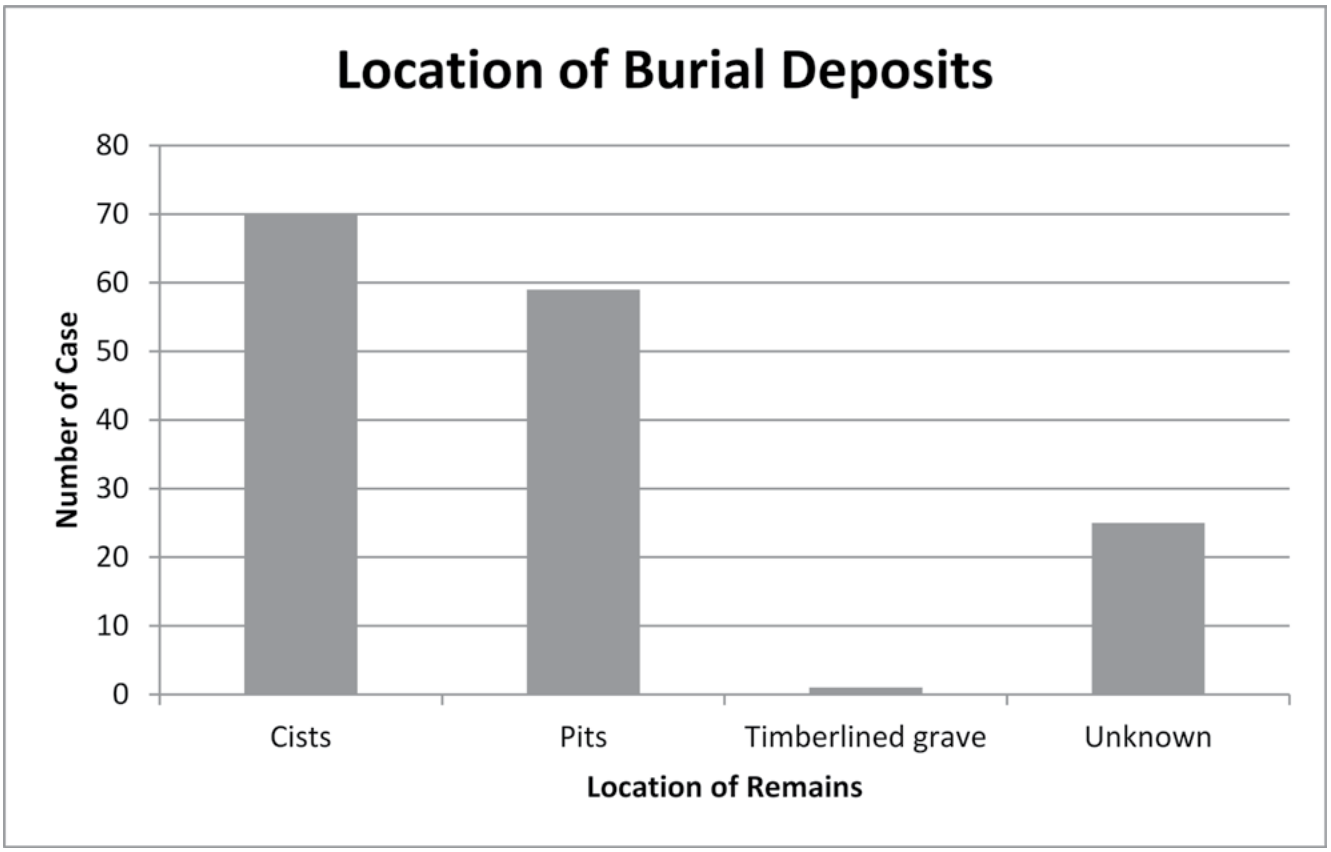


Fig 9 Location of remains found in Early Bronze Age burials (n=155)

1995 two pits were excavated in the area, in response to further coastal erosion. One of the two pits was found to contain sherds of pottery from two vessels, one of which was a Cordoned Urn. In the second pit lenses of charcoal, burnt stone and a Bronze Age flint assemblage were uncovered.

A local Early Bronze Age?

Thus far, the evidence presented seems to indicate a lot of similarities with practices and material culture known from Britain and Ireland. However, the absence of some types of material culture from the Isle of Man is indicative of a degree of difference from some aspects of other local Bronze Age cultures across Britain and Ireland. This holds much in common with the interpretation of the evidence presented for the Ronaldsway Late Neolithic period, where clear similarities and differences in practice and material culture can be understood in a context where these were adopted and adapted from other places.

In terms of the deposition of Beakers we might draw more parallels between the Isle of Man and Ireland, where single-graves are rare and Beaker sherds are commonly found at non-funerary sites. However, there are also key differences between Ireland and the Isle of Man in terms of Beaker-associated practices. In Ireland a range of Beaker-associated material culture such as bracers, v-perforated buttons, copper daggers, lunulae, sun discs and other gold objects are found outside of funerary contexts.[147] These objects appear to have had very clearly prescribed depositional traditions in 'pits, spreads, old and new megaliths, disused timber circles, burnt mounds, caves and other natural places'.[148] Carlin suggests these kinds of objects were deposited at communal sites and are hard to label 'personal possessions' but were part of ceremonial practices important to local communities.[149] For Carlin the adoption of some aspects of Beaker-associated material culture and rejection of continental European and British Beaker burial practices is about being part of supra-regional networks and social relations, but in a local context.[150] As such, people living in Ireland at the time adopted aspects of these exotic objects but deployed them in local practices that fitted within existing cosmologies. However, on the Isle of Man there are no known examples of bracers, v-perforated buttons or lunulae, and only a single example of a sun disc. The kind of community practices associated with Beaker material culture suggested by Carlin for Ireland were potentially unknown on the Isle of Man, deemed inappropriate, or carried out in different ways.[151]

In terms of the earliest metalwork, there are no known halberds, copper daggers or knives from the Isle of Man.[152]

[147] Carlin 2012
[148] *ibid*, 273
[149] *ibid*, 273–4
[150] *ibid*, 300
[151] *ibid*, 273–4
[152] Though there are the two small 'knife-like' blades, one bronze and

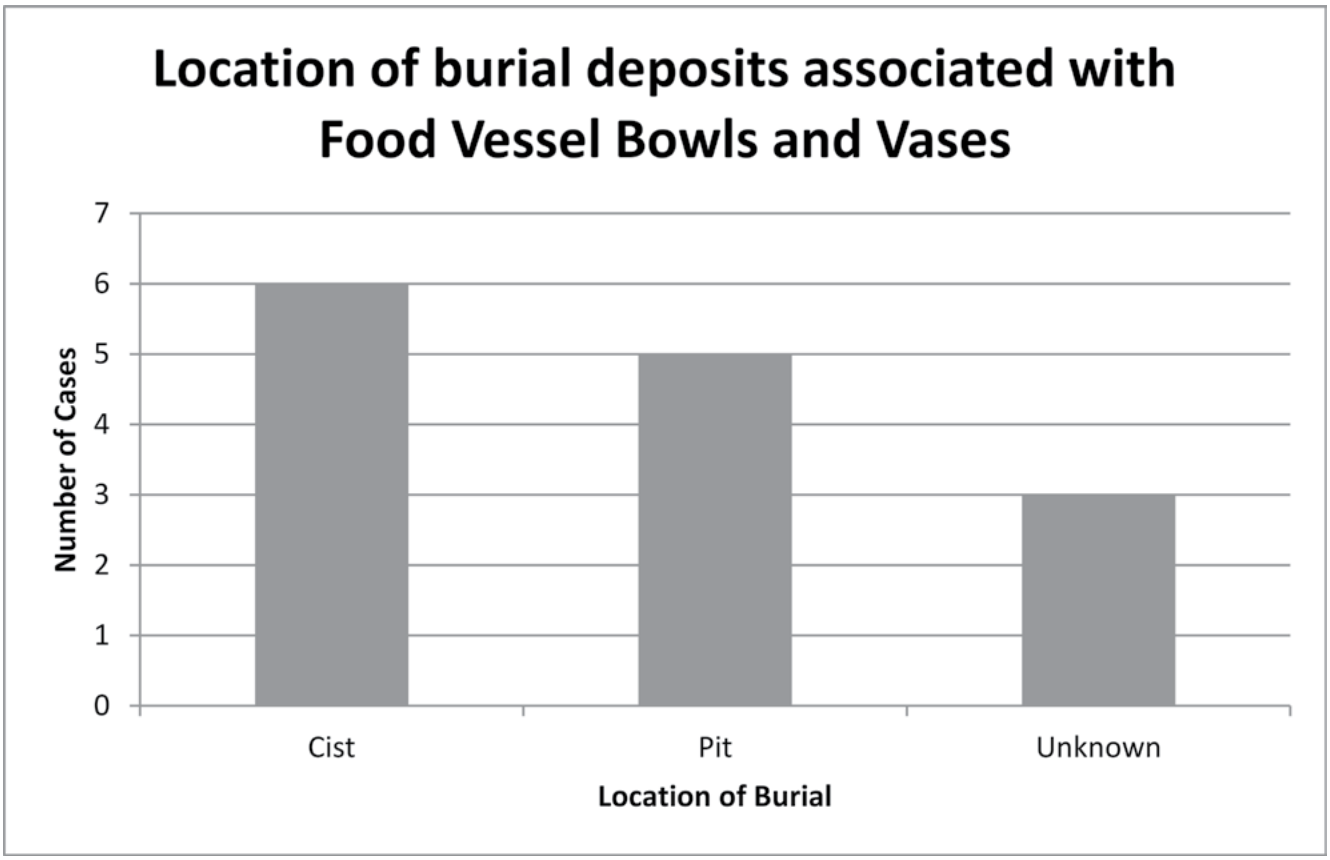


Fig 10 Location of remains found in Early Bronze Age burials associated with Food Vessel Bowls and Vases (n =14)

Given the distribution of halberds across Ireland and south-west Scotland,[153] one might expect them to be found on the Isle of Man. Similarly, one might expect finds of copper daggers and knives on the island (though probably as single finds, as is the case in Ireland, rather than within graves). It would appear that, despite the clear evidence for contact with Ireland, communities on the Isle of Man were not interested in depositing halberds and knives and possibly not interested in using them either. Needham has suggested that the distribution of copper daggers and halberds across Britain and Ireland is indicative of two differing regions with different beliefs and practices.[154] It would appear from the current evidence that the Isle of Man was part of neither of these regional 'communities' *c* 2500–2200 cal BC.

There is an absence of other kinds of material culture such as flint knives and daggers, bronze blades, copper and bronze neckbands, spacer necklaces, amber beads, and composite necklaces which were prominent in the rest of Britain and Ireland. There are eight finds of beads from the Isle of Man (Table 5).[155] It is possible that the dominance of cremation burials skew these data, because if beads / necklaces were placed on the deceased during cremation then they may have been destroyed. The lack of composite bead burials and amber beads is not surprising, given their southern British distribution. However, the generally low number of beads may warrant further consideration. My research suggests that three flint knives have been found in Early Bronze Age burials on the Isle of Man (though there are more examples from settlement scatters) and three potential examples of bronze blades, from graves, all in too poor a condition to be confidently identified.[156]

The somewhat unclear picture that emerges suggests that the deposition of ornamentation and grave goods made of materials resistant to decay appears to have been uncommon on the Isle of Man. Whether these objects were rejected by communities on the island or their circulation patterns restricted them from the communities is unknown. In some ways this low number of grave goods appears to strengthen the argument for links to Ireland, where grave goods are also few.[157] However, when we consider other forms of material culture that appear to be associated with community deposition practices in Ireland, such as lunulae and halberds, these are absent from the Isle of Man. This appears to add more weight to the argument that communities on the Isle of Man were selecting, adopting and adapting practices and material culture from elsewhere to suit their own needs.

one potentially made of copper, that have been recently discovered (see Fig 3)

[153] O'Flaherty 2003

[154] Needham, 2012 Rhind Lectures, http://www.socantscot.org/article.asp?aid=1207 (17 June 2014)

[155] Based on information from D Higgins and P Davey pers comm; Woodcock 1996; 2001

[156] One is lost and the other two are fragmentary and of unclear form, one of these two also has an uncertain association with a burial

[157] Carlin and Brück 2012, 198



Fig 11 Cordoned Urn from Garey Mean, found inverted in a pit over cremated remains – scale in cm (MNH 1954-566) (© Manx National Heritage)

The use of perforated stone axes on the Isle of Man is also noteworthy. Thirteen examples have been found on the island (Fig 12). One was found in a cist where no bone survived and the others were all single finds. Table 6 shows the variety of perforated stone axes found on the island. The deposition of battle axes outside of funerary contexts is somewhat unusual[158] and perhaps speaks to the translation of these objects by communities on the Isle of Man into a context where grave goods were rare but the deposition of axe shaped objects in the ground had a long history.

The apparent dominance of battle axes over axe-hammers on the Isle of Man is worth consideration. Needham considered the distribution of axe-hammers and battle axes across Britain (though not Ireland) and was able to establish areas where battle axes were dominant and ones where axe-hammers dominated and, similarly to the division between copper daggers and halberds, used it to suggest different regional communities.[159] Needham notes a concentration of axe-hammers around the Irish Sea basin, yet on the Isle of Man they do not dominate. Battle axes dominate and are most frequently found deposited alone, outside funerary contexts. Whether this was an active assertion that practices on the island where different to those in the east, or whether it was simply that such practices did not fit with existing practices on the Isle of Man remains unclear.

Site	Type and number of beads	Treatment of the body
The Cronk, Upper Lherghydhoo	Two bone toggle beads	Cremation
The Cronk, Upper Lherghydhoo	Two poorly preserved, roughly spherical clay beads	Cremation
Ballaharra (uncertain dating)	Two shale disc beads	Not associated with a body (found within the megalith)
Ardwoaillach	Two disc beads (may be either jet or lignite)	Cremation

Table 5 Early Bronze Age beads from the Isle of Man

Type of perforated stone axe	Number known
Battle axe	7
Mace-head	2
Axe-hammer	1
Unknown classification	2

Table 6 Perforated stone tools from the Isle of Man (n=12)

Re-considering the Early Bronze Age on the Isle of Man

Starting from a position where the notion of an isolated Late Neolithic on the Isle of Man is rejected, we are left to consider the ways in which relationships with other places were important in the emergence of an Early Bronze Age on the Isle of Man. The influence of Ireland during this period is clear. The earliest metalwork is produced from copper ore mined in Ireland and shows typological links to Ireland. As the Early Bronze Age continues, there is evidence of the increasing influence of Scotland and Wales in the metalwork deposited in the Isle of Man. In terms of burial practices we see what appears to be a rejection of Beaker single-burial practices and the adoption of Food Vessel burials on the island, indexing key links to, and relations with, Ireland further (and in particular the north and east of Ireland). However, there is also evidence of a broader Irish Sea influence from England, Wales and Scotland with the later adoption of Collared Urns. The large number of Cordoned Urns known from the Isle of Man is a strong indicator of relations with both Scotland and Ireland. In many ways it is to be expected that an island located in the middle of the Irish Sea should be influenced by a variety of neighbours.

Talking about connection in the Early Bronze Age, however, is not to be read as taking a position where the Isle of Man 'returned to the mainstream'.[160] It is important that we consider the ways in which communities on the island appear to have adopted and adapted practices from elsewhere and the practices they appear to have rejected. The evidence

[158] Needham 2011

[159] *ibid*

[160] Woodcock 2004



Fig 12 Perforated Stone tools from the Isle of Man: top left – battle axe from Jurby (MNH 1954-2801), top right – battle axe from Knockaloe Beg Cist (MNH 1954-593), bottom left – battle axe from Ballawilliegell (MNH 1971-201), bottom right – mace-head from Cronk Mooar (MNH 1954-1687) (author's photograph, with kind permission of Manx National Heritage)

for continued contact and links to other places means that at least some members of communities on the Isle of Man would have been exposed to, and aware of, practices and forms of material culture from across the Irish Sea area. This means that in terms of Beaker practices they would have been aware of both Beaker burial practices from Britain and the use of Beaker pottery in pits and settlement scatters, the construction of wedge tombs and the deposition of Beaker material culture as seen in Ireland.[161] The few fragments of Beaker pottery uncovered on the island and the single Beaker burial would appear to support this view. Whilst the presence of sherds in settlement deposits and lack of Beaker burials does appear to point to links with Ireland, the absence of wedge tombs, lunulae, copper daggers, v-perforated buttons and bracers indicates that practices from Ireland were not adopted wholesale.[162]

Similarly, when considering metalwork we can note the absence of halberds, and the very small number of bronze knives, blades and daggers that have been uncovered. I have also suggested that there is a high proportion of bronze axes from the Isle of Man, dating to the Early Bronze Age, that show signs of deformation to their butt end. This possibly suggests links to earlier RTB axe practices, resulting in the selection of bronze axes with damaged butt ends for deposition on the island. In terms of burial practices there are only seventeen known inhumation burials thought to date to the Early Bronze Age from the island.[163] It appears that inhumations were even less common on the Isle of Man than in Ireland. Whilst much of the burial evidence from the island in the Early Bronze Age seems to show similarities with that from elsewhere, the amount of grave goods does appear to have been very limited, especially when it comes to decorative objects. The dominance of battle axes over axe-hammers also appears to indicate a local adaptation of the Early Bronze Age on the Isle of Man.

[161] See eg Carlin 2012

[162] A note of caution is required: in 1996 in Ireland sixty-five sites had been identified with Beaker pottery, but following a boom in construction, that number increased to 150 sites – the vast majority of which were non-monumental green-field locations where no archaeological remains had been previously identified (see Carlin 2012). The Isle of Man has seen relatively little archaeological excavation in recent years, and we might wonder about the potential for currently undeveloped land to contain non-monumental sites that date to both the Late Neolithic and Early Bronze Age

[163] Crellin 2014, appendix Bronze Age burials

Contextualizing the evidence from the Isle of Man

Understanding change in this period, and the movement of people and material culture associated with this and the spread of ideas and practices, is complex. Needham comments that there has been a revival in the importance of movement in seeking to understand the changes at the start of the Bronze Age: '…not a return to sweeping pan-European uniform migration processes, but a series of more nuanced approaches which take account of local cultural contexts'.[164] The increasing role of isotope analysis appears to have been instrumental here. Needham presents a model for the arrival of the Beaker package from continental Europe that focuses on the interaction between indigenous Grooved Ware-using populations and migrant Beaker-using populations.[165] Such a model allows space for both groups to influence the adoption of Beakers in Britain.

For many authors it appears that the Beaker period, as associated with 'classic' Beaker burials in Britain, is seen as a necessary step towards the emergence of a Bronze Age, and it almost feels like a compulsory step (though Needham's model is careful to show change and variation through time)[166] that one had to have Beakers to have the Bronze Age that came after: '…there is little doubt that the initial intrusion of a culture born overseas had a massive impact on indigenous culture giving rise to a historical trajectory that would otherwise have been radically different'.[167] Obviously, the evidence from Ireland (and the Isle of Man) serves to demonstrate that this is not a uni-linear process, and that it is possible for the Bronze Age to emerge out of arguably quite different circumstances. O'Brien has talked about the ways in which the clear influence from continental Europe in terms of metallurgy and Beakers has served to blind us to the important role of indigenous populations.[168]

Carlin and Brück[169] as well as O'Brien[170] suggest that in the Late Neolithic, exchange and interaction for Ireland seem to focus on Britain. They suggest that there are clear and strong links with Scotland at the start of the period, evident in the appearance and exchange of Grooved Ware, and links to south-west Scotland and north-west England evident in the movement of porcellanite and tuff axes. However, as the period goes on, it appears that Wessex became the focus of attention. Copper metallurgy arrived as an established technology in Ireland *c* 2500–2400 BC.[171] Exactly where copper metallurgy came from is still under question. O'Brien appears to favour Atlantic France as a possible origin for metallurgy, suggesting that this drew on earlier connections and the movement of Beaker-associated material culture.[172] Carlin and Brück also argued that between 2500–2200 BC there is increasing evidence for links with a wider range of Continental connections, in particular with the Atlantic façade but also with central and northern Europe, evidenced by a diversity of material culture. They suggest a decline in this kind of contact after 2200 BC.

Shepherd has argued that the early Beaker influence on Scotland mostly likely came from continental Europe, and in particular the lower Rhine area, given similarities in burial practices between the two places.[173] He goes on to argue that they established connections with the early metal users in Ireland. There is evidence for this in the transfer of motifs from lunulae to Beakers from the north-east of Scotland, the movement of copper and the adoption of Food Vessels. The later development of the Migdale-Marnoch metalworking tradition[174] in north-east Scotland would appear to indicate the growing importance of earlier connections with Britain in terms of the movement of tin and continued movement of copper from Ireland. Indeed, Curtis and Wilkin highlight the link between 'rich' burials and routeways, along which materials and people are presumed to have travelled in north-east Scotland.[175] The evidence for Wales seems to suggest that copper halberds and axes arrived from Ireland after 2450 cal BC, but it is harder to place a clear date on this.[176] There is also the difficulty of dating when copper mining in Wales began, though we now have increasing evidence that it may have been early, during the last quarter of the third millennium cal BC.[177]

Where does the evidence discussed in this paper fit within this broader picture? It can be argued that the evidence from the Isle of Man suggests more similarities with Ireland than elsewhere, evidenced by the adoption of metallurgy and new burial practices. Whilst we can easily network Ireland into larger European practices, it is harder to do this for the Isle of Man. Many of the things that appear to signal Ireland's involvement in larger Continental networks are absent from the Isle of Man, perhaps as a result of the strength of pre-existing Ronaldsway practices and beliefs. However, it is also clear that Ireland had strong links to Scotland and Wales in particular, and later to England; and as the Bronze Age continued these diverse links came to influence communities on the Isle of Man as well. Indeed, we need to consider the possibility that the island was a key node of connection between these places.

Discussing the emergence of the Bronze Age in Britain and Ireland is made all the more difficult, but also interesting, as a result of the diverse regionality that is becoming ever clearer. O'Brien has argued for a strongly regional character to the Irish Chalcolithic, with specific territories for different tribes.[178] The north-east of Scotland has long appeared as a distinctive region during the Beaker and Early Bronze Age period,[179] and recent work by Curtis and Wilkin has served to show even more discrete and differing regions within this area.[180] The Isle of Man is yet another example that can be

[164] Needham 2007, 41
[165] *idem* 2005
[166] *ibid*
[167] *ibid*, 210
[168] O'Brien 2012, 223
[169] Carlin and Brück 2012, 203–4
[170] O'Brien 2012, 215
[171] *ibid*, 212
[172] *ibid*, 218
[173] Shepherd 2012, 169–70
[174] Needham 2004
[175] Curtis and Wilkin 2012, 247
[176] Burrow 2012, 174
[177] Timberlake 2006, 83; Timberlake and Marshall, this volume
[178] O'Brien 2012, 214
[179] See eg Needham 2005
[180] Curtis and Wilkin 2012

added to this increasingly nuanced picture. In one sense it is very like other places and regions, in that it adapted and adopted aspects of material culture and practice from elsewhere to fit with existing beliefs and practices.

The exact nature of connection and movement in the Late Neolithic and Early Bronze Age poses a challenge. Taking the evidence for metalwork alone, O'Brien argues that the circulation of copper was a complex process, involving down-the-line trade, secondary distribution of primary products and metal recycling.[181] No single model of movement, exchange and connection will work for this period. Rather it is a combination of varied kinds of contact. I believe it is not possible, nor productive, to identify archaeologically whether contact and connection in prehistory relates purely to organized trade routes, a more flexible approach to exchange, movement for social reasons, or to heroic journeys. Instead I would suggest that such divisions between social and economic motivations are irrelevant at this time and that movement, contact and exchange would always have had both social and economic aspects, and that these two would have been inextricable.

Splitting the social and the economic, and even naming such categories to begin with, are the product of modernist ways of thinking and approaching the world.[182] Instead we need to adopt a position where we expect that people will move around, meet others from different communities, be aware of how things are done differently elsewhere and be influenced by them in ways that are not merely concerned with the simple imitation and easy adoption of the practices of other communities.

Conclusion

This paper has shown that the notion of an isolated Late Neolithic on the Isle of Man cannot be sustained. Rather, a position where communities were aware of their differences from and similarities to others, and sought to emphasize this difference in particular, is adopted. It is in this context of connection that the Bronze Age on the Isle of Man appears to have emerged, with Food Vessel dates and an increasing amount of copper metallurgy suggesting a swift adoption of practices prevalent in Ireland in particular. The influence of Ireland appears to be foreshadowed by the apparent rejection of Beaker burials on the Isle of Man and appearance of Beaker sherds in settlement contexts. With time, it appears that influences on the Isle of Man became more diverse, with practices and material cultures from around the Irish Sea coming to influence the islanders. Alongside the rejection of an isolated Late Neolithic this paper has also sought to show that communities on the Isle of Man did not wholesale adopt practices from their neighbours but rather appear to have rejected some and manipulated and adapted others to fit within their own practices and beliefs.

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[181] O'Brien 2012, 212

[182] For further discussion see Brück 1999; 2014; Brück and Fontijn 2014; Latour 1993; Thomas 2004

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One foot in sea, and one on shore: movement along the British North Sea coastline in the Early Bronze Age

Alice Rogers

This paper explores prehistoric movement along the British North Sea coastline, specifically movement facilitated by the sea itself. Firstly the concept of movement will be discussed, before looking at it within a maritime context. Then these ideas will be applied to movement along the British North Sea coast. The mechanics of travelling along a sea route are considered within the discussion of maritime havens, where potential stopping places along the coastline are identified. Finally, evidence from Beaker vessels and the burials within which they appear, is presented. This work examines how the Beaker vessels and their associated practices can provide evidence for movement along the British North Sea coast. The forms of the vessels are considered, as are their decorative traits, alongside looking at where the Beakers could be placed within burial contexts. A group of burials which provide evidence of maritime mobility are also discussed.

Introduction to movement

In the Developed World we tend to take movement for granted. Modern technologies have made it simple for us to travel even great distances. Most of us would not think twice about jumping into a car or train and visiting relatives on the other side of the country, or even exploring the world by plane or boat. Not only is movement in itself much easier, but we have developed technology which allows us to avoid movement altogether. Phones and the internet allow us to communicate with people without the necessity of being physically close, and we can even source all our subsistence needs through internet shopping. It is perhaps no wonder then that movement, in itself, has often been overlooked in the social sciences.[1] In archaeology, rather than looking at the process of movement, we have tended to focus upon the end results, for example, the objects which were deposited many miles from their place of origin. The routes these objects took and why people participated in movement have not really been explored. In many ways we still approach the subject of movement with a 'pots with legs' viewpoint. This is the Culture History approach to the archaeological record in which the people behind the artefacts were not considered.[2]

However, in recent years this tendency has begun to be addressed, as represented by sessions such as 'Past Mobilities' at the 33rd Theoretical Archaeological Group conference in 2011,[3] or the Neolithic Studies Group 2012 autumn meeting titled 'Movement and Mobility in the Neolithic'.[4]

Unlike in the Developed world, movement was fundamental to life in prehistory. Without it, people would not have been able to obtain the vital resources necessary for life, such as food and water, building materials for shelter, and clothing for warmth. Movement also allowed interaction to take place. These activities range from the small scale of daily living, such as finding food and moving around a home or settlement, to long-distance movement covering vast tracts of land and sea. All scales of movement are integral to life, but this paper will focus upon long-distance movement, movement which results in different communities interacting with each other. These communities could be neighbours living in adjacent plots of land, or they could be separated by much greater distances.

We have plenty of evidence that people during prehistory did engage with long-distance movement, for example, the Alpine jadeite axeheads were deposited up to 2,000km from their place of origin during the Neolithic period.[5] Yet long-distance movement was by no means simple in the past, which prompts the question of why people choose to undertake these journeys. Long-distance movement offers many benefits to its participants, which can be grouped under three headings: practical, social and ritual.

The practical benefits encompass access to more or new resources. These can be in terms of raw materials with specific geographic sources, such as stone types, flint or metal ores, but can also include access to other resources such as food or building materials. So, for example, an inland community might travel to the coast to gain access to the materials specific to that habitat, for example as edible resources like vegetation, water fowl or fish, or other resources such as sea-mammal bones and teeth.

Movement also provides social benefits to its practitioners, as it inevitably results in meeting new people and communities. At a fundamental level this allows the diversification of the gene pool by sourcing new mates.[6] But, just as importantly, it also forges new relationships which can then be called upon in times of need, such as a scarcity of resources. Meeting new people also provides access to new ideas, technology and knowledge.

Much work has been conducted looking at the social benefits which are provided by movement, most notably by Mary Helms in her work *Ulysses' Sail*.[7] Helms argues that in preindustrial societies, distance would have been perceived differently to how it is today. Today we know exactly where

[1] Urry 2007
[2] Johnson 2010
[3] Leary 2014
[4] Kador and Leary 2016
[5] Pétrequin *et al* 2012
[6] Lévi-Strauss 1949; Vander Linden 2007
[7] Helms 1988

we are in the world and where other lands and peoples are: there is very little left in our world that is unknown to us. In contrast, this conception of the world as a 'known' place would have been unheard of in prehistory. Instead, distance was an unknown, and thus may have been conflated with other unknowns such as danger or the supernatural, as could the items, ideas and beliefs brought back.

The difficulty and danger associated with travelling long distances and moving in the realm of the unknown can impart power and status to those undertaking the journey.[8] This idea was expanded in the work of Kristiansen and Larsson, where they associate the ability to undertake journeys with a form of masculine power.[9] As such, we should not view movement as simply a functional, practical process, but understand that it probably had a much deeper meaning in the past.

Though the benefits of movement can be grouped into these three different catagories, they all overlap to a certain extent. As mentioned already, it is unlikely for movement to take place in isolation from other communities. In addition, even travelling to access a resource (such as a specific type of rock) can be bound up in ideas concerning danger and the supernatural, and thus may have had ritual connotations or ceremonies involved in the process.

Maritime movement

This paper focusses on a particular type of movement; that conducted over the sea. This form of movement sees people using the routeways the sea provides to travel to different lands and people.

In recent years Needham used the idea of maritime movement in order to explain the appearance and distribution of the Early Bronze Age so-called 'precious cups' on both sides of the Channel.[10] The discovery of the Ringlemere gold example provided the impetus to investigate the link between the western distribution of these artefacts (along the south coast of England) with the eastern examples on the other side of the North Sea and in the Rhineland.[11] Though Needham argues that the cups themselves were not items of exchange between these communities, they represent the sharing of ideas and belief systems. Needham described the coastal communities engaging in this sea travel as belonging to a 'maritory', whereby different communities are linked by their use of the sea as a route for movement, as opposed to being linked by routes overland which would form a 'territory'.[12] The idea that movement facilitated by the sea can cause distant communities to form relationships resulting in exchange practices and shared material culture and beliefs is explored in my research.

An historical example of a 'maritory' can be found when examining the distribution of language. Along the eastern coast of Africa, from northern Mozambique to northern Kenya, a distance of almost 3,000km, the coastal language of Kiswahili is spoken.[13] It is also spoken on some of the nearby islands.[14] In this case, it is common access to the same coastline (or sea in the case of the islands) which has linked this vast region together. This 'maritory' is visible, or perhaps audible, in the common language shared along its length.

When we consider maritime movement in prehistoric Britain, we tend to do so in terms of contacts across the sea; perhaps due to the British Isles' location off the main continental landmass. Thus we think of cross-channel contacts, linking us with mainland Europe, or between our various islands. However, movement across a sea is not the only way of travelling on it. Instead, when thinking about maritime movement in the past, it is also beneficial to consider the other axis of travel that the sea offers: movement *along* its coastline. Coastal movement offers its practitioners many benefits. These have been discussed in detail elsewhere,[15] but they encompass providing a clear route, improved navigation, increased safety and opportunities for access inland.

The potential of undertaking sea voyages along a coastline has been considered in detail for the Mediterranean region, for example Broodbank's examination of the archaeology of the Cyclades.[16] One of the key texts for developing the theory of coastal movement is Braudel's *The Mediterranean in the Age of Phillip II.*[17] In this volume he discusses how much of the movement in the Mediterranean Sea would have hugged the coastline rather than risking open water. In addition to the above benefits, Braudel highlights the social implications of coastal sea travel. Travelling across a sea generally implies a single destination, whether that is a known community or just the concept of the 'other side' of the water. However, when traveling along a coastline, there are opportunities to pull into the shore numerous times. This increases the opportunities to interact on any one voyage. As Braudel describes, 'this is how the princes and notables of this world would have travelled [...] taking the time for festivities, visits, receptions'.[18]

Therefore, a community living alongside a coastline would not only be able to take advantage of following the shore as a route, but would also have opportunities to welcome visitors using the coastal route. This would increase their opportunities to take part in a maritime network and can explain the links between communities living alongside the same coastline. Evidence for coastal communities engaging in their own networks of interaction can be found dating to the Anglo-Saxon period. Along the coastline from the Wash to the Humber, there is a larger amount of Ipswich Ware found in coastal settlements compared to those further inland. This suggests that there was a distinct trading network operating along these shores that bypassed the official trading centre at York.[19] Indeed, the distribution of Ipswich Ware falls within a band 10km deep from the eastern coast-

[8] Helms 1988
[9] Kristiansen and Larsson 2005
[10] Needham 2006
[11] *ibid*
[12] Needham 2009
[13] Mack 2011
[14] *ibid*
[15] Rogers 2016a; 2016b
[16] Broodbank 2000
[17] Braudel 1972
[18] *ibid*, 104
[19] Loveluck 2013

line south of the Humber,[20] strongly suggestive of a coastal trading network.

Maritime havens

However, movement along a coastline is not enough to result in exchange and interaction taking place between different groups; instead there also need to be suitable places for this to occur. In maritime movement, and especially along coastal routes, this would involve pulling into the shore.

The shoreline itself offers an ideal location for exchange and interaction to take place in a maritime setting. Many anthropological accounts of trade and exchange in non-western settings include instances of these activities taking place on beaches. For example, in the Kula network gifts are often exchanged on the beach.[21] In addition, the Busama customs dictate that exchange 'should be carried on away from where people live, preferably alongside the road or *on the beach*'.[22]

The beach can be perceived as a suitable location for exchange due to its liminal properties. This feature of the coastline has been considered in detail by Westerdahl[23] and also by Mack.[24] These liminal properties arise from the fact that the beach marks the point where the two opposites of land and water meet,[25] but can be seen as neither, as the movement of the tide leaves it in a permanent state of flux.[26] By being a liminal area, the beach could have perhaps been seen as a suitable place for exchange and interaction to take place. Being liminal, it could have been experienced as outside of the normal social bounds of that society, so could have been a suitable place to receive newcomers, both the people from the different communities and also the objects and ideas that they may have brought with them.

If we follow the above premise, then we may surmise that we could perhaps use archaeology to detect possible coastal gathering sites that were used for exchange and interaction practices. As such, they would have had a few key features which we can look for in the archaeological record. Firstly, they would have offered easy access for coastal sea traffic. The vessels that are postulated as having been used in prehistory would not have needed built harbour constructions due to the shallow draughts of the boats.[27] Therefore, we do not need to be looking for the built harbour constructions of later periods. Instead, places such as sandy beaches and estuarine locations would have been accessible, unlike areas with high, rocky cliffs. In addition, the exchange sites would also need to have good access from the inland for the communities living there, perhaps best represented by rivers. This, once again, highlights the suitability of estuary locations for this type of site.

Though I am suggesting that natural harbours would have been used as locations for the interaction and exchange, and perhaps also production, operating in prehistory, it does not mean that there would be no material traces for archaeologists to detect. Adam Rogers argues that 'human action and use would have impacted these waterfronts'.[28] In the context of the type of human action and use envisioned for natural locations used as areas for sea-facilitated exchange and interaction, we would expect to find traces of the detritus associated from these events. This could encompass a concentration of atypical artefacts, such as rare or exotic materials (for example jet or amber), well finished flint or stone tools (such as the various arrowheads), and also other items such as pottery, which may have been items of exchange, but could also be indicative of gatherings of people in terms of feasting activities. It is also possible that if a site was highly suitable for providing this type of location, then it could have been used as such through time, and therefore may reveal this type of archaeological signature from different time periods. The important distinction to make is that the assemblage is unexpected for its liminal context. Furthermore, we would expect these finds to be relatively dispersed, so as not to indicate a settlement site, and also not include other features typical of a settlement assemblage, such as domestic items and waste.

If we apply these ideas to previously examined sites then we can start to detect potential prehistoric coastal gathering locations, or maritime havens, in the archaeological record. A rewarding starting point is the two sites which were examined by Diana Coles in her PhD thesis.[29] After examining the flintwork from the sand-dune sites at Luce and Culbin Sands, Coles concluded that the exceptionally large assemblages indicated that these sites had acted as aggregation sites during the Neolithic and Early Bronze Age. She likened their use to that of the southern causewayed enclosures, though this comparison does not hold in terms of chronology. However, what this work does show is that there are exceptional finds assemblages on beach sites, which have no immediate settlement associated with them. In addition, both of these sites with the exceptional assemblages have excellent access, both from the sea and the land, such as the Great Glen for Culbin Sands.[30]

Another potential location for a maritime haven in the literature is that of the earlier use of Hengistbury Head, Dorset. As at Culbin and Luce Sands, Hengistbury Head also had a large collection of Neolithic and Early Bronze Age flintwork.[31] In addition, the fact that the site was used as a port location during the Iron Age further supports the interpretation of it having had a similar function in the Neolithic and Early Bronze Age.

The idea of locating these more informal coastal trading centres in the archaeological record has already been considered in Anglo-Saxon research.[32] Various beach exchange sites have been identified by looking for concentrations of imported pottery and coins, for example at Oostende and

[20] *idem* 2010, 35
[21] Malinowski 1922
[22] Sahlins 1974, 236, emphasis added
[23] Westerdahl 2005, 2010
[24] Mack 2011
[25] Westerdahl 2005; 2010
[26] Mack 2011
[27] McGrail 2001
[28] A Rogers 2013, 185
[29] Coles 2008
[30] *ibid*, 189
[31] Cunliffe 1978; Gardiner 1987
[32] Loveluck and Tys 2006; Loveluck 2013

De Panne along the Flanders coast[33]. Sites have also been identified along the British North Sea coastline, such as that at Sandtun, West Hythe.[34] The authors suggest that these locations were used on a seasonal basis for fishing and also trading.

As the research presented in this paper is concerned with detecting a coastal network operating along the British North Sea coast during the Neolithic and Early Bronze Age, a preliminary study was conducted looking for potential maritime havens along its coastline. Based upon what has already been discussed concerning the need for easy access from the sea, only large areas of sandy beaches were examined. Furthermore, due to isostatic uplift, only locations to the north of the River Tees were considered, as it represents where the prehistoric coastline is more likely to have survived intact.[35] In order to identify potential sites, archaeological databases were explored to locate any exceptional assemblages. Since most of the area under consideration in this preliminary study was along the Scottish coastline, Canmore was the primary database used (Royal Commission on the Ancient and Historical Monuments of Scotland database),[36] though for the English locations the Historic Environment Records,[37] Portable Antiquities Scheme[38] and Archaeology Data Service[39] were also employed.

The sites which were identified in this brief survey as providing potential coastal gathering places along the British North Sea coast were Forvie Ness, Aberdeenshire, Montrose Basin, Angus, Tentsmuir, Fife, and finally possibly the area around Holy Island in Northumberland. Probably the most likely of these sites is that at Tentsmuir in Fife. Tentsmuir is a coastal dune site on the southern headland of the estuary, thus providing it with both sea and land access. Several archaeological surveys have been conducted at this coastal site, such as that by the Forestry Commission and Headland Archaeology in 1997, or the finds recovered by Coutts.[40] The records on Canmore show an exceptional assemblage of not only flint work (such as barbed and tanged arrowheads), but also include items made of exotic materials, such as jet beads and amber beads.

Tentsmuir is a site which meets all the requirements for a maritime haven. Its geography lends itself to access, both by sea and by land. The assemblage of finds contains several uncommon artefact types and well-finished examples. In addition, the evidence of exotic materials, such as the jet and amber, indicate movement of people from the materials' sources to the deposition location, in these cases from along the British North Sea coast in Yorkshire and perhaps East Anglia. Finally, the archaeology at Tentsmuir also displays a continuity of use over a long period, from the Mesolithic through to the Bronze Age. There is even some evidence of use of the site during the medieval period.[41]

The British North Sea coastline

My doctoral research, which forms the subject of this paper, was designed to determine whether communities during the Neolithic and Early Bronze Age were exploiting the British North Sea coastline as a route for movement. Movement, in itself, is difficult to detect archaeologically, especially movement by water, where physical traces of the route would not exist and survival of the vessels used would be limited.[42] Therefore, in order to archaeologically detect movement we have to look for proxies. As discussed above, one of the primary motivations for undertaking movement is to gain resources. This can be something as quotidian as food or material for shelter, or something more intangible, such as experience or knowledge. Evidence of foreign items or ideas can therefore provide insight into the movement patterns of that community. If we find separate places with similar material culture and practices in the archaeological record this could be indicating movement occurring between the communities.

For my research a methodology was designed in order to attempt to detect interaction and exchange resulting from coastal movement along the British North Sea coast. A study

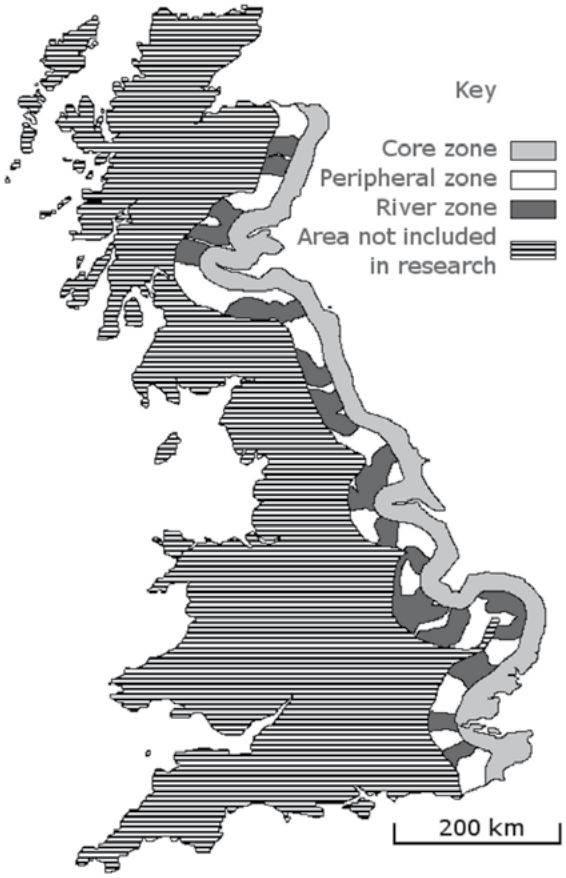


Fig 1 Map of Britain showing the zones used in this research

[33] Loveluck and Tys 2006, 144
[34] *ibid*, 150
[35] Shennan and Horton 2002
[36] Canmore <https://canmore.org.uk/> (23 March 2015)
[37] HERS <http://www.heritagegateway.org.uk/gateway/chr/default.aspx> (2 April 2015)
[38] PAS <https://finds.org.uk/> (25 March 2015)
[39] ADS <http://archaeologydataservice.ac.uk/> (2 April 2015)
[40] Coutts 1971
[41] Canmore ID 105318
[42] Van de Noort 2006

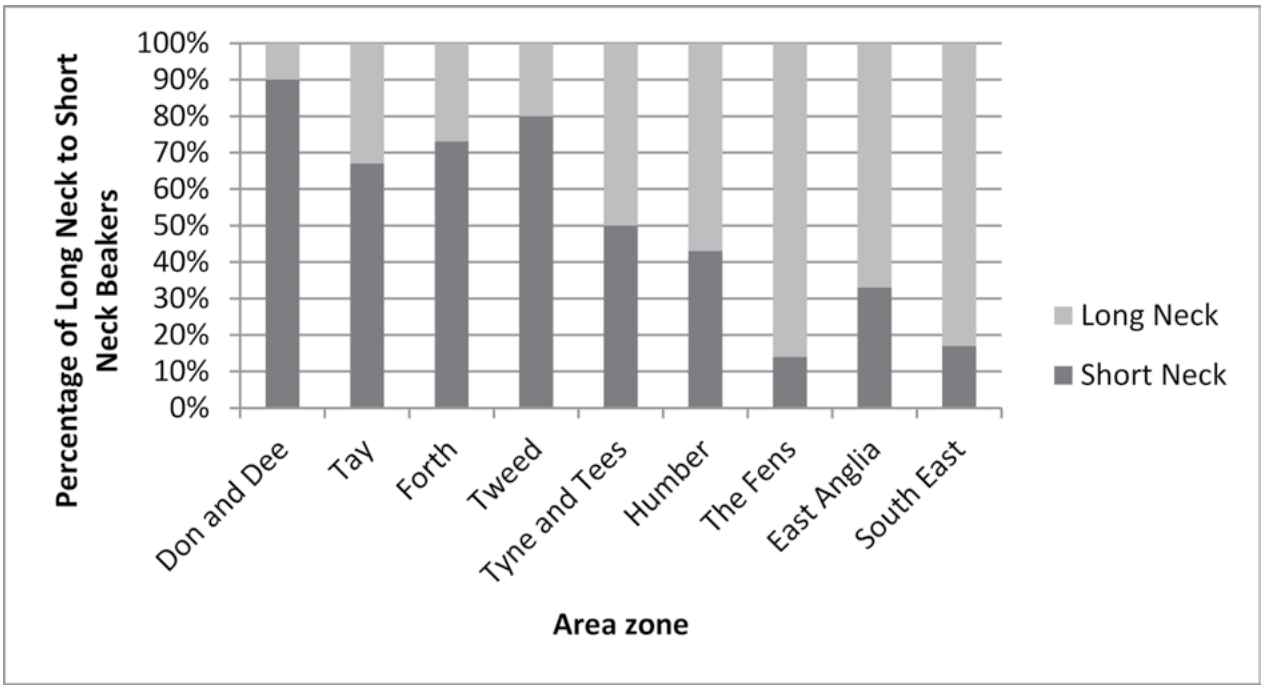


Fig 2 Graph displaying the proportions of Short and Long Neck Beaker vessels with each other in the zone along the length of the British North Sea coastline

area was selected encompassing land within 50km of the present-day coastline (with the area around the Wash being the only exception where the study area was extended further inland, to take account of land reclamation). In order to detect coastal interaction, this study area was further divided in relation to access to the coastline, the hypothesis being that communities living in areas with good access to the sea were more likely to use it than those living further away. To this end, land falling within 20km of the sea is considered the 'core' zone, and that between 20 and 50km termed the 'peripheral' zone (Fig 1). I hasten to add that these terms are in no way related to earlier core / periphery models used in archaeology. Instead, these terms are merely describing the spatial relationship of that location with the sea. The 'core' zone represents the land which has good access to the coastline, so the ability to use it on a daily or regular basis (based upon an average walking pace of five kilometres an hour, so journey times of up to four hours to reach the destination). The communities living in the 'peripheral' zone, due to their greater distance, are more likely to have used the sea on a less frequent basis. However, since previous research[43] has suggested that many journeys were undertaken along river courses, this possible mode of transport was also factored into the research with the addition of a 'river zone' (see Fig 1). This corresponds to the land within 10km of large rivers running through the peripheral zone, and thus taking into consideration the routeways that rivers would have provided in the past.[44]

As stated above, the hypothesis that this research is based upon is that those communities living in areas with better access to the coastline are more likely to engage in interaction facilitated by movement along its length. If we apply this to the different zones defined in my research, then we would expect to see more evidence of interaction in both the 'core' and 'river' zones. The idea that communities living alongside the coastline would take advantage of the route it offers for interaction is logical if we consider their physical relationships to other communities. Working from the premise that engaging in movement and exchange was attractive to communities, then we would expect a community to make as many contacts as possible. However, if we only consider land-based movement, then the available routes for movement are limited for the communities living alongside the coastline. If, however, we do include sea-based movement, then the opportunities for interaction are vastly increased. Not only can we now include movement in either direction along the coastline, but we can also consider movement across the sea. Therefore, it is possible to argue that communities living alongside the coast actually end up with more easily available opportunities for interaction than those further inland.

Preliminary results: the Beaker evidence

In order to detect whether the British North Sea coastline was being used as a route for movement in the Early Bronze Age, a subset of the project's database was examined; the Beaker vessels, both those deposited within burials contexts and those from monuments. This particular subset of data was chosen for a number of reasons. Firstly, Beaker chronology is well understood and is based upon a good dataset

[43] Davison *et al* 2006; Haughey 2012

[44] Haughey 2012

	Short Neck Beakers		Long Neck Beakers		
River zone	**Number**	***χ² value***	**Number**	***χ² value***	**Total**
Don and Dee	19	*49.42*	2	*49.42*	21
Tay	2	*0.08*	1	*0.08*	3
Forth	8	*2.99*	3	*2.99*	11
Tweed	8	*5.29*	2	*5.29*	10
Tyne and Tees	1	*0.02*	1	*0.02*	2
Humber	15	*24.50*	20	*24.50*	35
The Fens	1	*8.94*	6	*8.94*	7
East Anglia	2	*2.02*	4	*2.02*	6
South East	1	*3.42*	4	*3.42*	5
Total	57	*96.68*	43	*96.68*	100
$\chi^2 = 193.36$					

Table 1 χ^2 results for proportion of Short Neck and Long Neck Beaker vessels along the British North Sea coastline

of radiocarbon dates.[45] Therefore, changes through time are understood and will not be confused with evidence for interaction. In addition, they form a discrete set with at least one aspect in common; this means that they are comparable with each other. Finally, the numbers involved within this dataset, 177 Beaker vessels, provides a good number for a preliminary study, as there are enough to detect meaningful patterns.

The 177 Beaker vessels within this dataset correspond to 138 burials (containing 164 vessels) and thirteen depositions of Beaker vessels in nine monuments. These vessels were then assigned to a chronological period based upon Needham's 2005 scheme.[46] As expected, the majority of vessels fall within his 'Beaker as an instituted culture' phase, 2250–1950 cal BC, with 147 vessels belonging to this period.

The Beaker vessels have several potential ways to demonstrate evidence of interaction taking places between communities within the study area. These can be grouped under both quantitative and qualitative analysis. Quantitative analysis can examine the various distributions of these vessels along the coastline, looking at the numbers within the different zones (based on river catchments). Qualitative analysis, on the other hand, can examine aspects such as the vessel style and provide detailed context considerations.

Using Needham's classification of Beaker styles, the two most common forms appearing within the British North Sea coastal zone are the Short Neck and Long Neck varieties. These two types, however, appear to have different distributions. The further north along the British North Sea coast, the greater the proportion of Short Neck to Long Neck vessels, and vice versa heading south (Fig 2). The fact that these types of Beaker are not distributed equally along the coastline is supported by a very high degree of significance when undertaking chi-squared analysis on the figures. The chi-squared result for a test looking at the distribution of Short and Long Neck Beaker vessels along the British North Sea coastline was very high, with $\chi^2 = 193.36$ (Table 1), when in order to achieve a significance of 0.001 only a value of 26.12 is needed. This clearly shows that the distribution of these vessels is not equal along the coastline considered in this research. Instead, the results perhaps suggest smaller zones of interaction operating within the larger British North Sea coast zone. These results are supported by research conducted into the Early Bronze Age mortuary practices of Northumberland by Fowler, who notes that Short Neck Beakers are found 'widely between Yorkshire and Aberdeenshire, and people in the North East of England were clearly involved in intra-actions within this extended region'.[47]

Though the results suggest that certain types of Beaker vessels were more prevalent along certain parts of the British North Sea coastline, it does not suggest restricted zones of interaction. While Short Neck vessels were far more numerous in the zones north of the Humber, they still occurred in the south. What this distribution perhaps shows is more regular contact occurring between nearby communities living alongside the British North Sea coastline, and perhaps less regular long-distance voyages. This is the sort of pattern that we would expect to occur when looking at the contacts between communities sharing the same coastline, with regular trips occurring between close communities and longer, arguably more dangerous and complex journeys happening on occasion. This idea is perhaps emphasized by the fact that a similar, but opposite, pattern occurs with the distribution of the Long Neck vessels; showing more regular contact in a restricted geographical area (this time the south), but also evidence of longer-distance contacts.

In addition, this distribution is supported by analysis on other items of material culture from the Early Bronze Age period. A good example of this is the circulation of the jet v-bored buttons.[48] Not only are these produced of a material whose source is along the British North Sea coastline (the jet originating from the Whitby area), but the map of findspots shows that many of these objects can be found along this route.[49]

[45] Needham 2005; Sheridan 2007; Healy 2012

[46] Needham 2005

[47] Fowler 2013, 120

[48] Shepherd 2009

[49] *ibid*, 338, fig 1

Name	Zone	Age and sex	Head direction	Side	Location	Grave goods
Ferry Fryston B – Grave 2241	Humber	Mature male	E	L	Flat Grave	Beaker, bronze dagger, flint knife and awl, wristguard, amber ring
Ferry Fryston – Grave 1	Humber	Unknown	?	?	Monument	Beaker, bronze awl
Heslerton – Grave 2BA217	Humber	Adult male	E	L	Flat Grave	Beaker, jet button
Barnack – Bural 34	The Fens	Neonate	NW	L	Monument	Beaker, flint flake
Barnack – Burial 28	The Fens	Mature Male	NE	L	Monument	Beaker, bronze dagger, wristguard, ivory(?) pendant
Beauforts – BNF04	South East	Mature female	W	L	Monument	Beaker, flint scraper

Table 2 Burials with the Beaker vessel placed below the deceased's legs

A further way in which Beaker vessel evidence can reveal interaction along the British North Sea coast is by looking at their use within burials. One way that this can be achieved is by examining their position in the grave in relation to the deceased.[50] Following on from methodology applied in previous research,[51] the position in which an item could be placed in the grave in relation to the deceased was divided into a series of zones. The items could be placed in association with one of three different areas of the body: the head, the torso and legs. In addition, the item's relationship to the position of the deceased was also recorded, in terms of whether it was placed in front of the body or behind it. In some cases the item could be placed towards one of the ends of the grave, if it was the skull end this was described as 'above', and 'below' if at the feet end.

If we examine the position of the Beaker vessels in those graves with relevant information, we find that a Beaker can occupy any position around the body of the deceased. However, there do seem to be preferences, for example, 77 per cent of all the burials have the Beaker placed behind the body. Furthermore, though Beakers could be placed in any position in relation to the deceased, 42 per cent of burials along the British North Sea coast had the Beaker placed behind the head. Burials displaying this positioning can be found the length of the British North Sea coast, from Kent up to Aberdeenshire, with only a couple of blank areas on the distribution map (the Forth and East Anglia zones). The prevalence of this Beaker positioning could be evidence of a sharing of burial practices along this coastal route. Other similarities within Beaker burials indicative of interaction along the British North Sea coast, specifically between Yorkshire and Aberdeenshire, have been highlighted in Shepherd's recent work.[52]

Overall trends within the burial record are not the only way of indicating exchange and interaction. At the opposite end of the scale a small group of burials exhibiting similar practices can likewise show contacts between communities. A good example of this occurring in the Beaker evidence along the British North Sea coast can be detected in the burials which have the Beaker vessel placed at their feet (Fig 3). This group comprises six burials which share similar traits (Table 2). Perhaps one of the most noticeable similarities between the burials is the context of the grave itself. In four out of the six cases the burial is located within a barrow, with three graves occupying the centre position. In addition, the two burials which are recorded as flat graves are actually located within the barrow complexes of Heslerton and Ferry Fryston respectively, thus continuing the trend of monument association. The burials are also all aligned on an E-W axis.

If we examine the grave goods interred with the burials, then more similarities emerge. All are buried with at least one additional item of material culture to the Beaker vessel, ranging from a flint flake to items of adornment and weaponry. However, there are discrepancies between the levels of furnishing of the burials, with the three male graves being better furnished than the female and neonate. Two of these male graves are strikingly similar (Ferry Fryston B, Grave 2241 and Barnack 28). In both cases the male individual is buried with a dagger and wristguard, along with an item of adornment (a pendant and amber ring respectively). Both graves are also very similar in size, with that at Ferry Fryston B being 3.31m^2 and that from Barnack 3.08m^2.

The similarities between these two burials belie the distance between them (over 130km as the crow flies), and suggests contacts between the two communities. Though an overland route is possible between these two locations, there are also excellent links via the British North Sea coast. The burial at Barnack is located less than 300m from the present day course of the River Welland, and the burial at Ferry Fryston B is less than 600m from the River Aire; both of which drain into the North Sea. It is therefore conceivable that the similarities between these graves arose from contacts borne upon coastal maritime movement along the British North Sea coast. Further support for at least one of the individuals being involved in sea travel comes from the pendant within the Barnack grave, which is suggested to be of sperm-whale or walrus ivory.[53]

The objects placed within these burials speak of distant contacts. The wristguard interred with the individual at Ferry Fryston B was made from Group VI stone from Langdale, Cumbria, and the amber for the ring could have been sourced where it had washed up along the East Anglian coastline or even further afield in the Baltic.[54] Additionally, the gold studs decorating the wristguard in the Barnack burials could have been sourced from Ireland (though it has been suggested that some gold was even imported into

[50] Tuckwell 1975
[51] A J Rogers 2013
[52] Shepherd 2012
[53] Donaldson *et al* 1977, 210
[54] Beck and Shennan 1991



Fig 3 Map of burials where the Beaker was placed below the feet; Ferry Fryston Grave 1, Ferry Fryston B Grave 2241, Heslerton Grave 2BA217, all Yorkshire, Barnack Burial 28 and Burial 34, Cambridgeshire and Beauforts BNF04, Kent



Fig 4 Distribution of Beakers which feature multiple zigzags in their decoration; Heslerton IR270, Garton Slack 75 Burial 3, Garton Slack C63 Burial 3, Garrowby Wold 104 Burial 1, all Yorkshire, Cairnpapple Hill Grave SH8, West Lothian, and Chatton B2 and B3, Northumberland; illustrated Beaker is from Chatton B2

Ireland itself).[55] Clearly the objects in these two graves were deliberately making references to the far-flung contacts of the individuals, and by extension, their communities. The similarities between the graves suggest that one of the axes upon which they were travelling was the British North Sea coast.

Another way in which evidence of interaction can be detected within the archaeological record is by looking at the decorative traits of the Beaker vessels. Common decorative styles on the Beakers can reveal communities sharing ideas and visual references. This can point to specific geographical networks, long-distance contacts, and also reveal how some communities adapt foreign influences into a local context.

Some styles of Beaker decoration display geographical distributions which suggest sub-networks of contact operating within the overall British North Sea coast zone. Two particular decorative traits demonstrate this well. The first is the group of vessels which have areas filled with repeating, closely spaced zigzags (Clarke's Beaker Motif Group 3.20 and 5.37).[56] These have a restricted distribution encompassing the area from the Humber to the Forth (Fig 4). In addition to the similar decorative styles, these vessels were also placed in very similar contexts of deposition, which is a grave within a monument. In fact, of the burials which had information regarding their exact placement within the monument, five out of six were placed centrally. The combination of similar decorative traits and context emphasize the likelihood of contact between these communities.

Another decorative trait evident on the Beakers of the British North Sea coast which seems to indicate a sub-network of movement and contacts consist in multiple rows of filled triangles hanging in the same direction (Clarke's Beaker Motif Group 4.29).[57] In contrast to the Beakers discussed above, which had a northern distribution, vessels displaying this trait are all found within the Humber zone or further south (Fig 5).

A particular decorative trait which seems to suggest long-distance contacts is found on vessels featuring linked, filled lozenges (Clarke's Beaker Motif Group 4.33).[58] The distribution of vessels with this trait seems to suggest its origin, or at least widespread adoption, within the Humber zone, where there are five Beakers displaying this style of decoration. However, this dataset also contains two outliers from

[55] Standish *et al* 2014
[56] Clarke 1970
[57] *ibid*
[58] *ibid*



Fig 5 Distribution of Beakers which feature multiple rows of filled triangles hanging in the same direction; Saxton Burial 3, Hedon Howe 281 Burial 4, Aldro 54 Burial 1, all Yorkshire, Elms Farm Pit 24305, Essex, Monkton-Mount Pleasant Grave 6371 and Manston Burial 1, both Kent; illustrated Beaker is from Hedon Howe 281 Burial 4



Fig 6 Distribution of Beakers which feature linked lozenges in their decoration; Catterline, Aberdeenshire, Aldro 116 Burial B, Hanging Grimston 56 Burial 4, Garton Slack 37 Burial 6, Garrowby Wold 104 Burial 1, Ferry Fryston B Grave 2241, all Yorkshire, and Berden, Essex; illustrated Beaker is from Ferry Fryston B Grave 2241

this main distribution, in the furthest northern and southern zones (the Don and Dee and South East) (Fig 6). The group of burials containing this style of Beaker forms a fairly cohesive set within the Humber zone, especially in terms of the orientation of the grave (around the E-W axis), the position of the inhumation (generally on its left-hand side with the head towards the west, the only exception being the female who was buried on her right side with the head to the east), and also the other items within the grave. These items include martial equipment, such as daggers, maces, wrist-guards, and also items of adornment, including jet buttons and amber rings.

The two graves which contain Beakers decorated with the same motif, but located away from the main distributions of the vessels, display both similarities and differences to the group in the Humber zone. The burial within the Don and Dee zone shares the same alignment as those from the Humber, and, in addition, has the Beaker placed in association with the interment's legs, another common trait. However, the grave also has evidence of local practices, such as burial within a cist.

The grave in the South East zone appears quite different to those already discussed. For example, the posture of the deceased within the grave contrasts with the burials in the main distribution, in that the person was lying in an extended position on their back. However, we can also detect similarities between the graves, pointing towards knowledge of another community's burial practices. Once again the Beaker was placed in association with the legs of the deceased, and the inclusion of a bronze armlet as part of the grave goods suggests similarities with the well-furnished graves in the Humber zone.

The above discussion of Beaker styles has started to show how foreign influences gained by movement and interaction can be incorporated into more familiar local styles. The selective use of foreign influence can occur for different reasons. It could have been a way for the home community to continue to assert their own identity, even under the pressure of contact. Another possibility as to why foreign influences can be detected within local contexts can be found within the work of Mary Helms.[59] In her work looking into travel she discussed how distance could have become linked with danger in pre-industrial societies. Therefore, the items, or ideas, which were bought back from long distances could be considered dangerous by association.[60] Using the items

[59] Helms 1988

[60] *ibid*

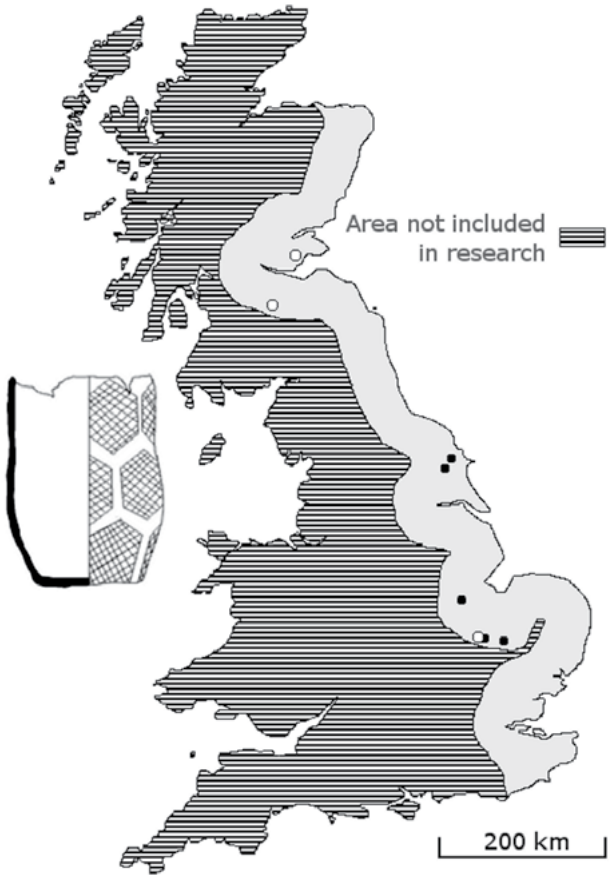


Fig 7 Distribution of Beakers which feature filled hexagons in their decoration; Heslerton Barrow 1L, Acklam Wold Burial 1, both Yorkshire, Tallington Pit Grave, Lincolnshire, Low Grounds F1080 and Waterhall Farm Grave 1, both Cambridgeshire; illustrated Beaker is from Heslerton Barrow 1L. Beakers marked with white points are examples of Beakers with the similar filled lozenge decoration; Balfarg Henge Grave, Fife, Biggar Common Pit, South Lanarkshire and Low Grounds F1068, Cambridgeshire

with foreign influences within a local context could be perceived as mitigating or controlling some of these dangers.

A possible example of this occurring in the British North Sea zone can be found when looking at the distribution of a particular Beaker style. The vessels which were decorated by filled hexagons (Clarke's Beaker Motif Group 4.34)[61] tend to have been deposited within the Fenland zone, often within the graves of females whose bodies had been placed on their right side with heads to the north (Fig 7). However, one vessel found in the Humber zone was treated quite differently. In this case the Beaker was not placed in a grave at all. Instead, it was smashed upon the ground surface at the north side of a monument. The similarity in decoration between the Beakers shows that interaction was taking place between these communities, but the different context shows how foreign influences could be absorbed into a local milieu.

Conclusions

The preliminary results reported above are part of a wider project to examine movement and interaction along the British North Sea coast during the Neolithic and Early Bronze Age. The findings show the potential of considering a coastal movement route in prehistory, with links evident between several different regions. However, it also shows the benefits of moving beyond the straightforward notion of exchange as a trade in goods and merely examining the distribution of foreign objects. Instead, what this research shows is that exchange and interaction can manifest themselves in many different ways within the archaeological record, and that determining a community's attitude to foreign ideas and influences can reveal its attitudes to long-distance movement.

This research looks at movement as a whole. It considers the routes that may have been taken, the locations where interaction between communities could have happened, and how the foreign influences were incorporated into local practices. By approaching the subject in this way we will hopefully be able to understand such a fundamental part of prehistoric peoples' lives.

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[61] Clarke 1970

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Mapping the flow: introduction to Atlantic Europe and the Metal Ages project

Catriona Gibson, Peter Bray, Kerri Cleary, Fernando Fernández Palacios and John T Koch

In order to approach the subject of connectivity and the exchange of objects and ideas between different parts of Europe's Atlantic façade in the Bronze and Iron Ages, the inter-disciplinary 'Atlantic Europe in the Metal Ages' project brings together multiple strands of evidence not normally considered in conjunction: settlement and funerary archaeology, archaeometallurgy, stelae iconography and linguistics. Drawing on these varied strands of evidence, the project also takes a fresh look at prehistoric group identities and the origin of Celtic languages.

Introduction

Atlantic Europe in the Metal Ages (AEMA) is an interdisciplinary project, funded by the UK's Arts and Humanities Research Council (AHRC), that has been set up to explore the nature, scales and directions of interaction and exchange in Britain, Ireland, Armorica and the western Iberian Peninsula from *c* 2900 to *c* 700 BC. The research is being undertaken by a core team of archaeologists and linguists at the University of Wales and Oxford University, but also involves collaboration from Bangor University and the Department of Digital Humanities at Kings College, London. The interdisciplinary nature of the project provides a significant opportunity to superimpose numerous layers of different types of data, many of which would not usually be brought together and compared. The large interactive open-source GIS database holding all these datasets will be accessible for use and updating well beyond the life of the project, thus providing an important resource for future research. The database will also include Iron Age and place name evidence gathered in the earlier AHRC-funded 'Culture and Celtic Speech' project. The resulting multidisciplinary resource will allow experts in various fields and the public to draw informed conclusions concerning alternative models of Celtic origins, tracing the potentially numerous and complicated networks of connectivity, and periods of dis-connectivity, that existed throughout Atlantic Europe between the third and first millennia BC.

Impetus for the project and research questions

There is both general and more specific impetus for the AEMA project. The general desideratum is for researchers working on different aspects of the later prehistory and protohistory of western Europe to be able to move more easily across disciplines and national boundaries to compare detailed evidence at a non-superficial level.

A more specific motivation arises from Celtic studies. Although few researchers working today in subjects that could be termed 'Celtic' would regard themselves as encompassing the entire field (eg language, literature, history, archaeology, all periods, all regions), there is a shared narrative of Celtic origins. According to this standard account, the Celtic languages and groups identified as 'Celts' (*Keltoí* in Greek sources, *Celtae* in Latin, etc) first emerge in the Early Iron Age in west-central Europe, then spread from there together with Hallstatt and La Tène material culture.[1] Even when not spelled out explicitly, this model underlies current work by experts in many fields, as well as being deeply entrenched in public consciousness. However, when scrutinized directly, the Iron Age central European model of Celtic origins (IACEMCO) is now widely recognized to be obsolete.[2] There is little to commend it as an explanation for how Celtic languages came to be spoken in Britain and Ireland, there being no convincing evidence for mass in-migration of users of Hallstatt and La Tène material or 'Celts' from the Continent.[3]

It is in dealing with evidence from the Iberian Peninsula that the IACEMCO becomes, rather than unhelpful, simply impossible. On the one hand, there is a dearth of evidence for intense contacts with central Europe during the Iron Age, thus contrasting with the range of shared artefact types and complex practices across the Atlantic zone during the Beaker Copper Age and Atlantic Late Bronze Age. On the other hand, we find peoples called *Keltoí*, *Celtici* and *Celtibēres*,[4] and there is abundant evidence for ancient Celtic languages spoken in what is now Spain and Portugal.[5] Furthermore, the Hispano-Celtic languages are attested from an early date (at least by the seventh century BC; see below) and show a range of linguistic archaisms not found in Celtic linguistic evidence of northern Italy, Gaul, Britain and Ireland. In Palaeohispanic studies the IACEMCO is often revised as: for 'Hallstatt Early Iron Age' read 'Urnfield Late Bronze Age'.[6] But this revision does not solve the problem, as the clearest evidence for Urnfield influences in the Peninsula is found in north-east Spain in Catalonia, where

[1] Further to this section, see the longer treatment of Koch 2013b

[2] eg James 2000; Cunliffe 2001; Collis 2003

[3] Koch 2007

[4] Collis 2003, 110; Koch 2014

[5] Hoz 1992; Villar 2004

[6] As already set out in Bosch-Gimpera 1942

the non-Indo-European Iberian language was spoken in pre-Roman times.

Another key detail of the pre-Roman languages of the Iberian Peninsula is that archaic Celtic languages are found side-by-side with other Indo-European languages that agree in some, but not all, significant ways with the developments of the Celtic branch of the family. To provide a single comparison, we may take the place name *Segontia Paramika*, recorded in north-central Spain in the Ptolemaic Geography. The first element is clearly Celtic, comparable, for example, to *Segontium*, the ancient name of Caernarfon. *Paramika* means 'paramount', a word built as on a preposition *par-* 'in front of' + a superlative suffix *-am-* + adjectival suffix with the feminine ending *-ika*. All of that too is very Celtic, except the fact that *par-* preserves Indo-European **p*, which is regularly lost in this position in the Celtic languages. Therefore, *Paramika* must be counted as 'pre-Celtic', 'para-Celtic', or 'Celtoid' by definition.[7] Not far away, the Celtiberian language supplies the word VERAMOS 'supreme' with the same typically Celtic superlative suffix. But in this word the **p* of older **uper$_a$mos* has been lost in diagnostically Celtic fashion.[8] In other words, ancient Celtic and its nearest kin are found in close quarters in Spain. This pattern would be expected near the epicentre of the innovations marking the emergence of Celtic from Proto-Indo-European and not if the language had first evolved far away, then arrived in Spain by mass migration or other means, fully developed.

In the light of the foregoing, if the IACEMCO is not merely to be called into question, but replaced by a superior account of Celtic origins, this will require looking behind the Iron Age and into the Bronze and Copper Age backgrounds of the regions where ancient Celtic languages are found. It will also require re-examining the evidence from the Atlantic regions, setting aside the assumption that Celtic spread to these parts having first evolved near the source of the Danube. While we do not presume to provide a new, universally acceptable answer for the question of Celtic origins, we will make a large corpus of the evidence necessary to reach an informed conclusion on this question accessible to all.

The database and the datasets employed

Increasingly, archaeological researchers are using open-source GIS databases for collating, analysing, visualizing and sharing their work (eg ArchAtlas, English Heritage Atlas of Rural Settlement in England [EHARSE] and English Landscapes and Identities [EngLaID]).[9] The AEMA project benefits from the technical expertise of the Digital Humanities Team at Kings College, London, who have designed a robust, relational GIS database where each detailed entry is attached to co-ordinates, images, metadata and, where available, AMS radiocarbon determinations. By project completion, it is envisaged that hundreds of thousands of entries will have been input. For philology, datasets comprise place names, personal names and inscriptions, and the languages under consideration include Ogamic Primitive Irish, ancient Brittonic, Gaulish, Lepontic, Celtiberian, Callaecian (northwest Hispano-Celtic) and the language of the south-western inscriptions (also known as Tartessian), as well as Lusitanian (an Indo-European, but probably non-Celtic, Palaeohispanic language).[10]

The principal archaeological datasets are burials, settlements, hoards and metal deposition, the chemical analysis of metals and graphical representations (rock art, stelae and statue menhirs). The data can be analysed at various spatial and temporal scales, from local and regional to supra-regional, and from shorter time-brackets (eg phases covering 100–200 years) to longer-lived phenomena (eg the Bell Beaker complex, the 'Atlantic Bronze Age'). With the recent significant advances in AMS radiocarbon dating and the ability to employ Bayesian modelling, the project aims to provide more precise chronological brackets for exploring some of the key developments for the Copper and Bronze Ages of Atlantic Europe. Some concerns that the project is addressing through thematic queries include the emergence and development of the 'Bell Beaker Phenomenon' and the multiple interaction networks that can be witnessed during this time. Drawing on geographically extensive datasets will help shed further light on the complex nature of the spread and intermingling of the Bell Beaker 'package' throughout the various Atlantic regions where it was adopted. This 'package' represents an eclectic mixture of different objects with different origins and inspirations, accompanied by innovative technological, ideological and funerary traditions.[11] Mapping the ways in which these materials, practices, ideas and knowledge-sets were selected in distinct ways and at different times, but then superimposed on to, or adapted by, various local social groups, will reveal further complexities in the nature, scale, influence and intensity of such interaction networks, and the various directions of flow in different regions.

The database will also help date the spread of innovative technologies (such as in metalworking [eg tin bronze][12] or ceramic production) with more accuracy, and trace transformations in rituals and ideologies over time with more conviction, as witnessed through changes in burial and social practices. Other relevant developments include addressing continuities versus discontinuities in interaction networks during the subsequent Early and Middle Bronze Ages. Data collection will permit a detailed exploration of possible reasons underpinning the much more intensive reactivation of connectivity in Atlantic Europe in the Late Bronze Age. The research will also consider the potential ramifications of all these ebbs and flows of interaction with regard to changing social, technological, and ideological systems, including the question of transmission and sharing of languages. This linguistic dimension can be considered as a theoretical implication of measurable intensity of contacts

[7] Ballester 2004b

[8] Wodtko 2000, 444–5, 459–60; Jordán 2004, 391–2

[9] Web sites include ArchAtlas 4.1 <http://www.archatlas.org/Home.php>; EHARSE <https://historicengland.org.uk/research/current/heritage-science/atlas-of-rural-settlement-in-england/>; EngLaID <http://www.arch.ox.ac.uk/englishlandscapes.html> (14 June 2016)

[10] Wodtko 2010

[11] cf Brodie 1997; Müller and van Willigen 2001; Vander Linden 2006; Haak *et al* 2015; Kristiansen *et al* 2017

[12] Pare 2000

and complexity through exchanging information. It will also be possible to consider in much greater depth the Bronze Age background of the locatable linguistic evidence of inscriptions and ancient place names in the context of multi-period landscapes.

The archaeological researchers are collecting evidence from diverse sources, but in particular are employing the large quantities of data generated from developer-led investigations throughout Europe over the last twenty years or so; much of it unpublished grey literature. Dealing with datasets that cross modern political boundaries requires an appreciation of the inherent biases in the resource, and this is particularly pertinent with metal objects (single finds or hoards). These include the conditions of recovery that reflect the history of archaeological research in various countries, the predominant economic regimes that may have promoted recovery – such as deep ploughing or peat cutting – and different types of archaeological legislation and planning policy, including the Portable Antiquities Scheme (PAS), which have been introduced in some countries but not others. Since metal detecting is illegal in some countries (eg Spain and Portugal), it is perhaps unsurprising that far fewer metal objects are known in the archaeological record from certain regions such as Iberia, and most have been recovered by accident (dredging, ploughing etc), thus lacking good contextual information (Fig 1). These quantitative and qualitative biases will be factored into the overall analyses, to ensure that the emergent patterns are not interpreted in misleading ways.

Why this project is so timely

In several key respects, the AEMA project is an outgrowth of the earlier AHRC-funded 'Culture and Celtic speech' project (2000–2004), also based at the University of Wales. One of the core activities of that project was to map ancient Celtic group and place names alongside distributions of over two hundred Hallstatt- and La Tène-type artefacts and sites.[13] The resulting correlations nicely confirmed the traditional picture of the spread of Celticity from west-central Europe into northern Italy and eastward down the Danube basin. The Iron Age evidence, however, could not be easily squared with traces of the early Celtic languages further west, especially in the Iberian Peninsula. It thus appeared likely that earlier archaeological stages might be relevant.

In the meantime, there have been major advances with the ancient Celtic languages, including new discoveries and improved readings of previously known inscriptions, as well as renewed philological work on the many hundreds of Celtic names recorded in Greek and Roman texts. Although involving the work of many individual researchers in various countries, two notable initiatives in this period were the Hesperia project on Palaeohispanic inscriptions and a series of projects undertaken at Aberystwyth University on Ancient Celtic names.[14] At the University of Wales and Oxford University a particularly seminal area has been the new discoveries and on-going interpretive work on the corpus of inscriptions on stones of Early Iron Age date from southern Portugal and south-west Spain,[15] which is discussed further below.

Recent developments in archaeology, including scientific techniques such as isotope and ancient DNA analysis, chemical analysis of metals and the widespread use of AMS dating, have all contributed to tracing the movement of objects and people in the past with more conviction, and have demonstrated that past interaction was complex and multi-layered, but also often subtle and difficult to detect. Numerous different webs of connectivity were undoubtedly flowing simultaneously. This has been abundantly demonstrated with recent approaches to the Beaker phenomenon, as mentioned above. Some of the older models of interaction, however, were restricted to more simplistic depictions on maps. Examples include arrows pointing in one or a maximum of two directions, or expanding waves or contours indicating which areas were in contact with others and how ideas, technologies and object styles potentially spread from one nexus to another.[16] These kinds of distribution maps tend to focus around a single theme or upon specific artefact types, and patterns are gleaned from restricted datasets studied in isolation, such as the overall distribution of Bell Beaker pots or the spread of tin bronze. In order to trace the more complicated and indeed 'messy' networks of interaction[17] that were at play and depict these in more finely nuanced ways, we need to employ new investigative tools that embrace more integrated studies. As these data can be interrogated at a number of different scales of analysis, the levels of connectivity can be mapped both chronologically and spatially, from the local to the supra-regional. The following sections will briefly introduce some of the key research themes that are currently being undertaken as part of the project's remit.

Thematic research area I: some settlement and burial patterns in Early–Middle Bronze Age Ireland

Metalwork and its technologies of production are long-established as a means by which to identify connections between Ireland and various regions of the 'Atlantic façade', such as a non-Irish type Early Bronze Age ear ornament/pendant from Benraw, County Down, that can be paralleled with remarkably similar objects known from Portugal (Ermegeira and Cova da Moura for example),[18] or the distribution of Late Bronze Age Class A and B Atlantic cauldrons in Ireland, Britain, France and the north-west Iberian Peninsula.[19] To fully understand the meaning and intensity of these contacts, however, we also need to examine other aspects of society such as settlements, burial and ritual systems. Can these manifestations of social and economic organization be considered as varied interpretations of an archetypal concept visible across Atlantic Europe at

[13] Koch *et al* 2007

[14] eg Raybould and Sims-Williams 2007; Falileyev *et al* 2010

[15] Cunliffe 2013, 244–5; Koch 2013a

[16] Some of these cartographic depictions include Clark and Piggott 1965, 101; Renfrew 1987, fig 9.1; Cavalli-Sforza *et al* 1994, 257, fig 22; Kristiansen and Larsson 2005, figs 91, 108; Cunliffe 2010, figs 1.5, 1.8

[17] cf Karl 2010, fig 2.4

[18] Armbruster and Perreira 1993, 124; Cahill 2006, 267–8

[19] Gerloff 2010, 46

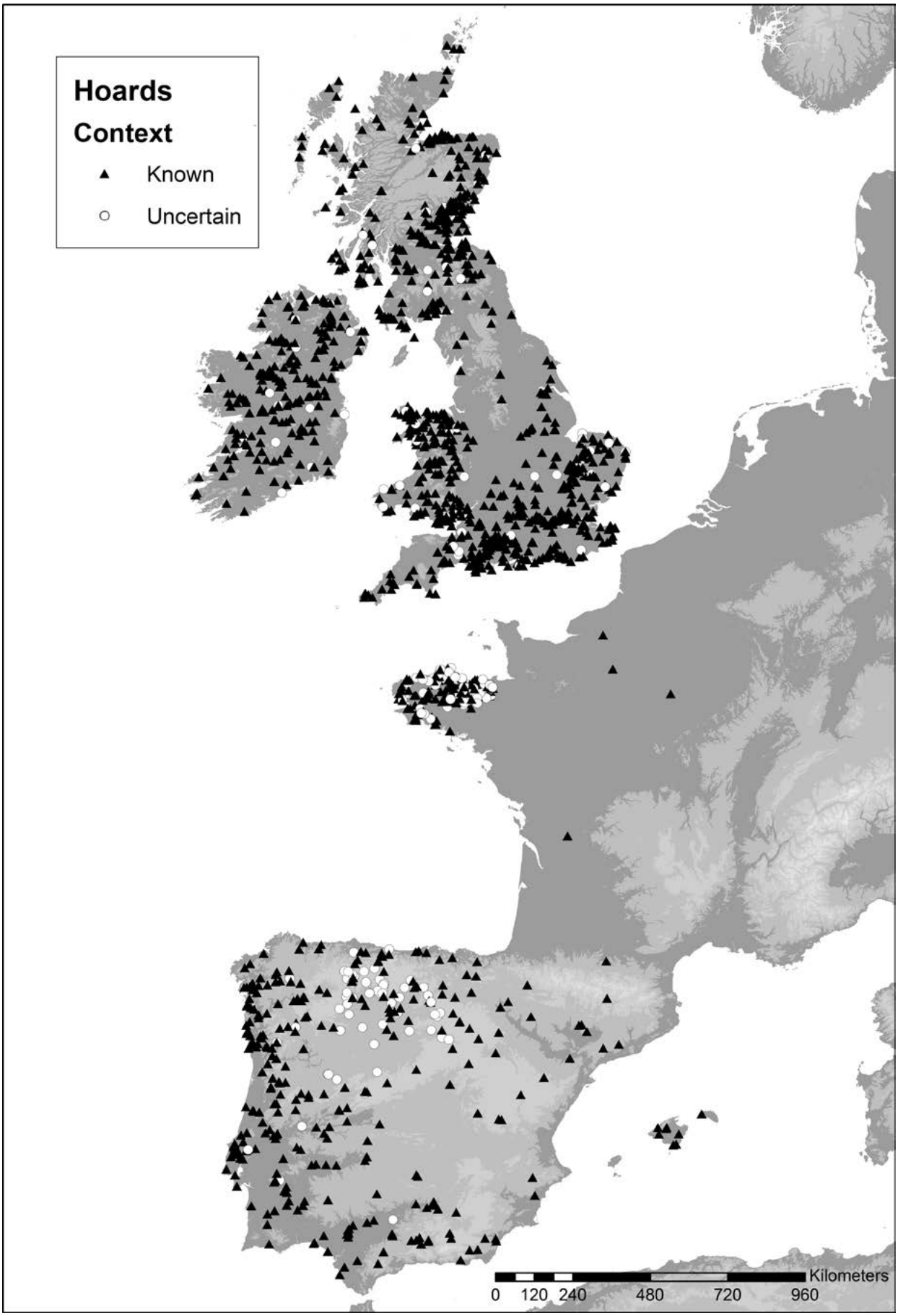


Fig 1 Distribution of Late Bronze Age metalwork deposition in parts of Atlantic Europe, highlighting biases; NB database as depicted here is still in its preliminary collection stage (source: AEMAP project with collaboration from C Gibson and N Jakeman)

different times? Were those undertaking the sea crossings and transporting the material culture also transferring and adopting ideologies to and from the places they visited? If so, would this still be archaeologically identifiable during the seeming 'cessation of traffic along the Atlantic littoral' from the end of the Copper Age until the Late Bronze Age.[20]

This brief case study will examine some changes in general settlement and burial practices in Ireland during the early and mid-second millennium BC, or the period defined as the Early Bronze Age (*c* 2200–1600 BC) into the Middle Bronze Age (*c* 1600–1100 BC).[21] Archaeologically, this traditionally represents a time of increasing insularity that is bracketed on either side by two periods of intensive interaction in Atlantic Europe – the Beaker Chalcolithic and the Late Bronze Age. As such it is essential to gain a better understanding of how the earlier connections were maintained or rejected, built on or reacted against, before the emergence of the so-called 'Atlantic Bronze Age'.

Settlement

While burial practices have always been synonymous with expressions of belonging to a particular group, increasingly consideration has been afforded to the important role prehistoric settlement architecture also played in the construction of identity, embodying and emphasizing links between materiality, people and ideas.[22] Although we have moved away from culture-historical approaches of defining societies into distinct groups based on their material culture, the impact of long-established interconnectedness must still be considered. Given the distinct traditions of domestic architecture across Europe in the Bronze Age, from longhouses to shorter rectangular structures to roundhouses, it is worth reflecting how the Irish data might be interpreted. While considering Bradley's argument that 'apart from the construction of hillforts' the Atlantic Bronze Age 'had little impact on the built environment', his suggestion that in parts of Atlantic Europe 'the distribution of roundhouses was discontinuous and structures of this type went out of favour at different times from the Bronze Age to the Early Medieval period'[23] demands further exploration. Indeed, it is this proposal, that circular structures came to prominence in certain regions at certain times, that is most intriguing. Rather than *en masse* cross-comparisons, it is the regional similarities, and indeed resistance, that may hint at complex connections along the Atlantic seaboard during this period.

It is widely acknowledged that settlements spanning the Late Neolithic through to the beginning of the Middle Bronze Age are somewhat elusive, not only in Ireland and Britain but also in other areas of Continental and Atlantic Europe. Burials, some of them elaborate and rich, hoards, single finds, and concentrations of settlement debris, including pits and hearths, are well-represented, but the house structures generally remain archaeologically invisible. Whether this is the result of residential mobility or a lack of modern understanding of irregular house plans is still uncertain. If we consider the Beaker settlement activity at Ross Island in County Kerry, for example, the post and stake holes uncovered indicate possible asymmetrical floor plans that probably represented temporary seasonal camps for transient mining communities.[24] From the mid-second millennium BC the number of archaeologically visible settlements considerably increases, and it has been suggested that in Ireland large houses peak at *c* 1600–1400 BC,[25] a pattern that will be examined further through Bayesian modelling of dates collated from over 300 excavated settlement sites. This apparent Middle Bronze Age 'building boom' has been particularly evident in Ireland as a result of developer-led excavations since the late 1990s; sixteen structures, for example, were uncovered along a 41km stretch of the M8 motorway in south County Tipperary.[26] These farmsteads, some of which were originally enclosed by wooden fences and ditches, generally comprise one or more roundhouses, measuring *c* 7m in internal diameter but some up to *c* 13m, often with ancillary features including pits, external hearths and fence lines.[27] A comparable emphasis on domestic architecture, with similar building footprints and spatial layout, is also recorded throughout Britain at this time.[28] Furthermore, by the Late Bronze Age, 'typically British circular constructions', 6–10m in diameter, were being constructed in north-western France, at Cahagnes and Malleville-sur-le-Bec in Normandy[29] and at La Grosse Roche in Brittany.[30] On closer examination, however, simple roundhouses were also being constructed in this area by at least the Middle Bronze Age (1650–1350 BC), such as at Le Vivier (Brittany),[31] on the island of Tatihou (Normandy) and further to the north-east at Rœux, Étaples, Seclin and Erre (Nord-Pas-de-Calais).[32] If we accept these houses as architectural manifestations of the long-recognized connections between north-west France and southern England, as a region ('maritory') where communities engaged in maritime contacts, particularly during the Early–Middle Bronze Age,[33] then perhaps we should look for similar evidence in other parts of the Atlantic façade.

These limited examples need not imply that a distinct Atlantic roundhouse tradition existed, but rather that similar architectural preferences could indicate spheres or degrees of influence that were locally adapted at different times in different places, as convenient expressions of identity or 'anchors for social memory'.[34] Further investigation by the AEMA project will help determine if additional architectural

[20] Burgess and O'Connor 2008, 41

[21] These date ranges are generally accepted for Ireland, see Grogan and Roche 2010, 38–41, on ceramic traditions, but also Roberts *et al* 2013, 22–5, for discussions on synchronized chronologies for Britain and Ireland

[22] Downes and Richards 2005; Brück and Fokkens 2013

[23] Bradley 2012, 16–17

[24] O'Brien 2004, chapter 6

[25] Ginn 2013, 47

[26] McQuade and Moriarty 2009, table 1

[27] Cleary 2007a

[28] Ellison 1981; Barrett 1994; Ashmore 2001; Halsted 2005; Brück 2008, 245–8

[29] Mordant 2013, 576

[30] Briard *et al* 1988

[31] *ibid*

[32] Bourgeois and Talon 2009, 44

[33] Needham 2000; Cunliffe 2001; 2011

[34] Jones 2008, 107 in reference to Borić 2008

similarities might be identified, including orientation, symmetrical layout and the elaboration of house entranceways through the erection of substantially larger posts or the addition of a porch-like structure, as recognized at numerous Irish and British roundhouses[35] and at some of the north-western French sites, such as Rœux and Tatihou. Furthermore, by plotting the flow of metal and the existence of similar burial practices in relation to these settlements, spatial and temporal distributions of sites and artefacts along the coast and the banks of major rivers might provide further insight into the exchange and communication routes that were utilized.

Burial

Changes in burial rites and associated grave goods in the Irish Bronze Age will also be examined. Based largely on work by Brindley, Bayliss and O'Sullivan have suggested that inhumation in the Early Bronze Age became 'established and died out quickly',[36] probably lasting just one or two generations, whereas cremation, largely urned, had two notable phases. The earlier phase, associated with Food Vessels, Encrusted Urns and Vase Urns, rose steadily, until a dramatic decline, perhaps by around 90 per cent, in the decades around 1875 cal BC. Thereafter, the use of cremation, although at a much lower level, was fairly consistent and included burials associated with Collared and Cordoned Urns. Furthermore, grave goods in the form of bronze daggers, miniature vessels and knives of various materials may also have ceased, in tandem with the rapid decline of the Irish urn tradition. The use of stone cists for burial also appears to have ended shortly afterwards, by at least 1810 cal BC, and the subsequent adoption of Cordoned Urns may coincide with the inclusion of bronze razors.[37] Using the project's GIS database to temporally model known sites, it is hoped to gain a better understanding of how funerary practices in Ireland were reflecting wider social contexts and connections. For example, there could be a link between the various burial traditions and the flow of metal, and this question will be explored through combining patterns gleaned from funerary practices with those created through mapping the changing compositions of metal during this time (see below). At Ross Island, analysis of the associated radiocarbon dates by Lanting indicated that the initial mining activity probably ceased around 1900 BC, although a declining availability of metal by 1800 BC is more generally reported, and evidence for mining at several sites on the Mizen Peninsula in County Cork, including Mount Gabriel, is interpreted as representing subsequent copper extraction from *c* 1800–1400 BC.[38] Applying Bayesian analysis to refine the copper mining dates could offer some insights into whether or not the opening and closing of copper mines or the exportation and importation of ore had wider social implications that were ultimately reflected in burial practices. For example, in the twenty-second century cal BC, contact between Scotland and Ireland was intensifying as a result of the flow of copper and the inception of the Migdale-Marnoch tradition of bronze metalwork. It has been suggested that this was also the time when the funerary pottery with exaggerated necks appeared in Scotland, probably as a reaction to the roughly contemporary appearance of neck-less Food Vessel Bowls in Ireland.[39]

The funerary customs dating from the decline of Cordoned Urns into the Middle Bronze Age are more difficult to define. Not only had the cist and pit burials, so abundant in the Early Bronze Age, generally fallen out of use, but there was also a move away from specially produced funerary pottery in favour of coarse domestic vessels. These were increasingly deposited in a fragmented condition, along with a tendency towards incomplete burials.[40] It is recognized, however, that too few unaccompanied cremations have been accurately dated, and thus our understanding of the longevity of the tradition of unfurnished pit and cist burial requires further refinement.[41] Various barrow types have also been suggested as potentially 'filling the gap', but a recent synthesis of fifty-three excavated examples assigned only eleven sites to the period 1700–1300 BC, although the dating of five of these sites was contentious, and a further six barrows were dated to between 1300–1000 BC.[42] Moreover, while the construction of substantial burial monuments increases again during the Late Bronze Age, the bodies and artefacts remain fragmented. Future analysis as part of the AEMA project will help determine the nature of burial practices during this period, when house architecture seemingly became more permanent and perhaps increasingly formalized. Yet, at the same time, there is a recognizable decline in the formal burial practices used during the Early Bronze Age. Not surprisingly, there is also a lack of metalwork, and indeed of all non-ceramic artefacts, in burials after the Early Bronze Age, but the deposition of single finds does increase significantly, although it is not until the Late Bronze Age that hoards become more frequent.[43]

The AEMA project will also facilitate a closer examination of funerary rites in other Atlantic regions where loosely comparable practices might be identified. After the Early Bronze Age there is a widespread change regarding what object types were deemed suitable for accompanying the dead (pots), and what objects were no longer considered appropriate in funerary contexts (metal). This may have been guided by supra-regional conventions, but possible explanations underlying this switch remain relatively undeveloped. In Brittany, for example, the large, rich Early Bronze Age burial mounds fell out of use, and burial practices from the Middle Bronze Age remain largely unknown, while in other areas of north-western France cremation cemeteries continue in use, but grave goods remain sparse. This is in contrast to eastern France, where rich burial mounds become commonplace.[44] The deposition of gold and bronze objects in north-western Iberian burials ceases from the Middle Bronze Age onwards and ceramic containers almost exclusively accompany the

[35] Brück 1999; Cleary 2007a; Ginn 2014

[36] Brindley 2007; Bayliss and O'Sullivan 2013, 83–5, 97

[37] Bayliss and O'Sullivan 2013, 79, 85

[38] Lanting 2004, 314; O'Brien 2004, 572–3; *idem* 2013, 443

[39] Wilkin 2010

[40] Grogan 2004; Lynch and O'Donnell 2007

[41] Grogan and Roche 2010, 41

[42] McGarry 2008, 20, appendix XXXIII

[43] Eogan 1983; Bourke 2001; Becker 2013

[44] Mordant 2013, 581–2

dead. New funerary contexts and practices also develop at this time, including a tendency to locate cemeteries in areas adjoining or inside settlements.[45]

Interim conclusions

The acquisition of 'exotic' Early Bronze Age objects such as amber, copper, faience, gold, jet and tin have been interpreted as cosmologically driven, with these items perhaps belonging to the élite and ritual specialists.[46] The patterns of exchange suggested by these types of objects also indicate important inter-personal or inter-group relations across large geographical areas. Although the exact purposes of these connections may have waned over time, the cosmological legacy may have lingered, developed and adapted. Alongside artefacts, prehistoric settlement and burial practices can also be used to identify possible shared beliefs. While the principles underlying burials are long-attested, houses also likely reflected the ideologies of the inhabitants.[47]

It has been suggested that in the Early Bronze Age, burials in the north-western Iberian Peninsula played an important role as 'agents of group identity, legitimization of territory and power maintenance and negotiation', while from the Middle Bronze Age onwards there was a shift towards contexts more connected to the world of the living, such as sites of metal deposition and the settlements themselves.[48] In Ireland, the centuries around 1600 BC can be considered the beginning of something of a 'grey area' when determining connections with other parts of Atlantic Europe. The expression of identity, social relations and status similarly moves from the sphere of death to that of life. Within this ideological shift, implying a reduced separation between the sacred and the profane, it is possible that increasingly solid and formalized domestic architecture, specifically roundhouses, may have been used to express belonging, whether regionally or inter-regionally. Although an understanding of contemporary burial practices is still under review, it is evident that fragmented artefacts, especially 'domestic' pottery, and incomplete burials became increasingly common during the Middle Bronze Age. These patterns of behaviour must also be examined in relation to the intensified deposition of metalwork. The bias of bronze weapons towards river contexts, and of gold ornaments and ceremonial items towards dry or bog contexts may represent different identities, with the latter perhaps reflecting communal, rather than individual, concerns.[49] Through a programme of Bayesian modelling and GIS analysis the AEMA project will enable a temporal and spatial investigation of artefact and site distributions, providing an opportunity to examine periods of connectivity and dis-connectivity throughout the 'Metal Ages' and trace expressions of shared ideologies along the Atlantic façade.

Thematic research area II: identifying metal flow through artefact chemistry – beyond provenance

Metal has always lain at the centre of archaeological interpretations of prehistoric Europe, *c* 2900–700 BC and beyond, and the various elements and alloys discussed are still employed to label our chronological divisions. Its past relevance has partially been driven by the importance of metal in our contemporary world. It is commonly asserted in older papers that the arrival of metal brings modernity, science and social progress:

> 'Modern science and industry not only go back to the period when bronze was the dominant industrial metal, their beginnings were in a very real sense conditioned and inspired by the mere fact of the general employment of bronze and copper.'[50]

Thus, much of the history of archaeometallurgy (whether consciously or not) has operated within a framework of understanding this defining 'industry'. Alongside some nebulous feeling of 'progress', a more concrete and archaeologically useful aspect of metalwork is its ubiquity and variety. We cannot ignore the fact that Bronze and Iron Age societies *did* choose metal for personal display, to demonstrate influence and connectivity, for depiction in artwork and as a practical tool. Much of our database of metalwork finds is archaeologically visible only because people in the past carefully hoarded metalwork or selected it for grave goods. That they often used local production traditions, styles and technological innovations makes these objects ideal for building typo-chronological frameworks and models of social interaction. Unsurprisingly, this type of investigation is now far more commonly pursued than ideas of metal's inherent superiority over stone or flint.

From the beginning of modern science, chemists have also tried to interpret ancient metallurgy. Their tool was the chemical composition of copper-alloy artefacts only, to the exclusion of research derived from excavation and ideas of identity and context. This work began in the late 1700s[51] and quickly became focussed on two key questions: firstly the chronological sequence of alloy use, and secondly an obsession with the provenance of metal. It can be argued that by the mid-nineteenth century the work of certain scholars[52] had already created the framework for the scientific study of metal that still persists today.

Through the rise of typo-chronology and absolute dating methods, the importance of inferring a time period from the object's alloy composition decreased. What remained was a belief that variation in the chemical composition of artefacts could be matched with a source. This resulted in the chem-

[45] Bettencourt 2008, 103; *eadem* 2010, 39, 41

[46] Needham 2009, 14

[47] Hodder 1990; Parker Pearson and Richards 1994; Bradley 2005

[48] Bettencourt 2010, 41–2

[49] Becker 2013, 32

[50] Childe 1930, 2–3

[51] Caley 1948; Pollard *et al* 2014

[52] eg Göbel 1842; Damour 1865

ical analysis of over 40,000 European Bronze Age artefacts. The same conceptual thread of 'chemical signature equals provenance' runs through the work of several important projects and teams.[53]

This vast amount of data created by this work has formed an important legacy. However, we would argue that the scientific engagement with early metal has run in parallel to mainstream archaeological foci such as identity, social connections, value, display and the agency of material culture. This lack of integration has left both areas of research poorer, as neither has fully engaged with the conclusions of the other. The AEMA team therefore aims to capitalize on the large legacy dataset for early metalwork, along with advances in GIS systems, fully to combine the various approaches to early metalwork, archaeological context, typochronology and material science. This work will build upon a wide range of influences that have stressed the importance of an integrated understanding of metal and, more broadly, material culture as a whole.[54]

A key concept within this work is 'flow', through a shared space and time, of ideas, languages, people and things. To apply this to metallurgy requires a conceptual break with the direct-matching, statistical provenance approach as developed in the nineteenth century, towards one of both material agency and data-rich modelling.[55] We feel that it will be possible to interpret a series of related aspects of flow:

a) The ultimate source of raw materials, technological ideas, languages, stylistic tropes or social practices.
b) The practical source of these things for ancient people. This source may be far removed in time and place from the initial spark of an idea or a mine and may be received after passing through many neighbouring hands.
c) *Their* conceptual provenance for metal or technology. For example, we may be able to step back and see a link across a continent for amber moving from the Baltic into the eastern Mediterranean, but how did people in the past understand the source of this material, when they may have only witnessed the last few steps in the chain?

The traditional approach of provenance chemists was to look just at section 'a', without giving equal consideration to the other areas. We would argue, however, that it is more relevant and fruitful to think about the practical and conceptual aspects of material flow in the past, while of course acknowledging the presence of ancient mines.

To realize this new understanding of metalwork we will interweave the datasets outlined in this paper using GIS and the frameworks of absolute chronology and geography; thus synthesizing datasets that are not often brought together. We also need to approach the chemical-composition dataset in very different ways from that of many past projects. We will not simply look for maximum statistical differences or significant clumps of data and feed that into our GIS model. A major part of the AEMA work is to develop a method of chemical interpretation that *characterizes* past practice rather than assumes a simple provenance relationship. The remainder of this section briefly sketches our approach, which allows us to identify mixing, recycling and exchange pathways, as well as underlying primary sources; in short, sections 'a' and 'b' in our characterization of flow. Through combining all the aspects of the AEMA project, we hope that our conclusions will start to discuss section 'c': regional traditions of expression, language and materials.

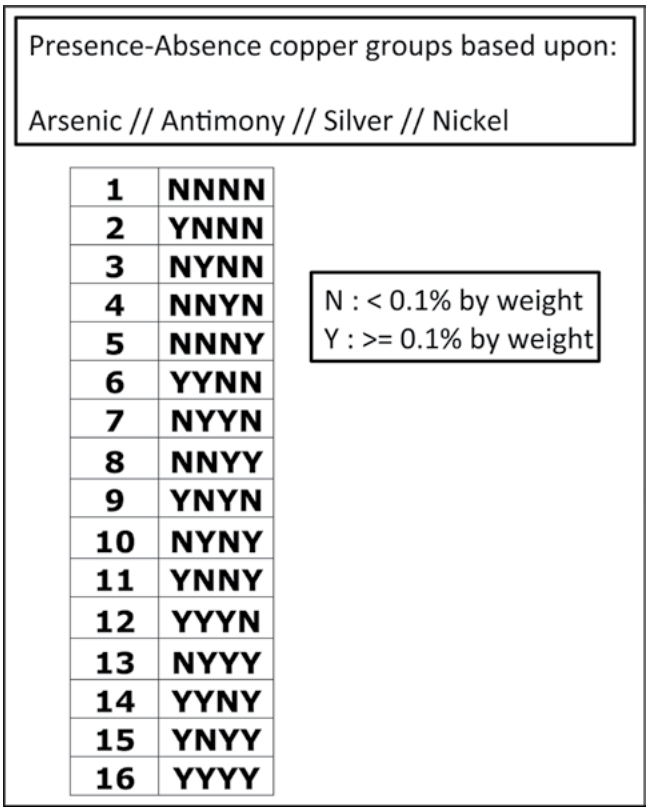


Fig 2 Definition of the chemical composition copper groups that will be used by the AEMA project (source: P Bray)

Underlying our approach to the chemistry of copper alloys is the simple assumption that the final percentage figures for diagnostic, low levels of arsenic, antimony, silver and nickel are in fact a palimpsest. They represent a blend created by the mineralogy of the mine, technological practice and subsequent mixing and re-melting. These diagnostic elements have been chosen as they are consistently looked for by all large-scale analytical projects and their individual properties help unpick the various technological, mining and recycling stories.

It has always been part of the foundry workers' knowledge base that the chemistry of a unit of alloy is not fixed.[56] Beyond loss through spillage and other accidents, the dif-

[53] These include the *Early Mining and Metallurgy Group* of the *Royal Anthropological Institute* (Coghlan and Cook 1953), the Stuttgart-based SAM project, *Studien zu den Anfängen der Metallurgie* (Junghans *et al* 1960; 1968; 1974), up to the present day (Ling *et al* 2014)

[54] Appadurai 1986; Geselowitz 1993; Budd and Taylor 1995; Needham 1998; Gosden and Marshall 1999; Killick 2001; Ottaway 2002; Woodward 2002; Gosden 2005

[55] For material agency see Gosden 2005 and for data-rich modelling see Needham 1998

[56] Hampton *et al* 1965; McKerrell and Tylecote 1972; Charles 1980; Beeley 2001

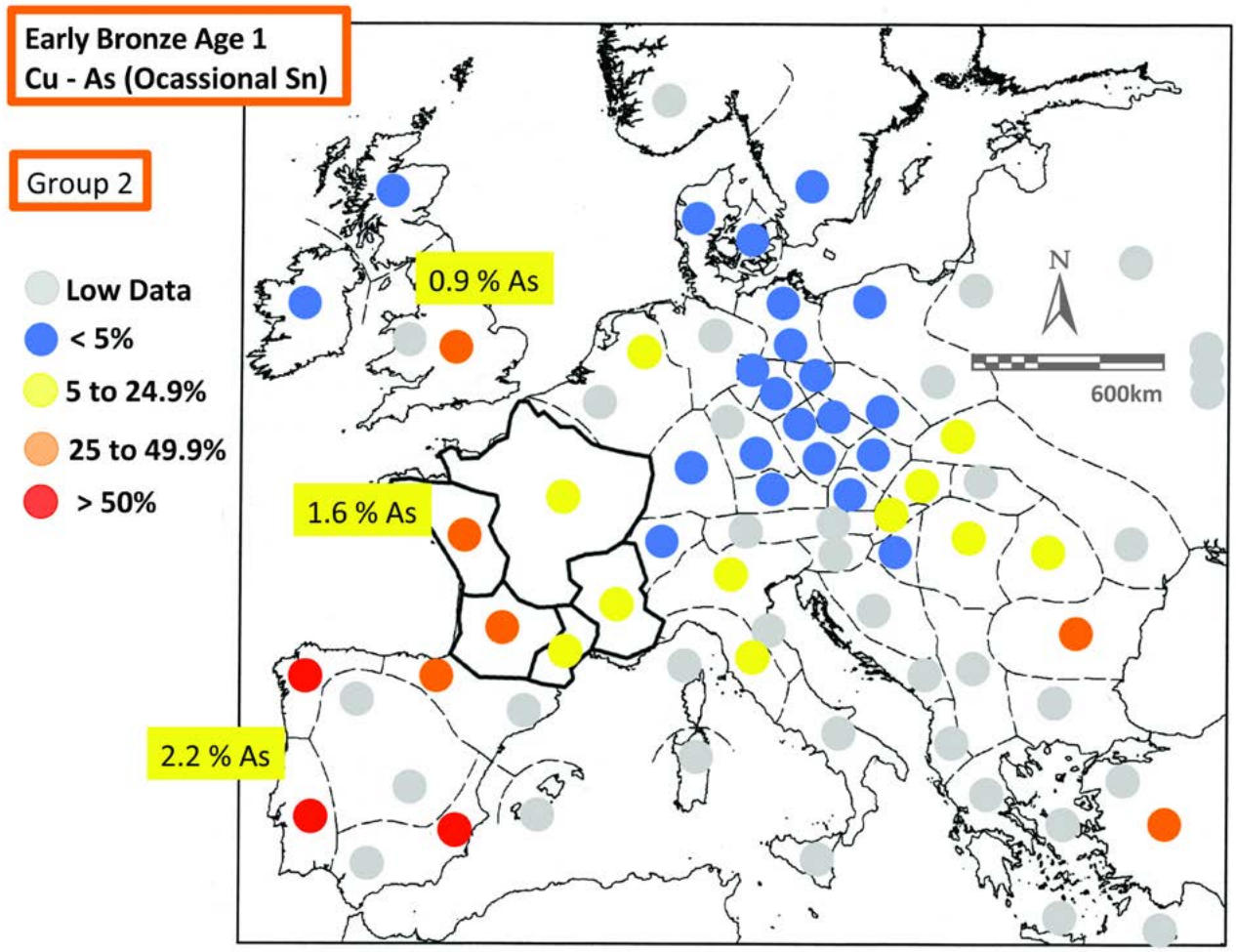


Fig 3 Distribution of Copper Group 2 in the Early Bronze Age 1 period; also shown are the average arsenic levels in these artefacts for Iberia, western France and southern England (source: P Bray)

ferential rates of loss through oxidation and vaporization of those oxides alter the composition of the melt. Vulnerable elements include the rapidly oxidized arsenic and antimony, while silver and nickel are resistant to loss. Merkel describes such changes as potentially creating 'confusion',[57] while we see the exact opposite. We have an excellent opportunity to create a rough arsenic clock of cycles of re-melting.[58]

Alongside a simple, progressive clock as metal units undergo re-melting during their 'lifetime', we add a simple presence or absence characterization. This is a heuristic step to put copper alloys into sixteen broad groups, based on the different combinations created by arsenic, antimony, silver and nickel being either above 0.1 per cent by weight (present), or below that threshold (Fig 2). This threshold is a compromise based upon the lower limits of detection of past experimental procedure and the fact that if 0.1 per cent is reported, it is relatively unlikely to be a false positive.

We do not equate one of these groups as indicating one source; instead this is an experiential stage that allows further analysis, including examining the distribution of arsenic within an assemblage. A consistently skewed high level of arsenic is likely to be associated with relatively prime metal, while a low level indicates cycles of re-melting. We expect units of copper alloys to be able to move between groups, especially through mixing, but occasionally also through oxidative loss. This has been explained in detail for how metal mined at Ross Island[59] near the start of the Irish Early Bronze Age once contained arsenic, antimony and silver, at around 1.5 per cent each. After repeated recycling events over around 300 years, a small percentage of these units survive in use, though now only the noble silver remains alongside the copper base.[60]

A simple statistical approach, such as a cluster analysis, would conflate all the different layers of the palimpsest into one, and mislead the researcher. We believe that many aspects of the life history of a unit of metal can be identified by linking presence-absence chemical relationships, chemical levels and profile, archaeological context, object typology and chronology. The final object's chemistry allows us to infer the invisible history of the artefacts that archaeologists can never directly study.

[57] Merkel 1982, 287
[58] Bray and Pollard 2012
[59] O'Brien 2004
[60] Bray and Pollard 2012



Fig 4 Schematic depiction of a typical warrior stela with object panoply reflecting inspiration from both Atlantic and Mediterranean spheres; this is the stela of El Viso I, Córdoba (after Harrison 2004, fig C54)

A simple plot of some of these approaches is illustrated in Figure 3. It shows the varying importance of our Copper Group 2 in the European Early Bronze Age 1. This chemical type contains artefacts that have a copper base along with arsenic over 0.1 per cent. A red dot in a region means that over half of that region's assemblage is in Copper Group 2. Orange shows a region with between 25 and 50 per cent, yellow shows 25 down to 5 per cent, and blue absent. This simple device clearly shows the importance of the Iberian mines in producing copper of this type. The map shows a very convincing drop-off as metal passes through small-scale exchanges into France and even southern England. We can tell that these exchanges include local re-melting and casting of fresh objects because of the associated drops in average arsenic level. We begin with very high levels of arsenic recorded in Spain, dropping to only 0.9 per cent by the time the same base copper has been melted and transformed multiple times, eventually being deposited in England.

Rather than focussing solely on some success in characterizing Iberian copper compositions, we can begin to move into a real flow of ideas, local production and metal exchange. During the course of the project, dozens of such flows will be considered alongside the distribution of settlements, burials and associated funerary practices, rock art, stelae, hoarding behaviour, survival of written languages and others, to build up an integrated approach to the social and material background of Celtic languages. Instead of isolated find spots, typographical drawings, or bald lists of chemical levels, we hope to offer a more dynamic view of metals' place in the European Metal Ages.

Thematic research area III: the Bronze–Iron transition in western Iberia – stelae and the coming of literacy

The superimposition of multiple datasets to help identify new patterns of interaction and connectivity can be illustrated with a further example, this time from Late Bronze Age Spain and Portugal. In western Iberia, the emergence of the Late Bronze Age stelae tradition (from around 1250–950 BC)[61] coincides with the apparently quite dramatic increase in metal deposition, reflecting renewed interaction with wider Atlantic spheres.[62] Many of the stelae depict an eclectic combination of warrior's gear indicating inspiration from both the Atlantic and Mediterranean. The former includes swords, spears and shields, while the latter comprises chariots, lyres, mirrors, combs and brooches; central European helmets are also occasionally engraved (Fig 4).[63] These so-called 'warrior' stelae were originally thought to have been grave markers,[64] and thus considered to have functioned in a similar capacity to the preceding Middle Bronze Age 'Alentejo' stelae, and the subsequent Iron Age south-western stelae; both of which are often found in association with cist burials (see below). However, less than 2 per cent of the Late Bronze Age stelae (from a corpus of over 150 examples) have associations with a funerary context, and most of these examples were reused as grave markers or covers, implying that this was not their original purpose.[65]

Generally the stelae and the deposits of Late Bronze Age metal objects are studied in isolation, but new potential interaction networks emerge when their spatial distributions are overlain. Weapons, particularly swords, were often placed in rivers – generally the principal rivers of the Douro, Tagus and Guadalquivir.[66] Gold and silver ornaments were deposited in the ground, often on mountain routes or along hill crossings associated with traditional transhumant routes.[67] When their distributions are compared with the Late Bronze Age stelae, although they show some spatial

[61] Brandherm 2013

[62] cf Kalb 1980; Coffyn 1985, 16–18; Jorge 1998; Ávila do Melo 2000, 23–4

[63] Celestino 2001; Harrison 2004; Díaz-Guardamino 2010; 2012

[64] Roso de Luna 1898; Almagro Basch 1962; 1966, 105–6

[65] The stela of Solana de Cabañas, in Cáceres, was apparently found overlying a grave (Roso de Luna 1898), but the pot accompanying the cremation was likely Iron Age (Celestino 2001, 348). Other examples include that of Setefilla, reused to cover a double grave of seventh-century BC date (Aubet *et al* 1983, 19), and the two stelae of Cortijo de la Reina I and II which covered Orientalizing graves (Murillo *et al* 2005, 30–2)

[66] Ruiz-Gálvez 1995a; Brandherm 2007

[67] Ruiz-Gálvez 1992, 235; *eadem* 1995b; Gibson 2013, 87–8

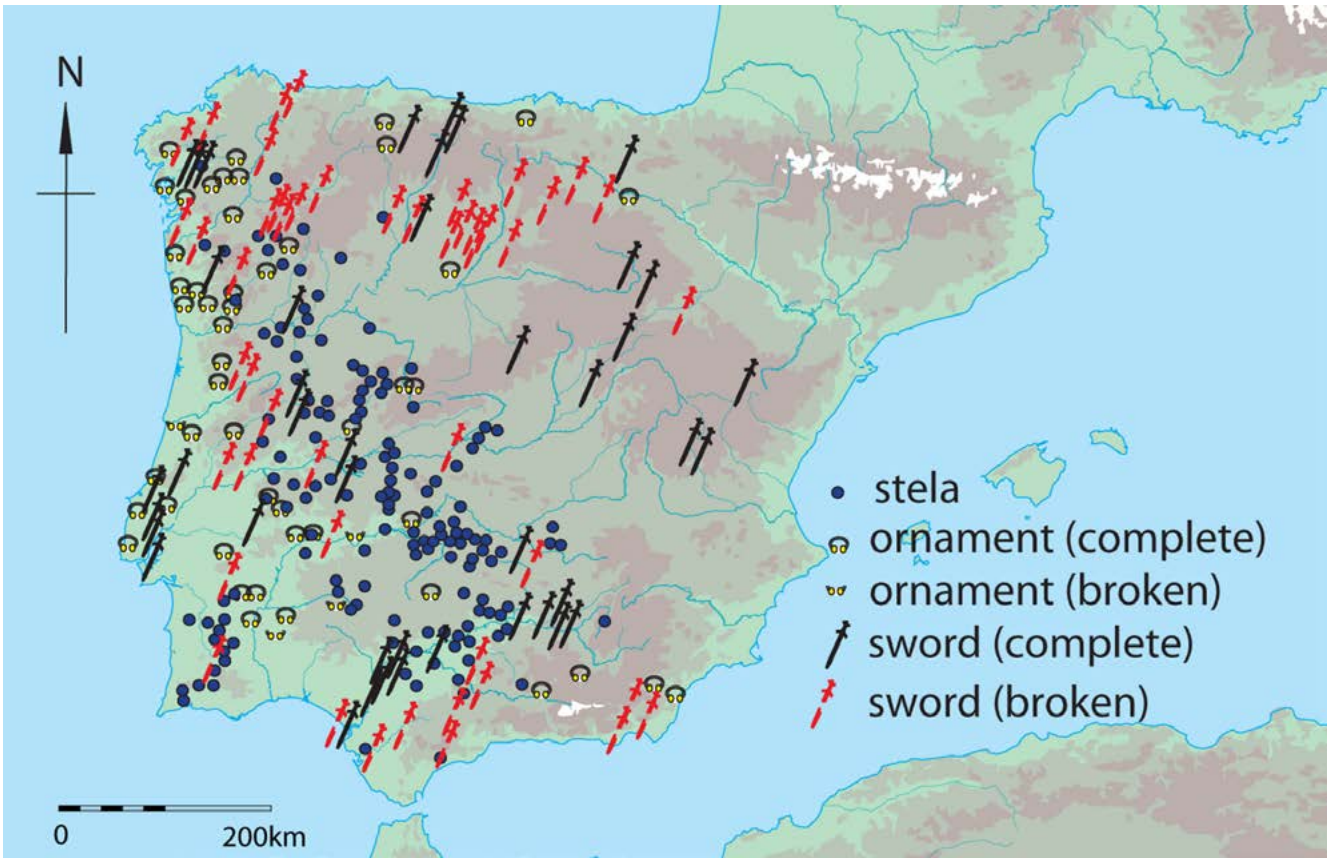


Fig 5 Spatial distribution of Late Bronze Age sword and ornament deposits and the placement of 'warrior' stelae in western Iberia (amalgamation of Gibson 2013, figs 3.4 and 3.7 with additional data)

overlap, in the main they appear to have been consigned to distinct topographical zones (Fig 5). The stelae, although frequently placed close to rivers and fording points, ignored the main fluvial arteries and were dotted around their tributaries.[68] What they all have in common, however, is that they highlight and are seemingly closely linked with routes of movement throughout the landscape – both terrestrial and fluvial – and between upland and lowland zones. The resulting pattern may reflect specific types of symbolic expression by different regional groups engaging with the re-ignition of wider Atlantic exchange spheres and long-distance interaction. Perhaps different social groups were conveying similar things in different ways through inter-regional networks, and the stelae may also have acted as a substitute for the deposition of actual objects in the ground or water.

A later stelae tradition with writing develops in the Early Iron Age Orientalizing period and is represented by a corpus, now numbering nearly 100 examples.[69] Their densest concentration is in south Portugal, with a thinner scatter over south-west Spain.[70] Form and context indicate that at least some of these stones had a funerary function.[71] These south-western (SW) inscriptions have thus far received relatively slight attention, disproportionate to their significance. If we call Italy 'south-central Europe', then the south-western inscriptions preserve the earliest written indigenous language in western Europe. These literate stelae have usually been studied separately from the Late Bronze Age series. However, overlap is indicated by transitional examples and instances of reuse, with writing added to some Late Bronze Age warrior stelae and respecting the earlier design.[72]

Until the recent discoveries from the necropolis of Medellín (Badajoz, Spain), which recovered a SW stela in a context dated to 650–625 BC, the chronology of the SW inscriptions was tentative.[73] Its script and language were clearly the same as those on the stelae from south Portugal.[74] Almagro-Gorbea argued that this stela belonged to a mature and widespread second stage of literacy. In other words, Medellín reflects the middle – not the beginning – of the tradition. There was also graffiti on late seventh- and sixth-century BC pottery from Medellín, showing further developments in the script.[75]

[68] Ruiz-Gálvez and Galán 1991; Galán 1993

[69] Correia 2009

[70] Koch 2013a

[71] Brandherm 2013

[72] The stela of Almodôvar is a transitional example with a warrior inscribed with a contemporary inscription (Alves Dias and Coelho 1971, fig 1). Reuse is indicated by the Late Bronze Age stelae of Cabeza del Buey IV (Domínguez de la Concha *et al* 2005, fig 8), Capote (Celestino 2001, 441–2) and Cerro Muriano II (Murillo *et al* 2005, 16–17) which were all engraved with later SW inscriptions; note also the argument for an essentially Late Bronze Age context for the SW inscriptions in Ruiz-Gálvez 2013

[73] Almagro-Gorbea 2004; 2008

[74] Koch 2013c

[75] Almagro-Gorbea *et al* 2008

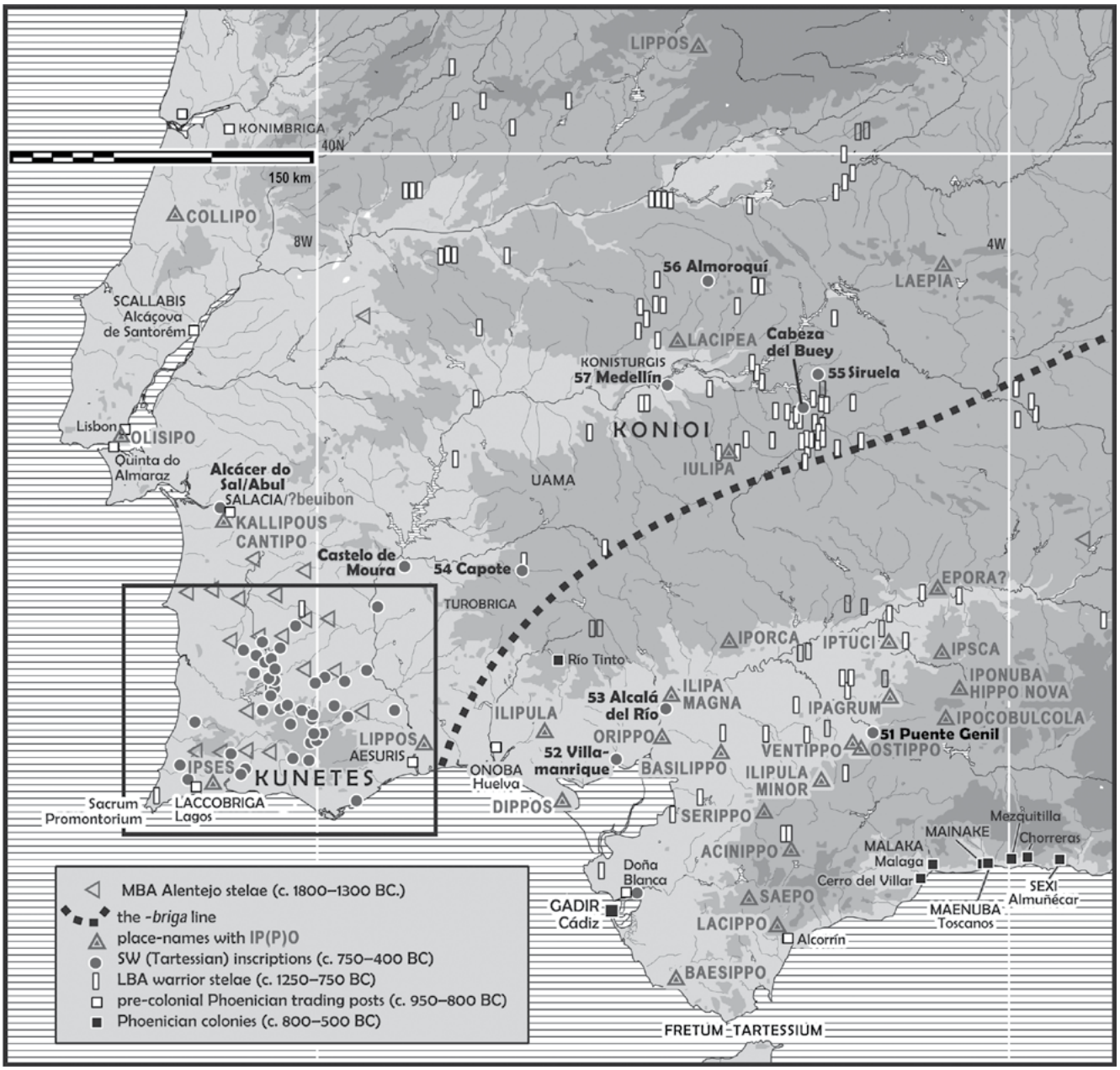


Fig 6 Distribution of the various stelae traditions in western Iberia, highlighting the spatial overlap between Alentejo and SW stelae (source: J T Koch)

In their geographical distribution and contextual association there are especially close links between the SW stelae and the Middle Bronze Age Alentejo stelae, which display carvings of weapons datable to 1800–1300 BC (Figs 6 and 7).[76] Both groups are concentrated in south Portugal, and both are connected with necropolises,[77] unlike the intermediate Late Bronze Age stelae. Both the Middle Bronze Age and Early Iron Age burials associated with stelae are interred in rectangular cists surrounded by circular or subcircular surface stone pavements or platforms, which were built sequentially against one another, so later ones abut or overlap earlier ones. The stelae themselves (though often carved leaving the lower third empty in order to be set in the ground upright) have repeatedly been found buried face-down as cist covers.

In the past, the SW inscriptions tended to be seen primarily as a manifestation of eastern Mediterranean or Orientalizing influences. It is now generally agreed that the SW script is primarily derived from a western Semitic alephat (vowel-less alphabet), similar to an early form of the Phoenician script.[78] However, as we begin to view the stelae within the AEMA project in a broader context and draw the full

[76] Díaz-Guardamino 2010; note that the date range provided for the objects depicted on the Alentejo stelae has been confirmed by radiocarbon dates from the inhumations in the associated cist burials (eg Gomes and Monteiro 1977, 172–8; Silva and Soares 1981, 168)

[77] Brandherm 2013

[78] Rodríguez Ramos 2000; Correa 2005; Hoz 2010



Fig 7 Middle Bronze Age 'Alentejo' stela from the necropolis of Pedreirinha, Santa Vitória, Beja, with sword and 'ancoriform' idol (source: J Aaron)



Fig 8 South-western stela of Abóboda 1, Gomes Aires near Almodôvar, indicating a combination of warrior imagery and an inscription; the stela was reused as a lid that covered an Early Iron Age urn burial accompanied by a large spearhead (source: J Aaron)

sequence of Bronze Age stelae and statue-menhirs into account, a different picture emerges.

The distribution persistently shuns the areas with the densest eastern Mediterranean influence. They do not occur inside the Phoenician colonies, and none have yet been found in Huelva, often identified as the core of the orientalized native polity called Ταρτησσός, by the Greeks.[79] Only two were found along the Guadalquivir, another area of intense Orientalization.

The evidence we have thus far compiled suggests this working hypothesis about the cultural message of the SW inscriptions: they do not embrace the Orientalization, but represent a secondary reaction to it on its periphery.[80] The combined message is clearly of identification with the country's indigenous ancestors and perhaps a deliberate attempt to instil mythical continuity with the preceding Bronze Age. Although the script is based on Semitic models, it has been fundamentally altered to create the earliest of the Palaeohispanic scripts used to represent native languages. Thus newfangled literacy is being used to make a nativist statement (Fig 8).

The phonetic basis of the SW script is by now largely decoded.[81] Although the classification of the inscriptions' matrix language remains controversial, there is now broad consensus that a large number of names in the corpus are Indo-European and many of these specifically Celtic. Repeatedly identified Celtic names include: **aalaein**, **aark^{u}ui**, **aib^{u}uris**, **ak^{o}osioś**, **alb^{o}oroi**; **]anb^{a}at^{i}ia**, **b^{o}ot^{i}ieana**, **k^{o}ob^{e}elib^{o}o**, **liirnest^{a}ak^{u}un**, **lok^{o}ob^{o}o**, **mut^{u}uirea**, **niirab^{o}o**, **ooɾoir**, **rinoeb^{o}o**, **sarune(ea)**, **t^{a}alainon**, **]t^{a}arnek^{u}un**, **t^{i}ilek^{u}ur̲k^{u}u**, **t^{i}irt^{o}os**, **]t̲^{u}urk̲^{a}aio[**, **-uarb^{u}ui**, **uursaar**.[82]

The interpretative work on the recent excavations at the Early Iron Age necropolis at Medellín has focussed attention on a shared name for the literate group occupying the region of the SW inscriptions, which stretches about 300km from Sagres point to the upper Guadiana. *Konisturgis*, which means 'town of the Κονιοι', was most probably the pre-Roman name of Medellín.[83] According to the Greek geographer Strabo,[84] *Konisturgis* was the most famous town of the Κελτικοί, ie the 'Celts' of the south-western Iberian Peninsula. Κονιοι and its variant Κυνητες / *Kunētes* are probably Celtic names, related to Welsh *cŵn* 'dogs'. That word was common as an epithet for heroes, like the Irish *Cú Chulainn*, the legendary 'Hound of Ulster'. The war band of Dark Age Strathclyde were called the *Cynwydion*, essentially the same name as Κυνητες.[85] According to Herodotus, writing in the fifth century BC, the Κυνητες were the westernmost people of Europe and neighbours of the Κελτοί.[86] A picture is emerging of the Κονιοι or Κυνητες as a coherent group distinct from – though in contact with – Phoenicians and Tartessians. From the protohistoric horizon, their traditions point back to origins – whether real, adopted or invented – deep in prehistory. As a socio-linguistic model,[87] one may consider the possibility of the *lingua franca* of the Atlantic Bronze Age asserting itself as a badge of identity on the margins, having lost its place to the superior maritime skills and economic influence of the Phoenicians.

Thematic research area IV: reconsidering the ogham stones and Palaeohispanic linguistic data in their Atlantic context

The spatial relationships between inscriptions and archaeological sites in the British Isles are also being explored by the AEMA project. One example is the distribution of stones with ogham inscriptions, and while it is acknowledged that many are *ex situ*, having been relocated to ringforts, souterrains and churches, other stones have a direct connection with prehistoric sites, the inscribers perhaps deliberately choosing to mark pre-existing monuments. At Knowth, County Meath, for instance, ogham 'graffiti' is recorded on the orthostats of the Middle Neolithic passage tomb.[88] The incorporation of ogham into stone circles is suggested at Glenaglogh in County Cork and Brandsbutt in Aberdeenshire,[89] while at Breastagh in County Mayo an ogham inscription is recorded on a probable prehistoric standing stone located centrally among a megalithic complex that included wedge tombs, a court tomb and a stone circle.[90]

One aspect that certainly requires further research is the possibility that ogham stones had some significance as boundary or territorial markers and how this might relate to inscriptions on probable prehistoric standing stones. A roughly linear distribution of at least nine standing stones, one of which has an ogham inscription, extend northwards from County Waterford into the Suir River Valley in County Tipperary, perhaps marking out a territorial division or an ancient routeway skirting along the eastern limit of the Knockmealdown Mountains, with a hilltop enclosure also overlooking this eastern entrance into the river valley (Fig 9).[91] In south-east Wales the prominent hilltop landscape position of an ogham stone at Ponsticill, within 300m of three cairns of potential Bronze Age date,[92] could be associated with a routeway extending up to Y Gaer hillfort to the north-west, while the stone at Brandsbutt mentioned above is also interpreted as marking a route to the hillfort of Dunnideer.[93] The natural setting of these inscribed stones will also be examined, particularly those placed along the coastline and major rivers. Perhaps it will be possible to determine potential patterns between the locations of later

[79] cf González de Canales *et al* 2006; 2009; López-Ruiz 2009

[80] Brandherm 2016

[81] Untermann 1995; Hoz 2010; Ferrer i Jané 2010 on the closely related Meridional script

[82] Correa 1992, 98–101; Untermann 1997, 166–8; Ballester 2004a, 119–20; Villar 2004, 262–6; Almagro-Gorbea *et al* 2008, 1050; Koch 2013a; cf Guerra 2010

[83] Alarcão 2001, 335–8; Almagro-Gorbea *et al* 2008, 1036–42

[84] Strabo III.2.2

[85] Koch 2013a, 190–2

[86] Herodotus II.34 and IV.49; Koch 2014

[87] cf the approach of Wodtko 2013

[88] Byrne 2008

[89] Macalister 1945, 108–9; Shepherd 1984

[90] Ferguson 1879

[91] Cleary 2007b, 45, 50

[92] Redknap and Lewis 2007, 176–8

[93] Forsyth 1996, 103

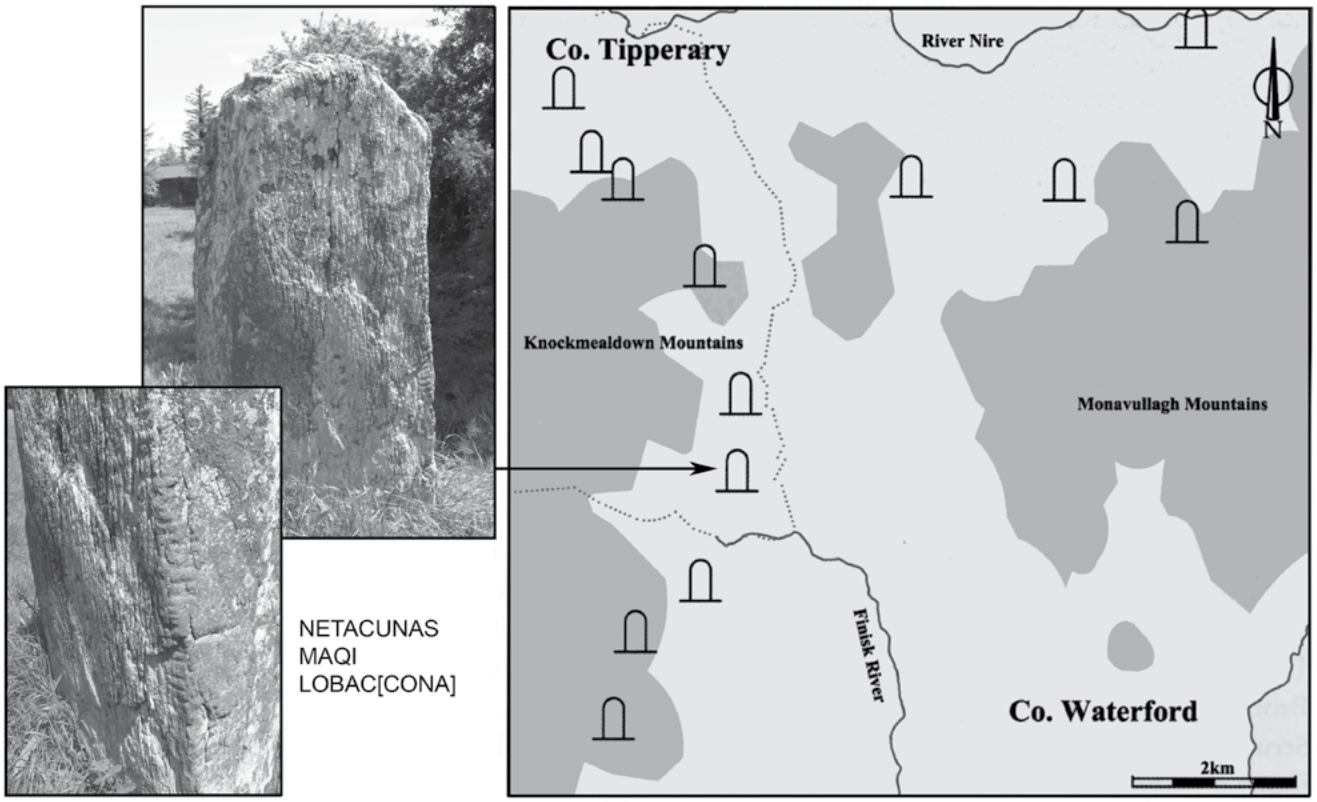


Fig 9 Ogham-inscribed stone at Priest Town, County Tipperary, within a linear distribution of at least nine standing stones that may represent a territorial division or ancient routeway (after Cleary 2007b, fig 3.3; Macalister 1945, 256)

prehistoric sites and the use of ogham inscribed stones to demarcate important points on the landscape, pathways of movement and territories.

The AEMA research on the *longue durée* archaeological and temporal contextual associations of ogham stones is also being widened to include a much broader linguistic and archaeological appraisal of other regions of Atlantic Europe. In recent years the number of comprehensive publications on Palaeohispanic linguistic material has augmented.[94] Despite this, the Celtic dataset from the Iberian Peninsula has not yet been compared in detail with early British and Irish Celtic material ranging from the earliest inscriptions to the early medieval period. Several linguistic databases have been created as part of the AEMA project, thus facilitating a new approach that can be combined with the archaeological evidence more confidently.

One case study from this new approach is a comparandum between the Celtic personal names in early medieval inscribed artefacts from the British Isles (with a special stress on the ogham stones) and the personal and – to a lesser extent – god names occurring in the Iberian Peninsula in ancient times. A total of fifty elements of personal names from the British Isles have been detected which have correspondences in the Iberian Peninsula.[95] This means a considerable degree of similarity in name formation in both areas and raises a number of questions, not least of which is how to account for such a close resemblance between territories separated spatially by hundreds of kilometres and temporally by several centuries.

Although there is only one identical personal name – MEDDOGENI – *Medugenus* – the others show very close correspondence to names in the Peninsula. Examples include COVALOTI (*CIIC* 96),[96] from Celtic **valos* 'sovereign, prince', and *Valoddus* (Burgos) and *Valutio* (Orense); BIR[R]ACIAS[97] and BIRACO (*CIIC* 89), from Celtic **birros* 'short', and the theonym *Biracidegino* (León); LADDIGNI (*CIIC* 138), from Celtic **lados* 'deaf', and *Ladienus* (Soria) and the theonym *Ladico* (Orense); DEGO (*CIIC* 122) and DEGOS (*CIIC* 197), from Celtic **degos* 'fire, flame, blaze', and *Endegus* (Zamora) and *Degant(ae, -iae)*, theonym from León and CLUTAR (*CIIC* 446), from Celtic **kluto-* 'fame', and *Clut-*, *Clout-*, *Cloud-*, amongst others.

Another set of correspondences relates to Celtic elements occurring in personal names in both geographical areas. There are many possible examples, amongst which are VLATIAMI (*CIIC* 185), from Celtic **wlati-* 'sovereignity' (cf Old Irish *flaith* 'dominion, ruler', Welsh *gwlad* 'country'), and names in *Vlati-* in the Iberian Peninsula; CATTUBUTTAS (*CIIC* 58), from Celtic **katu-* 'battle', and names in *Catu-*

[94] The coordinated research project Hesperia http://hesperia.ucm.es/en/actual.php (14 June 2016), developed since 1998 in several Spanish universities, will be an indispensable tool once the databank is entirely on open access in the near future

[95] A detailed account of all the data will be published by Fernández Palacios

[96] All *CIIC* references correspond to Macalister 1945 and 1949

[97] Power *et al* 1997

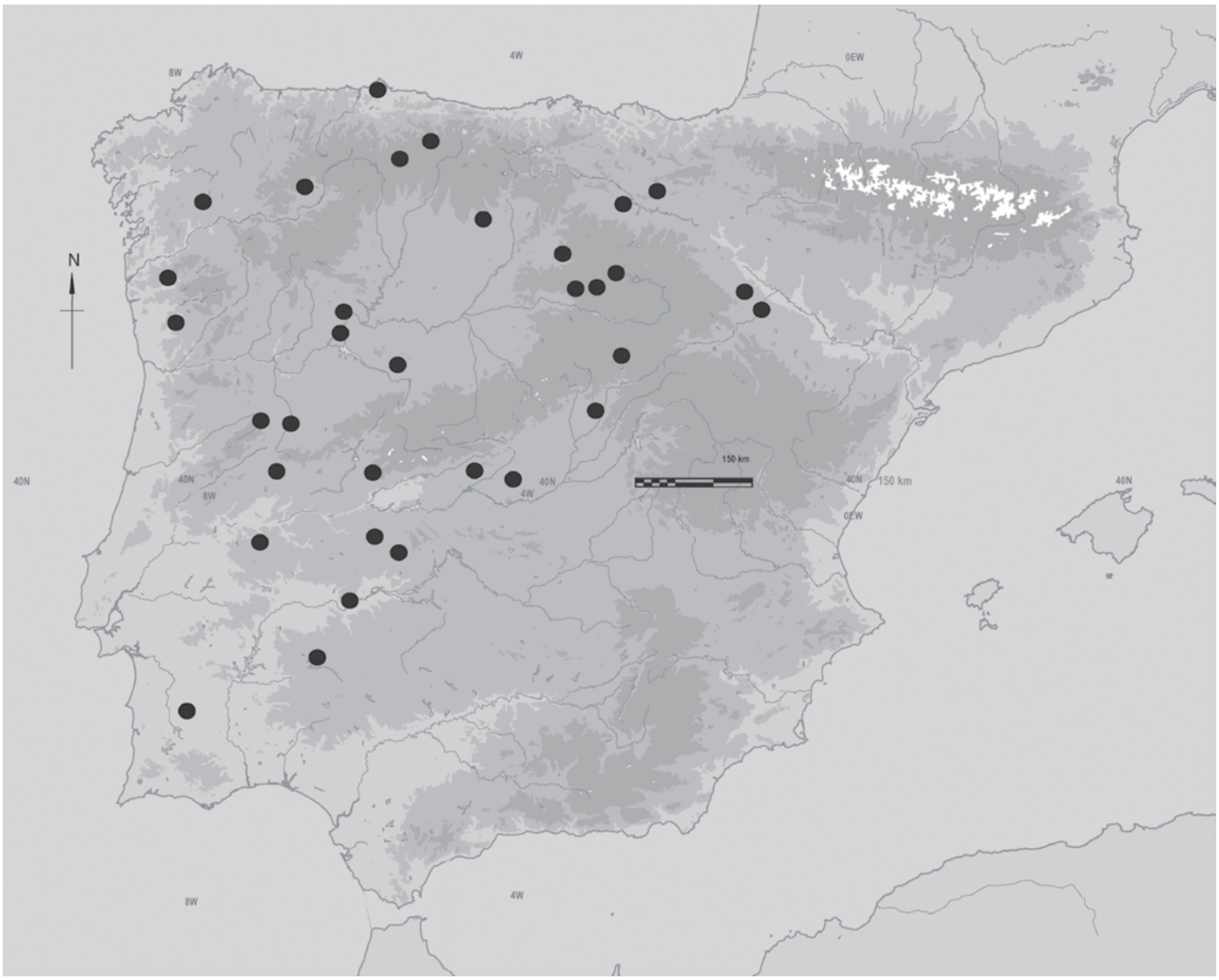


Fig 10 Distribution map of personal names in *Medu-*, *Meidu-*, etc (source: AEMAP project with data from Hesperia Project database and Vallejo 2005, 356)

in the Peninsula; DOVATUCI (*CIIC* 37), from Celtic **tukos* 'stuffed pig', or 'fat', and the theonym *Monitucinis* in Hispania, the first part of which occurs in non-ogham MUNICONNA, from Celtic **moni-* 'neck' or 'protection, patronage', and also in *Muni-* personal names in the Peninsula; MAQI-RODAGNI in a non-ogham inscription, with Celtic **rōd-*, and *Ambirodacus* in the Peninsula.

The data can, however, be interpreted in many ways, and we must be cautious advancing conclusions that may be proven erroneous or misleading. Without entering into all the linguistic fields from which the data can be analysed, we will briefly approach the semantic range. The coincidences and parallels between names in the Peninsula and the British Isles point to a semantic field related to concepts ascribed to high-status people, thus strength and power (names containing **douis-* 'strong, good', **brigo/ā* 'high, might, power', **wlati-* 'sovereignity'), war (**wik-o-* 'fight', **katu-* 'battle'), high-status references (**valos* 'sovereign, prince', **maglo-* 'noble, chief', **kluto-* 'fame') and supernatural powers (**sagos* 'seer'). Moreover, the groups involved seem clearly to demarcate social relations (**karos* 'dear, friend', **genos* 'lineage, family', **magus* 'servant, child', **moni* 'protection, patronage') and show preference for positive notions (**medu-genos* 'mead-' or 'honey-born', **medu-* 'mead, honey', Old Irish *cóem* 'dear', **erku-* 'to shine, to glorify', **meli-* 'honey', **su-* 'good'). It is evident, however, that one cannot simply extrapolate the information recovered from the naming of people in order to produce an undistorted description of social habits, because personal names are subject to fashions and are sometimes used by people who did not speak the languages involved in the naming coinage. Even so, the material is worthy of further analysis, and in this respect can be made more robust through employing extra-linguistic fields to adequately measure the fitness of the linguistic analysis.

Moreover, in our case study there is some, although more limited, evidence for common names, even possible nicknames, such as those with **birros* 'short', **lados* 'deaf' and **tukos* 'stuffed pig' or 'fat'. This serves to highlight potential biases that might exist regarding the various social groups represented in the record, and that more emphasis is given to those with higher status. Although interpretation of these

datasets must be approached with due caution, two important provisional conclusions may be drawn from the preliminary approach to the onomastic data. The first one is the large number of elements occurring in early medieval personal names from the epigraphic sources in the British Isles and which have comparanda in theonyms or epithets of theonyms from the ancient Iberian Peninsula. The second one is the predominant distribution in western and northern Iberia of the onomastic correspondences with the material from the British Isles, with relatively few matches occurring in the territory of the Celtiberians.

If we compare this evidence with that from the Iron Age south-west inscriptions of the Peninsula, we may postulate personal names like **ak^{o}osioś** (*MLH* IV J.56.1)[98] or **anb^{a}at^{i}ia** (*MLH* IV J.16.2) with good correspondences in Celtiberia and Extremadura. Even more relevant for our purposes is the existence in the south-west of the presumed personal name **b^{o}ot^{i}iea** (*MLH* IV J.18.1), with parallels not only in the Peninsula (Celtiberia, Lusitania, etc) but also in the British Isles (COLABOT [*CIIC* 106], etc). Once linguistically scrutinized, the last comparison could provide a fine example of overcoming problems concerning connectivity between geographically distant places. Further analyses relating onomastics from other times and places should help us to clarify some aspects of the connections or disconnections that the project has begun to envisage.

A last point to highlight is the importance of practising linguistic analysis that is not detached from the things named. This is not to say that we must go back to *Wörter und Sachen* with the elements of analysis of a century ago. Techniques have developed and the anthropological – and in most cases more precisely the ethnological – field, have many contributions to make in order to provide a better resolution of the problems formulated from linguistics. Thus, we began by pointing out that the only complete match between the names in the British Isles and the Iberian Peninsula is MEDDOGENI – *Medugenus* ('mead / honey-born'), and this can be better understood if we take into account the importance of bees in ancient societies and specifically in early medieval Ireland, of which *Bechbretha*, an Old Irish Law-tract on bee-keeping,[99] is an obvious and relevant proof (Fig 10).

Preliminary conclusions

When the family of languages that has been conventionally labelled 'Celtic' for over 300 years first becomes visible during the Iron Age, it is found dispersed widely over western and central Europe. An explanation for this state of affairs, that is well known and still widely believed today, goes back to the mid-twentieth century and envisions the Celts spreading from west-central Europe, carrying with them Hallstatt and La Tène material culture. This traditional model accounts inadequately for the Celtic languages in the Atlantic west, dismally so in the Iberian Peninsula, where there are early and archaic Celtic languages with no links to Hallstatt or La Tène influence. To devise a more workable model of Celtic origins requires an integrated sociocultural account of the later prehistory of western Europe as an essential preliminary. The inter-disciplinary AEMA project aims to take an important step towards this goal by synthesizing datasets that are generally kept separate. Through embracing extensive temporal and geographical spans and following a multi-disciplinary methodology, the research will be able to move across and dissolve unhelpful and artificial divisions created by specialist fields, chronologies, countries and modern research languages. This creates an opportunity to provide a more united and informed approach to complex questions that cannot be understood in isolation (temporal, spatial or otherwise). Bringing together, superimposing, interlinking and querying such diverse datasets will help tease out the complex and tangled networks that existed during the Metal Ages and help identify how different connections and interaction zones emerged, developed, transformed, intensified, diminished and perhaps reconnected in Atlantic Europe between the third and first millennia BC. The four research themes presented above are areas of interest, bearing upon aspects of Celtic origins, in which the integrated cross-disciplinary approach of the AEMA project has begun the bear fruit. It is also anticipated that as the data resource expands and becomes available to other researchers, it will open directions not yet foreseen for future interpretation and hypothesis testing.

Postscript

The Atlantic Europe in the Metal Ages Project was a three-year AHRC-funded project that was completed in April 2016. This paper was written at a relatively early stage within the project, and more detailed information regarding its outputs can be found in recent publications. These include *Celtic from the West 3. Atlantic Europe in the Metal Ages: questions of shared language*[100] and *Exploring Celtic Origins. New ways forward in archaeology, linguistics and genetics.*[101] In addition, the database generated from this project is now freely available on-line and fully searchable.[102]

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[98] All *MLH* IV references correspond to Untermann 1997

[99] Charles-Edwards and Kelly 1983

[100] Koch and Cunliffe 2016

[101] Cunliffe and Koch forthcoming

[102] http://www.aemap.ac.uk/search/ (14 June 2016)

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The Bronze Age mines dating project and some new ideas on ore extraction and smelting

Simon Timberlake and Peter Marshall

This paper provides an overview of the history of the earliest metal prospection and mining in Britain, based on fieldwork undertaken over the last couple of decades by the Early Mines Research Group, and with a particular focus on the chronological succession of mining activity at different extraction sites across Wales and England. It also presents a model of how Early Bronze Age mining activity in different parts of Britain might have been organized within a wider framework of social and economic relationships.

Bronze Age Mining in Britain

Introduction

Over the last twenty-five years the discovery and excavation of some thirteen Bronze Age metal mines or prospection sites, and the probable identification of at least eight others, has provided a suitable timeframe for the first exploitation of metal in Britain.[1] This consisted of a widespread phase of early prospection which took place between 2000 and 1650 BC, followed by production at a very limited number of sites (such as the Great Orme in North Wales) which continued up until the Late Bronze Age.[2] All of these investigations, except for that on the Great Orme, form part of a long-term programme of study currently being undertaken by the first author (ST) and the Early Mines Research Group (EMRG).

Most of the mines are located along the western seaboard of Britain (Fig 1a), with a concentration in North and mid-Wales, but particularly in mid-Wales where they are associated with lead and copper veins (Fig 1b); these being worked at points where enriched pockets of copper mineralization lay closest to surface.[3] Many of these sites were originally identified on the basis of finds of cobble stone tools, the majority of these tools collected as beach pebbles along the coast. Only at distances greater than 20 kilometres from the coast do we find the regular use of river pebbles and glacial erratics.[4]

Given that mining in south-west Ireland began around 2400 BC,[5] it would seem reasonable to suppose that the current pattern of sites represents an eastward migration of copper prospecting which follows the decline of production at Ross Island in Co Kerry, Ireland – yet in reality this pattern is far from simple. At this point it may be useful to summarize what is known of the already archaeologically investigated and dated prehistoric mines, alongside others suspected of being Bronze Age.

Isle of Man

We can see the evidence of possible Bronze Age copper prospection on this island close to one of the shortest sea crossings between Ireland and Britain. Traces of primitive mining have been detected upon the stunning cliffs of North Bradda Head [SC 18617063][6] and also South Bradda Head [SC 185697],[7] where stone hammers have been found (Fig 2). The mineral outcrops here were described by Lamplugh as being amongst the most spectacular displays of quartz veining in Europe.[8] Traces of copper staining on these veins can be seen some way out to sea, much as it might have been when Bronze Age peoples crossed in their plank boats or *curraghs* from Ireland. Similar finds of hammerstones associated with copper mineralization and possible indications of working (ie at [SC 28396603]) have also been made on the Langness Peninsula, a short distance to the east.[9]

The presence of this 'metal route' seems all the clearer when we examine the Copper Age / Early Bronze Age metalwork from the island, which shows affinities with both Irish and early Welsh and Scottish (Migdale) axes, along with the mixing (or recycling) of Ross Island metal with copper from other sources.[10]

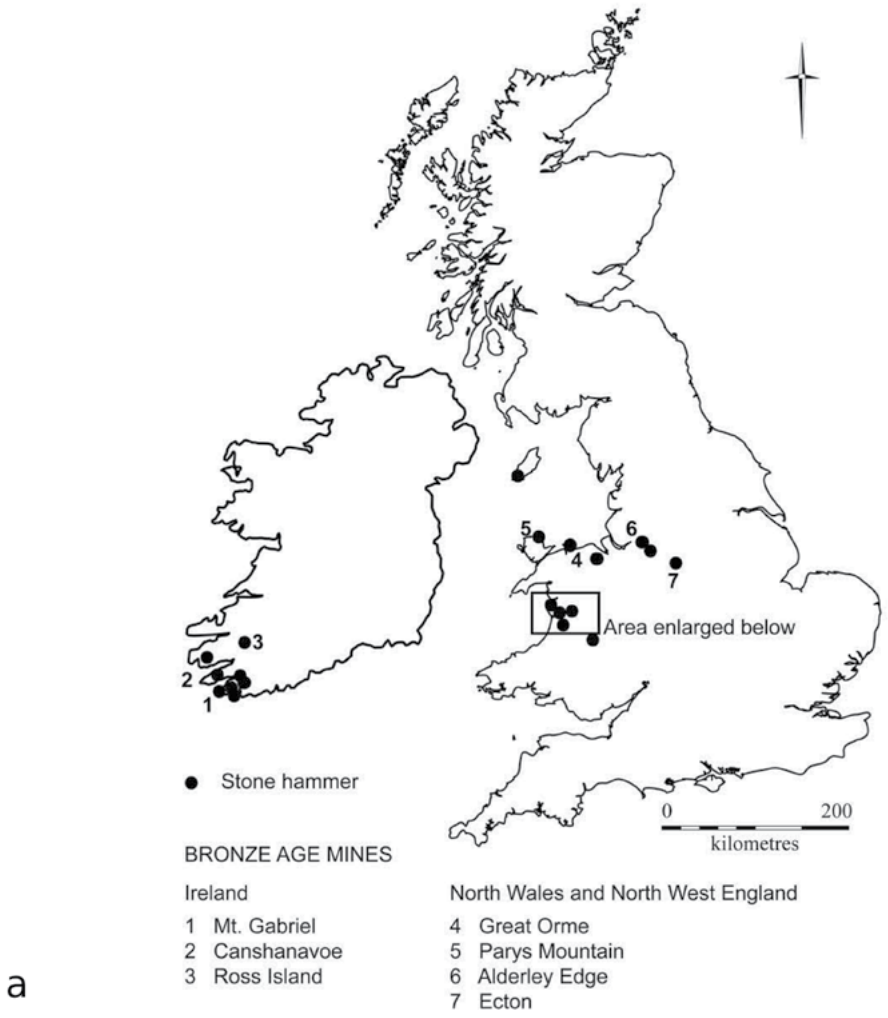
North Wales

Parys Mountain (Mynydd Parys)

On the island of Anglesey, evidence of Early Bronze Age copper mining has been found at least at four to five locations underground at Parys Mountain, where David Jenkins has been working since the early 1990s.[11] Prior to this, 'primitive' surface workings, mined using stone cobble tools and brushwood fires, were reported as having been found in an area close to the summit of the mountain in 1796.[12] One of these early mining sites was re-discovered at the Oxen Quarry just to the north of the windmill by Oliver Davies in the mid-1930s,[13] then archaeologically excavated by the EMRG in 1988 [SH 445905].[14] This provided the very first

[1] Timberlake 2009a
[2] Timberlake and Marshall 2013
[3] Francis 1874; Timberlake 2003, 9
[4] Timberlake and Craddock 2013, 42
[5] O'Brien 2004
[6] Pickin and Worthington 1989
[7] Doonan and Hunt 1999
[8] Lamplugh 1903, 530; Dewey and Eastwood 1925, 81
[9] Doonan and Eley 2000, 47–8
[10] Davey *et al* 1999, 55, 58
[11] Jenkins 1995
[12] Sykes 1796; Briggs 1976
[13] Davies 1939
[14] Timberlake 1990a

D Brandherm (ed): *Aspects of the Bronze Age in the Atlantic Archipelago and Beyond. Proceedings from the Belfast Bronze Age Forum, 9–10 November 2013.* Archæologia Atlantica – Monographiæ III (2019 [2025]): 101–119



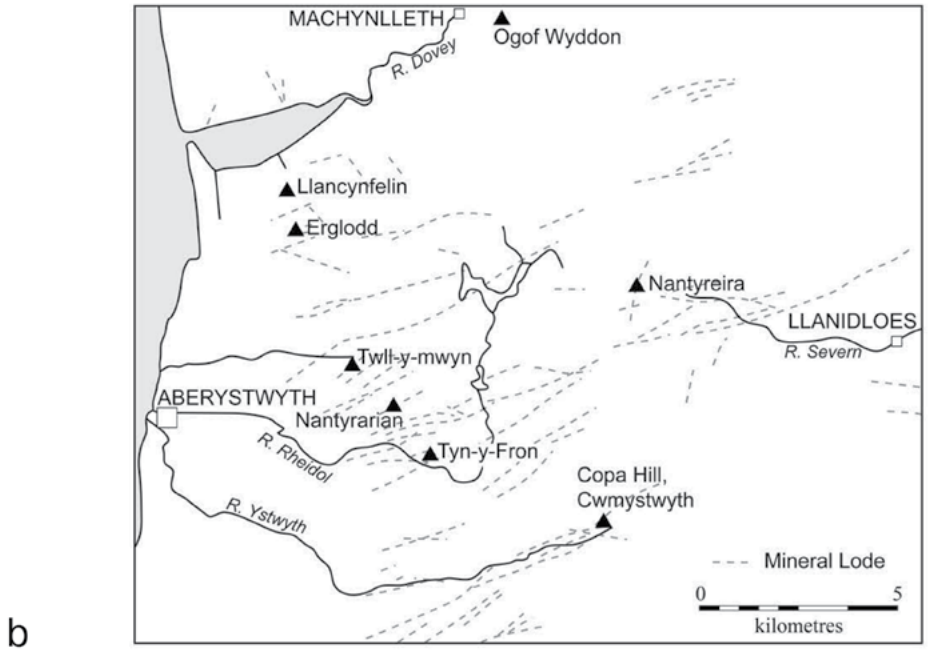


Fig 1 a Map showing cobble stone mining tools and Bronze Age mines in Britain and Ireland; **b** shows the prehistoric mines and mineral veins of central Wales (drawing Brenda Craddock, EMRG)

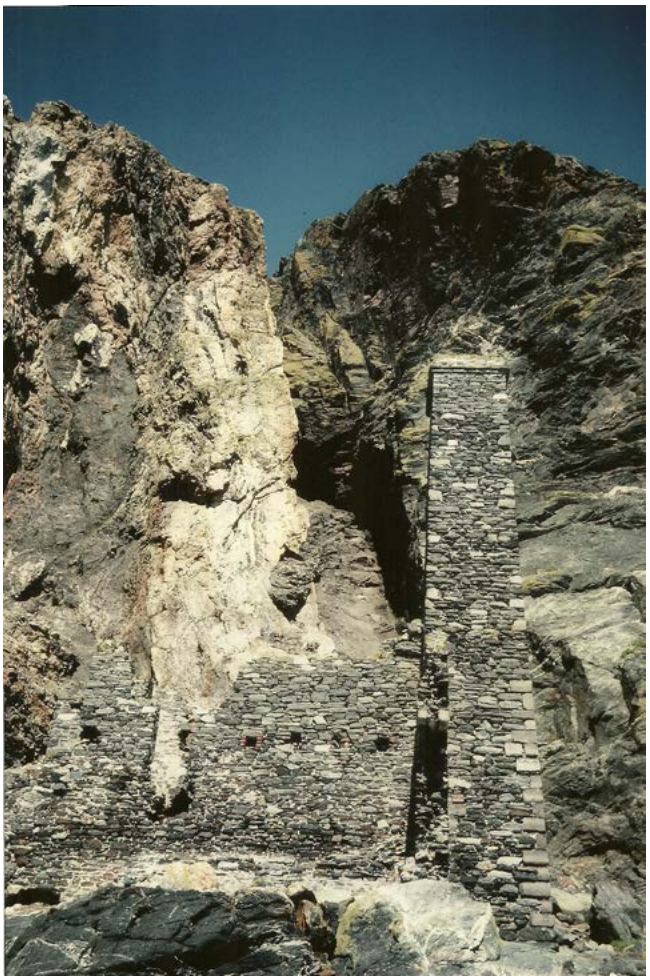


Fig 2 South Bradda Head cliffs and copper vein, Isle of Man (photograph courtesy of D Jenkins)



Fig 3 Ancient opencast at Nantyreira (Snowbrook) Mine, Plynlimon, the upper portion of which (at least) is Bronze Age in origin, February 2012 (photograph Simon Timberlake, EMRG)

Early Bronze Age ^{14}C dates for the mine, from the sampling of the remains of oak fuel used in fire-setting.

It seems possible that that the prehistoric miners were working within opencast drifts, dug from surface to depths of over 20m, using just fire and stone tools. These workings may have followed the small stockwork veins from which they could have been extracting small amounts of oxidized / supergene minerals present within those areas above the water table.[15] In the eighteenth century AD, when the deposit was rediscovered, lumps of native copper weighing up to 15 kilos were found close to the surface,[16] either within the gossan or supergene zones of the ore body.

Cobble stone mining tools have also been recorded from the small Pant y Gaseg Mine west of Bull Bay [SH 412945], where they were found during renewed mining here in the nineteenth century.[17] It appears unlikely that this mine was anything more than a prehistoric trial, and so far current fieldwork has failed to re-locate the actual site of this suggested Bronze Age working.[18]

Great Orme

Some 20km to the southeast of Parys Mountain along the North Welsh coast lies the important complex of Bronze Age workings known as the Great Orme Bronze Age Mine', a mine which has been claimed, with some justification to be (amongst) the largest of Bronze Age metal mines in Europe.[19] The main workings here are located within the Pyllau Valley on the Great Orme's Head [SH 771831],[20] the geology, mineralogy and exploitation of which is discussed in much greater detail within Williams.[21]

In my opinion the likely presence of vertical and horizontal karstic features within the Carboniferous Limestone of the Great Orme might be the reason why mining was able to reach depths of over 30m unhindered by water. Similarly, the existence of natural passages would have made access across the full extent of the mineral deposit easier, with some open or loosely filled joints being widened through the use of simple mining techniques, with little or no recourse to fire-setting.[22] This factor might help to explain the longevity of mining here; for example, the further phases of working which took place during the Middle and Late Bronze Age. As the workings got deeper we find that the

[15] Timberlake 2010, 290
[16] Lentin 1800; Southwood and Bevins 1995, 14
[17] *Anon* 1872
[18] D Jenkins pers comm
[19] Lewis 1990, 10; *idem* 1996
[20] Dutton and Fasham 1994
[21] Williams, this volume
[22] Timberlake 2013, 42



Fig 4 Comet Lode opencast and prehistoric mine tips, Copa Hill, Cwmystwyth (photograph Simon Timberlake, EMRG)

spoil starts to be backfilled in an organized way as mining 'deads' (carefully stacked waste rock filling the abandoned chambers and galleries).[23]

X-Ray diffraction analysis undertaken on samples of mine spoil collected from the sites of springs locally referred to as 'washing sites' on the Orme[24] has shown that it has been possible to successfully distinguish between mineral spoil originating from quite different areas or different geological environments within the mine.[25]

Estimates of Bronze Age copper production range from less than 30[26] to nearly 1800[27] tons of metal. To some extent this difference of opinion reflects uncertainties regarding the type and grade of ore collected, and the nature and efficiency of the smelting process. Hopefully the work of Williams (and others) will shed new light on this matter in due course.

Central Wales

The largest concentration of Early Bronze Age mines and prospecting trials on the British mainland is to be found



Fig 5 Roof of mine gallery worked with stone tools at a depth of 2.5m below the surface of the infilled opencast on Copa Hill (photograph Simon Timberlake, EMRG)

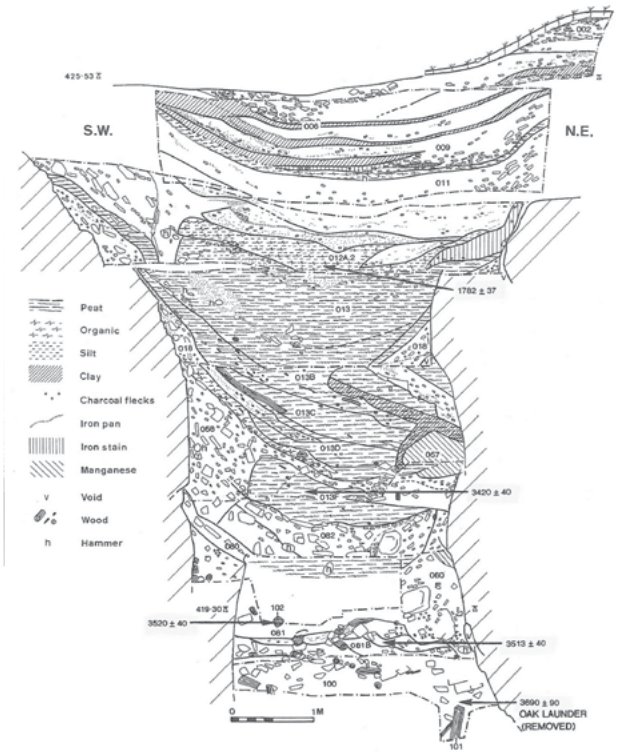


Fig 6 Section through the 8.5m deep excavated interior of the Comet Lode opencast with uncalibrated (EBA-Roman) ^{14}C dates indicated (drawing B Craddock, EMRG)

within a 25km radius of Plynlimon in central Wales, all the sites being linked to surface outcrops of copper ore associated with the lead-zinc-silver mineral veins of the Central Wales orefield. Within some of these veins we find small pockets of partly-altered chalcopyrite which form discontinuous sub-economic enrichments, yet the very small number of Bronze Age mines amongst these appear as more localized sub-groups of sites within a much wider spread of copper mineralization.

These sub-groups are now thought to be examples of 'prehistoric prospection areas',[28] and consist of the following Bronze Age mines and trials: (1) Dovey (Balkan Hill Aberdovey [SN 613963][29] and Panteidal [SN 661974][30] on the north side of the Dovey estuary and Ogof Wyddon [Park Lodge] near Machynlleth [SH 760001][31]); (2) Cors Fochno which forms the eastern lowland-upland margin of

[23] Lewis 1996
[24] Jenkins 2013, 14
[25] Jenkins and Timberlake 1997, 58–61
[26] Timberlake 2009a, 97
[27] Randall 1995
[28] Timberlake 2002a, 183
[29] Bowen and Gresham 1967, 55 (based on information from R Fenton's '*Tours in Wales 1804–1813*' re-published as a Supplement in *Archaeologia Cambrensis*, **17**, 1917)
[30] Timberlake 2009b, 6–7
[31] Timberlake and Mason 1997

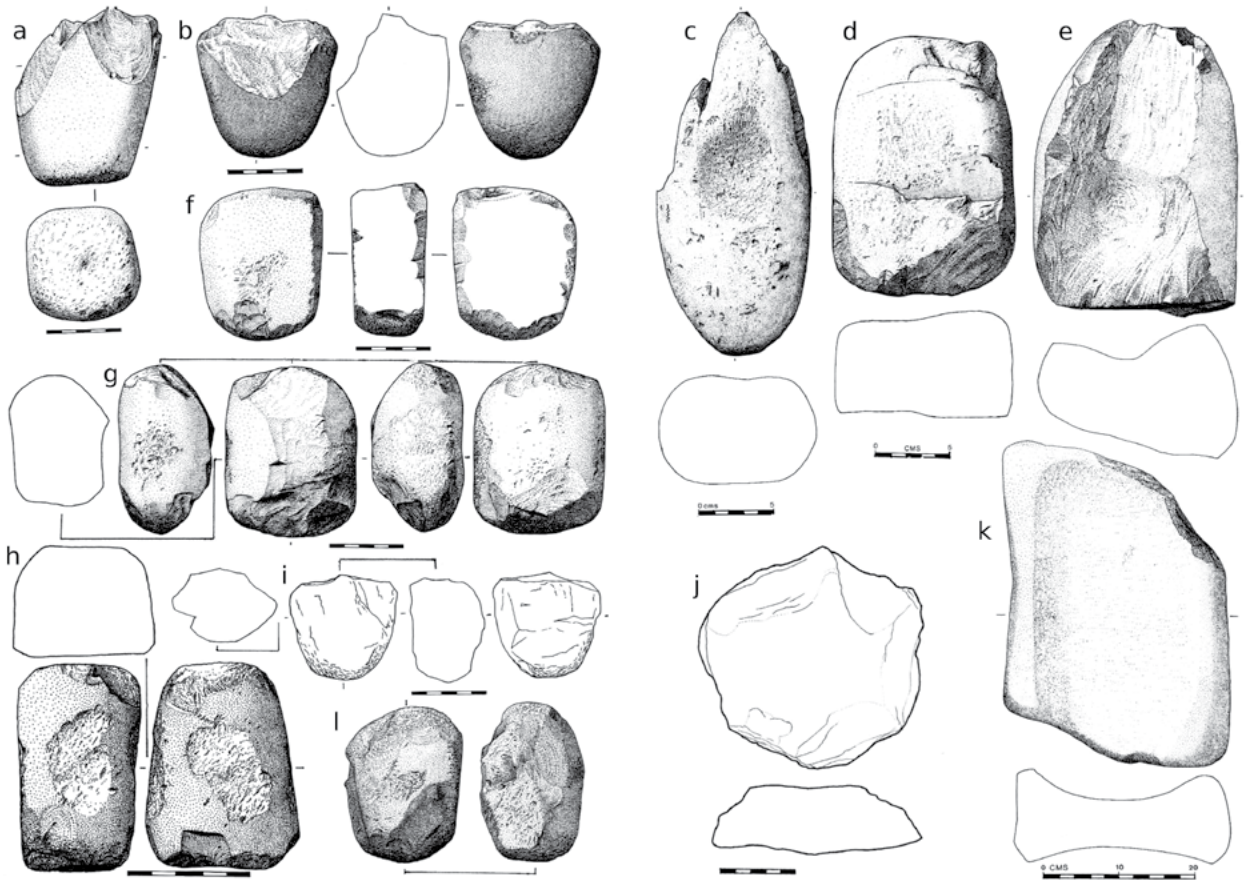


Fig 7 A range of cobble stone mining tools from Copa Hill which reflects the degree of recycling and also multi-purpose utilitarian use (drawings B Craddock, EMRG)

Borth Bog (Llancynfelin [SN 652951],[32] Pwll Roman [SN 652951][33] and Erglodd [SN 657 903][34]); (3) the Melindwr-Nant Silo-Rheidol valleys east of Penrhyncoch and west of Devil's Bridge (Twll y mwyn [Cwm Darren] [SN 682 833],[35] Nantyrarian [Blaendyffryn] [SN 705815][36] and Tyn y fron [SN 724785][37]); (4) the Upper Ystwyth (Grogwynion [SN 712723],[38] Copa Hill [SN 811752] and Penparc, Cwmystwyth [SN 795741][39]); and (5) Plynlimon-River Severn (ie Nantyreira [Snowbrook] [SN 826874][40] and Nantyricket mines [SN 865868], located on the banks of the River Severn and its tributary just a few kilometres to the east of its source). Both Copa Hill and Nantyreira are true upland sites; both of these located between 400 and 500m AOD at two of the most isolated mining locations in Wales (Fig 3).

All of the above sites have been identified from finds of cobble stone mining tools, and whilst most have been radiocarbon-dated (see below), some such as Balkan Hill, Panteidal, Pwll Roman and Nantyricket still remain to be excavated. Grogwynion, which has no copper and is probably a Medieval–Postmedieval lead mine, yielded just one or two stone tools, therefore might only have been 'visited' once during the course of Bronze Age prospection undertaken in the Ystwyth Valley.[41]

Copa Hill (Copper Hill), Cwmystwyth

Probably the most important, and certainly the best studied of these mid-Wales Bronze Age mines is the Comet Lode opencast on Copa Hill. In some respects this site with its scree slopes and weathered-out hammerstones resembles some of the axe factories of the Later Neolithic (Fig 4).

In fact the Comet Lode opencast is a good example of a small to medium-sized Bronze Age mine, one which is also unique in terms of its near-complete survival and lack of later disturbance. The pristine state of this site made it an ideal choice for archaeological investigation. Today more than five thousand tons of prehistoric mine spoil cover the

[32] Timberlake 1995, 62–3
[33] *idem* 2004a
[34] *idem* 2006, 82–5
[35] *ibid*, 79–81
[36] Timberlake 1995, 64–5
[37] *idem* 1996
[38] Thorburn 1990, 44
[39] Timberlake 2003; Timberlake and James forthcoming
[40] Timberlake 1990a, 18–20
[41] *idem* 2013, 118

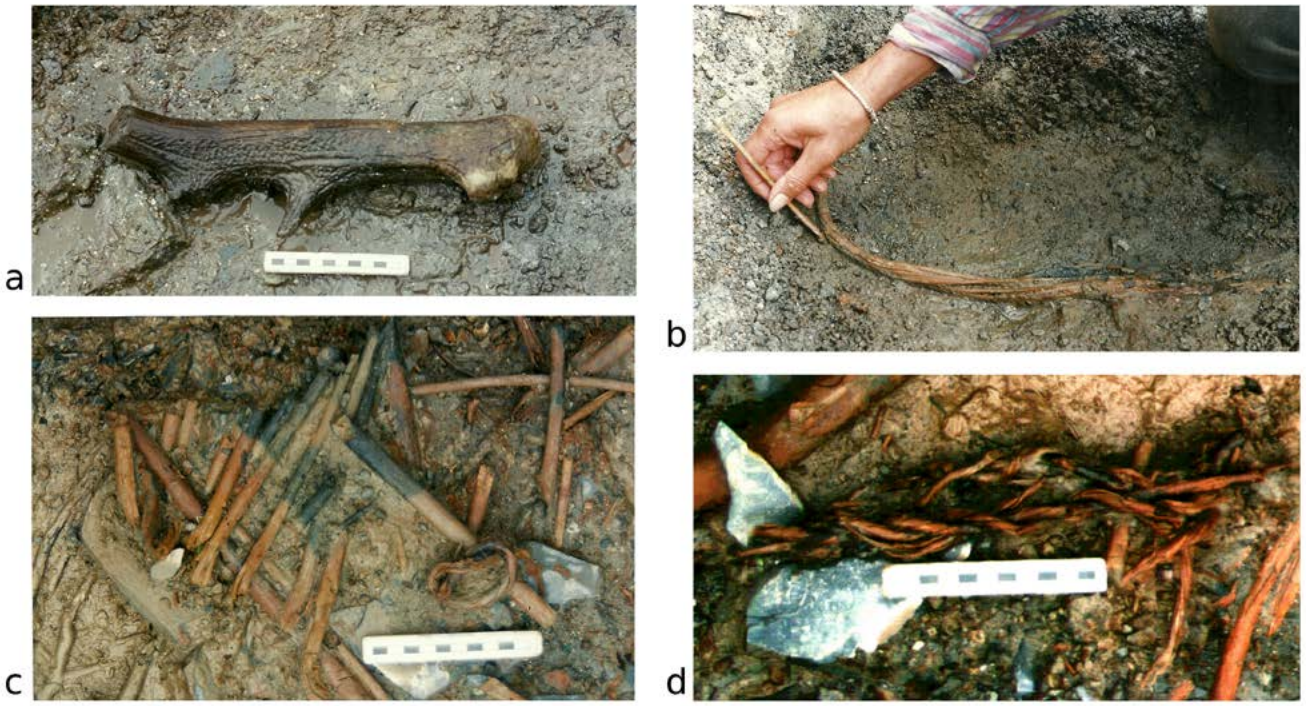


Fig 8 Organic finds from the Comet Lode opencast: **a**) antler hammer-pick tool discarded on the floor of entrance cutting; **b**) broken fragment of a twisted withy (hazel) handle for a stone hammer; **c**) part of the burnt and discarded remains of a 'kreel type' basket made of hazel, probably for carrying ore; **d**) hazel withy tie or rope, possibly for carrying firewood (photographs S Timberlake, EMRG)

hillside below the outcrop of the 10m+ deep infilled Bronze Age opencast.[42]

During the first major excavation of this site in the early 1990s a short fire-set gallery with the imprint of stone-tool hammer marks in its roof was found at a depth of about 2.5m inside of the infilled opencast trench[43] (Fig 5).

Inside of the main opencast trench mining was carried out on a series of different levels, with rock benches left in between the mined-out veins, and with climbing routes on wooden stemples descending the narrower worked-out fissures. Flooding and then gradual infill of this 10m+ deep mine began around 1800 BC, depositing slumped-in mine spoil and peat within its base. The site was finally abandoned as a mine around 1600–1500 BC. Preserved within the peat-filled interior are more than 8m of sediments dating from the Early Bronze Age to the Medieval Period, providing an almost complete palaeoenvironmental record for the mine and surrounding landscape (Fig 6).[44]

From the Bronze Age mining levels many thousands of stone tools were recovered and recorded, many of which show a range of utilitarian uses. With the exception of just one or two examples, none of these were grooved tools, and only 9 per cent showed some evidence of modification for the purposes of hafting. However, more than 41 per cent had been re-used, some of them up to three or four times, and all for different tool functions (Fig 7). The toolsets included mining hammers, chisels, wedges, crushing stones and ore anvils – and very rarely grinding stones.

The waterlogged condition of the mine sediments overlying some of the rock floors of the mine has also permitted the survival of many of the objects and tools of daily working life. These include some of the twisted handles made of hazel that once held hammerstones used as mining tools, fragments of kreel-type baskets used to carry or to wash ore, ropes for lifting bags or for carrying wood, and the remains of antler picks used as mallets with wedges and stone chisels (Fig 8). When these organic artefacts were discarded, some of them were thrown as fuel onto the fires that were used to break up the rocks.

However, the most sensational find from these excavations was the discovery of this hollowed-out 5m-long log launder (Fig 9), perhaps one of the earliest examples of mine drainage known. This was one of three such launders excavated, this one being found *in situ*, in its last functional position within the entrance cutting to the mine. The sides of this length of alder tree trunk reveal the marks of the metal axes used to carve it out.

It seems likely this launder was used to try and tap water coming in at a spring on the edge of the working. We know from the sediments present in the mine that flooding was a problem in the deeper workings. This continued ingress of water contributed to the eventual demise of the mine at or around 1600 BC. Once channelled, this drainage water may also have been used for washing and separating the

[42] Timberlake 1991, 186

[43] *idem* 1990b

[44] Mighall *et al* 2002



Fig 9 Early Bronze Age alder wood launder *in situ*, at the front of the prehistoric opencast, Copa Hill (photographs S Timberlake, EMRG)

crushed ore. Ore was separated from the gangue minerals, lead minerals were separated from the copper, and perhaps also the malachite from the chalcopyrite.

A Bronze Age ore from Cwmystwyth

Micro-excavation of some of the lenses of crushed mineral present within the Bronze Age mine spoil has revealed the presence of considerable amounts of relict chalcopyrite (most of this oxidized to goethite), the vast majority of which was discarded during the hand-picking and concentration of ore.[45] This supports the idea that it was the associated oxidized minerals such as malachite which were being sought. More than likely these would have been very thoroughly removed following crushing and separation, leaving little or no trace of them today. To some extent we can still see this in those mines not discovered in the Bronze Age (such as Guefron Mine east of Plynlimon), where we find occasionally deeper zones of weathering and much better survival of secondary minerals.

A recent re-examination of some of the crushed Bronze Age mine spoil on Copa Hill has revealed the presence of some of these minerals, which ore replacement textures suggest were part of the original constituent of the veins rather than just the product of post-mining mineral alteration. Some of the relevant microscope thin-sections photographed by Alan Williams show cores of native copper and cuprite surrounded by malachite and azurite, all of which is replacing chalcopyrite. We found the same sort of thing within drill corings taken from the sides of the emptied Bronze Age workings.[46] These show that the prehistoric miners worked the relatively soft oxidized portion of the carbonate-quartz vein right up to the solid un-altered sulphides, then stopped.

Then there is the question of lead. Near to where the launder lay was found a small vein of lead which had been worked using hammers and a stone chisel. Either side of this were found lumps of lead ore (galena) that had been mined and then discarded.[47] The miners may well have known (or perhaps just believed) that if they followed this, they would eventually re-discover the copper. Yet within this area there was also some evidence that the lead ore had been crushed, there being clear evidence for the deposition of alternate layers of lead-rich and copper-rich sediment.

[45] Mighall *et al* 2000

[46] Jenkins and Timberlake 1997, 33–6

[47] Mighall *et al* 2000

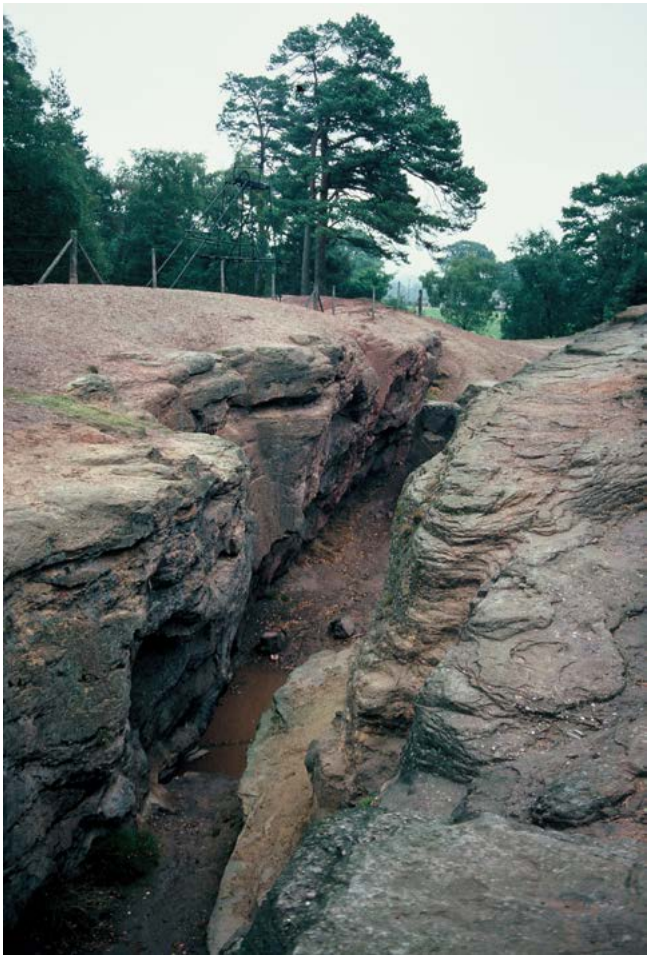


Fig 10 Engine Vein opencut, Alderley Edge, Cheshire, showing Bronze Age mining pits (LH side) bisected by later workings (photograph courtesy of The Manchester Museum, AELP archive)



Fig 11 Grooved cobble stone mining hammer recovered from Engine Vein during excavations in 1997 (photograph courtesy of The Manchester Museum, AELP archive)

Alderley Edge, Cheshire

More than a hundred kilometres to the north-east of Cwmystwyth there was also mining of malachite and azurite during the second millennium BC at Engine Vein [SJ 860775] (Fig 10), Brynlow [SJ 875783] and Pillar Mine (Stormy Point) [SJ 861778] on Alderley Edge, and at the neighbouring village of Mottram St Andrew [SJ 855773],[48] all sites close to present-day Manchester. Here copper minerals were found impregnating the conglomerate, sandstone and shale bands within the Triassic Sherwood Sandstone rocks that formed the escarpment overlooking the edge of the Cheshire Basin.

In 1878 a Bronze Age wooden shovel was recovered from Brynlow Mine,[49] whilst the sometimes complexly grooved stone mining hammers found here at Alderley Edge are unique for British Bronze Age mines (Fig 11).[50] One of the small pit workings located close to the southern edge of Engine Vein was archaeologically examined in 1998. This provided an interesting record of the prospection for copper around 1900 BC, its subsequent use for ore processing, and finally as a hearth.[51]

Clear imprints of the stone tools used in the mining of this pit could be seen on the surface of the sandstone, along with the soot stains from fire-setting, and a layer of cobbles lying in its base. These included some neatly broken and perhaps deliberately placed fragments of stone tools.

Ecton Copper Mine, Staffordshire

Recent archaeological work in 2008 and 2009 has focused on the Ecton Copper mines in Staffordshire, located on the western edge of the limestone Peak District of central England. Three possible sites of Bronze Age extraction for copper carbonate ores were identified on the mineralized outcrops close to the summit of Ecton Hill, two of which, Stone Quarry (Dutchman) Mine [SK 09905825] and The Lumb [SK 09755800] were archaeologically investigated.[52] On The Lumb, one of at least four short bedding-plane opencuts was partially dug to reveal a series of hollows worked using

[48] Timberlake 2005a
[49] Garner *et al* 1994
[50] Timberlake 2005b
[51] Timberlake and King 2005
[52] Timberlake 2014



Fig 12 The Lumb outcrop on Ecton Hill, showing possible Bronze Age mine entrances (photograph S Timberlake, EMRG)

hand-held hammerstones, bone picks, scrapers and antler points (Figs 12 and 13). The discovery of an Early Bronze Age flint scraper nearby was a rare find for this site.

The bone tools from Ecton have since been radiocarbon-dated and used to model the periodicity and sequence of mining within these hilltop sites. Some of the tools that were dated were in fact recovered from the spoil of a seventeenth-century re-working of the prehistoric Stone Quarry Mine.



Fig 13 Prehistoric extraction hollows within excavated opencast of Mine no. 1 on The Lumb, 2009 (photograph S Timberlake, EMRG)

A radiocarbon-dating chronology for British Bronze age mines (PM)

The first Bayesian modelling of radiocarbon dates for a British Bronze Age mine was provided for Ecton by John Meadows and Peter Marshall of Historic England in 2010 and 2012.[53] This incorporated the radiocarbon dates of twelve bone and antler tools taken from two different areas of the Ecton mine working (Fig 14). Interestingly, if one assumes that mining shifted from one of these locations to the other, then there is a very good correlation here with the model which suggests that the Stone Quarry tools are older than those on The Lumb. Therefore the duration of mining within the deeper workings at Stone Quarry might have been greater (between 30 and 120 years) than that on The Lumb (between 30 and 75 years) (see Fig 14b). The probability of course is that mining was much shorter than this at both locations. Unusually, there seems to have been a short recurrence of mining or prospecting activity on The Lumb sometime during the Middle Bronze Age.

The Bayesian-modelled dates for the Great Orme, on the other hand, suggests that mining here may not really have got underway much before 1700 BC, and had its most active period around 1500–1300 BC, when most of the copper was being produced. These dates come from both bone tools and charcoal, with samples distributed across the workings. Interestingly, some of the latest Middle Bronze Age to Late Bronze Age dates appear to come from the deepest levels within the mine

A model for the currency of all known Bronze Age mining in sites in England and Wales can be seen in Figure 15a. This has been constructed by taking estimates for the start and end of mining activity at each of the individual sites and combining them with the individual dates from these sites. This suggests that mining most probably started during the last quarter of the third millennium cal BC, and that the earliest dated mining activity took place in the mid-Wales group of mines (80 per cent probability).

British mines fall into three spatially distinct groups: mid-Wales (the Plynlimon area), the north Wales coast and north-west central England. The spread of mining activity across Wales and England is depicted graphically in Figure 15b. This shows the most likely order for the start of mining activity in these three areas, ie mid-Wales > North Wales coast > North-west central England = 43.3 per cent probability. This suggests an obvious movement eastwards from mid-Wales to England which took place over a relatively short period of time, with similarities in mining methods and tools implying a mutual knowledge and experience that once linked the miners of mid-Wales with central England.

Currently all of the Irish mine dates are in the process of being amalgamated into a chronological model for the British Isles. Although it is early days to draw a finite conclusion,

[53] *ibid*, 180

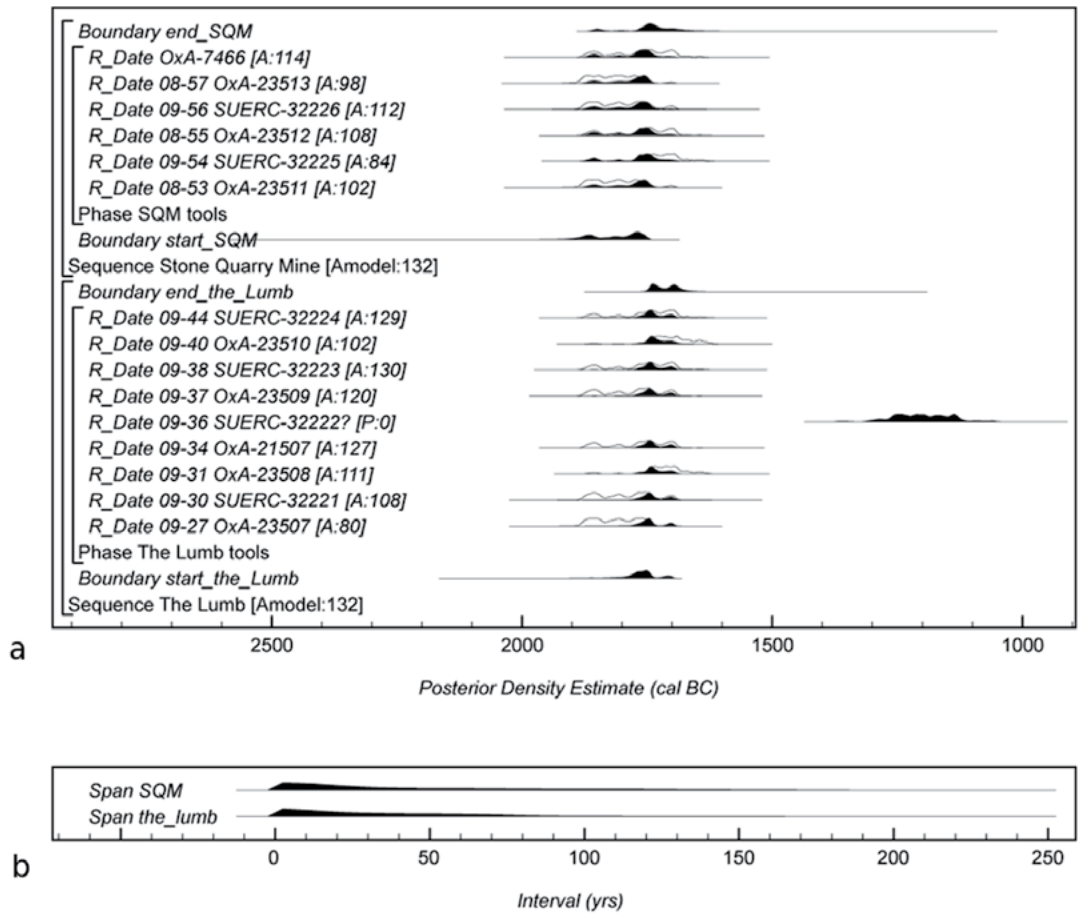


Fig 14 a Bayesian modelled ^{14}C dates of bone mining tools from the Stone Quarry and The Lumb Bronze Age mines on Ecton Hill; **b** Model showing suggested durations of mining at the Stone Quarry and Lumb Mines, Ecton (Peter Marshall, Historic England)

the evidence would seem to suggest that mining and the search for metals migrated to mainland Britain during the most active period of exploitation of the Ross Island mine, rather than just being a consequence of its demise, with the Mount Gabriel type mines being exploited later.

Some ideas on the origins of metal mining and prospecting for metal ores

A social model for the mining, smelting and distribution of metal

Since we have no direct evidence for smelting within the immediate neighbourhood of most of the British mines, we can only presume that the majority of this ore was being smelted at either permanent or temporary settlements, or else was being 'traded on' in the form of an unsmelted but enriched concentrate to itinerant metalworkers.

With plenty of pasture available, summer would have been the slack time of year, enabling mining to be undertaken communally, an activity engaged in by at least part of each family group.[54] Thus it would have been to temporary settlements or shepherding camps (such as might once have existed on the floor of the Ystwyth Valley below Copa Hill) that the initial products of mining, perhaps as little as one small bag of hand-picked, crushed and concentrated ore per day, would have been brought during the few months of residence within the area.

In fact the mining of ore may simply have been another means for 'low-status' subsistence farmers to enter into the exchange economy. Shennan refers to a slightly more sophisticated form of this relationship in his socio-economic study of the Bronze Age miners / metalworkers at the mining settlement of the Klingelberg in Austria.[55] However, for the Bronze Age inhabitants of mid-Wales, production of the actual metal may well have seemed an altogether less important goal than acquiring finished objects. Perhaps therefore it was the contacts and exchanges negotiated with passing metallurgists, first perhaps the influential 'Beaker' metalworkers, and then later on other elites, which provided these miners / pastoralists with their very first metal objects.

The ability to exchange ore concentrate for finished metal would have given those who mined the mineral (and who

[54] Timberlake 2002a, 185

[55] Shennan 1999

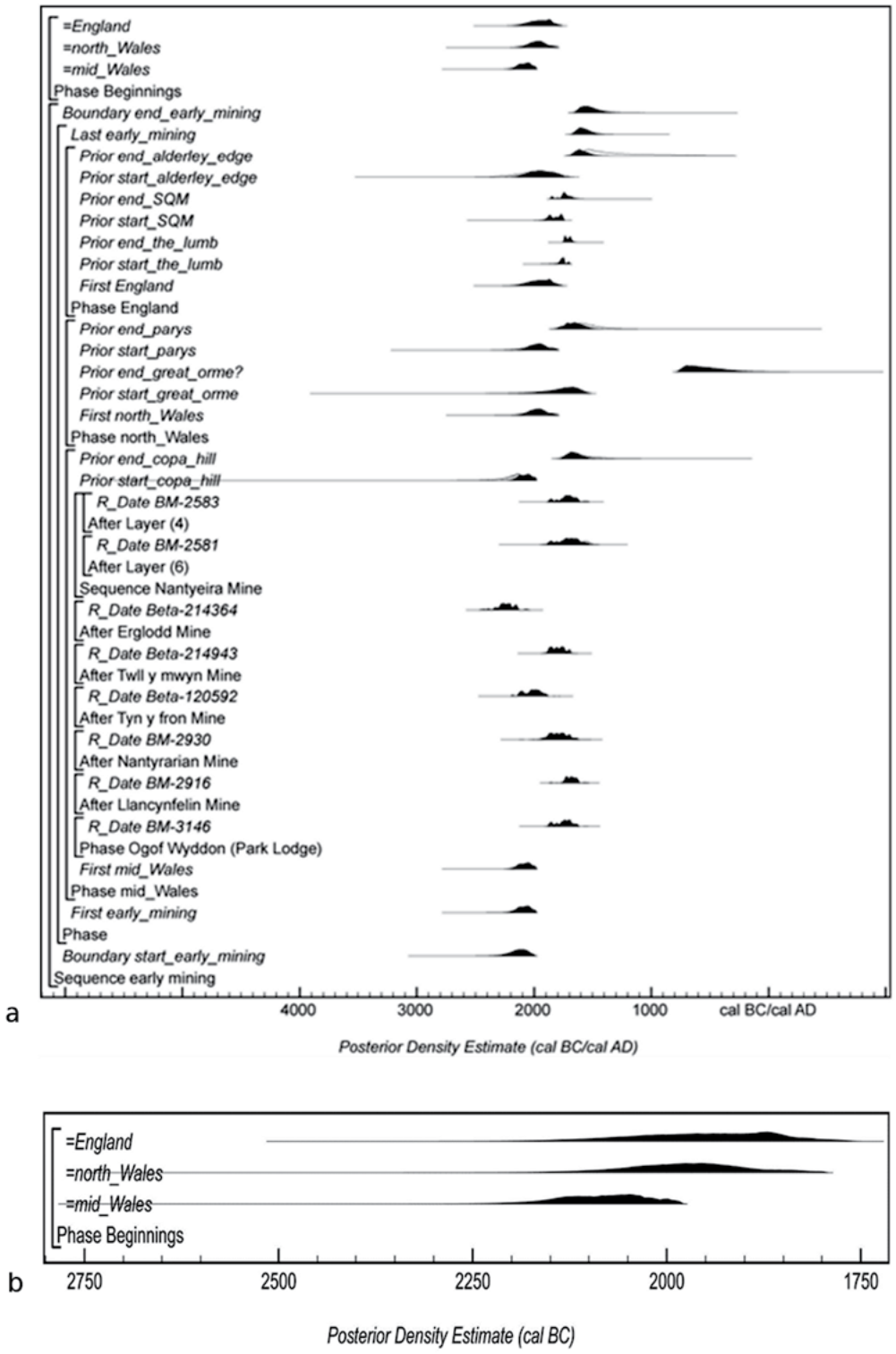


Fig 15 a Bayesian modelled ^{14}C dates for early mining activity in Britain; **b** shows the probable phase beginnings in mid-Wales, north Wales and in England (Peter Marshall, Historic England)

had ancestral rights to the land in which this was found) a distinct advantage over their neighbours. However, not having either the skills or the will to produce metal, or to control its distribution, meant that any form of elite or power base was very unlikely to develop as a result. We can see this, or the lack of it, within the mining territories of mid-Wales, and pretty much the same thing also along the North Wales coast close to the 'production centre' of the Great Orme. For example, there is no clustering of significant monuments centred upon the mines or their immediate hinterland, and



Fig 16 The Banc Tynddol gold disc from Copa Hill, Cwmystwyth. The foil disc weighs 2.51g, with a natural alloy composition of 94 per cent Au and 6 per cent Ag (photograph S Timberlake, EMRG)

all this despite the fact that the Plynlimon area appears to be a moderately busy landscape at the beginning of the second millennium BC. Even more significant is the relative paucity of contemporary metalwork within these areas.[56] As Briggs pointed out, there seems to be no evidence for any fall-off in distribution away from the presumed 'production zones', in terms of artefact findspots.[57] This contrasts with the pattern for stone implements in the Neolithic and perhaps also with gold objects in Ireland during the Copper / Early Bronze Age.[58] With copper and bronze, however, this lack of correlation is repeated across the whole of Britain in terms of the distribution of objects or ingots, a situation which persists at least until Late Iron Age and Roman times. The role of the itinerant metalworkers plus the active recycling of metal are perhaps some of the main reasons for this cloak of invisibility.

It is difficult now to try and model the movement of metalworkers in and out of these mineral landscapes, given the almost complete lack of evidence for settlement, smelting or metalworking hearths of this period. What we should try to remember, though, is the potential complexity of these metal pathways, particularly where this involves a multitude of different sources of manufactured metal and ore (many of which will remain unknown), a diverse production base (most smiths will be working on a small-scale using just temporary smelting and metalworking hearths), the mixing of the ores, and the alloying and re-melting of bronze.[59]

In the aftermath of the the 'first great copper rush' into Britain, it may have been as difficult for a Bronze Age smith to be certain of the source of his metal as it is for us to now to try and determine this on the basis of trace metal composition and lead isotope analysis. With the latter we are dealing not only with the cross-over in the plots for the British (EWLIO) lead isotope fields,[60] but also with the knowledge that from around 1900 BC onwards we could be dealing with both the intentional or inadvertent blending of copper through the gradual incorporation of scrap and melting together of primary ingots.[61] However, that is not to say that there will not be some occasions when a reasonable match between individual pieces of metalwork and the composition of a known ore source can be made.

During the Wessex I (Bush Barrow) phase of the Wessex culture we begin to see the emergence of a powerful elite occupying the chalk lands of Wiltshire around Stonehenge, and as a result the production of fine metalwork, including sheet gold ornaments, bronze daggers and decorated / undecorated low flanged bronze axes, which reaches its peak between 1800 and 1600 BC.[62] Not surprisingly, this period corresponds with the highest level of new prospection witnessed within all of the known mining areas of Britain. At the same time the metalwork compositions identified within the broadly contemporary Willerby (or IMP-LI6 type) metalwork assemblage indicates a range of possible sources, amongst them metal with generally low impurity levels suggesting an unmixed composition, at least some of which might have a Central Wales origin. In particular, there are several objects from the Lydd and West Overton grave groups that are naturally high in lead and which show a good match with the lead isotope ratios and mixed lead / copper ores from Copa Hill.[63] Either this reflects a suddenly much larger output from these mine(s), or else it is simply the result of smelting and metalwork production taking place more locally, and as a result being unmixed with other ores or metal.

Beaker metalwork and copper prospection

One of the most surprising finds of this fifteen-year long campaign of excavations on Copa Hill was a discovery made whilst investigating a Roman and Early Medieval lead smelting site on the valley edge at Banc Tynddol, close to the foot of the copper-rich Comet Lode. A short distance beneath the surface here within the top of what may have been a robbed-out now empty grave[64] was found a 38mm-diameter disc made of beaten gold foil (Fig 16). The disc with its concentric chased line(s) and repoussé decoration is fairly characteristic of Bell Beaker-type artefacts,[65] the punctate design on this showing some similarity with that appearing on the

[56] Savory 1980
[57] Briggs 1988; 1994; Timberlake 2009a, 113
[58] Taylor 1994
[59] Timberlake 2005, 32
[60] Rohl and Needham 1998
[61] Timberlake 2009a, 113
[62] Clarke *et al* 1985
[63] Rohl and Needham 1998, 91
[64] Timberlake 2004b, 137
[65] *idem* 2002b

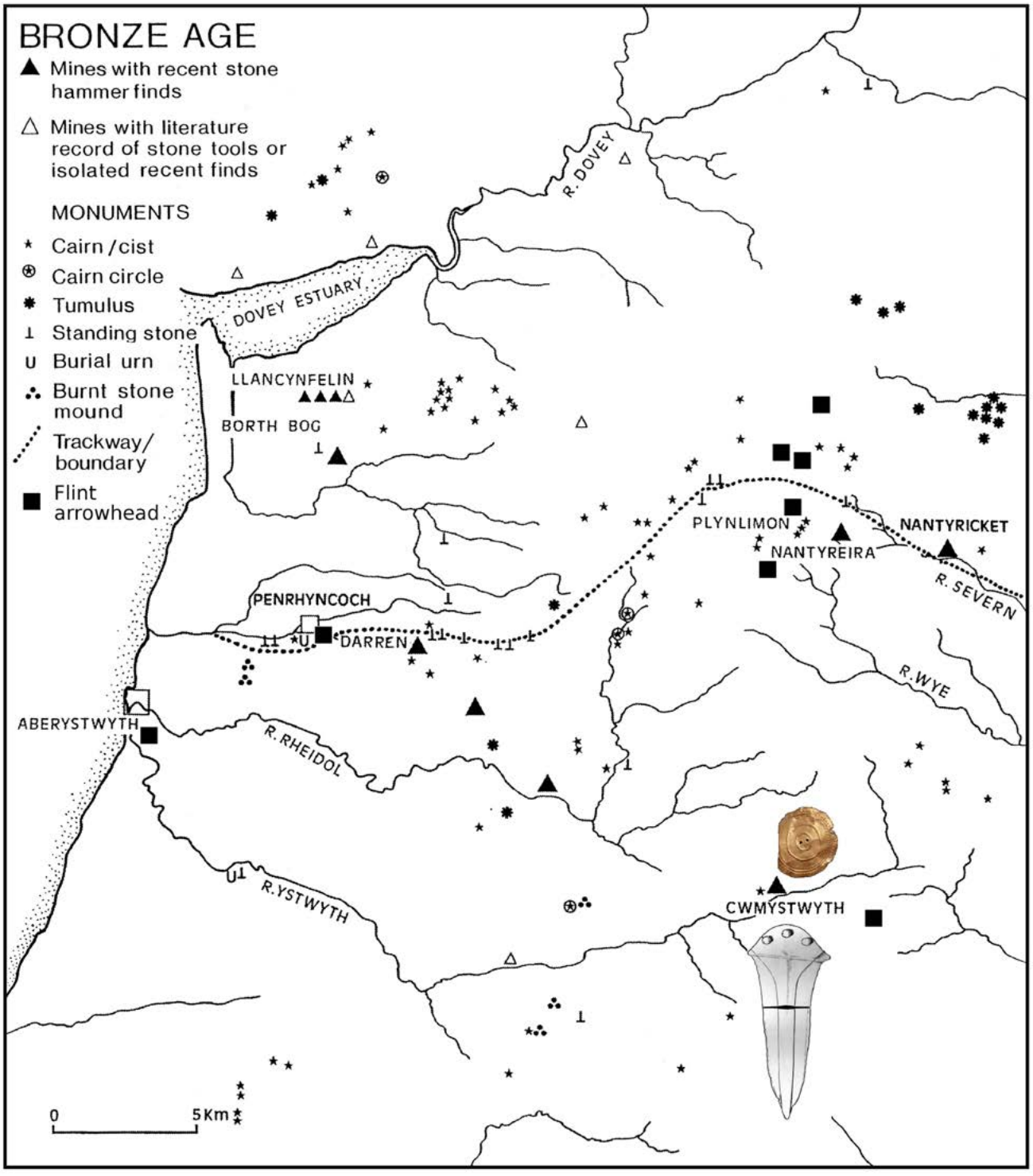


Fig 17 Map of the Plynlimon district, showing Bronze Age mines and prospection areas (1-5) together with the distribution of finds of a possible Beaker cultural affinity, Early Bronze Age monuments, and the indication of a possible route that skirts Plynlimon and links mining area; the large number of flint arrowheads may be significant (S Timberlake, EMRG)

gold hair-tress ornament worn by the Amesbury Archer, and also some of the perforated 'sun discs' elsewhere in Britain, such as Kirk Andrews on the Isle of Man.[66] The appearance of this find would seem to confirm a Beaker presence within the vicinity of the mine, the suggested date of this (2300–2100 BC)[67] coinciding with the very earliest evidence for prospection on Copa Hill.

When we study the Bronze Age landscape of North Ceredigion and the Plynlimon area, some interesting patterns begin to emerge. Firstly, the Banc Tynddol disc is not the only Beaker / Early Bronze Age artefact associated with

[66] Clarke *et al* 1985, fig 4.14

[67] Timberlake *et al* 2004

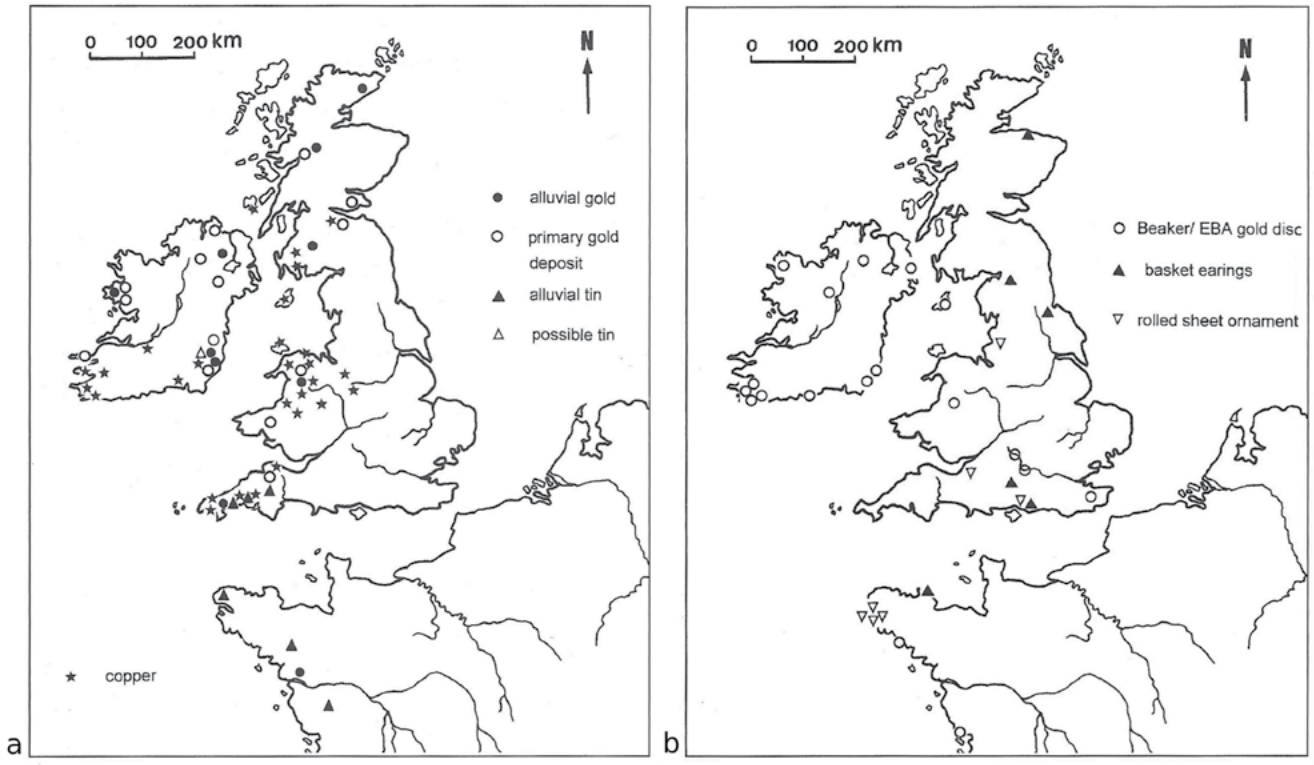


Fig 18 a Map of the British Isles and the Near Continent, indicating the potential sources of Bronze Age copper as well as alluvial tin and gold; **b** showing the distribution of some characteristic types of Beaker / Early Bronze Age sheet-gold ornaments (S Timberlake and B Craddock, EMRG)

mines and mineral veins. A copper halberd made of Irish Type 'A' metal was found at the Logaulas Mine a little further to the west along the Ystwyth Valley. Interesting also are the large numbers (up to one-hundred) of barb-and-tang flint arrowheads found within the Central Wales uplands, with the highest concentration of these on the slopes of Plynlimon (Fig 17).[68] Peate suggested an Irish affinity for these,[69] whilst their form suggests a very probable Beaker / Early Bronze Age origin,[70] and their distribution beneath the peat the result of hunting for red deer and other game within this tree-cleared upland landscape, particularly around the shores of upland lakes such as Bugeilyn, but also occurring as far as the mountain tarns south of Cwmystwyth.[71] The significance of all this for contemporary mining appears to be in the very large numbers (believed to have been several hundred) of antler mining tools, which it is calculated were once used on Copa Hill within the Comet Lode workings, with no doubt many more being used at the other mines.

Most of these Early Bronze Age mines seem to be located on the margins of tree-cleared areas, with burial cairns dominating the highest points. Between Penrhyncoch and the upper headwaters of the River Severn, intermittent lines of standing stones and other Bronze Age monuments define a territorial divide or routeway which skirts the northern slopes of Plynlimon, but also passes by a number of the earliest copper mines (see Fig 17).

The bigger picture – copper, tin and gold networks

As regards the various sources of metal, it is important also to look at this in a regional context. This map of the British Isles and Atlantic Europe shows a number of potential sources of copper as well as those of alluvial tin and gold (Fig 18a). The earliest high-nickel Bell Beaker copper artefacts which arrive *c* 2500–2300 BC[72] may in fact have been coming from Atlantic Spain, where there was an early Beaker metallurgical tradition. This may well have been one of the earliest routes for the introduction of metal, although early copper artefacts would probably also have been coming from the southern Alps, as well as from central Europe. Interestingly, one can also see some sort of correlation here between Atlantic France and Ireland in terms of gold ornament finds, gold sources, alluvial tin and mining (Fig 18b).

The Atlantic route appear to follows the tin resources from Iberia to Brittany to Cornwall,[73] and this may have been crucial to the first exploitation of tin from the abundant SW England alluvial sources around 2000 BC, when Britain enters a fully-fledged Bronze Age, with metalworkers manufacturing relatively high-tin bronzes.[74] But why were the abundant copper deposits of Cornwall never

[68] Peate 1925
[69] *idem* 1928
[70] Heath 2012, 31
[71] Timberlake 2009a, 101
[72] Needham 2002, 123
[73] Penhallurick 1986, 92, 101
[74] Tylecote 1986, 11

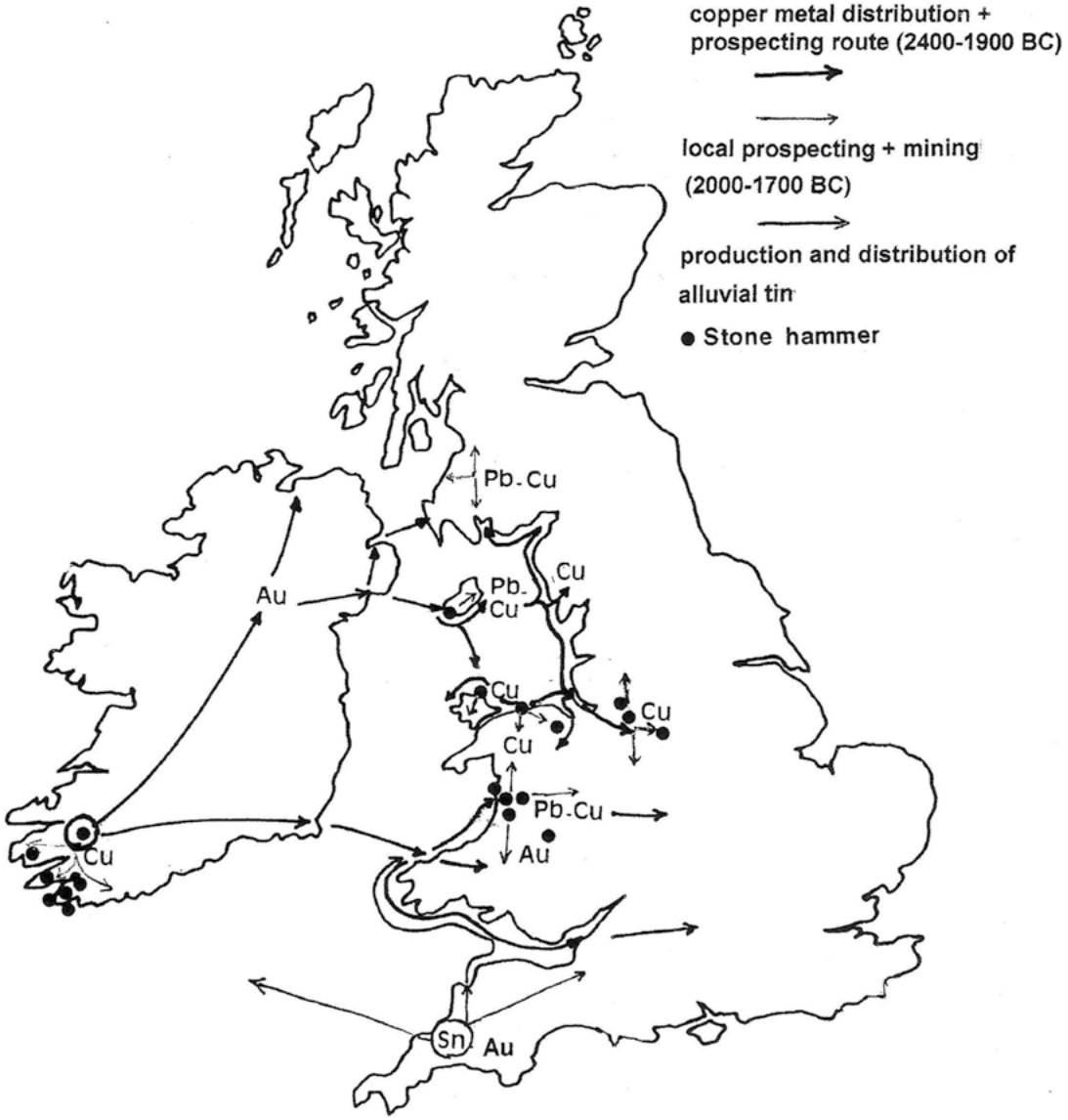


Fig 19 A possible model for the metal routes between Ireland and Britain, Cornwall, Wales and the rest of England during the earliest Bronze Age (S Timberlake and B Craddock, EMRG)

exploited? Perhaps this was because of established agreements between producing areas, but more likely it was the much greater value of the tradeable tin and gold found in the Cornish rivers which precluded the part-time miners / agriculturalists from bothering to look further to find and exploit the vein sources on the granite moorlands.[75] Wales was thus important for almost 700 years in being the single largest source of British copper.

Traditionally Ireland is still thought of as being one of the most important Bronze Age sources of alluvial gold in the British Isles,[76] although Cornwall, Wales and Scotland may also have been significant in terms of local production of gold lunulae and gold foil objects. The general composition of naturally occurring British (alluvial) gold extracted during the Bronze Age is pretty similar (97 per cent Au and 3 per cent Ag),[77] suggesting that only minute trace element variations and lead and other isotope compositions may be used to distinguish between them. However, new research is now suggesting that Cornwall may have been an important supplier of gold as well as tin at the beginning of the Early Bronze Age.[78]

We can see in this map of Britain (Fig 19) a possible model for the metal routes between Ireland and Britain, as well as between Cornwall, Wales and the rest of England. Ireland was probably still a net provider of copper up until *c* 1800 BC, whilst Cornish tin may have been making its way to Ireland for almost 300 years before that, crossing from SW

[75] Herring 1997, 20

[76] Penhallurick 1986, 113; Warner *et al* 2009

[77] Taylor 1980, 158

[78] Standish *et al* 2014, 220; *iidem* 2015

Wales into SE Ireland by the shortest route – most probably the same one that brought Irish copper and also an interest in mining and prospection to mid-Wales. Yet we should not forget the role of recycling in all of this.[79] This is why the situation gets so complex, both in analysing metalwork, and also in determining source.

Summary conclusions

The search for copper

Prospecting for new copper sources in Britain begins around 2100–2000 BC, before the decline of the Ross Island Mine.

Central Wales appears to have been one of the earliest areas of interest.

Prospectors or perhaps just the ideas of mining and metalworking then spread rapidly eastwards into Central–NW England.

Quite possibly this consisted of two subsequent or perhaps simultaneous phases of prospection: (1) Ireland > Central Wales > North Wales > NW England and (2) Ireland (via Isle of Man) > North Wales > NW England.

The Great Orme was probably discovered at this time, but was not worked significantly as a mine until later.

The earliest mines

There is a small amount of evidence for a Mesolithic–Neolithic interest in some of the surface showings of copper (and iron) mineralization – most likely as a source of blue and green mineral pigment. This has not been discussed here, yet there are a few anomalous Mesolithic and Late Neolithic radiocarbon dates associated with the earliest outcrop exploitation on Copa Hill,[80] whilst at Alderley Edge Mesolithic flint scatters (and 'hunting camp' sites) coincide with some of the Bronze Age mines.[81]

There might be a 'Beaker association' or influence to the initiation of metal mining activity.

The first Bronze Age miners may have been pastoralists practising transhumance agriculture, working within the upland mining areas during the summer–autumn months, bringing animals and fresh stone tools from the coast. Wood for fuel came from the clearance of new pastures.

Ore concentrate rather than metal may have been traded for metal artefacts, this being seen as a simpler means to enter the exchange economy. Apart from Pentrwyn (Great Orme) there is no evidence at all for smelting at the mines.

By 1600–1500 BC all of these mines (excluding the Great Orme) were flooded and abandoned.

Copper mining and production during the Early–Middle Bronze Age

The Great Orme was probably the main source of British copper between 1700 and 1400 BC.

Here miners may have lived in or close by to the mine – they were supplied with meat and tool material, and working may have been continuous.

The deepest workings suggest that mining continued into the Late Bronze Age – perhaps reaching water and the sulphide zone. Metal was now coming from other sources.

Metal production

From 2300 to 1800 BC the arsenical signature of Ross Island-sourced metal in British copper / bronze artefacts becomes weaker as metal is re-cycled and local metal is added.[82]

Lead isotope analysis is problematic as regards ore / metal provenancing for the British Bronze Age (ie there is some overlap of lead isotope signatures and one also needs to consider the 'pooling of metal' from a number of mined sources).

As a general rule, smelting probably takes place away from mines, perhaps in the nearby settlements. The Late Bronze Age smelting of copper at Pentrwyn on the Great Orme may be an oddity.

In the absence of archaeological evidence it is important to try and understand metalworking processes from the ore to the smelted metal, alloy and artefact through means of archaeological experiment. This can also be used as a form of 'predictive experimental archaeology'.[83]

Great Orme metal might have been the source of the Acton Park metalwork (1500–1400 BC).

Copper from Alpine sources (ie from the mining and smelting of chalcopyrite ore) reaches Britain as recycled scrap from 1400 BC onwards

Acknowledgements

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[79] See Bray in Gibson *et al*, this volume
[80] Timberlake 2003, 51, 103
[81] *idem* 2009a, 94
[82] See Bray in Gibson *et al*, this volume
[83] Timberlake 2007, 28

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Derrycarhoon mine and the supply of copper in later Bronze Age Ireland

William O'Brien

This paper presents the results of a recent investigation of a Bronze Age copper mine in south-west Ireland, and discusses the implications for an understanding of primary copper production during the late second millennium BC.

Introduction

It is widely accepted that Beaker culture groups introduced copper metallurgy to Ireland in the mid-third millennium BC.[1] The adoption of tin bronze from around 2000 BC led to a growing dependency on metal during the second millennium BC. This is reflected in the output of flanged axeheads and palstaves, dirks, rapiers and looped spearheads during the Killymaddy phase of the Middle Bronze Age (*c* 1550–1350 BC). Metal production intensified during the Bishopsland phase (*c* 1350–1100 BC), when influences from Continental Europe coming through southern Britain led to new metalworking techniques and a novel range of bronze artefacts.[2] Advances in bronze casting are reflected in the use of clay moulds to make new object types such as the first bronze swords (Ballintober type).

With the beginning of the Late Bronze Age there was further intensification of bronze and gold production across Ireland, culminating in the metalworking of the Roscommon (1150–1000 BC) and Dowris (*c* 1000–700 / 600 BC) phases. During the latter period metalworking reached new heights in terms of the scale of production, the great variety of metal products, and the technical accomplishment of the craft workers.[3] This was a time of conspicuous wealth in Ireland, most visibly expressed through large-scale metal production and depositional practices, and the use of prestige metalwork. There is a significant rise in the practice of hoarding bronze, with some 130 examples (80 per cent of the Bronze Age total) known from the Dowris phase.[4] While hoarding of itself does not provide an absolute measure of the amount of metal in circulation, the incidence of single finds of bronze objects does provide some general indication of increased bronze use during this period.

Irish metalwork was exchanged widely in Britain and the Continent during the Late Bronze Age, creating a network of contacts that led to new sources of metal. The archaeological evidence for an organized trade in metal to Ireland is weak, certainly in terms of ingot finds or shipwrecks comparable to Langdon Bay, Kent, or Salcombe, Devon.[5] The importation of bronze is indicated by new tool, weapon and ornament types with stylistic and technical connections to southern and western Britain, and farther afield into northern, central and Atlantic Europe. This also involved exports, as Irish metalwork was exchanged widely in Britain and on the Continent in this period.[6] Metal analyses indicate a growing reliance on imported Continental metal during the Middle Bronze Age, with declining supply from British and Irish sources.[7] It is likely that imported bronze from the Continent grew in importance during the Penard / Bishopsland phase, to eventually dominate copper supply during the Wilburton / Roscommon and Ewart Park / Dowris phases of the insular Late Bronze Age.[8] The identification of specific mine sources during this period is complicated by the uniformity of bronze composition, which itself is partly a consequence of widespread recycling.[9]

Some primary (smelted) metal may have been imported to Ireland from mines in Britain, where the only known copper mine in operation after 1400 BC is the Great Orme in north Wales. The circulation of copper from that source cannot be easily traced[10] and is likely to have declined by 1000 BC.[11] Trade links with the Continent led to new sources of copper,[12] with the most important supply possibly from the east Alpine mines in Austria. The increased incidence of scrap hoards suggests that recycling made a significant contribution to metal circulation during the Late Bronze Age in Ireland. This was well organized and included the use of secondary bronze from imported or older Irish sources.

This paper examines the possibility of a continued supply of primary copper from Irish mines during the Middle / Late Bronze Age transition, evidence of which has been lacking until now.

Copper sources

The south-west region of Cork and Kerry seems to have been the most important source of primary copper during the Chalcolithic and Bronze Age in Ireland (Fig 1). Copper mining began at the Beaker copper mine on Ross Island, Killarney, in the twenty-fifth century BC and continued there to around 1900 BC.[13] The abandonment of that

[1] See O'Brien 2004
[2] Waddell 2010, 187–213
[3] *ibid*, 233–77
[4] Eogan 1983
[5] Needham *et al* 2013
[6] Eogan 1995
[7] Northover 1982, fig 7
[8] *ibid*, figs 11, 13
[9] Northover 1988
[10] See Williams, this volume
[11] Lewis 1998
[12] Northover 1982
[13] O'Brien 2004

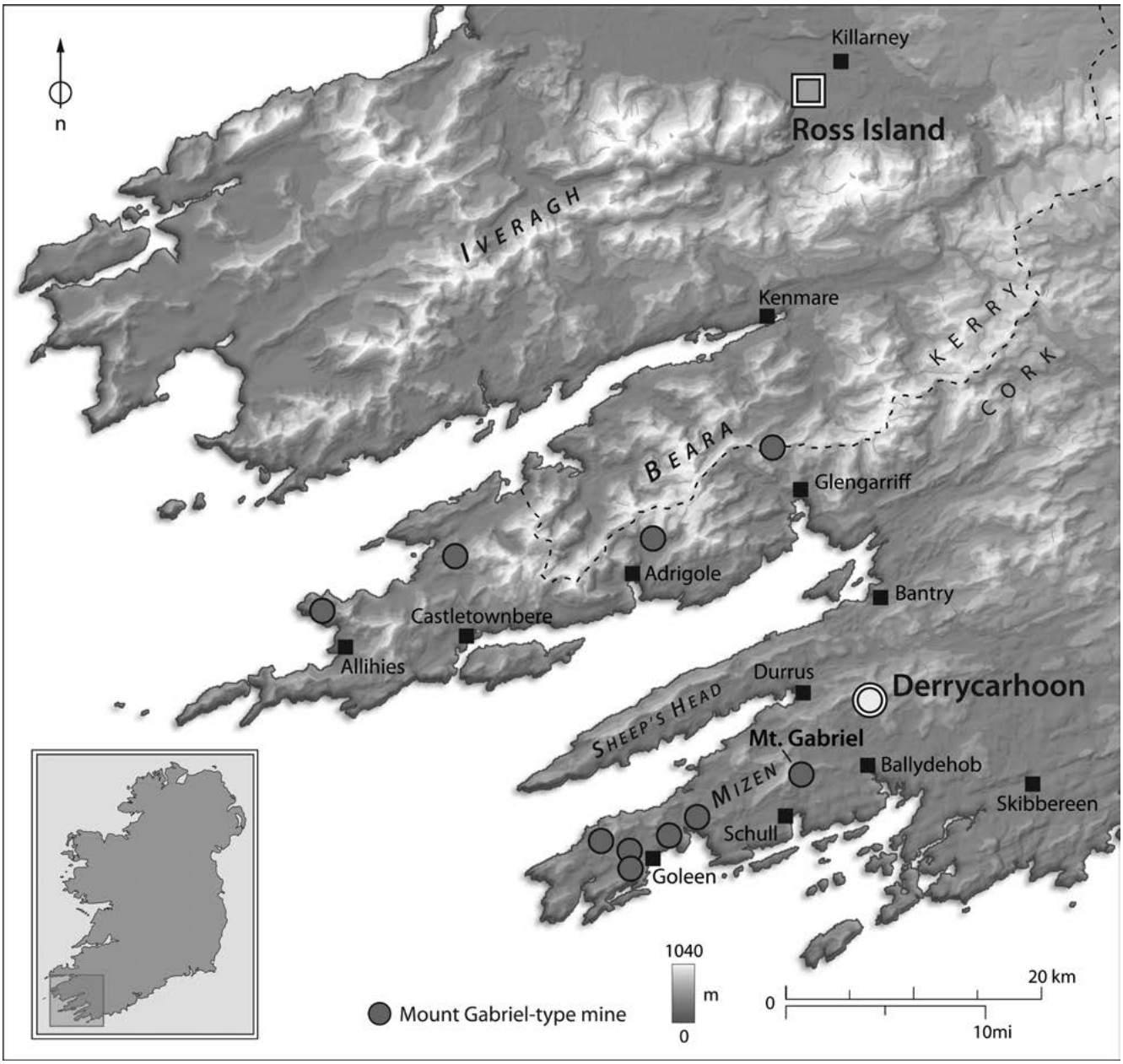


Fig 1 Prehistoric copper mines in south-west Ireland, showing location of Derrycarhoon mine in the Mizen Peninsula of West Cork

mine coincided with the commencement of copper extraction in the peninsulas of West Cork.[14] This is a region of late Devonian geology, where beds of green sandstone can contain low-grade disseminations of oxidized copper minerals. These 'copper beds' were mined on Mount Gabriel in the Mizen Peninsula and at nine other known locations *c* 1800–1400 BC, where small amounts of copper ore were extracted from mineralized exposures using fire-setting and stone hammers.

By 1400 BC primary copper production involving organized mining was declining in both Britain and Ireland, finally ending by 1000 BC. This is the picture presented by radiocarbon data from twenty early copper mines sampled in south-west Ireland, mid and north Wales and the English midlands.[15] The decline of copper mining was a wider phenomenon across Atlantic Europe, which coincided with a growing demand for metal in later Bronze Age societies with expanding trade connections.

Several theories can be advanced to explain these developments in copper supply during the later second millennium BC. One possibility is that mines did exist, but have not survived or cannot be easily recognized today. The former might be connected to a change in the type of ores extracted, possibly involving deeper mining of mineral deposits that were intensively worked in later periods. Against this, is the very notable absence in Ireland and Britain of slags connected to the smelting of copper-iron sulphide ores. This means that any indigenous mining after 1400 BC continued to rely on surface occurrences of oxidized mineralization. The de-

[14] O'Brien 1994; 2003

[15] *idem* 1994; 2003; 2004; Timberlake, this volume



Fig 2 Central mine area at Derrycarhoon, showing deposits of broken rock spoil in forest clearing

pletion of these accessible and easily smelted copper ores, combined with an inability to process primary mineralization, may have been significant factors in the decline of insular copper mining during the early part of the Late Bronze Age.

The destruction of mining evidence is certainly relevant, but is unlikely to be the entire explanation as Late Bronze Age mines are well known in other parts of Europe.[16] Archaeological visibility may be relevant, particularly if there were significant changes in mining technology. The replacement of fire-setting would remove distinctive wallrock patterns, while reducing the sample material available for radiocarbon dating. The use of large numbers of stone hammers in earlier copper mines is also relevant, as their replacement by specialized bronze tools would remove an important surface indicator of this activity. With no evidence that the latter were used to any extent during the Late Bronze Age, there may have been few options but to continue with the older technology.

The rise and fall of different mining regions can be understood in terms of boom / bust cycles; however, the abandonment of established mines in the Bronze Age was not driven by economic forces alone. This is a complex issue with many different variables, such as different technological constraints, and alternative means of metal supply such as recycling and long-distance trade. The closure of individual mines and a decline in mining at a regional level must also be understood in relation to the socio-political context of these ventures. Some of these issues can now be explored in relation to a recent discovery in south-west Ireland, which provides an insight into the final stages of copper mining in that region during the later Bronze Age.

Derrycarhoon

This copper mine is located on the north-east side of the Mizen Peninsula of West Cork, in what was known during the nineteenth century as the West Carbery mining district (see Fig 1). The mine is exposed today within a 1940m² clearing in dense conifer plantation (Fig 2), at an altitude of 155m OD on the upper southern slopes of a ridge that extends west from Mount Kid (298m OD). The Bronze Age mining centre of Mount Gabriel, 8km to the south-west, is clearly visible from Derrycarhoon.

This is an area of sedimentary rocks of Upper Devonian age, part of the Old Red Sandstone geology of south-west Ireland. Derrycarhoon mine lies within a transition sequence from rocks of continental (Castlehaven Formation)

[16] O'Brien 2013

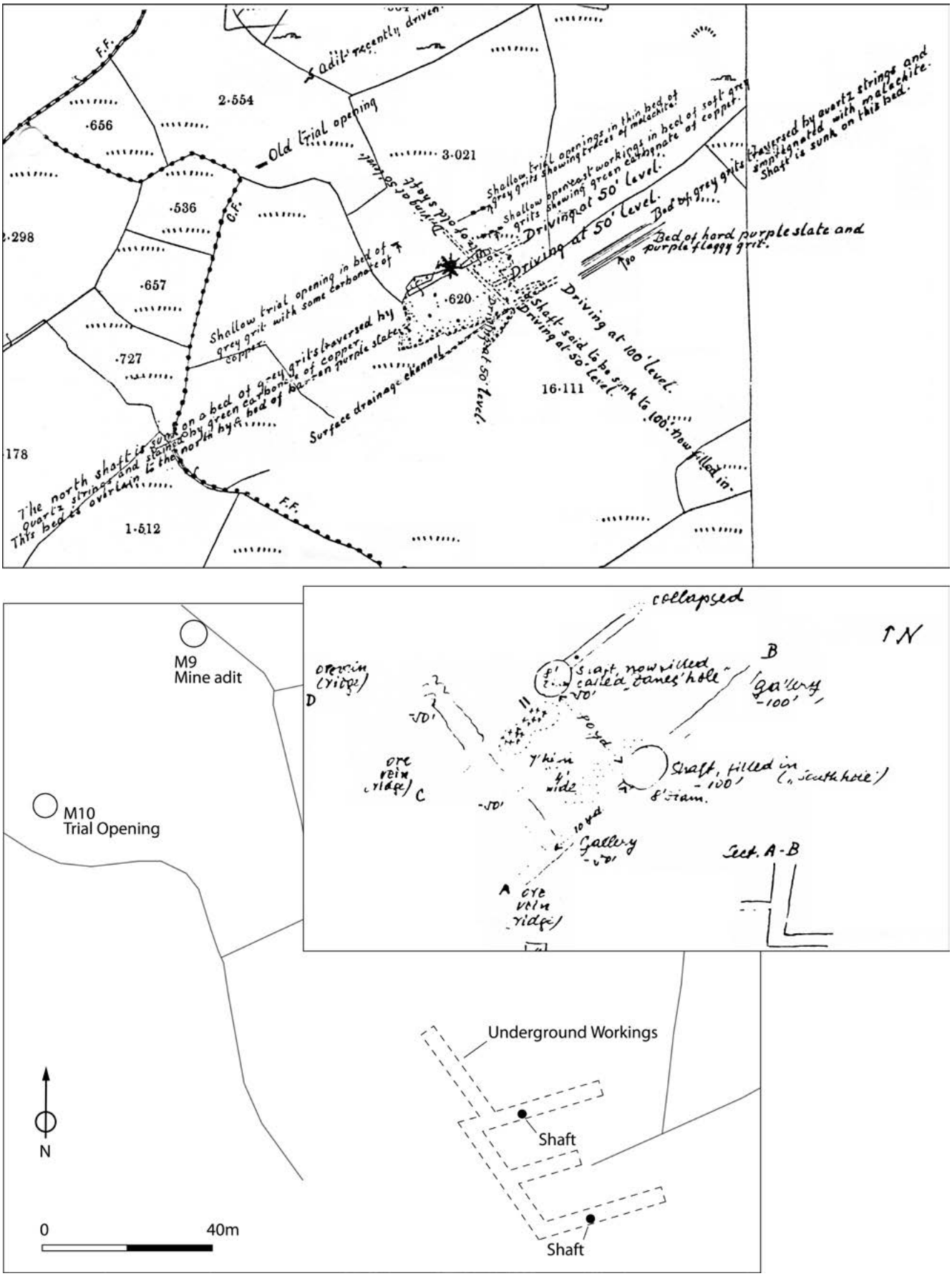


Fig 3 Historic sketch plans of Derrycarhoon mine, including those made by Tom Duffy (top) and Adolf Mahr (centre right) during a visit in October 1929. Also included is an interpretation of the nineteenth-century copper mine based on these records (bottom)

to marine type (Toe Head Formation). This represents a typical 'red-bed' sequence, where thin concordant bands of coarser green rocks (siltstone and sandstone) containing disseminations of copper minerals occur within a finer purple sequence of siltstone and mudstones.[17] Duffy observed that 'these mines were opened in beds of grey grits traversed by quartz strings'[18] in the purple mudrock sequence. He identified four main lodes in the mine, the most important being two green bands 1.8m (South Shaft Lode) and 3m (North Shaft Lode) across and separated by *c* 24m of purple mudrock, The strike of these beds is west / south-west and they dip very steeply to the north. Duffy also recorded two parallel lodes in the northern mine area, consisting of thin beds of 'soft grey grits showing green carbonate of copper', on which he noted six shallow trial openings.[19]

This description refers to sedimentary copper beds, where green channel sandstones, as well as calcareous conglomerates ('cornstones') carry small disseminations of copper sulphide and copper-iron sulphide minerals with secondary malachite. Another early account of the mine, possibly promotional in nature, refers to 'several parallel lodes near each other containing rich grey and purple copper ore and large deposits of carbonate of copper …'[20] There is also evidence of mineralization in minor quartz veins cutting across the copper beds.

The mineralogy, chemistry and lead isotope signature of the Derrycarhoon mineralization will be the subject of a separate study. Geological sampling in the mine has identified primary copper sulphide (chalcocite-djurleite) and copper-iron sulphide (bornite and chalcopyrite) mineralization, as well as secondary hydroxycarbonate minerals, principally malachite.[21] An assay of grab samples from surface spoil recorded copper contents of 35 per cent or greater.[22] This suggests that some of the Derrycarhoon ore was quite rich, even if much of the ore was of the lower grades typical of the disseminated mineralization in sedimentary copper beds. Stream geochemistry indicates a widespread occurrence of these copper beds in the Derrycarhoon area.[23] There are records of similar mineralization in the neighbouring townland of Shronagree, east of Derrycarhoon, where mining trials were conducted in the nineteenth century.[24]

Historical background

The recent mining history and antiquarian discoveries at Derrycarhoon mine can be summarized here.[25] The earliest documented mining dates to 1846 when a well-known miner in the West Carbery region, Captain Charles Thomas, partly cleared old workings at the site. Thomas conducted some surface trials and sent 46 tons of ore to the Swansea smelters in June 1848 where it sold for £180.[26] This venture lasted only a few years, which explains why the mine is not recorded in the Geological Survey six-inch mapping of 1853–56. The next recorded mining at 'Derri Carhoonie' was in 1856 when one ton of 3 per cent copper was raised.[27] However, there are no details as to that venture.

In the *Mineral Statistics* lists of working mines compiled by Robert Hunt Derrycarhoon is listed as a mine owned 1862–73 by Swanton and Co. There is no record that it was worked during that period.[28] Other sources indicate that by the early 1860s the mining lease was held by John Abraham Jagoe, though again there is no record of mining at that time.[29] There was a brief resumption of mining around 1912 when a venture led by a Mr McArthur of Glasgow drove an adit level from the northern side of the hill to intersect and drain the old workings (Fig 3).[30] This was not a success and mining efforts were abandoned. The mine has been prospected in the modern era; for example, in 1965 when the Toronto Mining Company conducted pumping and drilling operations at the site to no avail.[31]

The 'Danish Mines'

The re-opening of Derrycarhoon mine in 1846 led to the discovery of primitive workings and tools of which there was no local tradition. These discoveries attracted some attention in the *Mining Journal*, including the following entry:

> 'In searching in the early part of the present year, for indications of ore in the mountain district neighbouring to Ballydehob, in the west of the county, under the direction of Capt. Thomas, of Cornwall, no less than six old mine-holes were discovered on the lands of Derrycarhoon, three miles north-east of the village above named. Of these no previous tradition or suspicion had been entertained. They were all parallel lodes; one was about 30 fathoms in length and 10ft. broad, but its breadth at the time when I received information of the discovery was not fully known. They were found filled at the bottom with rubbish, and at the top were overlaid with bog stuff (peat), in some places to a depth of 14ft'.[32]

The discovery of these 'Danish mines', as they were subsequently termed, led to considerable speculation in contemporary mining and antiquarian circles. The finds were reported to the Cork antiquarian, John Windele, whose correspondence with a local informant, Tomas Swanton, provides an important record of these discoveries.[33] Windele was impressed by the apparent antiquity of the stone and wooden tools found, and by the considerable thicknesses of peat found inside the mine workings.

[17] See Pracht and Sleeman 2002 for details
[18] Duffy 1932
[19] *ibid*
[20] *Mining Journal* 1880, 585
[21] Keele 1969; Snodin 1972; Ni 1991
[22] Butler in Coghlan *et al* 1963
[23] Keele 1969
[24] Jukes 1861; Cole 1922
[25] See O'Brien 1989 for further detail
[26] *Mining Journal* 1848, 303
[27] *Mining Journal* 1856, 25
[28] See Cole 1922, 55
[29] *Mining Journal* 1880, 585
[30] Duffy 1932
[31] Unpublished records, Geological Survey of Ireland
[32] *Mining Journal* 1847, 70
[33] Windele MS 12, Royal Irish Academy, Dublin

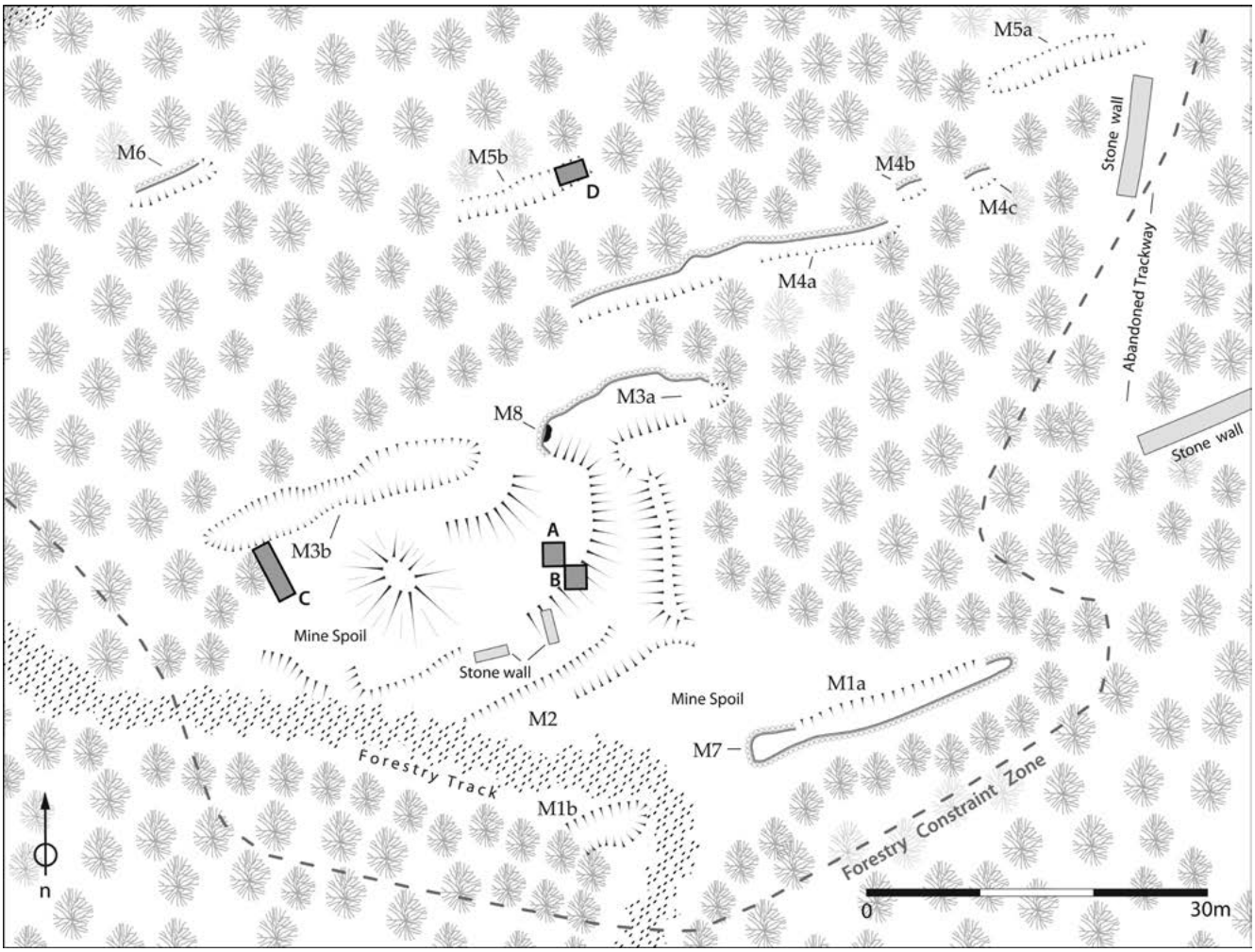


Fig 4 Surface survey of Derrycarhoon mine, showing location of early mine trenches (M1–6), spoil deposits, and archaeological excavation (A–D)

The director of the National Museum of Ireland, Adolf Mahr, visited the mine in 1929 in the company of the geologist Tom Duffy. The records of their visit contain sketch drawings of the nineteenth-century workings (see Fig 3). The archaeologist, Sean P Ó Ríordáin, visited the mine in 1947, in the company of Frank Mitchell who carried out some palynological analysis of peat growth in the mine area.[34]

The discovery of stone hammers and the primitive nature of the reported early mining at Derrycarhoon led Jackson[35] to include the site in a list of Bronze Age copper mines. This was disputed by Briggs[36] who attributed the 'Danish mines' at Derrycarhoon to the nineteenth century. He drew attention to the discovery of a curved wooden tube in the mine, which is now in the collections of the Pitt-Rivers Museum in Oxford.[37] Briggs subsequently obtained a radiocarbon analysis of 820±60 BP (OxA-1184)[38] indicating a date range of 1044–1284 AD for what is probably part of a later medieval suction pump. This indicates more than one phase of copper prospecting and / or mining prior to the 'Danish Mine' discoveries of 1846.

Reports in the *Mining Journal* and other sources confirm that the nineteenth-century mining at Derrycarhoon was conducted using iron tools and blasting powder in an shaft-and-gallery system. The latter is recorded in sketch plans made during a survey of the site by Duffy and Mahr (see Fig 3).[39] Briggs confused the two mining systems, transposing the record of six surface trench mines with underground levels mapped by Duffy and Mahr.[40]

The mining of 1846–47, and again in 1856, greatly disturbed the mine site at Derrycarhoon, as did mineral exploration in the modern era. The placing of a Preservation Order in 1970 did provide some protection to the central mine area. Unfortunately, the outer extent of the mine was not accurately mapped, which allowed this area to be deep-ploughed and planted with conifers at a later date, resulting in severe damage to the site (see Fig 2).

[34] Unpublished notes, Department of Archaeology, University College Cork

[35] Jackson 1980

[36] Briggs 1984

[37] *ibid*, figs 3, 4

[38] Hedges 1988

[39] See O'Brien 1989, fig 2

[40] Briggs 1984, fig 2; see O'Brien 1989 for discussion



Fig 5 Partly infilled trench mine (M4), Derrycarhoon

Archaeological survey

In 2007 the author surveyed Derrycarhoon mine as part of a forestry impact study.[41] This involved a careful search to identify surface indications of past mining and other activity, which were then recorded by total station mapping. The survey identified a number of partly infilled mine workings in the site (Fig 4). These include two vertical shafts sunk in the nineteenth century, the location of which is marked on a 1:2500 geological mapping undertaken in 1929 by Tom Duffy (see Fig 3). The 'south shaft' on his plan was originally sunk to a depth of 100 feet (30m), but was infilled in modern times. The precise location of this south shaft (M7) is unclear, but may be marked today by a small cavity at the western end of the southern-most trench mine (M1a). The 'north shaft' of Duffy's plan is partially infilled, but was originally sunk to a depth of 50 feet (15m). This shaft is visible today as a small opening at the base of a low rock face (M8), which descends some 6m to a 4m by 3m chamber, in which access to underground levels is blocked by drystone walling. Mahr noted that this shaft is known locally as the ''Dane's Hole'.[42]

The archaeological survey also identified the exact or approximate location of six parallel mine trenches discovered in the nineteenth century. These are straight rock-cut trenches (MI–6), up to 30m in length and averaging 2–3m in width, which cross the site in a north-east / south-west direction (see Fig 4). Three of these long narrow trenches cross the central mine area, with three others occurring within forest north of this clearing:

M1: The southernmost trench mine is today exposed in two sections, separated by a forest track accessing the mine clearing. The eastern part (M1a) consists of a 27m long by *c* 3m wide rock-cut trench, bordered by exposed rock faces on both sides. This trench is largely infilled and is open to a variable depth of 1–2m. The western section (M1b) may be the continuation of this trench on the other side of the forest track. It consists of an 8.2m long by 3.8m wide irregular trench, largely infilled with spoil.

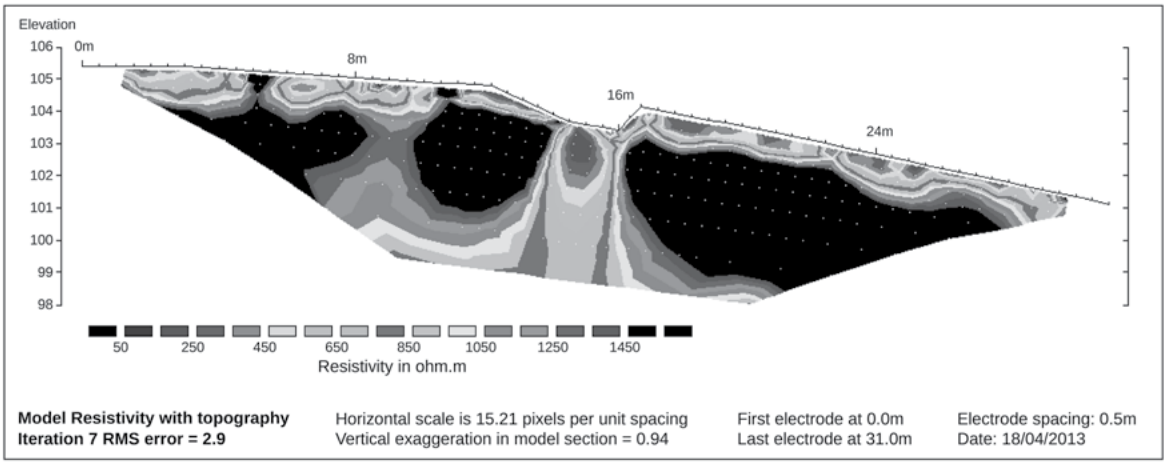
M2: The outline of a possible infilled trench working is visible in the central spoil area. This linear depression measures 14.4m long by 3.6m wide, with a depth of one metre or so. No bedrock exposure.

M3: The northern side of the forest clearing is bordered by a large trench that is possibly exposed in two sections today. The eastern part (M3a) is a 2m long by 2.2m wide depression below a vertical rock face. The western part (M3b) is a more distinct trench, 26.5m in length and averaging 4.4m wide, with a variable depth of 1–2m. This trench has sloping sides with some bedrock exposure, but is largely infilled.

M4: This long narrow trench is located directly north of the central mine area, an area covered today by conifers (Fig 5). The rock-cut trench (M4a) measures

[41] O'Brien 2007

[42] Unpublished notes A Mahr



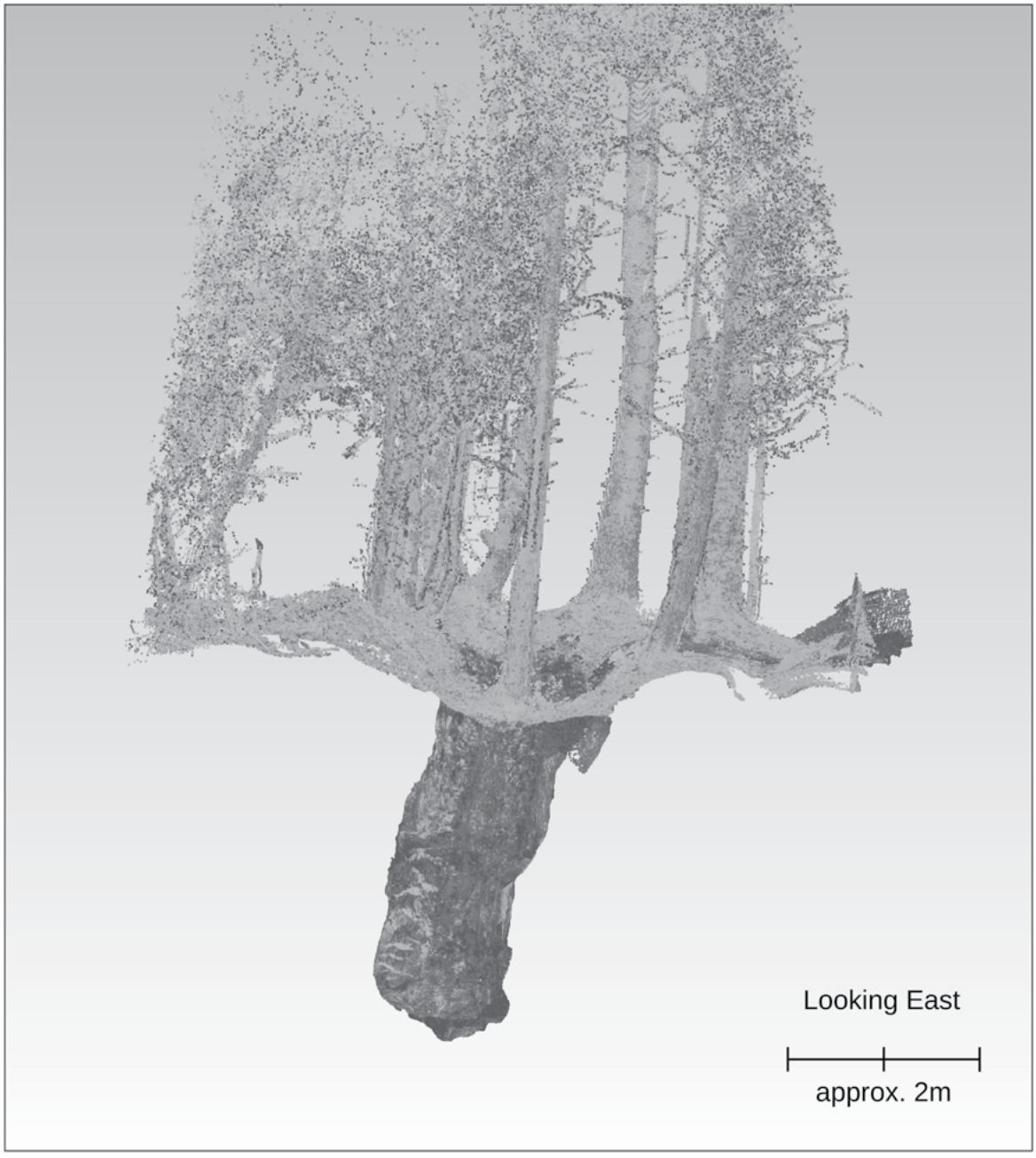


Fig 6 Visualization of Bronze Age trench mines at Derrycarhoon, showing laser scan image of Mine 5b (bottom) and an electrical resistivity profile across the same working (top; after Unitt 2013)



Fig 7 Mine 5b-1 pit after excavation, Derrycarhoon

30.4m long by 2.4m (max) wide, and is largely infilled, apart from some waterlogged pockets and possible rock arches. Two small depressions (M4b and M4c) on the western side may be the continuation of this trench. Auger probing in Mine 4b revealed a solid peat thickness of 1.5–2.5m at the western end and 1.8m at the eastern end.

M5: Two separate trenches to the north of the M4 working may form part of a single trench mine. The eastern example (M5a) measures 14.7m long by 2.2m wide. This trench is largely infilled, with an exposed depth of a metre or so, and only limited exposure of bedrock on the sides. The mine trench was probed to reveal a solid peat thickness of 2.1m (western end) and 0.5m (eastern end). The western mine (M5b) measures 11.5m in length, 2.15m in width (max), with an extant depth of less than one metre. This trench was also probed, to reveal a solid peat fill 2–2.5m in thickness.

M6: This mine trench measures 8.2m long by 1.4m wide. Auguring confirms that the upper part is filled by 0.6–1m of solid peat.

The overall depth of these six trench mines is uncertain due to infilling by peat and / or rock spoil. Electrical resistivity survey was undertaken to examine their full extent.[43] The results reveal narrow workings that extend to depths of at least 2–5m workings, where mineralization was removed from interbedded channel sandstones and siltstones (Fig 6).

Finally, the location of MacArthur's tunnel (M9) marked on Duffy's survey can also be identified in the northern part of the mine area (see Fig 3). There are no visible features connected with mining in this area, nor is there any indication of a 'trial working' (M10) marked on Duffy's plan some 50m to south-west of the adit entrance.

Surface spoil

Several surface deposits of broken rock are visible in the forest clearing at the centre of this site. These derive from different phases of copper mining, with earlier material subject to varying degrees of disturbance during the nineteenth-century operations. The rock spoil is fully exposed in some places, while in others it is covered by thin vegetation growth. Much of this spoil is spread between the partly filled trench mines (M1–3) that cross the central mine area in an north-east / south-west direction. There is a large spoil mound, *c* 3m high, on the northern side of the clearing (see Fig 4). This mine spoil consists of loose fragments of angular rock of varying sizes, mostly grey-green sandstone and siltstone from the copper beds, as well as fragments of white quartz. These are not strongly mineralized, with only light malachite staining visible on some clasts. The exposed spoil is devoid of any cultural material, except for one area on the

[43] Unitt 2013

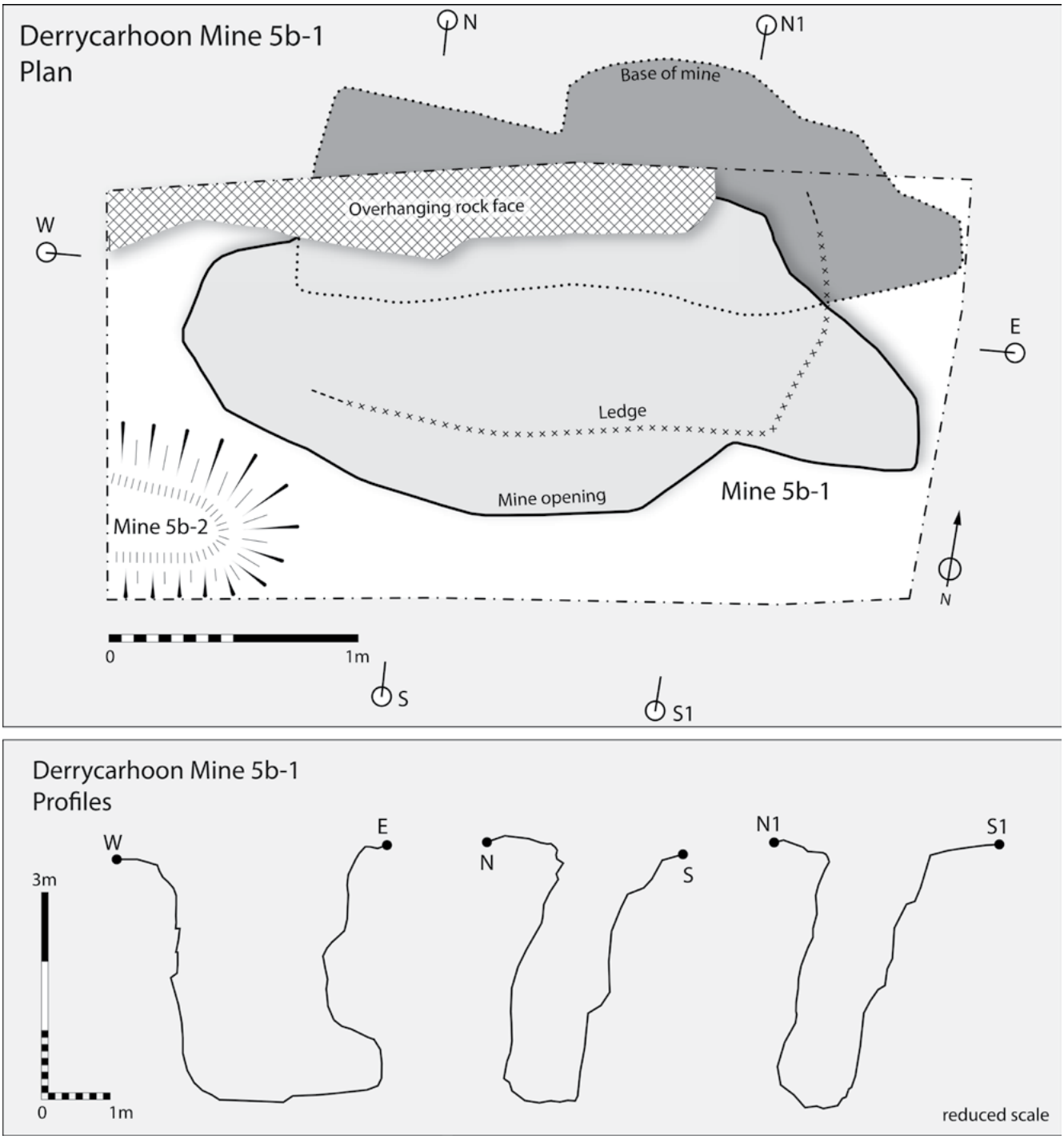


Fig 8 Post-excavation plan and profiles of Mine 5b-1, Derrycarhoon

northern side where there are numerous broken hammerstones. Two short lengths of dry-stone walling (see Fig 4) in the central spoil area were probably built to retain rock spoil during the nineteenth-century phase of mining.

Archaeological excavation

In 2010–11 the author carried out sample excavation at Derrycarhoon, with the aim of clarifying the physical record and chronology of early copper mining at this location. The initial focus was on spoil deposits containing stone hammers exposed in the central mine area.[44] The second season of excavation sampled one of the early mine trenches (Mine 5b), to record its geological setting, morphology and infill deposits, and to recover mining tools, radiocarbon samples and cultural material.[45]

[44] O'Brien 2010

[45] *idem* 2011

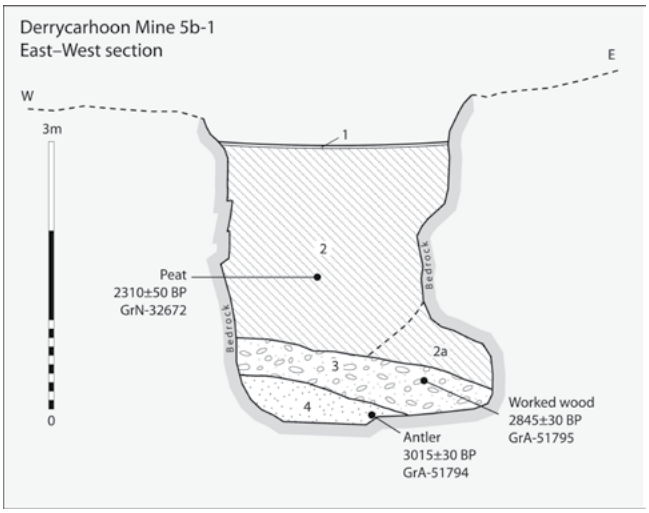


Fig 9 Archaeological stratification in Mine 5b-1, Derrycarhoon

Mine 5b-1

As previously stated, this is one of two separate workings (M5a and 5b) that may form part of a single trench mine in the northern part of the site. A 3.35m (east–west) by 1.75m cutting (excavation cutting D; see Fig 4) was opened across the eastern end of the mine. This exposed a steeply inclined, rock-cut pit (Mine 5b-1), with an average length of 2.75m and width of 1m (Figs 6 and 7). The mine varies in depth from 4m (west end), 4.1m (centre) to 3.8m (east end), taken from the top of the north wall. The mine reduces in length (east–west) from 2.9m at the surface to 2.65m at the footwall. The upper section ranges in width from 0.95m (east), 1.25m (centre) to 0.9m (west). The mine narrows at a depth of around 2m to a width of 1m (east), 1.1m (centre) to 1.02m (west). While the upper part is irregularly oval, the lower section has a rectangular profile at a height of 1.8m up from the footwall (Fig 8). The base of the mine ranges in width from 1.1m (east), to 1.25m (centre) to 1.07m (west).

The shape and size of Mine 5b was determined by its stratabound position along a steeply dipping band of grey-green coarse channel sandstone. This small 'copper bed' was impregnated by copper minerals over a short distance, where low-grade disseminations of copper / copper-iron sulphides were oxidized by percolating water to form small pockets of secondary minerals, principally malachite. Most of this mineralized rock was removed by the miners, though a portion does survive on the southern mine wall where there is visible malachite staining.

The northern wall of the mine working is near-vertical, with a slight overhang at the top. The wallrock has a smooth, cleavage-marked profile. Geological features include a vertical joint up the centre of the wall, as well as four white quartz veinlets on the lower west side. The base of the north wall slopes steeply to the floor of the mine. The east wall may be divided into three sections. There is a small recess with an arched profile at the base. This measures 0.95m wide by 1.15m high, and extends inwards to a maximum length of 0.55m. The back wall of this recess has a rough broken appearance, while the sides are cleavage-marked with several white quartz veinlets. The east wall is vertical for a height of 0.9m above this opening, with some cleavage markings and a few veinlets of white quartz. The upper part of the east wall is steeply sloping over a 1.7m height, with a broken profile along 30–70mm wide cleavage partings.

The south wall of the mine was exposed on the removal of 0.4m thickness of peat. The upper 1.7m slopes steeply to a ledge-like feature, below which it is near-vertical (see Fig 8). The central section is smooth, with a more broken profile on the east and west sides. The west wall is 3.1m high and is near-vertical. The upper part overhangs slightly and has a broken profile with cleavage markings. The lower 1.7m of the wall is relatively smooth, exposing a stack of 13 horizontal veinlets of white quartz that range 10–90mm in thickness. The base of the west wall slopes 20° downwards to the footwall for a distance of 0.9m. The lower part of the north and south walls are also sloping, with a 0.3m wide channel feature extending east–west along the centre of the footwall.

A close inspection of the mine walls did not reveal any smooth concave profiles characteristic of fire-setting. No metal-tool marks were evident nor any evidence for the use of blasting explosives.

Stratification Excavation of Mine 5b-1 began with the removal of a thin (<5cm) spread of conifer needles and loose humus (Layer 1; Fig 9). The upper part of the mine trench had become filled with a considerable depth of peat (Layer 2). This ranged in thickness 2.2–2.4m in the western and central parts of the mine to 3.3m on the eastern side. The peat was mostly compact, except on the lower eastern side where it was unconsolidated. The upper metre or so of peat was dark brown, while the lower deposit was a lighter brown in colour. This was well humified peat, containing only 16 small fragments of wood material of natural origin. These are all twisted roots, three of which have been identified as willow (*salix sp*).

This organic deposit accumulated over approximately 3000 years as dead vegetation blew into the flooded mine. This is confirmed by a radiocarbon result of 516–206 BC (GrN-32672) for a peat sample taken at a depth of 1.5m in the mine (see Fig 9). The removal of this peat infill exposed a coarse stony sediment at a depth of 2.2–3.3m below the surface. This loose deposit (Layer 3) contained large slabs of grey sandstone ranging 0.3–0.6m in length. There were also smaller stones in the 0.2–0.3m range, as well as some finer clasts. A large number of broken stone hammers and hammer spalls were recovered, as well as several fragments of waterlogged wood. These include some short lengths of roundwood with tooling marks, one of which is radiocarbon dated 1114–921 BC (GrA-51795).

Further excavation exposed a deposit of finely broken stone with occasional large clasts (Layer 4) at the base of the mine. This material seemed to be piled against the lower western wall of the mine to a maximum thickness of *c* 0.6m, thinning eastwards along the sloping footwall. The deposit contained broken stone hammers, as well as occasional fragments of roundwood. Some items of worked wood were found, including part of a stone hammer handle, a wedge and two large branches used as crude ladders. A portion

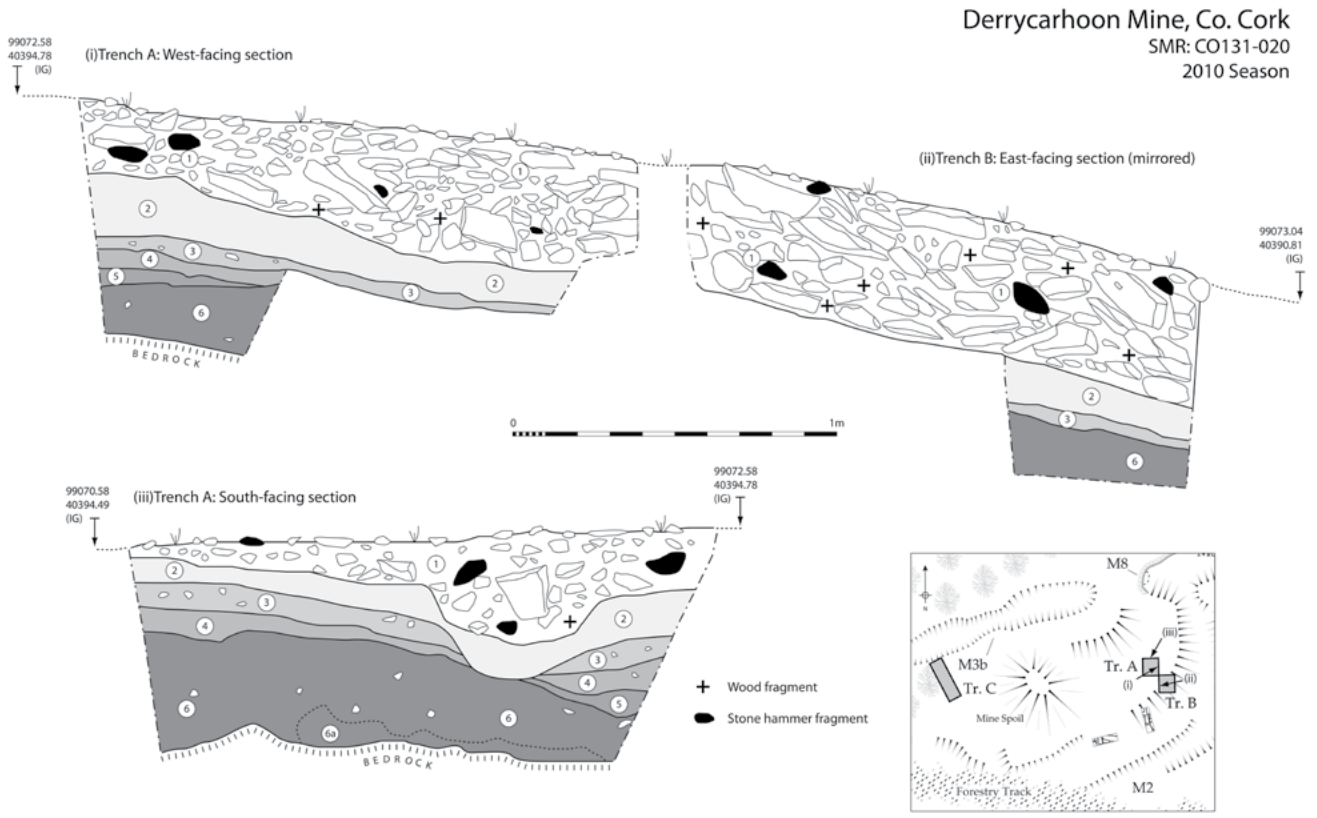


Fig 10 Stratification of test-pits A and B, central spoil area, Derrycarhoon

of an antler pick was discovered near the base of Layer 4 in the central floor area. A calibrated radiocarbon result of 1386–1132 BC (GrA-51794) for this antler provides a broad age range for the mine.

Mine 5b-2

A small bedrock depression was discovered next to the edge of Mine 5b-1 in the south-west corner of the excavation cutting (see Fig 8). This feature measures 0.75m in width (N–S), with an exposed length of 0.7m and a central depth of 0.65m. It was filled by peat, the removal of which revealed a thin deposit of fine stony sediment. This contained a broken stone hammer lying on a short length of twisted withy (10E287:02) radiocarbon dated to 1378–1119 BC (GrA-52011).

Mine 5b-2 may represent the edge of a deeper working on the western side of Mine 5b-1, part of an alignment of closely-spaced pits along the east–west direction of the copper bed. This creates the impression of a single continuous trench (Mine 5b), possibly extending east in the same manner to connect with the Mine 5a trench. As mining progressed, the individual pits were partially backfilled with discarded rock from adjacent workings, with the subsequent accumulation of 2–3m of peat in the flooded interiors.

Central spoil area

There is further evidence of prehistoric copper mining in the form of exposed deposits of broken rock in the central mine area. This mine spoil is not *in situ*, due largely to disturbance caused by nineteenth-century mining. In 2010 three small trenches were excavated in the central spoil area at Derrycarhoon (see Fig 4). Two adjoining test-pits, each 2m square, were opened in an area of exposed mine spoil containing a large number of hammerstones. Test-pit A was excavated to bedrock at a depth of 0.7m, while test-pit B was excavated directly down slope to a maximum depth of 0.75m. The stratification of both test-pits was similar, with the following layers exposed (Fig 10):

Layer 1: a surface deposit of broken mine spoil that was 0.04m in thickness at the north-west corner of Trench A, increasing to 0.6m down slope in Trench B. Very loose slaty stones with a light brown silt matrix. The largest stones were 0.15–0.3m in length, with the smallest 0.05–0.15m. Numerous stone hammers and fragments of waterlogged wood (no charcoal).

Layer 2: thin layer of soft black peat ranging 0.1–0.28m in thickness. Well humified and no stones or wood fragments.

Layer 3: mid-brown sandy silt with mottles of iron oxide; occasional small stones, none of which are derived from mining

Layer 4: grey / light brown silt with flecks of iron oxide.

Layer 5: black / dark brown silt with humic content; few stones.

Layer 6: orange sandy silt with high iron sesquioxide content; occasional stones. The lower part (Layer 6a) is more intensely iron-enriched in contact with the bedrock.

In summary, the stratification in these trenches consists of a surface spread of broken rock spoil containing hammerstones (Layer 1), overlying natural peat growth (Layer 2) on

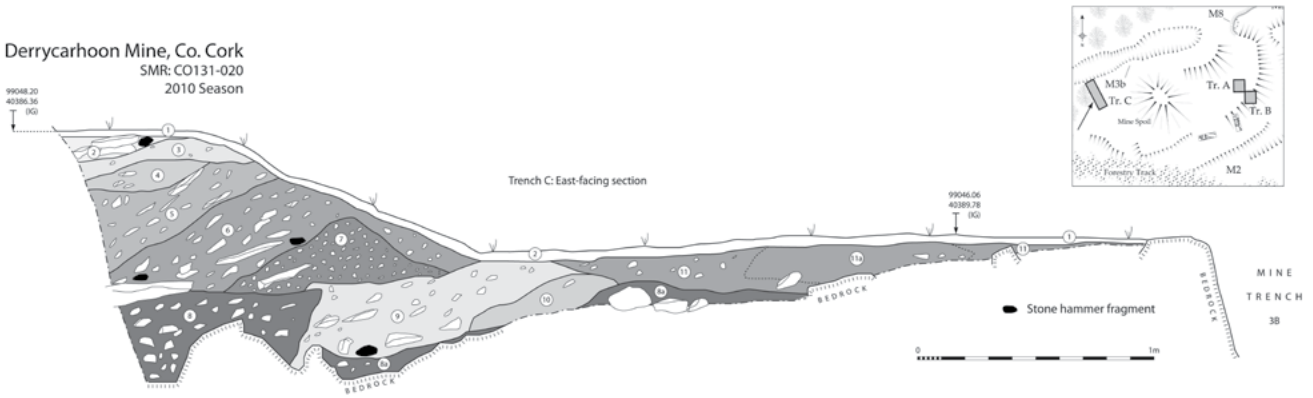


Fig 11 Stratification of test-pits C on southern side of Mine 3b, Derrycarhoon

a podzolized soil profile. The latter consists of a leached horizon (Layers 3 and 4) overlying zones of humic (Layer 5) and iron oxide (Layer 6) precipitation within loose sandy sediment of fluvio-glacial origin on bedrock. The removal of surface spoil (Layer 1) along the eastern side of test-pit A exposed a north-south channel of uncertain significance. This feature measured 0.6–0.7m wide on top and 0.5m at the base, with a maximum depth of 0.16m. It seems to have been dug into the leached soil horizon (Layer 3), and was partly infilled by late peat growth (Layer 2). The significance of the channel is unknown, but it is likely to pre-date mining at this location.

The thin deposit of mine spoil in test-pits A and B contained numerous stone hammers and fragments of waterlogged wood, but notably lacked any charcoal. A fragment of rowan roundwood with chop marks is radiocarbon dated 1370–1021 BC (GrN-32669), while a piece of young oak is dated 1369–1059 BC (GrN-32671), and a twisted hazel withy 1410–1114 BC (GrN-32670). These results confirm that this spoil came from a mine trench broadly contemporary with Mine 5b-1, but not necessarily from that working. The presence of waterlogged wood in a relatively dry, aerobic spoil context suggests that this rock spoil may have been redeposited during the clearance of an adjacent working (Mine 3) in the mid-nineteenth century.[46]

Further excavation in the central mine area involved a 4.9m by 1.5m cutting (C) extending from the southern side of Mine 3b at its western end. This is the location of the 'Bronze Age opencast' listed by Jackson.[47] The southern side of this excavation examined a low ridge of mine spoil up to 1.1m in depth. The northern half of the trench was covered by a thin natural soil, 0.2–0.3m in thickness overlying bedrock.

The following layers were excavated (Fig 11):

Layer 1: thin humus / sod

Layer 2: layer of white / grey mine spoil, consisting of finely broken slaty stone. Some stone hammer fragments, no charcoal.

Layer 3: dark brown soft peat, with occasional small stones.

Layer 4: mid-brown sandy silt with orange hue; occasional small stones.

Layer 5: grey / mid-brown sandy silt, very loose with numerous small to large stones and occasional stone hammer spalls.

Layer 6: grey / light-brown sandy silt, very loose and mostly made up of small to large slaty stones.

Layer 7: grey finely crushed slaty stone with copper minerals.

Layer 8: black manganese-stained layer on top of bedrock, with numerous stones including mine spoil. Layer 8a had a more intense black coloration.

Layer 9: mid-brown sediment, very loose with numerous stones (mine spoil)

Layer 10: light-brown humic silt; no mine spoil.

Layer 11: grey / light-brown humic silt with small stones; no spoil. Layer 11a had a slightly darker colour.

In summary, the stratification of test-pit C consisted of a thin surface deposit of re-deposited mine spoil (Layer 2) containing some broken stone hammers. This was removed to expose a thin peat (Layer 3) overlying lenticular deposits of broken mine rock (Layers 4–9). Some of this spoil contained stone hammer spalls, but there was no wood or other material suitable for radiocarbon dating.

Finds

The archaeological excavation at Mine 5b-1 and in the central spoil area uncovered a large number of broken hammerstones, a quantity of waterlogged wood, some of it worked, and a single object of deer antler. No other artefacts were discovered, and the absence of any material culture connected to mining in the early modern era is notable.

Stone hammers A total of 63 stone hammer fragments were recovered during the excavation of Mine 5b-1. These came from the stony deposits (Layers 3 and 4) at the base of the mine, with no examples found in the overlying

[46] O'Brien 1989

[47] Jackson 1980

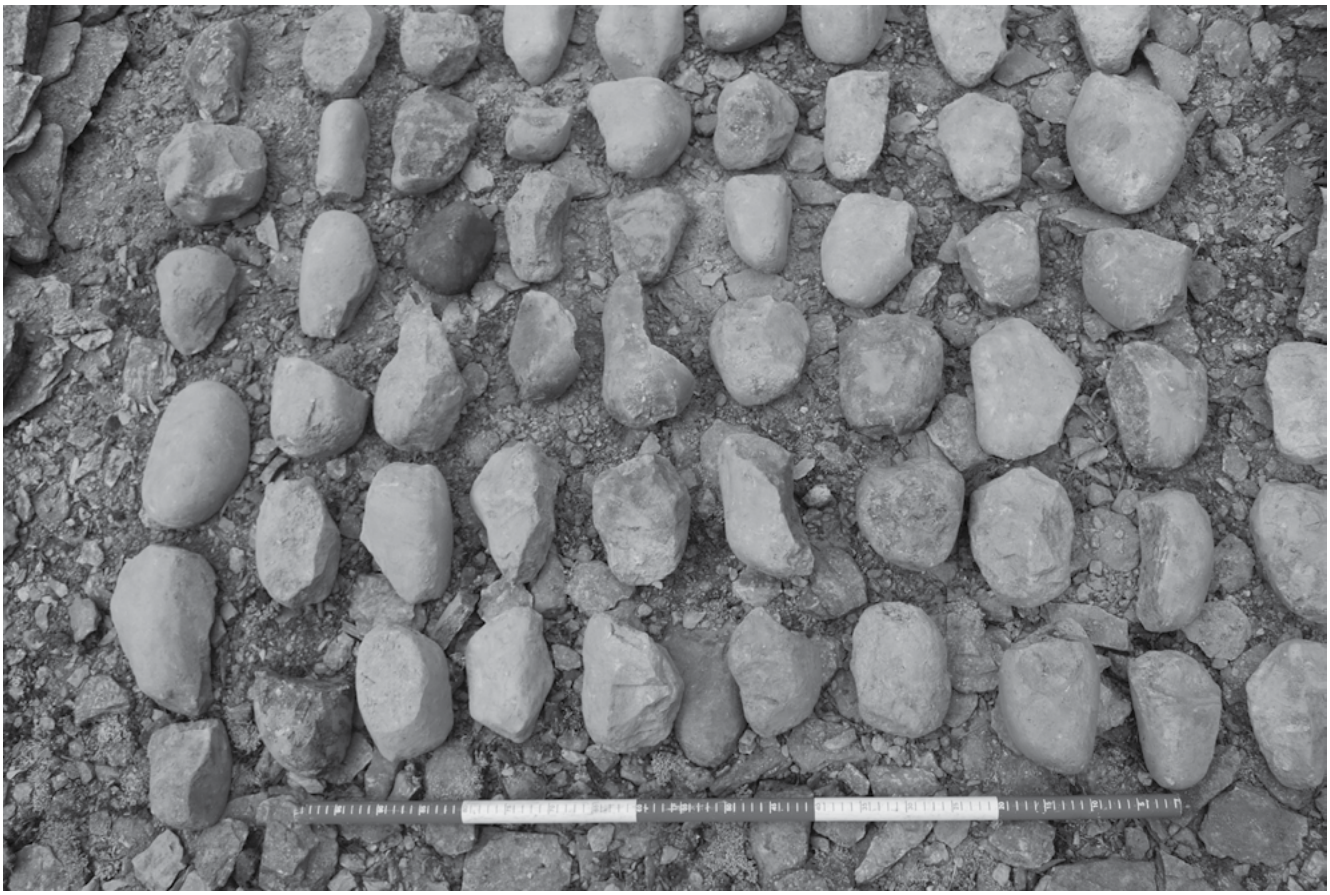


Fig 12 Selection of stone hammers excavated in test-pits A and B, central spoil area, Derrycarhoon

peat (Layer 2). In addition, a total of 273 stone hammer fragments were recovered from surface spoil in test-pits A and B in the central mine area, with eleven examples found in excavation cutting C.

These hammerstones comprise smooth, water-rolled, cobbles of natural origin, ranging ovoid to sub-ovoid to sub-rectangular in shape (Fig 12). Many have a broader end that was the main striking surface. Most exhibit some evidence of use at both ends, with a number having some degree of side use. There is a high degree of breakage, arising from heavy percussive use as hand-held or hafted hammers. The Mine 5b-1 collection includes 34 examples where >50 per cent of the original cobble survives, and 29 spall fragments (<50 per cent of original cobble). Only five of the former may be regarded as near-complete, while 19 of the 29 other examples suffered catastrophic longitudinal fracture through heavy use. The number of spall fragments in the collection is probably under-represented as the Layer 3 and 4 mine sediments were not sieved during excavation. There is a similar degree of use-breakage in the stone hammers from the central spoil area, with 171 spalls (<50 per cent original cobble) and 102 broken hammers (>50 per cent original cobble) recovered in test-pits A and B.

The stone hammers from Mine 5b-1 are all grey, medium-to-coarse sandstones, derived from the Old Red Sandstone geology of this region. Of the broken hammers found in test-pits A and B, 91 are of grey-green sandstone, with seven examples of purple sandstone and four unidentified. Their water-rolled appearance suggests that these cobbles were gathered from local beach sources and / or fluvio-glacial deposits.

The general size of the hammers can be estimated from original axial measurements that survive, and from the weight of the near-complete examples. The Mine 5b-1 examples range 130–213mm in length (average 165mm; 10 measurements), 65–153mm in width (average 103mm; 37 measurements) and 48–108mm in thickness (average 68mm; 13 measurements). The broken examples (>50 per cent of the original cobble) range 526–3145g in weight. Most of the hammers used in this mine probably weighed 1–2kg, with some heavier examples of up to 3–4kg, but not more. Smaller examples weighing 500–1000g were also used for particular purposes, such as in the modification of larger hammers for hafting. The examples from test-pits A and B in the central spoil area are similar in size, with an average length of 130–170mm, increasing to 180–220mm in larger examples, with occasional hammerstones as small as 110mm.

One third of the hammer fragments collected in Mine 5b-1 display some form of deliberate modification for hafting. This generally consists of one or more patches of shallow abrasion on the sides and / or face of the cobble. The abrasion was executed by shallow pecking using a smaller hammerstone to roughen the smooth surface of the cobble to grip a withy haft. The type of modification varied depending on the cobble shape, ranging from single or opposing side and / or face abrasions, to examples where a short rill was



Fig 13 Antler pick, Mine 5b-1, Derrycarhoon

executed across the medial line of the cobble. The latter is recorded on one example (10E287:168). No completely rilled or grooved hammerstones were found. The minimal nature of this haft modification can be explained by the brief use-life of these implements, which broke easily when striking rock type of similar lithology in this mine. One hafted example (10E287:153) seems to have been re-used as a hand-held implement after it broke. Most of the hammerstones found in the central spoil area were not modified for hafting. A shallow rill was observed on one example (10E287:140), with side abrasion on eleven examples and deeper side-notching on two others. Another example (10E287:179) was pecked more deeply to form a small notch.

Antler pick Possibly the most significant artefact from the recent excavations is an antler pick (10E287:01) found in Layer 4 at the base of Mine 5b-1 (Fig 13). This is made from two tines detached from the upper part of a red deer antler. The tip of both tines is broken; one with a single clean break, the other with heavy bruising. The tines measure 140mm and 120mm long respectively, ranging 29–31mm thick at the base to less than 17mm at the pointed ends.

Wooden finds from Mine 5b-1 The waterlogged conditions in this mine allowed the preservation of a small quantity of wood. These include ten objects that were deliberately shaped as tools or else bear chopmarks from the gathering of roundwood:

10E287:02 – Portion of stone hammer handle. Short length of twisted hazel (*corylus avellana sp*) withy, 128m in length, found under a stone hammer in the exposed part of Mine 5b-2. This withy was made by twisting two stems tightly together. When found, it was very soft and could not be lifted intact. The individual fragments were collected and samples taken for radiocarbon dating.

10E287:03 – Wooden wedge. Identified as holly (*ilex aquifolium*). Pointed length of roundwood, broken at one end. Slightly curved and measuring 197mm long by 30mm (pointed end) to 37mm (broken end) in diameter. Smooth surface with occasional pit-marks and no bark. The narrow end has a rounded point, with a single oblique cut-mark on one side and possibly shallow cuts on other sides.

10E287:04 – Portion of possible stone hammer handle. Identified as holly (*ilex aquifolium*). T-shaped wooden object made from a short offset branch attached to a carefully shaped portion of a main branch (Fig 14). The roundwood branch is 101mm long and 36–38mm in diameter, and is broken at the end. The attached portion was deliberately shaped by knife cuts to a sub-rectangular form measuring 70mm by 59mm by 27mm. This has a flat upper surface with short knife facets visible along the sides. A stone hammer would have been fastened to this platform using bindings of some type (see below).

10E287:05 – Wooden branch used as step. Identified as oak (*quercus sp*) with 17 growth rings ranging 3–6.2mm wide. Found in Layer 4 at base of mine, close to the western wall. A length of complete roundwood, broken at both ends with part of a projecting branch off one side. The main portion is 698mm long by 128mm (upper) to 149mm (lower) in diameter (no bark). The lower end is irregularly flat where it has been broken. The upper end is Y-shaped and originally had two branches, 68–79mm in diameter, one of which is completely detached with a portion of the second present.

10E287:06 – Wooden branch used as step. Found in Layer 4 at base of mine, close to the western wall. A length of complete oak roundwood (*quercus sp*) with 16 growth rings (no bark). When found, it was broken into three parts with some smaller fragments. The upper growth end is broken, while the lower end has shallow, short axe-marks all around the diameter. The overall length is 970mm, with a diameter variation of 129mm (upper), 127mm (centre) and 156mm (pointed end). The stumps of two detached branches are visible on one side of this log, 150mm and 750mm from the pointed end respectively.

Roundwood with tooling marks

10E287:07 – Pointed stick. Straight length of complete hazel (*corylus avellana*) roundwood with bark, measuring 116mm long by 26mm in diameter. Broken at one end; the other has a chisel point with two steep cuts (one shorter than the other) made by a metal blade.

10E287:08 – Pointed stick. Straight length of complete hazel (*corylus avellana*) roundwood with bark, measuring 106mm long by 19mm in diameter. Broken at one end; the other has a possible steep cut mark on one side.

10E287:09 – Pointed stick. Straight length of complete hazel (*corylus avellana*) roundwood with bark, measuring 138mm long by 20mm in diameter. Broken at one end; the other has a steep cut mark on one side with a blunted tip.

10E287:10 – Pointed stick. Straight length of complete hazel (*corylus avellana*) roundwood with bark, measuring 97mm long by 21mm in diameter. Broken at both ends, with a possible cut mark on one side.

10E287:11 – Pointed stick. Straight length of complete hazel (*corylus avellana*) roundwood with bark, measuring 137mm long by 26mm in diameter. Broken at both ends,

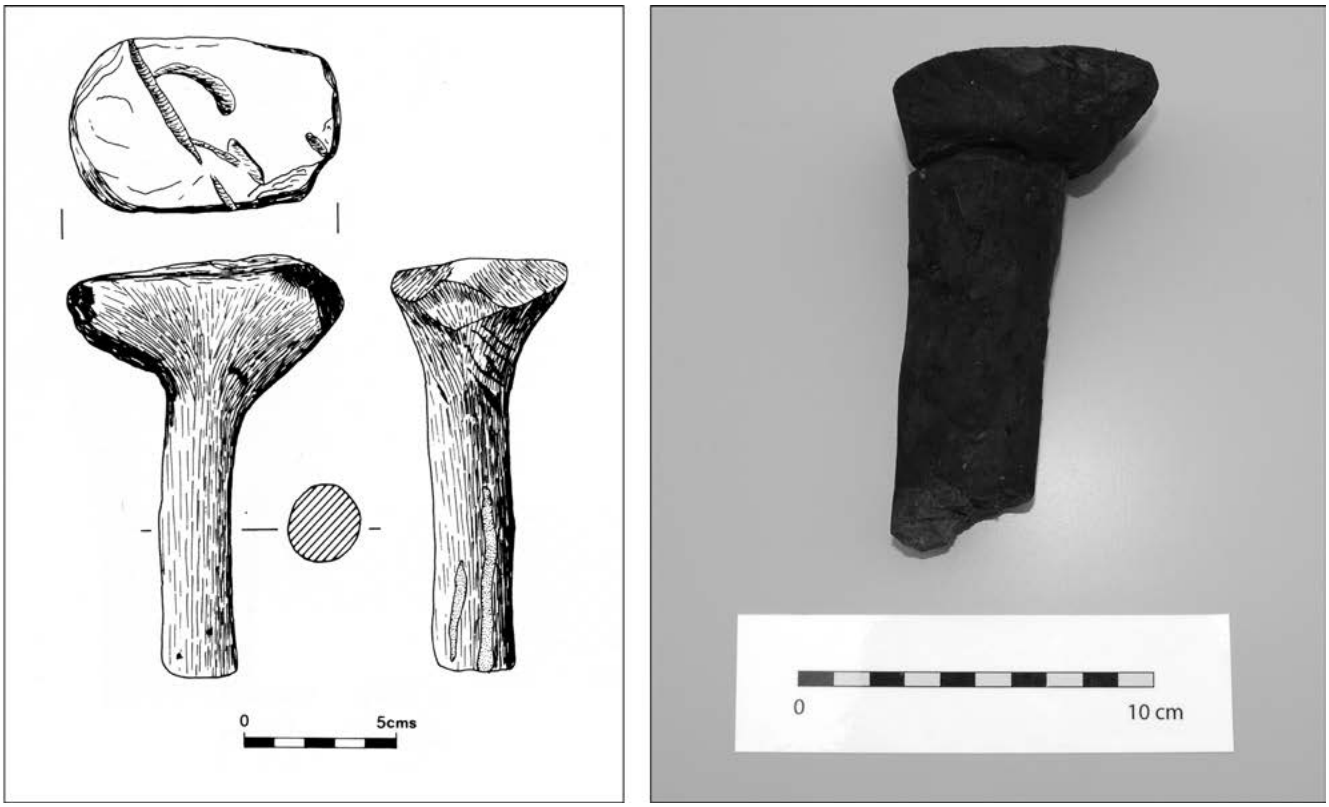


Fig 14 Part of wooden handle used to haft a stone hammer, Mine 5b-1, Derrycarhoon (right), with similar example from Mine 3, Mount Gabriel (O'Brien 1994, fig 69 no. 663)

with a definite cut mark on one side created by a sharp knife.

Roundwood with no tooling marks
Approximately 46 lengths of young complete roundwood, ranging 11–30mm in diameter, were discovered in Layers 3 and 4 in Mine 5b-1. They include numerous broken lengths of straight hazel, with the longest example measuring 429mm (10E287:22). Most have some bark adhering, but none are charred or have tooling marks. A total of 66 fragments of twig-like material were also recovered, none of which are charred.

Wooden finds from central spoil area Waterlogged wood was recovered during the excavation of surface spoil (Layer 1) in test-pits A and B in the central mine area. A total of 139 fragments were found (10E287:193–332), most coming from a depth of 0.15–0.6m in Trench B (Layer 1). These range in length from 20–275mm, with 90 examples under 60mm. Only one piece of complete roundwood was found. This measures 116mm long by 28mm in diameter, and has some fragments of bark, as well as possible chop-marks at one end. The remaining wood comprises of rough fragments with no surviving bark or surface tooling. These seem to have been broken from larger wood pieces. Two fragments were partly charred, with the remainder unburnt.

Some of these wooden finds may relate to mining equipment. Three fragments of possible twisted hazel withy (10E287:189–191) were found in mine spoil in test-pit B (Layer 1). These may derive from basketry or stone hammer handles used by the miners.[48] A length of worked pine (10E287:192), measuring 122m by 23mm by 8mm, was also found. This piece tapers to a point at one end, which is also heavily charred. It may be a lighting splint of the type used by miners on Mount Gabriel.[49]

Dating

There are several pointers to the antiquity of the 'Danish Mines' at Derrycarhoon. It is significant that when first discovered in 1846 contemporary sources indicate that 'no previous tradition or suspicion had been entertained' of these mines. This does not in itself imply a prehistoric age, particularly when radiocarbon dating of the Derrycarhoon Tube raises the possibility of late medieval mining or prospecting in the site.[50] More significant, however, is that the same nineteenth-century sources record up to 4m of peat infilling these trench mines. This peat association is confirmed by recent excavation and augering at the site. The accumulation of such a thickness of solid peat must indicate a pre-medieval date for these workings. This is supported by technological indicators, such as the use of antler picks and stone

[48] See Timberlake 2003, figs 71, 72 for examples from Copa Hill, Cwmystwyth, Wales
[49] O'Brien 1994, fig 73
[50] Hedges 1988

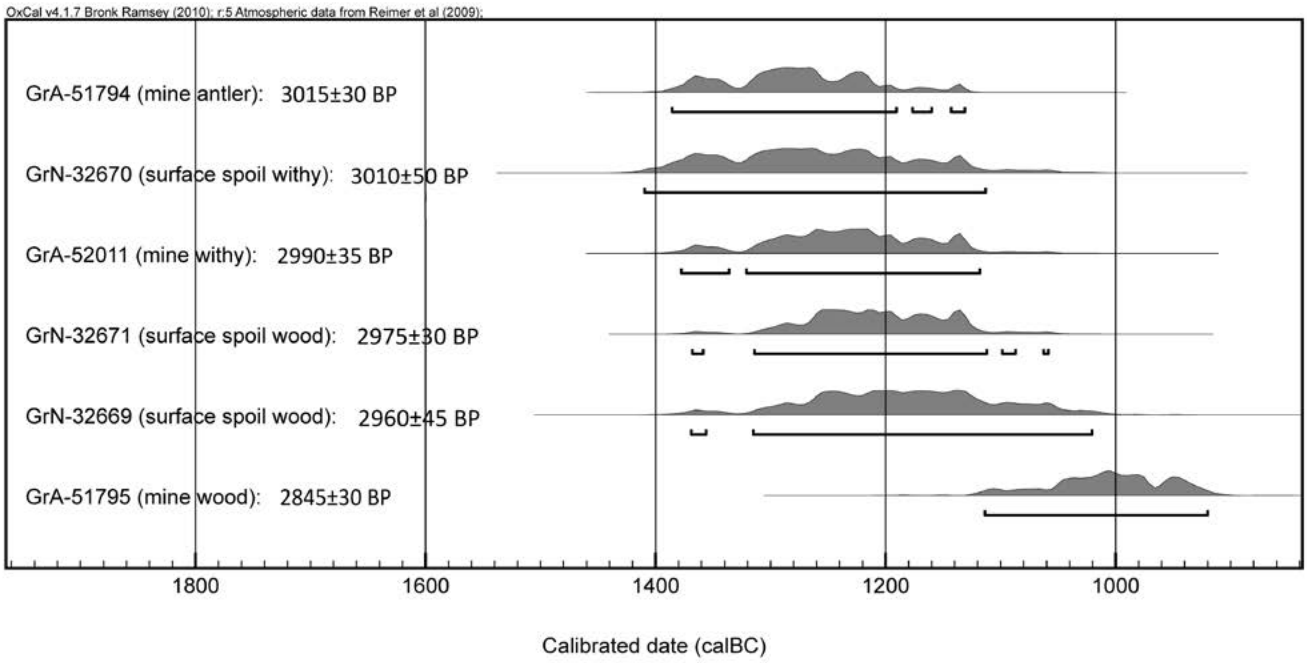


Fig 15 Calibration of radiocarbon results from archaeological excavations at Derrycarhoon mine (after OxCal v.4.17)

hammers, implements that were never used in historic mining contexts in Ireland. The stone hammer association is particularly significant, as scientific dating of find locations indicates these implements were only used for copper mining in south-west Ireland during the Chalcolithic or Bronze Age periods.[51]

The date of the earliest phases of copper mining at Derrycarhoon can be resolved by radiocarbon dating of organic samples taken from stratified mine contexts. Seven samples from the 2010 and 2011 excavations at Derrycarhoon were submitted to the Centre for Isotope Research, University of Groningen. The results are as follows (calibration at 95.4 per cent confidence using OxCal 4.1.7, Intcal09)

Sample 2010-1: Short length of complete rowan roundwood (10E287:193), identified as Maloideae spp / pomaceous wood (cf *Sorbus sp*) from lower part of Layer 1 spoil in test-pit B.
GrN-32669: 2960±45 BP. Calibrated 1370–1021 BC

Sample 2010-2: Possible twisted withy (10E287:189), 96mm long and identified as wild / bird cherry (*Prunus avium / padus*) from lower part of Layer 1 mine spoil in test-pit B.
GrN-32670: 3010±50. Calibrated 1410–1114 BC

Sample 2010-3: Fragment of unworked wood (10E287:194) identified as young oak (*Quercus sp*) from lower part of Layer 1 mine spoil in test-pit B.
GrN-32671: 2975±30. Calibrated 1369–1059 BC

Sample 2010-4: Sample of peat taken by auger at a depth of 1.4–1.5m inside Mine 5b-1.
GrN-32672: 2310±50. Calibrated 516–206 BC

Sample 2011-1: Fragment of red deer antler (10E287:01) from primary mine sediment (Layer 4), found at base of Mine 5b-1.
GrA-51794: 3015±30 BP. Calibrated 1386–1132 BC

Sample 2011-2: Fragments of twisted withy (10E287:02), identified as hazel (*Corylus sp*), found under hammer stone in Mine 5b-2 hollow.
GrA-52011: 2990±35 BP. Calibrated 1378–1119 BC

Sample 2011-3: Fragment of pointed roundwood (10E287:07), identified as young hazel (*Corylus sp*), from secondary mine sediment (Layer 3) in Mine 5b-1.
GrA-51795: 2845±30 BP. Calibrated 1114–921 BC

Taken together, these results indicate copper mining activity at Derrycarhoon over a long period, from the fourteenth to the eleventh centuries BC (Fig 15). The calibration of radiocarbon results for wood fragments from early spoil in the central mine area indicates mining in the period 1369–1114 BC. This is consistent with the date of 1386–1132 BC for an antler pick from Mine 5b-1, though the working period of that particular mine pit is likely to have been a single year / season. A later date of 1114–921 BC for wood and spoil dumped into this abandoned working raises the possibility of continued mining in Mine 5 into the eleventh century BC. The peat result from Mine 5b-1 suggests that the mine as a whole was probably abandoned early in the first millennium BC. The overall chronology remains to be clarified by further research, particularly as only a single section of one of six early trench mines is radiocarbon dated.

However imprecise, the radiocarbon results from Derrycarhoon firmly refute assertions made by Briggs that these 'Danish Mines' are early modern in date.[52] This Bronze Age mining can also be separated from a later phase of mineral

[51] O'Brien 1994; 2003; 2004

[52] Briggs 1984

exploration and / or mining connected to the 'Derrycarhoon Tube', now known to be of later medieval date. The results provide the first evidence for copper mining in Ireland during the Bishopsland (1350–1100 BC) phase of the Middle-to-Late Bronze Age transition, with the possibility of continued mining into the Roscommon phase (1150–1000 BC).

Discussion

Historical sources and the recent archaeological investigation indicate two major periods of copper mining at Derrycarhoon. The first occurred during the final centuries of the second millennium BC, when narrow mine trenches and pits were worked along the strike outcrop of parallel copper beds. These prehistoric workings were first recorded when the mine reopened in 1846. Intermittent mining was undertaken over the following decade, after which there were sporadic trials and prospection into the modern era. The nineteenth-century mining was very different in character to the earlier workings, involving a shaft-and-gallery system and the use of iron tools and explosives. The significance of the 'Derrycarhoon Tube' remains to be clarified by future investigations, but is of particular interest given the state of knowledge on later medieval mining in this part of Ireland.

Bronze Age mining at Derrycarhoon

The earliest mining at Derrycarhoon was based on the exposure of copper beds within a red-bed sequence of Late Devonian sedimentary rocks. Bronze Age miners walked the strike outcrop of these grey-green beds, looking for indications of copper where the surface rock was stained bright green by the secondary mineral, malachite. This prospecting knowledge was acquired over some five centuries of copper-bed mining in the Mizen Peninsula, as occurred on the slopes of Mount Gabriel during the period 1750–1400 BC, with similar workings in the Goleen area a century or so earlier. [53]

The methods of rock extraction employed by the Bronze Age miners at Derrycarhoon may be reconstructed from the Mine 5b-1 evidence. Unlike other prehistoric copper mines in Cork there is no evidence for the use of fire-setting. The wallrock profile in Mine 5b-1 does not have the smooth concavities produced by that technique, nor were any fuel residues (partly burnt roundwood and charcoal) found. The latter are notably absent from spoil deposits in the central mine area. This indicates a different approach to mining at Derrycarhoon from that on Mount Gabriel. While the mineralization is similar at both locations, the exposure of these copper beds is different due to variations in local and regional fold structure. Fire-setting is most useful when driving horizontal or inclined workings, such as those on Mount Gabriel. It is not particularly suited to the sinking of vertical workings, which explains why it was not employed in the Derrycarhoon trench / pit mines. The shape and size of the latter were largely determined by their stratabound position along a steeply dipping bedded formation of grey medium–coarse sandstones. This structural position exposed bedding planes and a penetrative rock cleavage on a near-vertical axis, allowing the miners to drive down into the lamination of the hard siliceous rock, using wedges and pick-like tools to prise out rock along 20–50mm wide cleavage partings.

This interpretation is supported by the type of mining tools found inside the Mine 5b-1 working. These include a large number of stone hammers, consisting of well-rounded natural cobbles, 130–213mm in length and 500–3500g in weight, all broken through heavy use. The origin of these cobbles is uncertain, but they probably derive from glacial deposits in the locality or storm beaches along the coastline of the Mizen Peninsula, 5km south of the mine. These hammerstones were carefully selected for use in a hand-held or hafted fashion in the breaking and crushing of rock. The type of minimal haft modification on the Derrycarhoon hammers is identical to that used at Mount Gabriel. In both cases, this is because the stone hammers had a brief use-life due to the fact they were used to strike bedrock of a similar lithology. There was little point in investing time in the rilling or grooving of these hammerstones when they might break after only a few minutes of use.

The hafting of the Derrycarhoon hammers is indicated by shallow abrasion marks on the sides of many of these cobbles. This abrasion served to grip either a twisted withy of flexible wood or the bindings of a wooden handle. The former is confirmed by the discovery of a short length of hazel withy under a stone hammer in the Mine 5b-2 hollow, and by three other withy fragments (10E287:189–91) found in the central spoil area. Such twisted withies may have been used on their own as handles. Rigid wooden handles were also used, a fragment of which was found inside Mine 5b-1. This carved T-shaped piece of holly (10E287:04) is almost identical to a carved wooden object found in Mine 3 on Mount Gabriel (see Fig 14). It is not known how these handles were fastened to stone hammers, with the use of withies or rawhide bindings a possibility.

These stone hammers were multi-purpose rock-breaking tools, used along with other implements at the mine face and in ore beneficiation on the surface. Examples of the former were found in Mine 5b-1 excavation. These include a possible short wedge (10E287:03), as well as a large number of slender pointed rods of hazel (10E287:12–54). These rods may have been used as prise-sticks in combination with the stone hammers and fingers; however, this is not certain.

The antler pick (10E287:01) from Mine 5b-1 is unique in the record of early copper mining in Ireland. Antler picks are well known from Neolithic flint mines in Europe and are also recorded in Bronze Age copper mines in Britain and Spain.[54] Antler is recorded in the Chalcolithic / Early Bronze Age copper mines on Ross Island, Killarney, Co Kerry, where its precise use is uncertain.[55] The Derrycarhoon example was found at the mine face, where it was used with stone hammers to prise out rock along cleavage partings.

The investigation of Mine 5b-1 provides several details on the operation of that mine. Movement in and out of the working was awkward due to its near-vertical profile and smooth walls, with no evidence that the miners made rock-cut steps. Excavation did uncover two large lengths of

[53] O'Brien 1994; 2003

[54] eg Timberlake 2003; Blas Cortina 2005

[55] O'Brien 2004, 373 pl 74

roundwood (10E287:05 and 06), both of which had short projecting branches. These were found in an inclined position at the base of the west wall, driven into a deposit of finely broken rock sediment (Layer 4) that had built up during the final phase of mining. This material provided a footing for the forked roundwood branches, which allowed the miners to climb in and out of the working.

Though now lost, the monoxlyous ladder found at Derrycarhoon in 1846 may also be from the Bronze Age mines. It is suggested that similar notched tree-trunk ladders were used in Bronze Age copper mines in Austria.[56] An example was discovered in a Late Bronze Age mine at Chinflon, Huelva province, Spain,[57] a site that is comparable to Derrycarhoon in terms of date and mining strategy. The use of such ladders in Ireland during the early mining period at Derrycarhoon is confirmed by the recent discovery of an example dated 1390–1120 BC in a *fulacht fiadh* at Cashel, Co Tipperary.[58]

The Derrycarhoon miners must have used some form of basket or sack to haul broken rock extract to the surface. No examples of such containers have been found, possibly because they were re-used in adjacent workings. In the case of Mine 5b-1 these were probably passed up by hand, as ropes were not necessary in a 4m deep working.

Lighting would not have been a significant problem in workings of this depth, as natural daylight would have illuminated the interior. The discovery of the charred splint of pine (10E287:192) in the central spoil area can be compared to numerous examples found in Mine 3 on Mount Gabriel.[59] No examples were found in the excavation of Derrycarhoon Mine 5b-1, and so the use of pine lighting chips may have been confined to deeper workings elsewhere in the site.

The extent of any drainage problems in these workings depended on rainfall during the mining season, which for this reason may have been confined to drier months. The investigation of Mine 5b-1 did encounter water seepage at a depth of 4m. These small, self-contained workings would have been easy to hand-bail and so water seepage is unlikely to have restricted the depth of mining, particularly as fire-setting was not employed. It is more likely that 5b-1 was abandoned when the mineralization ended, with the miners moving to an adjacent portion of the 'copper bed'.

Metal production

It is difficult to estimate the amount of copper produced at Derrycarhoon in the absence of detailed examination and dating of the remaining trench mines. The size of these workings suggests significant production over several centuries; however this must be viewed against the low-grade mineralization in the copper beds. No evidence of smelting or metalworking has been uncovered at the mine or in the general vicinity. This must be viewed against the limited extent of investigation, and the poor archaeological visibility in an environment disturbed by forestry and mining in modern times. The deep ploughing that accompanied recent conifer plantation has destroyed the immediate environs of the mine, and probably destroyed those locations where copper ore was smelted to metal. The discovery of smelting sites is complicated by the primitive nature of those processes, which probably involved carbon reduction of oxidized ore at low temperatures in simple pit furnaces, resulting in very small amounts of slag.

No copper-bronze artefacts of prehistoric date are recorded from the mine, nor is there any notable concentration of Bronze Age metalwork or ingots in the general vicinity. Some significance may be attached to the discovery of two bronze axeheads in the adjacent townland of Gortnagrough.[60] These are nineteenth-century finds with no recorded archaeological context or more precise find location. Both are of Eogan's Class 11 type, the common bag-shaped, side-looped, socketed axehead, of which some 1700 examples are recorded in Ireland.[61] The general type cannot be closely dated, but is believed to have its origins in the Bishopsland and Roscommon phases, *c* 1300–1000 BC. This raises the possibility that Derrycarhoon mine may have supplied copper to make some of the 40 or so socketed axeheads of various types known from the Cork region,[62] or a proportion of the 2100 examples recorded in Ireland as a whole.[63] This remains to be tested by a future programme of scientific analysis involving chemical and lead isotope characterization of the Derrycarhoon orebody and the copper used in socketed axeheads and other contemporary metalwork.

Cultural context

The period from 1300–1000 BC was a time of significant economic and social change in Ireland, with population growth and expanding settlement in many areas. Powerful chiefdom-type polities emerged in core regions, representing a wealthy stratum of society who controlled significant economic resources and trade. The food economy of the Late Bronze Age was based almost entirely on agriculture, combining stock-rearing with cereal cultivation. By 1000 BC there is much evidence for conspicuous consumption of gold and bronze objects produced to high technical and artistic standards, as well as trade connections to the Continent involving the exchange of metal and other materials such as amber.

There was also a darker side to this society. The large-scale production of swords and other bronze weaponry, as well as the building of fortifications and increased hoarding of valuables, suggest that this extended period of economic prosperity was punctuated by social instability leading to conflict and outright warfare at a local and inter-regional level. The building of large hillforts during the twelfth and eleventh centuries BC represents important centres of power and ceremony within their respective regional territories.[64] These include a hillfort at Mooghaun, Co Clare, located at the centre of a proposed chiefdom in

[56] Pittioni 1951, fig 5
[57] Andrews 1994
[58] Hughes 2008
[59] O'Brien 1994, fig 73
[60] Eogan 2000, nos 1132, 1615
[61] *ibid*
[62] O'Brien 2012, fig 244
[63] Eogan 2000, pl 112
[64] See O'Driscoll, this volume

North Munster,[65] and an example excavated by the author at Clashanimud in mid-Cork, which was a regional power base for a brief period around 1100 BC.[66]

No such hillforts have been identified in the West Cork region, where settlement during the Middle / Late Bronze Age seems to have had a dispersed pattern similar to that before 1500 BC, albeit with a denser spread of population. There is no evidence of any higher social organization involving power centres such as hillforts in these coastal communities. Some wider sense of identity and ethnicity is likely; however, it is not clear whether groups in the West Cork peninsulas were autonomous or under the control of larger polities in the Munster hinterlands. Mining was certainly underway at Derrycarhoon when the hillfort at Clashanimud was built, but no direct connection can be established between the two locations.

Several sources reveal an expansion of Bronze Age settlement across the south-west region from 1500 BC onwards. This is evident in pollen records from the Beara Peninsula, which indicate a long-term reduction in tree cover and increased indicators of agriculture.[67] There are similar findings for the Mizen Peninsula, where a permanent reduction in tree cover can be linked to increased agriculture during the later second millennium BC.[68] The environmental evidence of intensified farming can be linked to an expansion of settlement into areas that were previously unoccupied, such as the hill valleys of the Beara Peninsula.[69] The large number of *fulachtaí fia*, many of which date to the later Bronze Age, is a further indication of the density of settlement across the wider Cork region.[70]

Added to this evidence is the proliferation of new types of ritual monument across Cork and Kerry during the later Bronze Age. Known as the 'stone circle complex' these include two types of axial stone circle, as well as short stone rows, stone pairs, single monoliths, boulder-burials and radial stone cairns. These monuments have a broadly similar regional distribution, share a common orientation and often occur in the same site or in close proximity (Fig 16). They are generally interpreted as different physical expressions of a religious cult that emerged in south-west Ireland during the mid-to-late second millennium BC. There are also indications of continuity in religious symbolism with an older order represented by the building of wedge tombs in this region. Common elements include the special significance of white quartz, cremation burial, and a south-westerly orientation that emphasized the setting sun. The similar distribution of wedge tombs and 'stone circle complex' monuments suggests continuity in the spatial organization of Bronze Age settlement in West Cork and Kerry. There are indications that society continued to be organized on a segmentary basis after 1500 BC, possibly with some new hierarchical elements based around the control of economic and religious power.

Ballycommane revisited

No Bronze Age settlements can be connected directly or otherwise to Derrycarhoon mine. This is a problem of fieldwork and archaeological visibility in an area where prehistoric settlements are not easily recognized. The current study is an opportunity to review an excavation conducted by the author in March 1989 at a Bronze Age ritual site in Ballycommane townland, 3.5km north / north-west of Derrycarhoon mine.[71] This site is located at the eastern end of a synclinal valley that forms a north-eastern extension of Dunmanus Bay, 3km from the village of Durrus. It contains a boulder-burial and a pair of standing stones, carefully positioned on the summit of a low ridge in the centre of this valley.

The boulder-burial consists of a large erratic of massive vein quartz weighing an estimated 5–6 tons, supported by three smaller stones to an overall height of 1.33m. The removal of this quartz boulder exposed a flat stone in a space formed by the U-shaped arrangement of support stones. Excavation beneath this slab revealed a thin spread of dark brown sandy-silt overlying a lens of black silty sediment of unknown origin. No artefacts, human remains or charcoal were found, and so it was not possible to date the monument.

The excavation also investigated a pair of standing stones, located 2.43m and 5.38m to the east and north-east of the boulder-burial respectively. These are flat-topped monoliths, each around 1.3m in height and spaced 3.05m apart in a north north-east / south south-west alignment. Excavation at the base of the northern stone revealed a tiny cist, measuring 0.25m by 0.24m by 0.13m deep. This contained black silt, but no artefacts, human remains or other dating evidence.

While the monument at Ballycommane cannot be dated, radiocarbon results are available for similar monuments in this region. This includes a boulder-burial at Cooradarrigan in the Mizen Peninsula dated 1425–1266 BC and one at Bohonagh near Rosscarbery dated 1259–1024 BC.[72] Recent excavations conducted by the author at Barrees in the Beara Peninsula and Clogagh near Timoleague have also clarified the chronology of standing stone pairs similar to that at Ballycommane. The Barrees monument contained a cremation burial dated 1260–980 BC,[73] while an overall date range of 1269–979 BC has recently been obtained for three cremations at Clogagh, Timoleague, also in Co Cork.[74] The dating of stone circles is also relevant, with dates of 1115–791 BC for a central burial at Drombeg stone circle and 1371–1055 BC for a similar example at Bohonagh stone circle.[75]

These results confirm a later Bronze Age context for monuments of the 'stone circle complex' in south-west Ireland, broadly spanning the period 1400–800 BC. They also indicate that the building of many stone circles, stone rows and pairs, and boulder-burials, occurred at the same time as the mining at Derrycarhoon. While there is no proven connection, the monument at Ballycommane is probably

[65] Grogan 2005
[66] O'Brien 2012
[67] Lynch 1981; Overland and O'Connell 2009
[68] Mighall and Lageard 1999
[69] O'Brien 2009
[70] *idem* 2012, fig 135
[71] *idem* 1992, fig 7
[72] *idem* 1992; 2012
[73] *idem* 2009
[74] *idem* unpublished
[75] See O'Brien 2012 for discussion

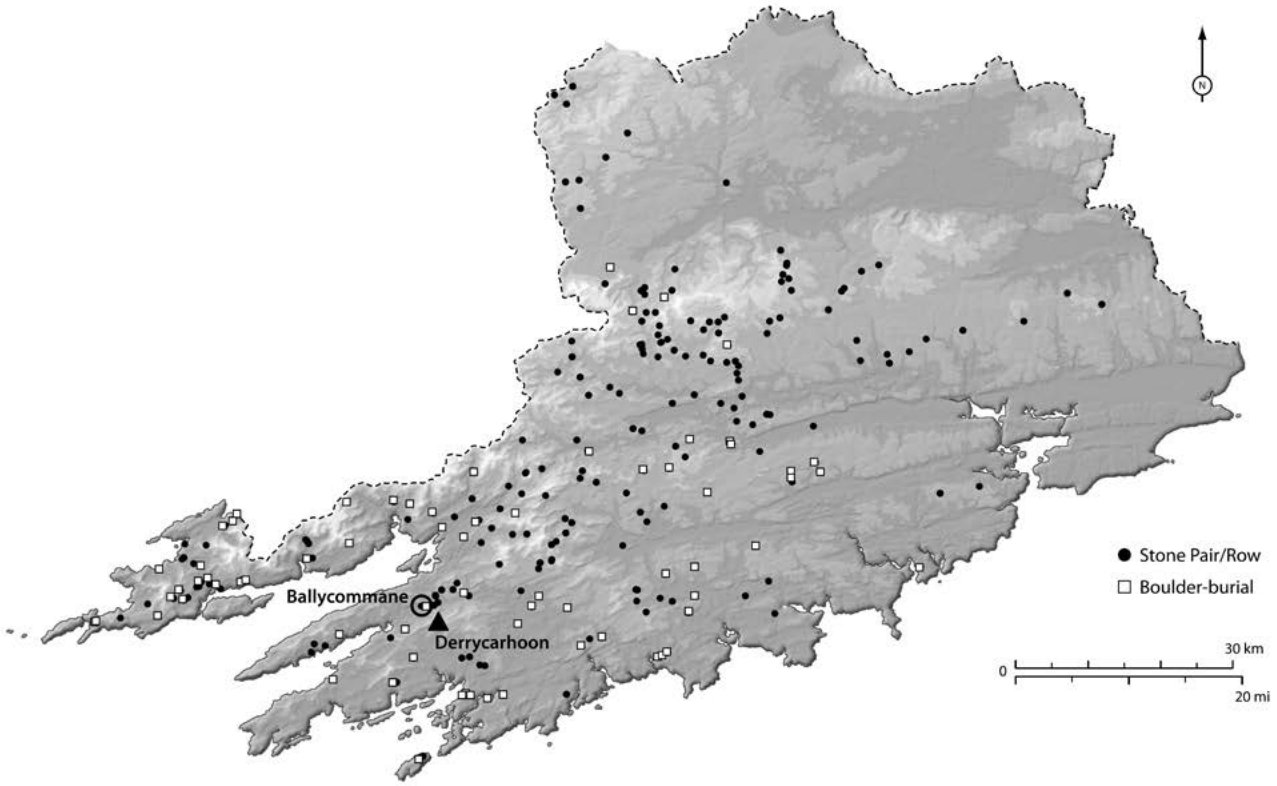


Fig 16 Distribution of boulder-burials and stone rows / pairs in Co Cork, showing location of Derrycarhoon mine and Ballycommane boulder-burial and stone pair

linked to the religious beliefs of the Derrycarhoon miners and contemporary Bronze Age communities in the region.

Conclusions

Recent investigations at Derrycarhoon mine provide important information on copper mining in south-west Ireland at the beginning of the Late Bronze Age. This is the first investigation of a prehistoric copper mine in Ireland that is not connected to the use of fire-setting. The confirmed use of antler picks in this mine is unique in Ireland. Derrycarhoon is also the first copper mine in Ireland that can be dated to the Middle / Late Bronze Age transition, *c* 1400–1000 BC.

Derrycarhoon represents a new type of prehistoric copper mining in the West Cork region. These workings differ from the inclined drift mines found on Mount Gabriel and other locations in the Mizen and Beara Peninsulas.[76] The differences should not be over-emphasized, as they relate in part to local geological settings. The type of strata-bound mining at Derrycarhoon reflects the geological structure of that site, where copper beds occur within steeply dipping sandstone formations. The use of near-vertical workings to mine this ore explains the absence of fire-setting. That said, there are obvious similarities with the Mount-Gabriel-type mining, including the type of mineralization exploited and a reliance on stone hammers bearing similar haft modification.

There are many parallels from the Bronze Age for the type of strata-bound trench mining at Derrycarhoon. This is where the strike exposure of a vertical or steeply inclined mineralized vein or bed was mined, creating a long, narrow working. Examples include the mines at Ai Bunar in Bulgaria,[77] Alderley Edge in Cheshire, England,[78] Chinflon and Cuchillares in Huelva, Spain,[79] and Vallarade Les Neuf-Boches at Cabrières, southern France.[80] Some examples are very large, for example the 'Tranchee de Anciens' at St Véran,[81] or the 'Blue Hole' on Ross Island.[82] Others can continue over long distances as a series of short trenches; for example, at Ai Bunar mine in Bulgaria, where trenches measuring 15–110m long followed the exposed veins for a distance of 1.5km.[83] The *furchenpingen* of the Mitterberg mine district in Austria are even more impressive.[84]

In respect of extractive metallurgy, the mining at Derrycarhoon represents a continuation of the older Mount Gabriel-type extraction of oxidized mineralization in this re-

[76] O'Brien 1994; 2003
[77] Chernykh 1978
[78] Timberlake and Prag 2005
[79] Rothenberg and Blanco-Freijeiro 1981; Andrews 1994
[80] Ambert 1984
[81] Barge 2003
[82] O'Brien 2004
[83] Chernykh 1978
[84] Stöllner *et al* 2011, fig 19

gion. The continued reliance on surface occurrences of low-grade, but accessible, oxidized mineralization relates to an inability to smelt chalcopyrite and other copper-iron sulphides in Ireland or Britain during the Bronze Age. This technological constraint, combined with the eventual exhaustion of easily worked deposits of oxidized ore, as well as other economic and cultural factors, explains the decline of copper mining in this part of Europe during the later Bronze Age.

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Linking ore to metal: characterizing the ores and tracing the metal from the Great Orme Bronze Age copper mine in north Wales

Robert Alan Williams

The Great Orme copper mine in north Wales is one of the largest surviving Bronze Age mines in Europe. Radiocarbon dates range from around 1800 to 900 cal BC, with most of them centring on the late Early to Middle Bronze Age. A new methodology is being developed to link mine ore to metal artefact, using the concept of defining a mine-based metal group based on extensive ore analyses (using geochemistry and lead isotope data in combination) as an alternative and parallel concept to artefact-based metal groups. The Great Orme mine is an ideal site to test this methodology, given the access to the ores worked (predominantly oxides rather than sulphides) in over 6km of Bronze Age workings. The mine-based metal group defined by the ores is proving consistent with the analyses of the bronze fragments from the mine and the copper metal prills from the nearby smelting site, which in all probability contain the metal the mine ores produced. Contrary to an earlier influential study of the ores suggesting only low-impurity metal could be produced, this latest research is strongly suggesting that the Great Orme mine produced a metal with variable arsenic-nickel impurities, which is consistent with a lot of British Middle Bronze Age metalwork. In particular, the combination of two independent types of data provides strong evidence to support the proposal that during the Acton Park MBA phase (1500 to 1400 BC) the metalwork found across much of Britain and occasionally on the Continent, from Brittany to Holland, originated from the Great Orme mine. A larger set of samples is now being analysed in the ongoing project to refine the mine-based group. Overall, a clearer understanding of the mine's contribution to the metal supply and the reach of exchange networks are likely to emerge along with the implications for the social organization of the mining. This 'work in progress' paper was written in 2014 and excludes the work completed in the following four years, which will be published shortly.

Introduction

The Great Orme is a prominent peninsula, approximately 3km by 2km, rising to 207 metres above sea level, overlooking the seaside resort of Llandudno on the North Wales coast (Fig 1). The mine site is situated in the closed Pyllau (Welsh for 'pits') valley and even prior to mining it may have been a large hollow in a karst landscape, acting as a focus for surface drainage, with water probably disappearing down joints or sink holes in the carbonate rocks.[1] This unusual landscape feature may have drawn pre-Bronze Age attention, especially with probable scarp exposures of potential pigment in the form of a green copper mineral (malachite) and a brown iron oxide (goethite), possibly associated with stunted vegetation. Therefore, the site could have been a place of special significance well before mining began, and this may explain the presence of a Neolithic chambered cairn called Llety'r Filiast adjacent to the mine site (Fig 2).[2]

The main Great Orme Bronze Age copper workings were only discovered in 1987 under modern mining waste, although some ancient underground workings had been previously identified and dated.[3] In addition, there were reports of ancient workings with stone and bone tools being discovered underground during mid-nineteenth century mining along with bronze fragments.[4] The very extensive workings, in rich secondary ore, are considered one of the largest ancient mines in Europe[5] and are now a mining heritage centre. The mine has over 6km of tunnels along the numerous interconnected north-south veins in dolomitized limestone, covering an area of about 245m by 140m and up to 70m below the surface.[6] There is a complex of often tight irregular underground passages as well as large mined-out chambers, including a large 'opencast' area at surface, part of which may have resulted from a past collapse. Artefacts include over 2400 stone mauls, around 30,000 bone-tool fragments and about 50 small bronze metal fragments. There is evidence that some of the veins, which have soft friable dolomite on each side, were worked by bone tools with only limited use of fire-setting in the harder rock areas. The workings have been dated using charcoal and bone samples. There are seventeen Bronze Age ^{14}C dates whose 2-sigma limits range from 1884 cal BC to 933 cal BC and with one Iron Age date (763–406 cal BC).[7] Several springs on the Great Orme were used for ore washing and have shown some evidence of being in use during the Bronze Age.[8]

The Pentrwyn copper smelting site, on a cliff ledge 1.2km east of the mines (Fig 3), is the only one yet discovered in Britain dating from the Bronze Age. A large part of the site has been lost during the construction of a road in the nineteenth century. Following the site's discovery in 1997 by Dave Chapman, excavations were undertaken in 1998 and 2011. The original radiocarbon date of 1755-1415 cal BC (Beta-127076: 3310±80 BP) from mixed charcoal from the 1998 excavation now looks suspect, after three new dates on carefully selected single species material collected in 2011 all gave Late Bronze Age dates around 900 cal BC (929–812 cal BC = Suerc-39896: 2730±30; 1005–842 cal BC = Suerc-39897:

[1] Dutton and Fasham 1994; Lewis 1996; Wager 2001
[2] James 2011
[3] James 1990
[4] Lewis 1990, 7
[5] O'Brien 2013, 445; *idem* 2015, 146
[6] Lewis 1996
[7] James 2011
[8] Lewis 1996



Fig 1 Location of Great Orme Bronze Age copper mine and Pentrwyn smelting site



Fig 2 General view of Great Orme Bronze Age mine site and heritage centre in the closed Pyllau valley; note the location of Llety'r Filiast chambered cairn and mound is an adjacent field



Fig 3 Pentrwyn Bronze Age copper smelting site during excavation (photograph David Jenkins)

2780±30; 930–809 cal BC = Suerc-44867: 2727±33).[9] Therefore, the site may be contemporary with the group of Late Bronze Age metalwork found in Pigeon's Cave nearby in 1898.[10]

A Bronze Age mining settlement or work camp has not yet been identified on the Great Orme. There are several undated hut circles on the headland, including over sixty on the hillfort at Pen-y-Dinas, 1km SE of the mine.[11] There is currently no definite evidence of Roman or Medieval copper mining, but activity had resumed by the late seventeenth century and continued with interruptions until about 1880, mainly exploiting areas beneath or adjacent to the Bronze Age workings.

Research objective

The previous Great Orme studies summarized below often reached conflicting conclusions, and this has given rise to confusion in the literature. Key differences concern the presence or absence of important trace elements in the ores, the mining and smelting of mainly sulphide or mainly oxide ores, lead isotope ore results that match or mismatch metalwork, the local or external origin of metal fragments in the mine and overall whether the mine was a major or minor contributor to British Bronze Age metalwork.

The current project is bringing all these issues together by testing the working hypothesis that if the Great Orme copper ores were the major British indigenous source of Middle Bronze Age metal, then the trace element 'signature' and isotopic 'signature' of the ores should be detectable in many contemporary metal artefacts. Due allowance will need to be made for the trace element split between metal and slag during smelting and for some metal recycling. A key test will be with the Acton Park metal assemblage that had a widespread distribution, focused on north Wales, in the Middle Bronze Age, when dating evidence suggests the mine was most active.

Completion of the following research objective will allow the hypothesis to be tested: Establish the geochemical and isotopic characteristics of metal produced from Great Orme ores from a programme of ore sampling and analysis. These results will define a mine-based metal group that will be tested for consistency with the analyses of copper prills from the nearby smelting site and bronze fragments excavated in the mine. The mine-based group will then be evaluated alongside artefact-based metal groups and databases of Bronze Age metalwork (OXSAM and OXALID).[12] Metalwork with which Great Orme metal is consistent will be identified, leading to an assessment of the mine's contribution to the metal supply and recycling, the reach of exchange networks and the implications for the social organization of the mining.

[9] Williams 2013

[10] Savory 1980

[11] James 2011

[12] OXSAM <http://fms.arch.ox.ac.uk/fmi/webd\#OXSAM> and OXALID <http://oxalid.arch.ox.ac.uk> (11 July 2016)

Methodology

i) Challenges of linking ore to metal

Tracing Bronze Age metal artefacts back to specific mines or mineral districts can help reveal important centres of production, exchange networks, and contribute to the understanding of a range of social and technological issues. To be successful in this field of provenancing has long been a cherished goal of archaeologists. The first serious attempt in Britain and Ireland dates back to setting up of the 'Ancient Mining and Metallurgy Committee' in 1945, whose members included such eminent archaeologists as Gordon Childe and Stuart Piggott.[13] The final report 'Ores and Metals'[14] successfully identified the 'Cork-Kerry region' as the probable source of the earliest copper, as discussed below. The Coghlan project did not attempt to look at ore sources for metal from later stages in the Bronze Age.

Large European studies such as the Stuttgart-based SAM project were based on analysing chemical impurities in metal artefacts (over 22,000) rather than ores.[15] While many artefact-based metal groups were defined, the hope that the geographical distribution of these groups would lead to links with ores sources, as originally intended, was not fulfilled.[16]

The advent of lead isotope measurements of metal artefacts and ores breathed new life into provenancing projects by matching isotopic signatures. While very good at excluding deposits, some expectations of matching were complicated by overlaps between some mineral deposits.[17] Other complications include more than one mineralizing event in a deposit, giving different signatures, and the presence of uranium and thorium combined with low levels of lead in the copper deposit, producing radiogenic ores with variable isotope signatures. A deeper understanding of the ore geology[18] and metal recycling[19] can help overcome some of the complications.

Overall, Pernicka and others believe that the best practice in provenancing studies is to use both the signature from the chemical trace element patterns and the signature from the lead isotopes of the ores and artefacts in addition to matching the dating of the mines and artefacts.[20] While not successful in all cases, this combination approach has resolved important questions.[21] Roberts claimed that even the combination approach is problematic unless a single copper source 'provided the copper objects in a broad region for at least several centuries'.[22] He quoted the Ross Island mine in Ireland as a successful example, and the working assumption in this project is that this also applies to the Great Orme mine.

Studies linking ore to metal face many challenges that are related to ore geology and mineralogy, ore variability, ore roasting, smelting temperature, redox conditions, smelting additives, volatilization losses, trace element split between metal and slag, and the geochemical and isotopic data overlaps between ore deposits. After reviewing past provenancing studies, it is apparent that one of the weaknesses is the lack of expertise linking geosciences to metallurgy. Modern mining industry management have recognized similar problems and have strived to link these two areas more closely to maximize metal extraction from modern ores. As a result, they have created a new discipline in recent years called 'geometallurgy', to bridge the gap between geosciences (ore geology, ore mineralogy and geochemistry) and metallurgy.[23] Therefore, by analogy an appropriate term for the new research approach being used by the Great Orme project is 'archaeogeometallurgy'. Killick recently pleaded for more training of archaeological specialists in ore geology to improve our understanding of the development of metallurgy because 'the literature is full of poorly informed speculation about ores used in the past'.[24] A similar view was adopted by Baron *et al* who appealed for a greater understanding of ore mineralogy and geochemistry in lead isotope metal-provenancing studies.[25] They commented that 'any provenance study should start with an ore deposit / mineralogical study of the mining sites, [...] conducted from a mining archaeological perspective'.[26] Artioli *et al* have started to use a geology-based approach in developing a geochemical and isotopic database of the numerous complex Alpine copper deposits for use in provenance studies.[27]

In Britain, a huge amount of archaeological effort has been put into typological classification of metalwork, into the analysis of assemblages and into extensive analytical work (chemical and isotopic) that has lead to the defining of artefact-based metal groups. More recently, metalwork databases of chemical (OXSAM) and isotopic (OXALID) analyses have been developed. However, there has been insufficient geological effort devoted to forming a comprehensive British metal-ore database of chemical and isotopic analyses. Important pieces of that overall picture have been produced by the extensive mineralogical work of Ixer and colleagues on various British and Irish mines and sometimes, but unfortunately not always, backed up by chemical analyses of the ores.[28] In addition, Rohl and Needham produced a pioneering study on the isotope analyses of British copper and lead ores, although without any ore analyses.[29] Some Welsh chalcopyrite ores have also been sampled as part of a broader project[30] and other isolated analyses.[31] In addition, experimental archaeological work is beginning to investigate the changes in trace elements on smelting, using actual ore from

[13] Anon 1946
[14] Coghlan *et al* 1963
[15] Junghans *et al* 1968; 1974
[16] Tylecote 1970; Pernicka 2014; Roberts 2014
[17] Pernicka 2014
[18] Baron *et al* 2014
[19] Bray and Pollard 2012
[20] Pernicka 2004; 2014
[21] *idem* 2014
[22] Roberts 2014, 433
[23] Bowell *et al* 2011
[24] Killick 2014
[25] Baron *et al* 2014
[26] *ibid*, 669
[27] Artioli *et al* 2008
[28] Ixer and Davies 1996; Ixer and Budd 1998; Ixer 2001; Ixer and Patrick 2003; O'Brien 2004
[29] Rohl and Needham 1998
[30] Jenkins and Timberlake 1997
[31] Jenkins and Lewis 1991

	Group	Principal Impurities
EBA	A	Arsenic, Antimony & Silver (Ross Island, Ireland)
	B	Arsenic & Nickel combinations
	C	(As <0.25% to >1.25%; Ni <0.06% to >0.06%)
		Traces only (<0.1%)
	D	Arsenic, Antimony, Silver & Nickel
	E	Arsenic, Antimony & Nickel
	F	Arsenic & Silver
	G	Nickel
MBA	M,N,O,P,R	Mainly Arsenic & Nickel combinations (As >0.1% to >1.05%; Ni<0.2% to >0.5%) some with traces of Co, Sb, Ag
LBA	MBA groups plus S & T	MBA types plus some high-Antimony and Silver types

Table 1 Condensed version of the artefact-based metal groups defined for the British Bronze Age by Northover (1980; 1991)

prehistoric workings (eg Alderley Edge)[32] rather than rich unrepresentative imported foreign malachite ores formed in completely different climatic zones and geological conditions.

Another challenge is that some existing ore analyses, particularly those in older publications,[33] are of limited archaeological use, because they are not representative of ores worked in prehistory, either by a lack of geological understanding or the lack of the ore type worked in prehistory. Often incorrect assumptions were made when sampling (eg sulphide ores mined rather than oxide ores) or unrepresentative samples taken (eg museum specimens or out-of-context mine tip material). Other issues are the use of less than ideal analytical procedures (single grains of an ore mineral rather than substantial samples of the full ore with associated minerals) and less than ideal analytical techniques (spot micro-analysis rather than using techniques allowing the use of portions of large crushed ore samples). Furthermore, there are often insufficient numbers of ore samples to establish the frequently wide natural variation of a particular ore deposit. A full understanding of the different mineralizing events of a deposit is critical to ensure the correct ore types are sampled. Ores are a world away from the relative homogeneity of metal artefacts, whose analysis can satisfactorily be based on milligrams of sample, or less in the case of micro-analysis. Filling this serious gap in our knowledge by using the correct sampling and analysis expertise could lead to a major step forward in linking ores to metal.

In Europe the picture is patchy, with some extensive local programmes of ore analyses,[34] but with very little information available in many countries. A starting point would be a Europe-wide listing and ore classification of mineral deposits. This could start with known prehistoric mining sites and then expand into areas of potential sites. The growing realization of extensive European trade or exchange of metal during the Bronze Age, including imports into Britain, means a better understanding of sources is essential to reveal exchange networks and the associated social implications.

The issue of recycling means a complication for the archaeometallurgical analysis of artefacts that needs to be considered closely. A recent major study looked at the issue in Britain and Ireland in the Early Bronze Age.[35] An important element in the study was using the Ross Island mine as a primary source 'end member' that was the dominant source for several centuries. This showed recycling, even at this early period, by monitoring the reduction in arsenic levels from remelting events. If Great Orme metal can be characterized as a major new 'end member' in the late EBA and MBA, it would be valuable in developing these recycling studies into later periods.

ii) Artefact-based metal groups and mine-based metal groups

To discuss the type of metal the Great Orme produced, it is necessary to understand the background to the British and Irish artefact-based metal groups that were defined at a time when no British Bronze Age mines had been discovered. There were various groups proposed, using artefact analyses based on the following impurities – arsenic, antimony, silver, nickel and cobalt. Coghlan and Case[36] defined three groups, but a much more detailed fourteen-group classification with a number sub-groups was defined by Northover,[37] covering the Early, Middle and Late Bronze Age (summarized in Table 1). He used these groups in an innovative paper discussing the long distance movement of bronze.[38] He has eight groups in the Early Bronze Age, which suggests many different sources, but one of the most important was Group 'A' metal, with an arsenic, antimony and silver signature. This has been convincingly linked to SW Ireland and in particular to the important Bronze Age mine at Ross Island.[39] There is a relatively small Group C for low-impurity metal (<0.1 per cent of any impurity).

[32] See Timberlake 2013
[33] Coghlan *et al* 1963; Tylecote 1986
[34] Pernicka 2014
[35] Bray 2010; Bray and Pollard 2012
[36] Coghlan and Case 1957; Coghlan *et al* 1963
[37] Northover 1980; 1982; 1991
[38] *idem* 1982
[39] O'Brien 2004

Northover noted that 'the dominant feature at the beginning of the Middle Bronze Age is the radical change in impurity patterns that takes place in a very short space of time, with little sign of continuity with the EBA metals'.[40] This major change was to mainly nickel and arsenic impurities (with little or no antimony) and these dominate Northover's MBA metal groups (see Table 1). Northover also noted that the source of the early nickel-arsenic MBA metal (Acton Park assemblage), sometimes containing lead, 'is unknown, but N. Wales or Shropshire are the strongest possibilities'.[41] He claimed that this source supplied Wales and much of lowland Britain, as well as being exported.[42] In the Late Bronze Age there is the sudden appearance of metals with high antimony, nickel and silver levels from an imported source.

Revisions to the Early Bronze Age groups have been suggested by Needham and Bray.[43] Metal prior to the Middle Bronze Age, which had arsenic and nickel impurities, is classed as 'Bell Beaker' metal. The source(s) are uncertain, but suggestions include Spain for the higher nickel variety (HNBB) and Wales or SW England for the lower nickel variety (LNBB). A completely new set of groups was proposed by Rohl and Needham, with twenty-three groups (IMP-LI 1 to 23) covering all the subgroups of the Copper and Bronze Ages which were subdivided based on a combination of metal-assemblage chronology, artefact chemical analyses and lead isotope analyses.[44]

The new methodology formulated for the Great Orme project is based on a radical alternative and parallel concept to artefact-based metal groups, namely the setting up of mine-based metal groups, as our knowledge of ores from a Bronze Age mine or group of mines increases. This requires detailed information for each mine on the prehistoric ores worked, their mineralogy, trace elements, lead isotope geochemistry and ideally the smelting technologies used. Some mines will have produced a range of metal compositions, and this is an important notion not generally appreciated. Mine-based groups can be used in parallel with artefact-based groups and help unravel the complexities of metal supply and exchange networks. In addition, this approach will help in the increasing interest in recycling issues in which identifying 'end-members' is extremely useful when considering mixing lines. The Great Orme mine offers an excellent opportunity to establish a mine-based metal group, given the access to extensive working for ore sampling. At Great Orme, the prills from the associated smelting site together with bronze metal fragments excavated in the mine give the opportunity to test whether the mine-based metal group (defined entirely on the ores) appears consistent with these metals, which in all probability contain copper produced from the mine's ores.

Using a Great Orme mine-based group in conjunction with British databases (OXSAM and OXALID) of chemical and isotopic analyses of Bronze Age metalwork, it should be possible to identify metal with which it is consistent. Overall, developing new interdisciplinary studies on Bronze Age mines rekindles the hope of successfully linking mines to metals, alongside recycling scenarios, and the wider understanding that this may bring to other areas of Bronze Age archaeology.

British and Irish Bronze Age mining

The spectacular discovery at the Great Orme has shown that we should never assume ancient mines are always destroyed by later workings. The work of the Early Mines Research Group and others in Britain over the last thirty years has revealed twelve dated Bronze Age mines or trials and another eight possible sites.[45] Estimates of the Great Orme mine's copper metal production need re-evaluating but currently lie between 25 and 1769 tons.[46] It is by far the largest Bronze Age copper mine discovered in Britain or Ireland.

By far the earliest activity was at the important Ross Island mine in Ireland (c 2400 BC). By around 2100 BC Copa Hill and other Mid-Wales sites were active, also Mynydd Parys in North Wales. Early in the following millennium, the active sites included Alderley Edge (*c* 1950 BC) and Ecton (*c* 1880 BC) in north-central England, as well as various mines in County Cork in Ireland (*c* 1800 BC). By about 1900 BC Ross Island had been abandoned, and then by about 1600 to 1500 BC the British mines, except Great Orme, where also abandoned, possibly due to flooding or exhaustion of workable ore.[47] Another possible reason may have been the discovery of the rich and easily worked copper deposit at Great Orme starting about 1800 to 1700 BC, probably peaking around 1600–1400 BC but continuing at least until the Late Bronze Age.[48] Other British Bronze Age mines may remain to be discovered, especially in the copper-rich mineralized region of SW England.

Previous Great Orme mine research

The main Great Orme Bronze Age mine complex was discovered in 1987, and there have been a number of major excavations and research projects. Dutton and Fasham[49] reported in detail on the extensive 'open-cast' excavations, and Lewis surveyed the maze of underground workings, setting clear criteria for the identification of early mining.[50] Subsequent work included small-scale excavations reported yearly,[51] research on the social and landscape-based context[52] and a major study on the tens of thousands of bones excavated.[53]

Influential Great Orme ore studies that were purely mineralogical were undertaken by Ixer and his co-workers, but

[40] Northover 1991, 65
[41] *ibid*
[42] *idem* 1982
[43] Needham 2002; Bray 2010
[44] Rohl and Needham 1998
[45] Timberlake 2009; Timberlake and Marshall, this volume
[46] Timberlake 2009
[47] Timberlake and Marshall 2013a; 2013b
[48] James 2011; O'Brien 2013; D Jenkins pers comm
[49] Dutton and Fasham 1994
[50] Lewis 1990; 1996; Jenkins and Lewis 1991
[51] eg David 2003
[52] Wager 2001
[53] James 2011

unfortunately without a programme of chemical analyses.[54] They concluded that the probable Bronze Age ore was composed mainly of chalcopyrite and malachite, sometimes with copper-bearing limonite, and that it was worked mainly from veins and to a lesser extent from vughs. They considered whether the ores contained significant levels of impurity elements (As, Ni, Ag, Sb, Co) 'often considered diagnostic in interpretations of the metalwork analytical data'.[55] They concluded that 'the mineralogy of the ores shows that they could only produce trace-element poor copper metal like most Bronze Age ores from the British Isles […] and that their usefulness in provenancing Bronze Age metal work based upon distinctive trace element signatures is very limited'.[56] This conclusion was strongly reflected in a number of other papers including Budd: 'the Great Orme ores contain no arsenic whatsoever',[57] Craddock: 'copper from the Great Orme cannot be identified in the contemporary bronzes […] the ore is characterized by very low nickel contents',[58] Northover: 'the problem with the Great Orme is that […] it is incompatible with the bulk of Middle Bronze Age metal',[59] and O'Brien: 'the copper produced was of high purity, making it difficult to follow its circulation'.[60]

This low-impurity conclusion was surprising, as most metalwork in the part of the British Middle Bronze Age (MBA), when the mine was probably at its peak, contained significant arsenic and nickel. Other scholars expressed the view that the mine was an important source of MBA metal (and some EBA metal), but were unable to resolve the conflicting complex mineralogical, geochemical, smelting, isotopic and artefactual analysis evidence.[61] The main objective of the current research project is to resolve these issues with a new methodology and an extensive sample analysis programme.

The Bronze Age smelting site at Pentrwyn near the mine was first excavated in 1998, and a few hundred grams of slag and copper metal prill particles were discovered.[62] Northover and Salter noted the unusual nature of the slags that were not fayalitic iron silicates but 'lime-ferrite'.[63] The presence of sulphides in the slags leads them to conclude that they were derived from the smelting of sulphide-rich ores. Based on Ixer and Budd[64] they could not directly link the impurities in the prills to the ores type found in the Bronze Age workings at Great Orme ('finding the origin of the arsenic is […] a problem') and thought that while a link was 'reasonable to presume […] the connection cannot be regarded as completely certain'.[65] They considered the small scale of the site might have been associated with assaying rather than full-scale production. Their micro-analysis (EMPA) of three copper prills (Table 2) found that two contained significant amounts of arsenic (0.52 and 0.62 per cent) and all three contained significant nickel (0.20 to 0.82 per cent), which had the best match to some Acton Park Middle Bronze Age metalwork but lacked the significant lead levels they commonly contained. In addition, their two lead isotope measurements on copper prills did not match this metalwork, but they thought this might be due to lead alloying. More details of Northover and Salter's conclusions are given in Williams.[66] The current study is based on copper prills and slags from the 2011 excavations combined with the data from the 1998 study.

Fragments of bronze wer found in the mine when miners broke into ancient workings in 1831 (possibly the tip of a mining pick) and in 1849.[67] These discoveries were associated with stone and bone tools and in one case a 'stag's horn'. One of the bronze fragments discovered in 1831 survives in the British Museum and has been analysed. More recently (1989 and 1992) numerous fragments of bronze have been excavated from a narrow underground vein location and are typically irregular and 5 to 15mm in diameter (Fig 4). While they were associated with stone tools, bone tools and charcoal, dated to 1412–1056 cal BC, a few iron particles suggest contamination in a later period from workings above. Further work on excavation context reports is required. There has been some debate as to whether the bronze fragments were broken off bronze mining picks / tools or were deliberately deposited in the mine.[68] However, drawing a comparison with bronze tips and fragments broken off the picks used in the Bronze Age salt mines of Hallstatt in Austria, there is a remarkable similarity.[69] For the Hallstatt specimens it is claimed that the high tin content makes the picks hard but brittle, and this is consistent with one of the Great Orme fragments containing an exceptionally high 14.9 per cent tin.

Over fifty bronze fragments were originally excavated, but only one was chemically analysed by the British Museum alongside the 1831 'tip' fragment.[70] Both fragments gave very similar impurity results with high nickel and arsenic levels and low antimony (Table 2). Northover stated that 'the bronze found in the Great Orme mine could not have come from that mine'.[71] Jenkins and Lewis also concluded, based on their three Great Orme ore analyses, that 'the bronze is unlikely to have been the simple product of local copper ores, and that the metal came from elsewhere'.[72] The iron content also led them to suggest it was from a slagged chalcopyrite ore rather than malachite. Both these conclusions are re-examined in the light of the current study.

Initial lead isotope studies by Joel and co-workers noted that the Great Orme copper ores and the bronze fragments

[54] Ixer and Davies 1996; Ixer and Budd 1998; Ixer 2001
[55] Ixer and Budd 1998, 34
[56] Ixer 2001, 218
[57] Budd 2000, 15
[58] Craddock 1994, 75
[59] Northover 1999, 223
[60] O'Brien 2015, 150
[61] Rohl and Needham 1998; Lynch *et al* 2000; Timberlake 2009; Bray 2012
[62] GAT 1999; Smith 2012
[63] Northover and Salter 1999
[64] Ixer and Budd 1998
[65] Northover and Salter 1999, 23
[66] Williams 2013, 95-6
[67] Lewis 1990, 7
[68] *idem* 1996, 132
[69] Kern *et al* 2009
[70] Lewis 1996, 131
[71] Northover 1999, 219
[72] Jenkins and Lewis 1991, 158

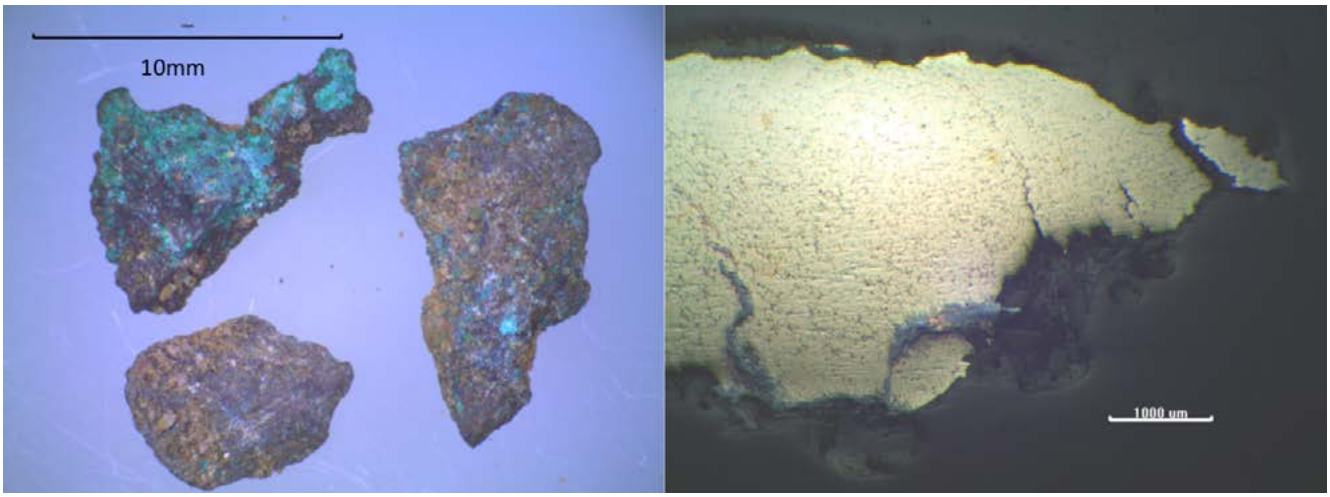


Fig 4 Corroded bronze fragments excavated underground in the mine; on the right, in polished section (scale bar is 1000 microns)

Pentrwyn copper prills – Samples from 2011 Excavation**														
Prill Ref No.	**Method**	**Cu***	**Fe**	**As**	**Ni**	**Sb**	**Ag**	**Pb**	**Zn**	**Co**	**S**	**Sn**	**Au**	**Bi**
		%	%	ppm	%	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm	ppm
P5	LA-ICP-MS	93,0	<0.06	500	0,13	19	10	106	<20	121	<0.2	<18	<0.02	<0.25
P10A	LA-ICP-MS	90,0	0,84	2291	<0.05	33	202	145	225	310	0,38	<18	<0.02	0,26
P10B	LA-ICP-MS	86,3	0,97	2848	0,09	32	244	68	268	204	0,47	<18	<0.02	<0.25
P12A	LA-ICP-MS	92,1	<0.06	817	<0.05	15	172	31	<20	8	<0.2%	<18	<0.02	<0.25
P12B	LA-ICP-MS	88,4	0,71	616	0,08	132	173	12417	346	345	0,29	<18	<0.02	0,98
P14B	LA-ICP-MS	88,1	1,10	1837	<0.05	27	114	63	107	90	<0.2	<18	<0.02	<0.25
P15	LA-ICP-MS	90,6	2,48	952	<0.05	18	211	74	843	238	2,99	<18	<0.02	0,26
P16D	LA-ICP-MS	91,2	1,38	1576	<0.05	18	144	16	157	80	<0.2%	<18	<0.02	<0.25
P16B	LA-ICP-MS	90,4	0,63	1266	0,07	14	109	49	94	197	<0.2	<18	<0.02	<0.25
P27	LA-ICP-MS	93,8	<0.06	1438	<0.05	23	135	27	<20	132	<0.2	<18	<0.02	<0.25
Pentrwyn copper prills – Samples from 1998 Excavation. Data from Northover and Salter (1999, in GAT report G1497 appendix II)														
Prill Ref No.	**Method**	**Cu**	**Fe**	**As**	**Ni**	**Sb**	**Ag**	**Pb**	**Zn**	**Co**	**S**	**Sn**	**Au**	**Bi**
		%	%	%	%	%	%	%	%	%	%	%	%	%
2222	EMPA (av. of 3)	96,95	2,83	0,62	0,29	0,00	0,03	0,08	0,00	0,09	0,02	0,00	0,00	0,00
2227	EMPA	98,24	2,44	0,00	0,82	0,01	0,16	0,02	0,04	0,17	0,08	0,01	0,02	0,00
2237	EMPA (av. of 13)	94,39	2,74	0,52	0,20	0,01	0,07	0,04	0,02	0,04	0,04	0,01	0,01	0,01
Bronze particles from underground in Great Orme mine – (from Lewis 1990, Rohl and Needham 1998) – Analysed by Craddock and Hook at British Museum)														
Sample Ref	**Method**	**Cu**	**Fe**	**As**	**Ni**	**Sb**	**Ag**	**Pb**	**Zn**	**Co**		**Sn**	**Au**	**Bi**
		%	%	%	%	%	%	%	%	%		%	%	%
1246 (Tip)	AAS	84,8	0,170	1,16	0,554	<0.04	0,051	0,509	0,004	0,051		14,9	<0.006	<0.019
1089(Loc. 21)	AAS	82,8	0,197	1,06	0,416	0,05	0,051	0,091	0,015	0,053		10,7	<0.003	0,017
Notes	* LA-ICP-MS uses the copper value from SEM-EDS analysis as the internal standard ** SEM-EDS indicates the balance of the analyses for the 2011 prills is mostly made up of oxygen													

Table 2 Pentrwyn copper prill analyses from the 1998 excavations using EPMA (Northover and Salter 1999) and the 2011 excavations (Williams 2013); AAS analyses of two bronze particles from the Great Orme mine (Lewis 1996; Rohl and Needham 1998)

gave similar results, but that the lead ore was very different.[73] Later came the pioneering lead isotope work of Rohl and Needham on British Bronze Age metalwork and ores.[74] They found the Great Orme ores to be very variable isotopically, due to being radiogenic, but showed some isotopical correlation with three of their twenty-three Bronze Age metal groups. However, important questions about the chemical composition of Great Orme ores and the ore type remained unresolved, as this was outside the scope of that study. A review of existing and new lead isotope data forms part of a later discussion section.

Materials in the analytical programme

i) Copper ores

Copper ore samples are at the heart of this study and will form the basis of establishing a mine-based metal group. The samples have been mainly been taken in situ from many parts of the Bronze Age 'opencast' and several kilometres of Bronze Age underground workings. Over one hundred samples (typically 20 to 500g, depending on the remaining mineralized areas) have been collected for initial examination, and from these about fifty typical samples were selected for analysis after simple visual hand-sorting to form an ore concentrate. Each sample was crushed and mixed to reduce variability. More detailed descriptions of the mineralization, ore types and other observations are given in later sections.

ii) Bronze fragments excavated in the mine

An important material to test for consistency with a mine ore-based metal group is to compare it with analyses of the bronze fragments found in the mine (Table 2). As there are only two existing chemical analyses and four lead isotope analyses, the remaining fragments (about 40) were eventually tracked down and new analyses are now planned.

iii) Copper metal from the Pentrwyn smelting site

Another important material to test for consistency with a mine ore-based metal group is the copper found as small round prills from the Pentrwyn copper-smelting site. Besides the data from the 1998 excavations, the current study examined the copper prills from the 2011 excavations.[75] Eighty-six grams of material were recovered, mostly around 1 to 10mm in diameter. Twenty-one samples were selected for detailed examination and analysis.

Analytical methods

The methods described below were used on the samples so far examined and analysed. Initial examination of all samples was done using a standard binocular microscope. Selected samples were mounted in resin and the surfaces were ground and polished. Reflected light microscopy (RLM) was used to examine microstructures and make preliminary phase identifications.

A mixture of macro and micro chemical analysis was used. For the ore samples, given their inhomogeneity, at least 5 grams of a hand picked ore concentrate (where sample size permits) were crushed and as large a sample as possible was used. For the archaeological materials (slags, prills and metal particles) mainly micro-analytical techniques were employed, given the sample scarcity and archaeological value.

The most suitable certified reference materials identified were a high-grade copper ore (VS R34) and a doped dolomitic limestone (GBW 07719) similar to the Great Orme host rock. Minor and trace elements were determined using atomic absorption spectroscopy (AAS) with a Perkin Elmer 3110 spectrometer in the Department of Archaeology, University of Liverpool. Various acid digestion combinations were tried on ore samples and standards, and the optimum found was to use 1 gram of ore dissolved in 60ml of aqua regia, reduced by evaporation to 20ml, filtered and then diluted to 40 per cent aqua regia for analysis. The AAS results show very good correlation with key trace elements in the certified standards (As and Ni within 0.6 per cent relative to the certified value). XRF methods (pXRF and XRF-WD) can be used directly on solid samples and avoid the dilution factor required when using solutions with AAS, which can be useful for low levels of certain trace elements. A bench-mounted pXRF instrument (Niton XL3t GOLDD+) was used with certified reference materials plus duplicate AAS samples, and they gave good results with several specific elements. A programme of external work with XRF-WD equipment is being planned to ensure the results obtained are reproduced with different analytical techniques. At an early stage in the project, three ore samples were analysed as a trial on a XRF-WD instrument (Phillips XL30) by PTM Ltd. In addition, XRD determinations were made on four ores and slags using a Panalytical MRD PW3040 with a copper anode and eight hour scans by PTM Ltd.

For the slags, prills and some ores, a scanning electron microscope with energy dispersive spectrographic analysis (SEM-EDS) in the Department of Archaeology, University of Liverpool, was used to examine microstructures with back scattering mode (BSE), and also for phase identification. Quantitative analyses on some of copper prills, slags and ore minerals were carried out. The SEM-EDS is a Jeol JSM-5300, with the ED spectrometer using a PGT Spirit system to obtain quantitative data. Calibration was on certified reference materials and mineral standards. All totals, before normalizing to allow for comparison, were between 98 and 102 per cent or known lower totals when analysing hydrated minerals (eg malachite). SEM-EDS is well known to have limitations at low concentrations due to high background noise levels, although levels down to 0.1 per cent are commonly quoted in the literature, albeit with reservations, but a limit of about 0.5 per cent is more realistic with many elements.[76]

For trace element analysis, other techniques were required. An electron microprobe (EPMA) was not available,

[73] Joel *et al* 1997

[74] Rohl and Needham 1998

[75] Smith 2012; Williams 2013

[76] eg Rehren *et al* 2012



Fig 5 Aerial view of the Great Orme Mine 'opencast' showing a number of irregular parallel north-south veins that continue under the mine spoil at the top of the image (photograph Roger Brown, Great Orme Mines Ltd)

and where enough sample weight was available, atomic absorption spectroscopy (AAS) was used as described earlier, as well as XRF-WD. For other samples, the relatively new method chosen was LA-ICP-MS, which consists of a laser ablation microscope connected to an inductively coupled plasma mass spectrometer at the School of Earth and Ocean Sciences at the University of Cardiff. The equipment consisted of a New Wave Research laser ablation microscope (model UP213) connected to a quadrapole ICP-MS (Thermo-Elemental X Series 2) using PlasmaLab software. A short 300–400 micron line scan with a laser wavelength of 213nm operating at 20Hz with a spot size of 55 microns moving at 6 microns per second was used. A helium atmosphere was used to flush the ablated material into the ICP-MS unit. Analysis was carried out on the ten Pentrwyn copper prills that were large enough (>400 microns) and seventeen ore minerals on uncoated polished sections. Reference materials used were copper alloys standards (C50.01 and C50.03) plus sulphides and silicates standards. The various analytical issues involved in the use of LA-ICP-MS in archaeometric research have been reviewed in the literature.[77] Fractionation and other effects occurring during laser ablation cannot be completely discounted, because this technique is relatively new in this application. Calibration has been one of the main discussion points with the technique. A very common strategy is to take as the internal reference sample a major element measured by SEM-ED analysis on the same sample, and in this study, copper or iron was used, depending on the material. A direct comparison of the results obtained from LA-ICP-MS and SEM-ED on the samples in this study is published elsewhere.[78]

To provide new and more accurate lead isotope data, three Pentrwyn copper prills from the 2011 excavation and three ore samples were analysed by the NERC Isotope Geosciences Laboratory at Keyworth. About 10mg of copper prill and about 50mg from the more abundant ore samples were ground with a mortar and pestle and then dissolved up in 16M HNO3 with some added HF at 100°C and left overnight. The lead was then extracted by ion exchange chromatography using resins and then a series of steps that produced a dry sample. Prior to analysis, the lead fraction was brought into solution using 1ml 2-per-cent Teflon-distilled HNO3, and thallium was used as a fractionation monitor. The analyses were carried out on a Thermo Fisher Neptune Plus MC-ICP-MS. The reported propagated analytical errors for the various sample ratios ranged between 0.003 and 0.012 per cent at the 2SE (standard error) level.

[77] Resano *et al* 2012; Neff 2012

[78] Williams 2013

Mineralization at the Great Orme mine

The Great Orme is an isolated outcrop of the Lower Carboniferous Limestone that is deformed into a gentle faulted syncline. It consists of grey massive and rubbly limestones, with some dolomitization, interbedded with mudstones and sandstones.[79] Epigenetic primary and secondary copper mineralization occurs mainly along and above the Pyllau valley and is associated with dolomitized limestones in a series of at least ten roughly north-south veins in faults (Fig 5) with steep westerly dips but showing little or no displacement.[80] In reality, the mineralized areas are much more complex than simple veins, with numerous interconnecting offshoots from the main veins and local 'flats' of mineralized ground under less permeable strata. In the centre of the mineralized area the veins and their offshoots appear to have convalesced into a 'stockwork' of mineralized ground in favourable lithologies, based on the large mined-out chambers underground and parts of the 'opencast'.

The primary copper mineralization is composed of chalcopyrite (a copper-iron-sulphide) deposited in numerous parallel veins, sometimes interlinked by an anastomosing complex of veinlets. This sulphide mineralization has been subject to 'intense, widespread, polyphase supergene alteration' to secondary minerals (Fig 6), principally green malachite, brown-black copper-bearing limonite and other minor minerals.[81] Note that there is no specific mineral called 'limonite', which it is a generic term for various hydrated iron oxides.[82] In this study, the only crystalline iron oxide detected in XRD analysis of ore samples was goethite, which confirms a previous study.[83] Recent XRD results suggested the presence of amorphous material that may also be some form of iron oxide.

A paragenesis diagram has been constructed to show the complex sequence of deposition of each mineral deduced by Ixer and Davies.[84] They considered the copper mineralization to be possibly late Mesozoic to early Tertiary in age (100–50Ma) and post-dating the associated lead vein which they considered to be no earlier than early to middle Trias (around 240Ma). The minor lead mineralization belonged to the Mississippi Valley-style mineralization and is situated on the margin of the north-east Wales lead-zinc-silver ore field. Ixer claimed that the later major copper mineralization belonged to the copper-dolomite association 'a minor but worldwide class of mineralization found in close proximity to some massive lead-zinc deposits'.[85]

Various definitions of ore for use with prehistoric mining and smelting sites have been attempted.[86] The modern definition of an ore is 'a naturally occurring solid material containing a precious or useful metal in such quantity and in such chemical combination as to make its extraction profitable'.[87] Substituting the word 'possible' for 'profitable' allows the definition to cover the prehistoric technologies available in a particular region, eg copper sulphide minerals would only be ores if the technology to smelt then was available. This change combined with very broad definitions of 'precious' and 'useful' gives a good working definition in a prehistoric context.

Ixer and Davies reviewed in detail all the types of mineralization present at the Great Orme and the structural and lithological controls.[88] They claimed the main Bronze Age ore was from copper veins consisting of chalcopyrite, malachite and copper-containing limonite (goethite). In addition, they believed the vugh infillings observed, with a similar mineral assemblage, were a significant ore. They considered that the blue azurite nodules, with traces of malachite, in sporadic mudstones and also a complex friable black material (mainly amorphous iron-copper-bearing oxide material) could have been 'by-product' ores. Both the disseminated polymetallic sulphides only found on surface mine tips from deeper nineteenth-century workings and the lead sulphide (galena) veins were rejected as being possible Bronze Age ores. In the nineteenth century chalcopyrite ore was mined from deep levels mainly below the Bronze Age workings, and some lead ore was also produced.[89]

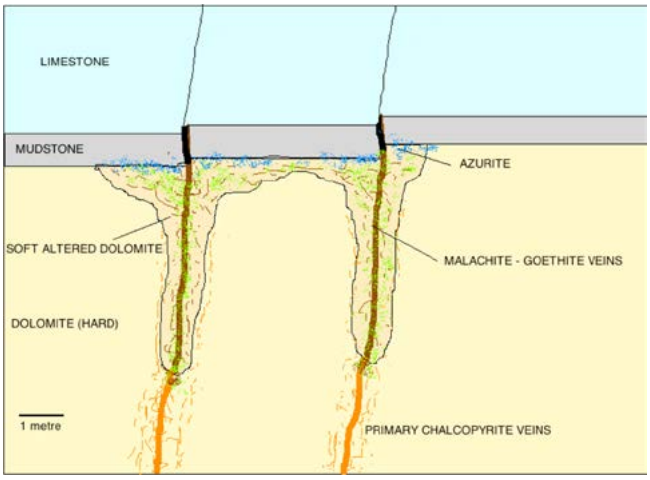


Fig 6 Schematic of Great Orme mineralization (adapted from Lewis 1996, fig 22)

A key feature of the hard malachite-goethite ore making up the central vein material is that it was easy to extract with bone tools because the dolomite on each side was soft and friable or 'rotted'.[90] Ixer attributed the phenomenon to the supergene weathering causing local dedolomitization and partial dissolution of the dolomite host rock locally adjacent to the vein.[91] This made an enormous difference to the ease of working and explains why fire-setting was often not required.

[79] Jenkins and Lewis 1991
[80] Lewis 1996
[81] Ixer 2001
[82] Taylor 2011
[83] Lewis 1996
[84] Ixer and Davies 1996
[85] Ixer 2001, 215
[86] Ixer 2001; Killick 2014
[87] OED 2014
[88] Ixer and Davies 1996
[89] Williams 1995
[90] Lewis 1996
[91] Ixer 2001

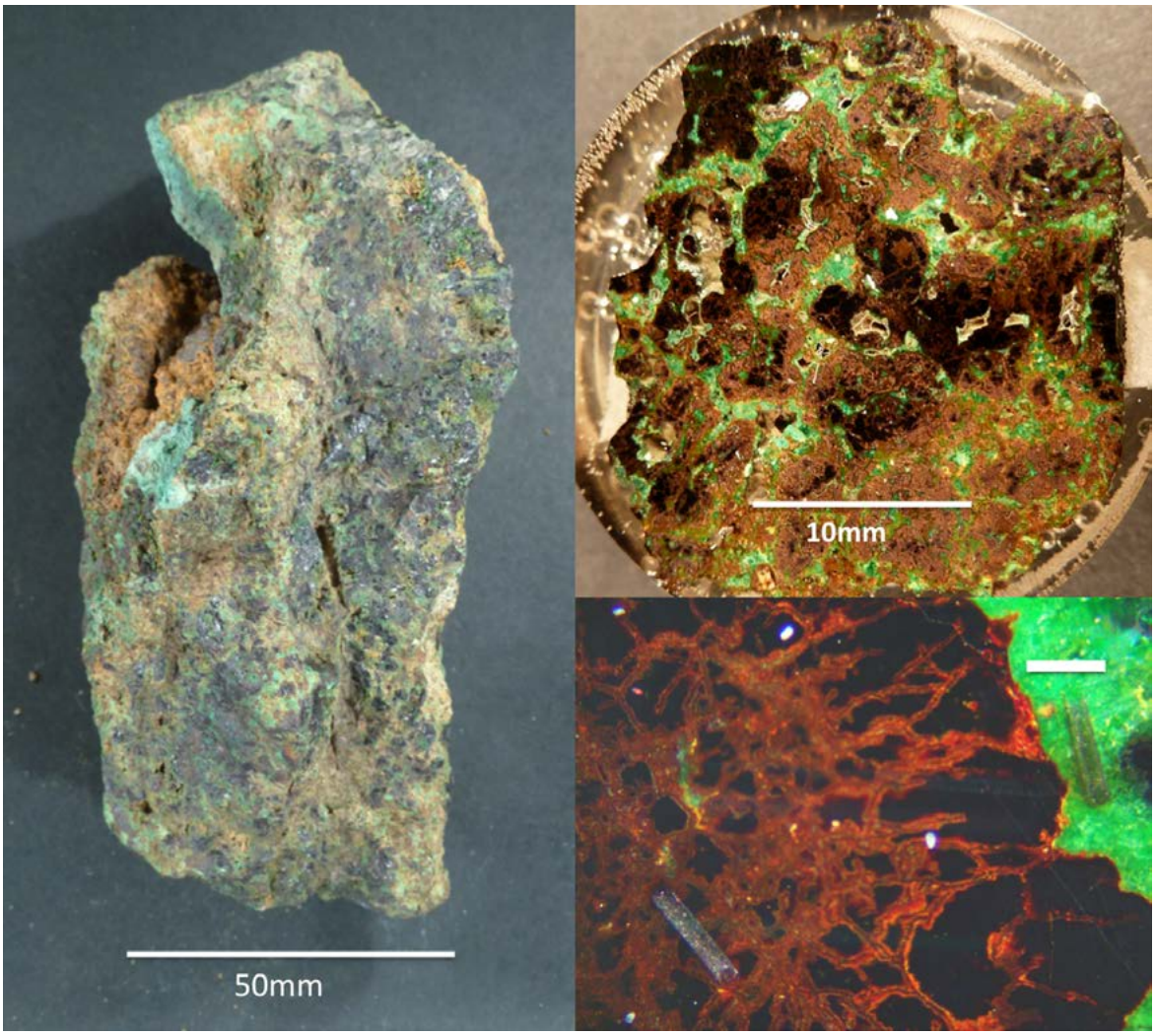


Fig 7 Malachite-goethite ore; on left is a hand specimen, at the top right is a polished section showing the intimate mixture of brown goethite and green malachite, at the bottom right is a reflected light image showing the laser ablation analysis 'trenches' in malachite and goethite (scale bar is 200 microns)

Ore sampling observations and comments

The potentially wide natural variation in ore trace elements makes sampling from as many parts of the mine as possible very important. A key question is whether what has been left in situ is actually the same material that was being worked. One striking observation was that wherever the ores were sampled in the large maze of Bronze Age tunnels, whether following major or minor veins that narrowed and split into numerous veinlets, the dominant ore type was always the black-green ore described below. This strongly suggests that the remaining mineralization consists of small-scale versions of the original larger veins. It also suggests that due to the great richness of the deposit some of the smaller veinlets were left behind. On the rare occasion when a large vein was uncovered during excavation in the 'open-cast', the samples obtained support this view.

The dominant black-green ore is an intergrowth of goethite (plus any amorphous iron oxides) and malachite with dolomite and frequently with calcite. This rich secondary ore (around 18 to 35 per cent Cu after hand-sorting) can range from being massive (Fig 7) in the main veins to almost lumpy or nodular in some veinlets, but with the same mineralogy.

The surviving evidence suggests the appearance of the virgin vein outcrops at Great Orme mine would not have been as pure green malachite veins but as black-green veins, with perhaps occasional local green veinlets of malachite re-deposited away from the primary veins. The malachite-goethite ore appearance may be reflected in the old name for the nineteenth-century Vivian's shaft in the centre of the old workings, which is 'Copper Ddu', 'ddu' being Welsh for black. Ixer attributed the name to a minor black mineralized material, mainly amorphous, which seems less plausible.[92] The malachite-goethite ore was formed by the supergene weathering of the primary copper-iron sulphide ore (chalcopyrite). The acidic weathering removes the sulphur from the system in solution as sulphates and converts the iron to hydrated oxides. The goethite often mimics the well-formed

[92] Ixer 2001

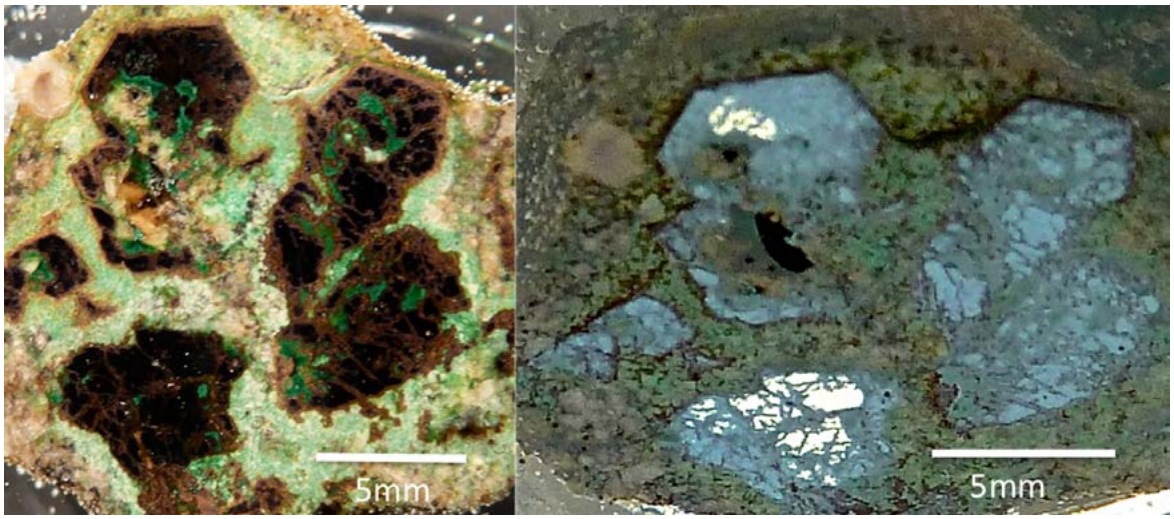


Fig 8 Polished section of another goethite-malachite ore showing the goethite mimicking (pseudomorphing), the shapes of the original chalcopyrite crystals (left) and the same image on the right in reflected light showing residual traces of the original chalcopyrite (yellow-white)

crystal shapes of the chalcopyrite (termed pseudomorphs, see Fig 8) and so was fixed at the dissolution site and is termed 'indigenous' goethite.[93] The copper from the sulphide goes into solution and then precipitates out mainly as green malachite (hydrated copper carbonate). Other minor secondary copper minerals (eg azurite) and gangue minerals (dolomite, calcite, minor pyrite, manganese oxides) are sometimes visible in hand specimens.

In classic supergene weathering systems the copper is moved downwards in acid solutions and enriches the copper in sulphides at a lower depth.[94] However, in the Great Orme case most copper appears to have been swiftly re-deposited as malachite around the altered goethite, which may relate to the higher alkaline pH in and around the carbonate veins precipitating the copper before major movement in solution occurs.[95]

Locally, there is evidence of some copper being transported in solution away from the location of the primary veins and then being redeposited within dolomite as a malachite-rich ore without any goethite (Fig 9) and should be considered a separate ore type. Extensive fieldwork underground and in the opencast strongly suggests that this ore type was uncommon compared to the malachite-goethite ore. The second example of movement of copper away from the primary veins is associated with mudstone horizons as azurite nodules (stable at lower pH), sometimes with flakes of malachite. They are very low-grade ores in the surviving outcrops, although very slow hand picking of azurite nodules is possible. For completeness, mention should be made of the surviving vugh (cavities in the rock filled with crystals) mineralization, generally in the hard wallrocks, which are mostly (but not always) low grade, often with the fine particles of green malachite in the calcite giving a very misleading impression of richness.

As will be seen in the smelting section below, the question as to whether sulphide ores or oxide ores were smelted is an important topic, given the complexities of sulphide (chalcopyrite) smelting. The sampling programme has found that most ores in the worked areas show complete or nearly complete conversion to malachite and goethite, especially in the most porous parts of the vein where there is likely to have been maximum interaction with water. As most of the large worked-out veins were probably porous with the soft dolomite, fully converted ore would probably have been the most common type originally present. However, residual traces of the original chalcopyrite can be found in some of the oxide ores (see Fig 8 left). In the harder, less porous parts of the vein, particularly in the remaining vein wallrocks even at surface, the conversion to goethite and malachite is often less complete and so there is much more residual chalcopyrite present (see Fig 8 right). Perhaps the remaining material was intentionally left because of its high sulphide content as well as being a much harder rock to mine.

Initial results

i) Copper ore: chemical analyses

This interim paper gives the results from twenty-eight hand-sorted crushed ore samples using atomic absorption spectroscopy (AAS). Three other bulk ore samples analysed by XRF-WD are also reported. In addition, the results from a set of laser ablation analyses (LA-ICP-MS) on phases in nine ores are presented that give an understanding of trace-element content of individual minerals of which bulk ore samples are mixtures.

Table 3 gives the minor and trace element results for twenty-eight ore samples (23 malachite-goethite ores and five malachite-only or azurite ores). The main observations are:

[93] Taylor 2011

[94] See Robb 2005, fig 4.13

[95] Taylor 2011

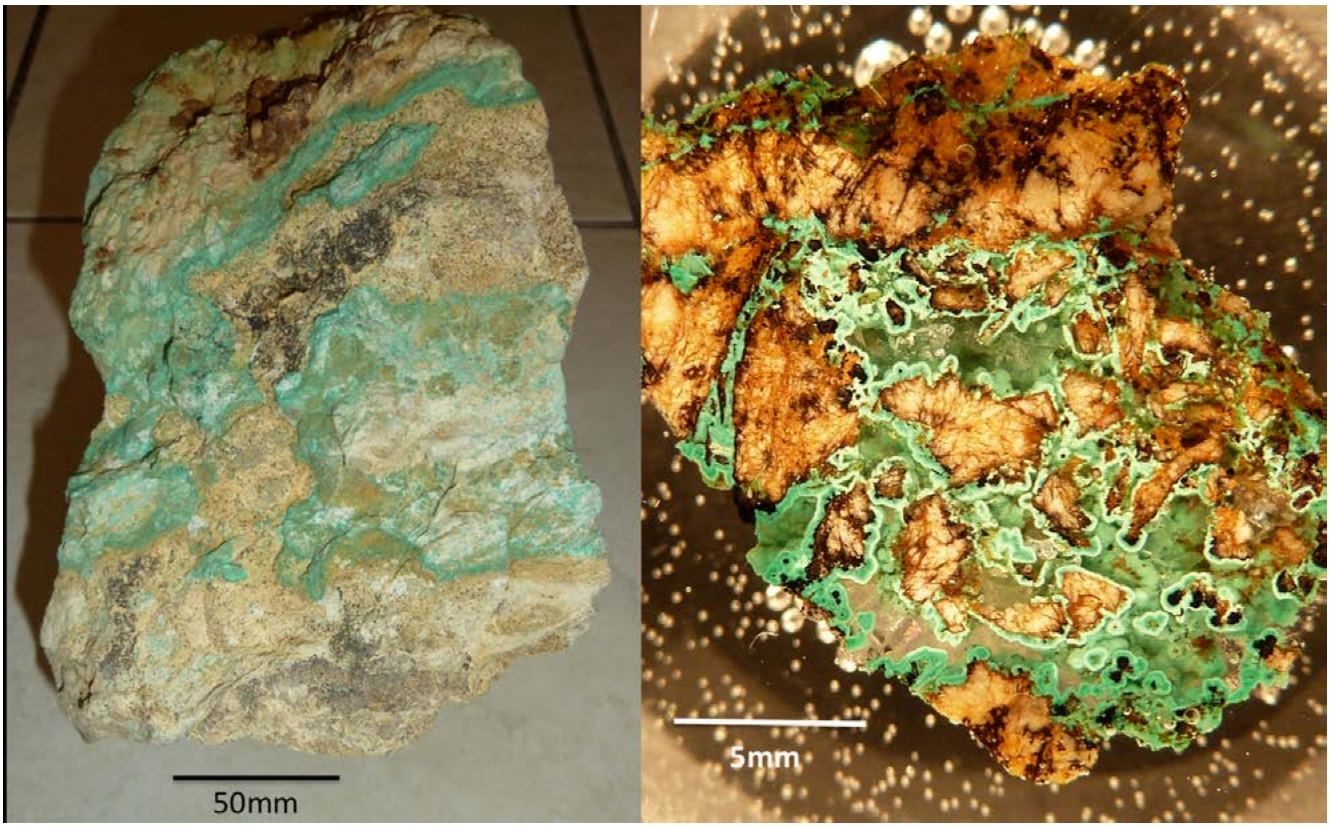


Fig 9 Malachite-rich ore; irregular veinlets within dolomite redeposited away from the site of primary mineralization; on the left is a large hand specimen and on the right is a polished section showing botryoidal malachite

- The copper content of the main malachite-goethite ores varies from 13 to 38 per cent. The malachite-only and azurite ores were at the lower end of this range, as they were generally impure (except for one sample which was a thin veinlet of nearly pure malachite).
- The malachite-goethite ores contain significant but variable amounts of arsenic (up to 0.52 per cent) and nickel (up to 0.28 per cent) with all these figures being before normalization to 100 per cent copper. The lower grade ores with only malachite had markedly lower levels of arsenic and nickel.

In other ore studies in the literature, trace element data from ores, which have variable copper contents, are usually normalized to 100 per cent copper in order to indicate the maximum possible impurity levels in the smelted copper metal.[96] When smelting oxide ores under reducing conditions, arsenic retention can reach almost 100 per cent.[97] The trace element split between copper metal and slag, when smelting oxide ores, has been explored in detail by Hauptmann.[98] He calculated a range of partitioning coefficients for each element. Arsenic and nickel showed a very strong tendency to concentrate in the copper metal, while zinc and cobalt concentrated more in the slag, with lead being in-between. These coefficients may be affected by smelting redox conditions, and Pollard and co-workers showed that smelting temperature was important, but only at relatively low temperatures.[99] To explore further the trace-element split between metal and slag, a smelting experiment with typical Great Orme ore is planned.

Antimony levels are extremely low. Silver levels are relatively low, while cobalt and zinc are very variable (see discussion below).

Lead levels are highly variable. A probable explanation is that there are low lead levels in the copper mineralization but lead enrichment where the copper veins are close to the earlier lead veins. This obviously has lead-isotopic implications.[100]

Direct smelting of only oxide ores avoids the oxidizing ore roasting stage required for sulphide ores, which can cause loss of volatile elements like arsenic. Hence, in oxide ores a lower level of arsenic (and antimony when present) may be required, relative to a sulphide ore, to give the same level in the copper metal.

Some of the malachite-only type ores generally have much lower levels of nearly all the trace-elements levels and so could produce a much higher-purity metal if smelted separately.

Table 4 shows the XRF-WD analyses of three Great Orme malachite-goethite ore samples, and allowing for the results

[96] Pernicka 2004
[97] Tylecote *et al* 1977; Hauptmann 2007
[98] Hauptmann 2007, fig 6.37
[99] Pollard *et al* 1991
[100] See below and Ixer 1997

Ore	Cu	Fe	As	Ni	Sb*	Ag	Pb	Zn	Co
Sample	%	%	ppm	ppm	ppm	ppm	ppm	ppm	ppm
Major Malachite-Goethite ores (veins in dolomite)									
GO 13	22,9	17,8	4005	546	80	262	724	70	104
GO 15	29,5	20,7	5219	1413	180	287	105	86	470
GO 16	31,1	16,7	3307	1821	90	314	510	259	1168
GO 20	20,5	13,5	2194	1034	70	44	453	260	403
GO 34	17,2	17,5	3053	1037	50	47	192	75	708
GO 40	17,8	15,3	2506	1173	50	230	719	201	602
GO 42	22,2	17,2	4293	2340	<40	97	141	32	692
GO 60	21,5	15,3	3602	1558	60	9	588	176	683
GO 64	36,3	7,0	1511	1529	<40	61	293	115	374
GO 65	23,9	19,3	3179	500	100	147	692	110	262
GO 72	38,6	14,2	2260	1141	<40	156	131	50	140
OC 3	31,6	23,3	3453	497	210	364	1058	86	69
OC 12	21,3	20,1	1918	341	<40	390	1256	1269	151
OC 16	28,3	18,4	1601	773	<40	248	648	268	192
OC 22	37,5	10,7	1771	583	<40	30	90	364	1024
OC 31	24,9	16,8	3597	1635	140	55	665	25	608
OC 39	27,7	17,5	1120	1258	50	75	315	23	86
OC 51	27,3	20,0	3499	464	120	129	635	493	40
EOC 2	29,2	24,2	1381	2501	120	81	17741	36	1044
EOC 3	29,4	19,0	2131	2691	170	135	4723	45	1334
GO 50b	23.7*	26.8*	5179	873	<40	268	394	1004	412
GO 68b	13,4	16.4*	3550	546	<40	136	600	260	303
GO 73d	16,7	23.6*	3983	2806	42	136	334	752	694
Minor Malachite-only ores (in mudstone, limestone and dolomite)									
GO 26	18,5	4,3	311	294	<40	16	52	11	52
GO 55	16,8	1,0	334	226	<40	16	37	12	133
GO 62	20,9	1,3	640	354	<40	17	50	46	89
GO 71b	52,6	7,3	365	169	<40	8	23	19	104
Minor Azurite pisoliths in mudstone									
GO 61	16,7	3,4	1013	281	<40	24	134	114	88

Table 3 Minor and trace-element macro-analyses of Great Orme ores using AAS except where indicated; all samples analysed by AAS except antimony and *values, which were by pXRF; certified reference samples used were VS R34 (high-grade copper ore) and GBW 07719 (doped dolomitic limestone)

Wt%	Ore G33	Ore G15	Ore G30
CuO	25.3	28.8	27.6
Fe_2O_3	19	22.9	20.4
As_2O_3	1.0	0.8	0.2
NiO	0.5	0.2	0.1
Sb_2O_3	<0.05	<0.05	<0.05
Ag_2O	<0.05	<0.05	<0.05
Co_3O_4	0.3	<0.05	0.1
CaO	10.7	6.9	9.7
MgO	4.9	3.6	4.9
SiO_2	5.6	3.8	3.6
Al_2O_3	0.7	1.2	0.7
TiO_2	<0.05	0.1	<0.05
P_2O_5	0.1	<0.05	0.1
K_2O	0.1	0.1	0.1
Pb_0	<0.05	<0.05	0.1
ZnO	<0.05	<0.05	<0.05
MoO_3	0.1	<0.05	<0.05
Mn_3O_4	0.3	0.2	0.2
SO_3	0.1	1.1	0.5
LoI 1200 °C	31.4	30.1	31.8
Total	100.1	99.8	100.1

Table 4 XRF-WD analyses of three bulk malachite-goethite ores; semi-quantitative (±15 per cent); courtesy of PTM Ltd

being quoted in the standard oxide form, the general levels of minor / trace elements are similar to the range of AAS ore results. The other elements present are consistent with a gangue of dolomite, calcite, minor silica and traces of sulphide.

Table 5 gives the results from the LA-ICP-MS analyses of various minerals in the malachite-goethite ores and also in a sample of malachite-only ore and azurite ore. The results show a similar overall picture to the AAS results, but also reveal important data on the distribution and variation of trace elements within the individual ore minerals.

The seven malachite ores analysed contained variable trace element levels with arsenic from 0.013 to 1.1 per cent and nickel from <0.05 up to 0.8 per cent. There were consistently low levels of antimony, silver and lead (except the sample taken near to the lead vein). Other trace elements cited by Pernicka of potential provenancing interest were all below detection limits (bismuth, gold, tin, tellurium and selenium).[101] The malachite-only ore sample (OC18) and the azurite sample were mostly at the lower end of trace element ranges.

The goethite (and probably amorphous equivalents) gave the most surprising results, often containing high levels of copper, other metallic elements and silica, but with iron levels below those in the pure mineral. Copper levels ranged from 1.5 to 7.7 per cent, almost an ore in itself. Some of this could be due to microscopic inclusions of other minerals, although none where observed microscopically. The other explanation relates to the remarkable structural properties of goethite.[102] Chang and co-workers reported that goethite can simultaneously accommodate 2 to 4 per cent of nickel, cobalt and manganese and that 'natural goethite may act as a sink for trace amounts of a large number of metal ions'.[103] In the Great Orme ores, the goethite had arsenic levels that ranged from 0.4 to 6.6 per cent and nickel levels from below the detection level to 0.6 per cent. Release of those trace elements during smelting could increase the level of these elements in the copper metal over and above the levels in the malachite mineral alone.

Other significant trace elements present in goethite, in very variable amounts, include lead, silver, antimony, zinc, cobalt and, interestingly, uranium (see isotopic section). It appears that the goethite could be scavenging and concentrating many trace elements from the solutions associated with the supergene weathering of the mineralized areas.

[101] Pernicka 2014

[102] Manceau *et al* 2008

[103] Chang *et al* 1998, 585

Ref No.	Mineral	Cu*	Fe*	As	Ni	Sb	Ag	Pb	Zn	Co	U	Mn	Mg	P	S	Ca	Si	Al
		%	%	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	%	%	%	%
GO 33	*Malachite*	55,75	5,02	10801	0,75	18	<3	22	349	2259	105	248	898	307	0,22	<0.05	0,14	0,02
GO 15	*Malachite*	56,12	4,25	4638	0,14	18	<3	<8	420	731	125	1006	29119	870	<0.2	4,01	<0.03	0,05
GO 35	*Malachite*	47,53	0,86	640	0,14	6	<3	12	301	331	15	223	2887	582	0,20	<0.05	2,05	1,21
OC 37	*Malachite*	56,93	0,07	560	<0.05	<5	<3	13	65	466	37	148	189	253	0,38	<0.05	0,05	<0.01
GO 30	*Malachite*	55,26	1,09	446	0,48	4	<3	39	70	2464	15	28	951	333	<0.2	<0.05	0,25	0,14
OC E1	*Malachite*	53,70	1,63	130	0,17	9	<3	1220	436	214	4	177	1473	203	<0.2	<0.05	0,04	<0.01
OC 18	*Malachite*	56,74	<0.06	304	<0.05	<5	<3	<8	1919	105	12	388	1479	<50	<0.2	<0.05	<0.03	0,02
OC 4	*Azurite*	43,01	0,91	477	<0.05	<5	<3	19	369	36	8	32	4679	1115	0,45	0,13	9,18	6,55
OC 4	*Chalcopyrite*	33,57	25,98	324	<0.05	37	132	79	45	19	<0.04	<5	<85	<50	31,67	<0.05	<0.03	<0.01
GO 15	*Chalcopyrite*	35,43	27,13	93	<0.05	44	8	<8	22	<4	<0.04	<5	<85	835	31,92	<0.05	0,05	<0.01
GO 5	*Chalcopyrite*	36,98	29,57	<15	<0.05	<5	<3	<8	27	<4	<0.04	<5	<85	814	34,45	<0.05	0,10	<0.01
GO 33	*Goethite*	5,00	44,87	66422	0,05	29	52	1127	1841	101	117	195	1246	4730	0,22	1,00	3,19	<0.01
OC 37	*Goethite*	3,43	57,78	19820	0,58	77	5	162	1184	1775	138	86	298	1130	0,19	0,26	2,28	0,05
GO 35	*Goethite*	7,23	43,61	12377	0,05	271	504	2712	1078	17	110	1841	702	2939	<0.2	0,13	0,98	0,06
GO 30	*Goethite*	1,45	46,24	7666	<0.05	157	1979	2542	349	<4	95	<5	1575	933	0,20	1,06	4,79	<0.01
OC E1	*Goethite*	7,66	42,30	3857	0,18	249	10	19694	565	615	196	16	685	806	0,74	0,69	3,31	<0.01
OC 50	*Galena*	0,18	<0.06	<15	<0.05	1277	724	838600	80	<4	<0.04	<5	<85	847	16,04	<0.05	0,07	<0.02

Table 5 Minor and trace-element microanalyses of individual Great Orme ore minerals from nine ore samples using LA-ICP-MS and also SEM-EDS measurements as the internal standard for major elements copper or iron

Comparing the micro-sample results in Table 5 with macro-sample results in Table 3 suggests that often an important proportion (sometimes a major part) of the trace elements in the bulk malachite-goethite ores is coming from the goethite rather than the malachite alone, hence the need to analyse the full ore and not just the malachite portion.

The chalcopyrites, by contrast, generally had low levels of arsenic (<15ppm to 357ppm) and nickel (all below detection limit) and low levels of other trace elements (Co, Zn, Pb, Bi, Au, Sn). The relatively low levels of arsenic and nickel in the primary chalcopyrites raise the question as to where these elements that are in the malachite and goethite originated. One mechanism would be a concentrating effect whereby, for example, the arsenic in the weathering chalcopyrite is locally concentrated in the goethite 'sponge'. Another mechanism would be that the weathering fluids are extracting nickel and arsenic from other types of primary mineralization within the deposit not now accessible. Ixer noted the presence on the nineteenth-century tips of a disseminated polymetallic sulphide ore which included minor amounts of various nickel, cobalt and arsenic sulphides including siegenite $(NiCo)_3S_4$.[104] The secondary purplish mineral erythrite ($Co_3(AsO_4)_2.8H2O$) has also been found underground, indicating the presence of cobalt and arsenic.

The galena from the lead vein contains significant levels of antimony (1277ppm) and silver (724ppm) and via weathering could be the source of these elements that are found absorbed in the goethite (although overall antimony levels remain very low). Arsenic levels were very low (<15ppm).

One important conclusion from the LA-ICP-MS results is that if you just look at grains of individual copper ore minerals (eg malachite or chalcopyrite), as has been done in some previous studies,[105] there is a potential to get some misleadingly low trace-element results if the goethite is excluded.

Overall, the geochemical results suggest that the Great Orme ores would typically produce copper with significant levels of arsenic and nickel instead of producing only the low-impurity metal that was claimed in the past. Antimony levels are low in all copper ore samples. This metal corresponds to several of the Middle Bronze Age arsenic-nickel metal groups defined by Northover (see Table 1) and also several of Rohl and Needham's groups.[106] In addition, it is a possible source of some low to medium-impurity EBA metal with low or undetected antimony. The geochemical boundaries of the proposed mine-based metal group are discussed below.

ii) Copper ore: lead isotope analyses

Previous studies have produced twenty lead isotope results on ores.[107] In the current study, three new measurements have been made so far and published[108] plus another eleven analyses that are planned. The existing data are reviewed in the discussion section.

iii) Bronze fragments excavated in the mine

The two previous chemical analyses are shown in Table 2 and analyses of other fragments are planned. There have been four lead isotope analyses and another four measurements will be done. The existing data are reviewed in the discussion section.

[104] Ixer 2001

[105] eg Jenkins and Timberlake 1997, appendix 5

[106] See Rohl and Needham 1998

[107] Joel *et al* 1997; Rohl and Needham 1998

[108] Williams 2013

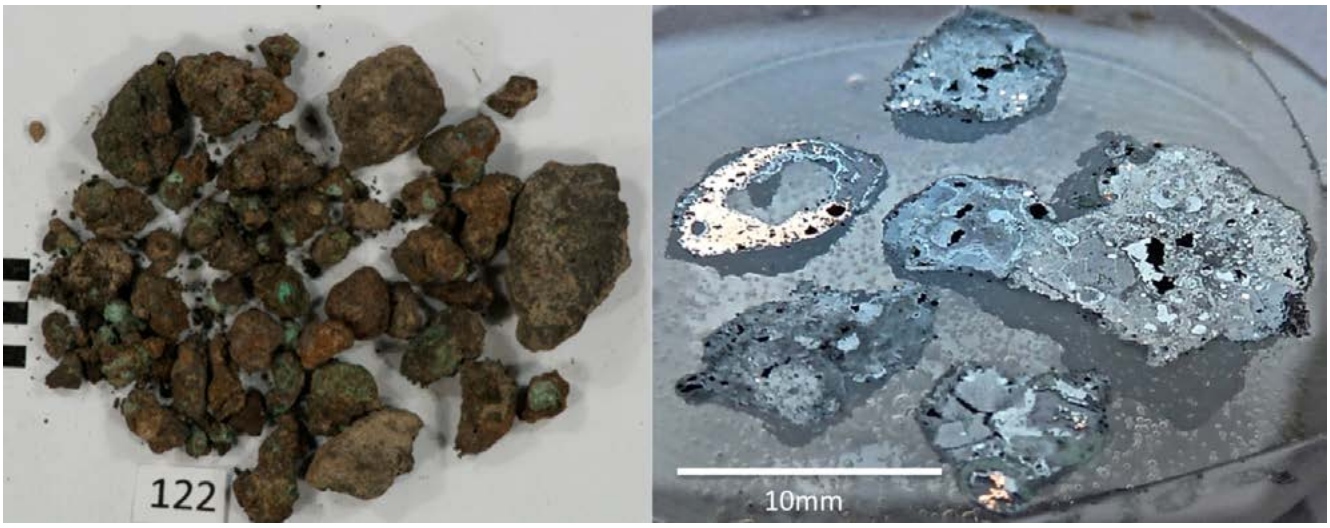


Fig 10 Pentrwyn slag and prills viewed in hand specimen (left – scale 2mm divisions) and in a polished section in reflected light (right)

iv) Copper metal from Pentrwyn smelting site

Chemical analysis of copper metal prills from the 2011 excavations (Table 2) using LA-ICP-MS (Figs 10 and 11) has shown arsenic levels up to 0.28 per cent and nickel levels from <0.06 to 0.13 per cent, although SEM-EDS analysis suggested nickel levels in other prills up to 1.4 per cent. A couple of the remaining larger prills will be analysed by AAS. These results are slightly lower than those found by Northover and Salter in the copper prills from the 1998 excavation, in which arsenic levels reached 0.62 per cent and nickel up to 0.82 per cent. In addition, the latest study found more variable iron levels (<0.03 to 3 per cent) with the very low iron prills, often lacking the gas cavities present in the other prills, suggesting they are either refined copper or reflect variable smelting conditions. All these results serve to demonstrate the likely variation in Great Orme metal composition.

A parallel study to the main research project has looked at the smelting slags and copper prills in detail, to understand the nature of the smelting activities, and the results have been published in a separate paper.[109] The conclusions from this work are worth summarizing, as they impact on the discussion about the level of trace elements in the ores required to produce copper metal with a certain level of impurities. If mainly sulphide copper ores are used, they have to be roasted under oxidizing conditions to remove sulphur and produce copper oxides before smelting under reducing conditions to produce copper metal. The process results in the loss of some volatile elements, particularly arsenic. Conversely, if mainly oxide copper ores are used, then the roasting step is not required and so they can be directly smelted under reducing conditions, during which up to 100 per cent of arsenic can be retained.[110] Hence, in oxide ores a lower starting level of arsenic is required than in sulphide ores to give the same arsenic level in the copper metal. Hence, knowing the ore type is important when considering impurity levels.

Examination of the slag particles and copper prills from the 2011 excavations that had survived weathering reveals original microstructures and mineralogy (see Figs 10 and 11). They are composed of magnetite (plus minor wüstite), copper prills and a small amount of glassy phase with weathering to cuprite and atacamite. These phases and the residual slag textures are consistent with the smelting of the Great Orme secondary malachite-goethite ores (rather than sulphide ores) with only occasional traces of sulphides. The latter would account for the sulphides observed, mostly in the 1998 material, and were probably discarded in the slag. The goethite would have converted to magnetite or wüstite, depending on the redox conditions, with the presence of both suggesting variable conditions. The malachite via cuprite would have formed copper metal prills. Only a small amount of glassy phase was formed, with the smelt never becoming fully liquid, but probably enough to allow some aggregation of the copper prills. There is no evidence for any fluxing additives (eg silica), and because the ores are remarkably low in silica they would only produce low levels of glassy phase. The heterogeneous slag mineralogy suggests the smelt was never fully liquid. Use of this simple process requires the crushing of the smelt to extract the copper prills, and so must have been followed by a re-melting refining stage to reduce iron levels. Only small amounts of smelting residue or slag were produced in this non-tap slagging process. Smelting of the oxide ore probably took place in simple 'hole in the ground' furnaces that would leave little trace and probably had variable reducing conditions and temperatures.[111]

Despite the remains at Pentrwyn apparently being on a small scale towards the end of the mine's long prehistoric life (based on three Late Bronze Age ^{14}C dates around 900 cal BC), they offer a window on the simple smelting process that may well have been used throughout the long life of the mine at larger smelting sites, situated locally or at more distant locations. Whether a fully slagging process would have offered any decisive advantages in smelting the plentiful high-grade, low-silica oxidic copper ores of the Great Orme

[109] Williams 2013

[110] Tylecote *et al* 1977; Hauptmann 2007

[111] Williams 2013

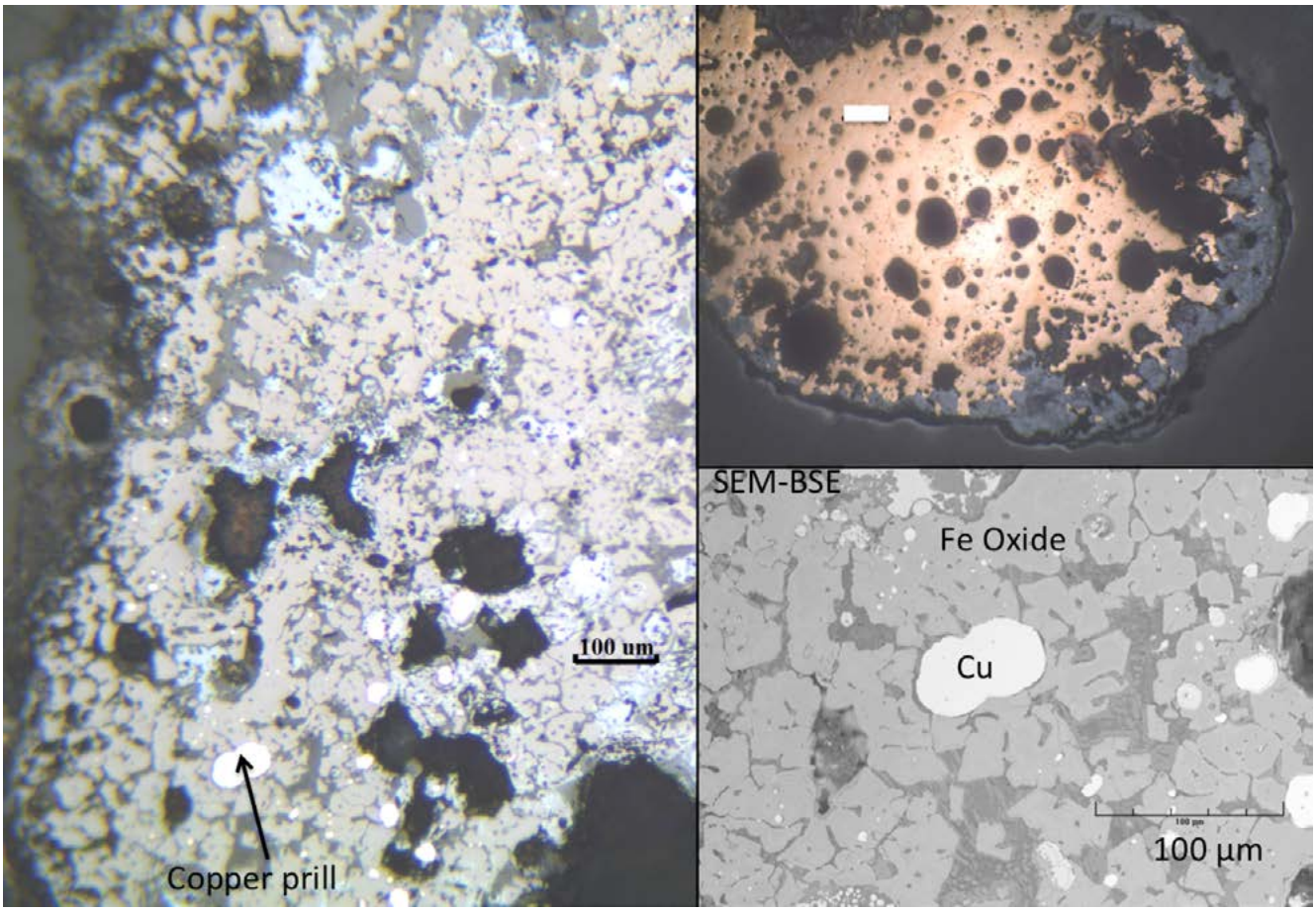


Fig 11 Pentrwyn copper prills and slag particles; on the left is a polished section image in reflected light showing copper prills (white), magnetite (light brown), cuprite (light grey) and atacamite (grey); on the bottom right is a SEM-BSE image showing copper prills (white), magnetite (medium grey) and a glassy phase (dark grey); on the top right is a polished section of a corroded copper prill with numerous gas cavities (scale bar 500 microns)

mine is debatable. This has a technological parallel with Iberia, where a similar simple smelting process using locally plentiful secondary carbonate and oxide ores was used on a small-scale for millennia, including the Late Bronze Age.[112] This contrasts with the classic larger-scale Bronze Age copper smelting sites in Israel and Jordan (oxidized ores)[113] and later in Austria and Italy (sulphide ores),[114] where fully developed slagging processes were used and produced large amounts of silicate slag.

Two lead isotope analyses were undertaken for Northover and Salter.[115] For the current study three further analyses have been carried out and published,[116] and a further four samples are planned. All the lead isotope data obtained so far on the prills match the more radiogenic end of the Great Orme ores. The chemical and isotope results are discussed further below.

Discussion

i) Linking ore to metal geochemically

Trying to illustrate graphically some of the geochemical ore and metal artefact data is challenging in two dimensions. A wide range of options is being explored (with or without log transformation, histograms, tertiary diagrams, 3D diagrams and using multivariate analysis), but currently simple binary plots of are being used. The chemical analyses in the OXALID database (based on Rohl and Needham's data)[117] have been used initially and will be later expanded to include data from the larger OXSAM database where chronological information is available. The blurring effects of recycling poses a challenge, but at this stage the working assumption is that at least some metal artefacts, especially nearer the ore source, could be mainly made from the original ore source, and a strong geochemical signal should also be present in other artefacts, depending on the percentage and composition of any recycled metal. Various scenarios will be considered once the mine-based group is fully established.

[112] Rovira and Montero-Ruiz 2013
[113] Hauptmann 2007
[114] Dolfini 2014
[115] Northover and Salter 1999
[116] Williams 2013
[117] Rohl and Needham 1998

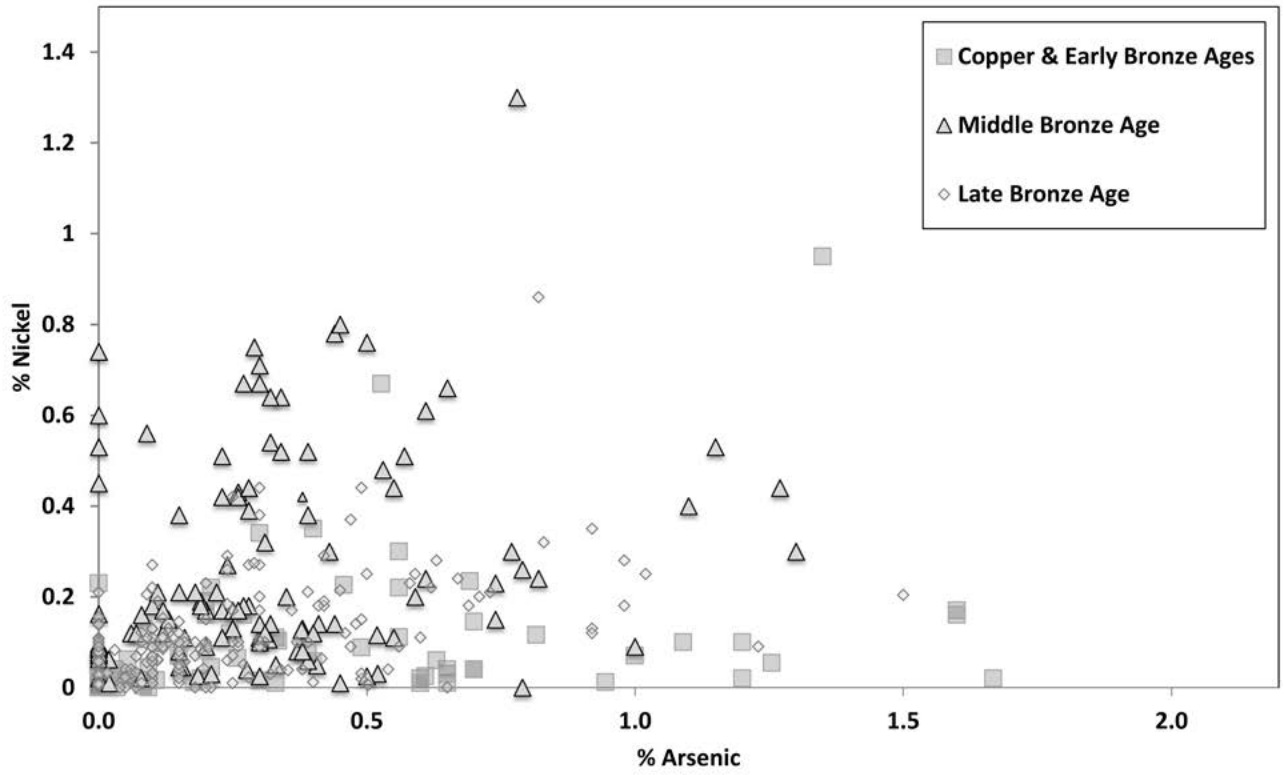


Fig 12 Arsenic and nickel plot of British and Irish Bronze Age metal artefact analyses (data from OXALID; Joel *et al* 1995; Rohl and Needham 1998)

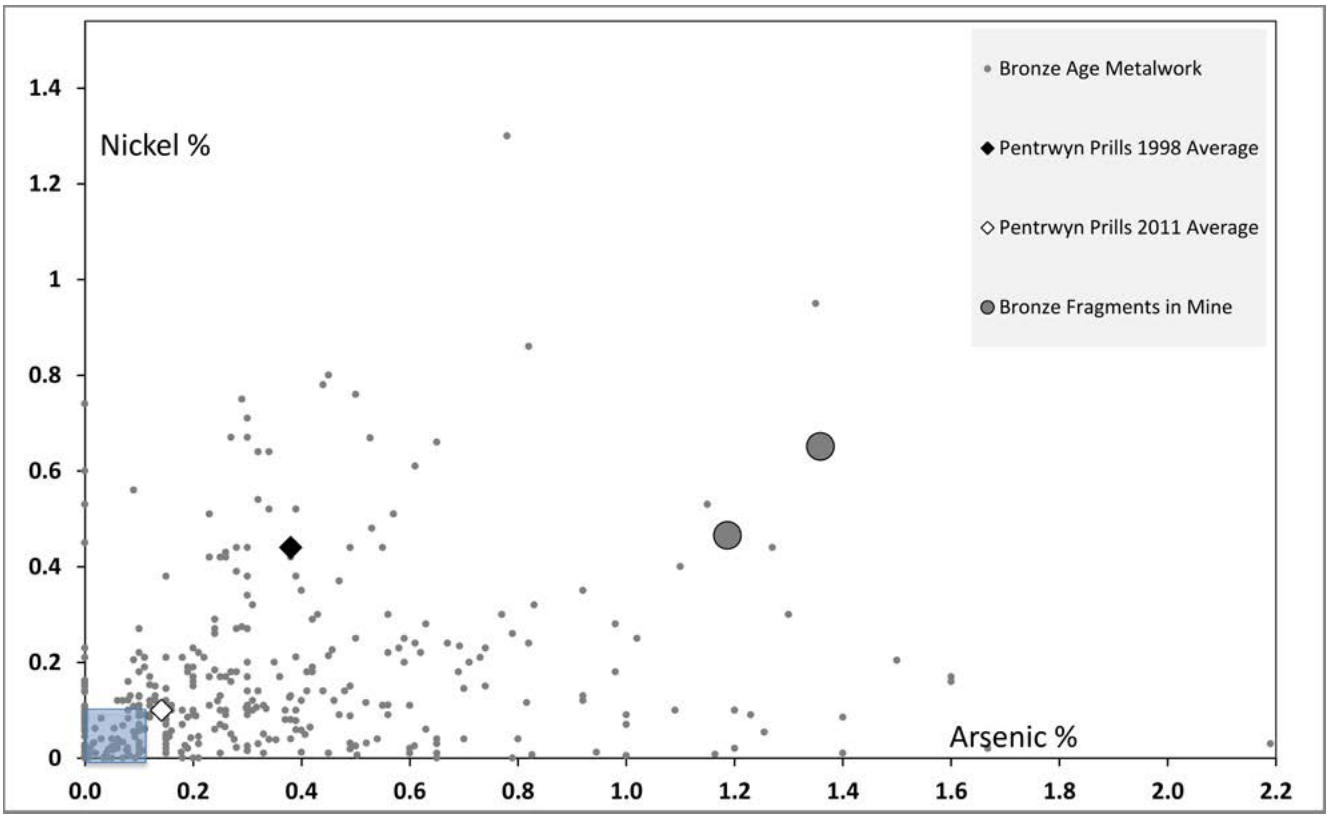


Fig 13 Arsenic and nickel plot of metalwork data from Figure 12 with the bronze fragments from the Great Orme mine and the Pentrwyn copper metal prills; shaded square indicates where low-impurity metal would plot

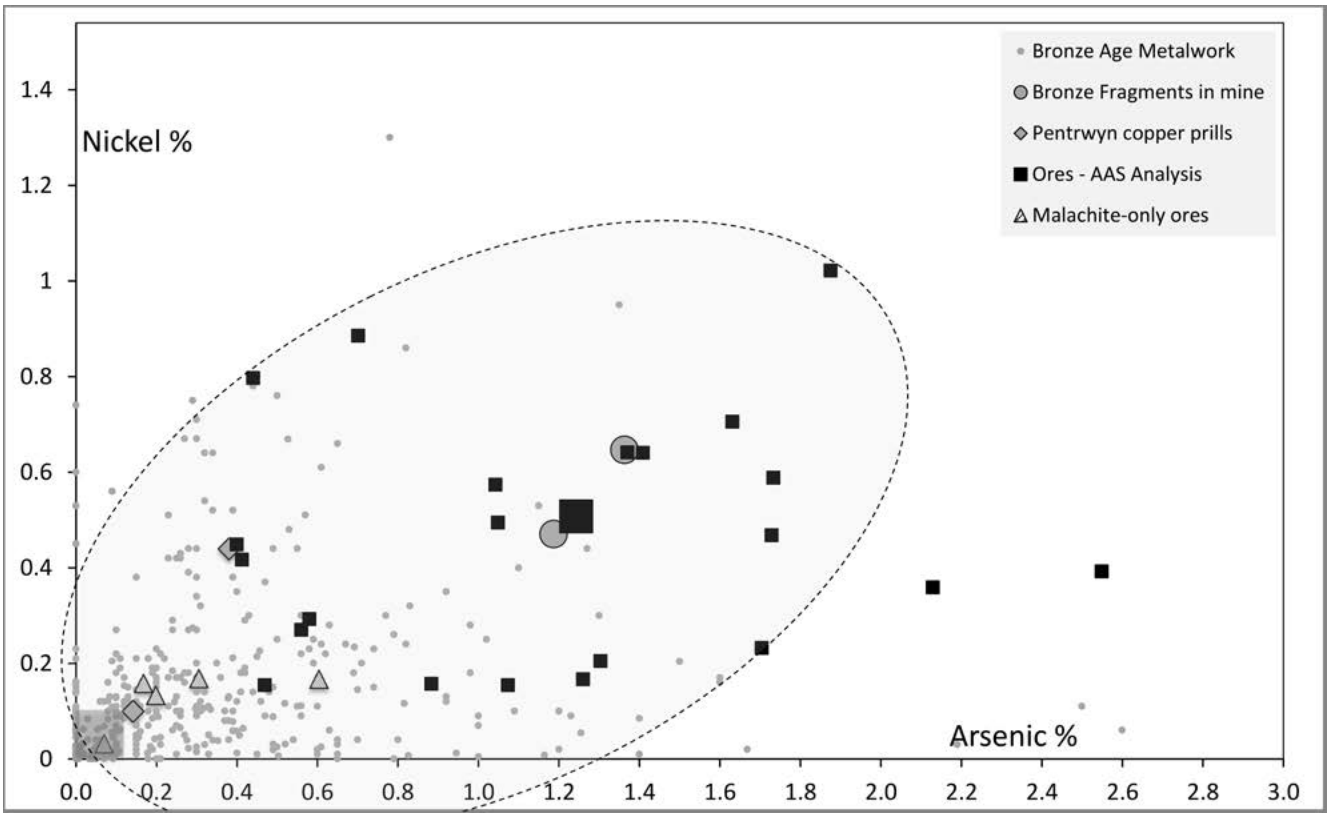


Fig 14 Arsenic and nickel plot of Figure 13 with the addition of the AAS bulk ore analyses (squares – largest is average); all ores normalized to 100 per cent copper

Nickel-Arsenic. The plot of nickel-arsenic in metal artefacts from the EBA, MBA and LBA (Fig 12) shows that a wide mixture of combinations of these two elements is present in all three periods, but with artefacts above 0.4 per cent nickel belonging mainly to the MBA. Using the same axes and data, Figure 13 shows a shaded area at the bottom left where 'low-impurity metal' would lie if Ixer and Budd's suggestion that the Great Orme ore could only produce this type of metal was correct.[118] Onto this graph are also plotted the two bronze fragments found in the mine (recalculated for tin content), which have relatively high arsenic and nickel levels. The two other points plotted are the average values from the two sets of Pentwryn copper prills, one of which still has notable levels of nickel and to a lesser extent arsenic.

Where then do the ore analyses that have so far been completed plot on this graph? Following the practice adopted by Pernicka,[119] the ore trace element levels have been normalized to 100 per cent copper, so that they represent the best-case scenario of full transfer of the trace elements in all the minerals present in the ore into the copper metal, without any losses, as discussed further above. In Figure 14, the plots of the twenty-eight ores analysed by AAS are shown (square symbols). Virtually all the ores show significant levels of arsenic and nickel, which clearly suggests that most ores would not produce low-impurity metal. Averaging all the ores analysed so far gives the point, shown by the larger square symbol, at around 1.24 per cent arsenic and 0.51 per cent nickel. This has a remarkably close similarity to the two bronze particles found in the mine, suggesting the mine ores could produce this type of metal, contrary to the statements quoted earlier. If so, it suggests that there was little or no loss of nickel and arsenic during smelting. The Pentrwyn copper prill compositions are consistent with the range of ore compositions shown. Also plotted in Figure 14 are the minor malachite-only (or azurite) ores (triangle symbols), which generally have a lower level of impurities.

Overall, the ore analyses provide strong evidence against the claim that Great Orme ore could only produce low-impurity metal. The ore data suggest that the metal produced by the main malachite-goethite ores could have medium to high levels of arsenic and nickel, even if there were some small loss of impurities during smelting and refining. The much rarer malachite-only ore would give a lower-impurity metal.

One specific research question is whether Great Orme ore could have been the source of the Acton Park metal assemblage of the early MBA. Plotting Acton Park arsenic and nickel data (corrected for tin content) obtained from both the OXALID and OXSAM databases onto a graph (Fig 15), shows a very similar range of metal compositions to that suggested by the Great Orme ore data, and so is a fully consistent source. The low (or undetected) antimony levels are also consistent between the ores and the Acton Park metal. Other elements need closer examination to decide on the

[118] Ixer and Budd 1998

[119] Pernicka 2004

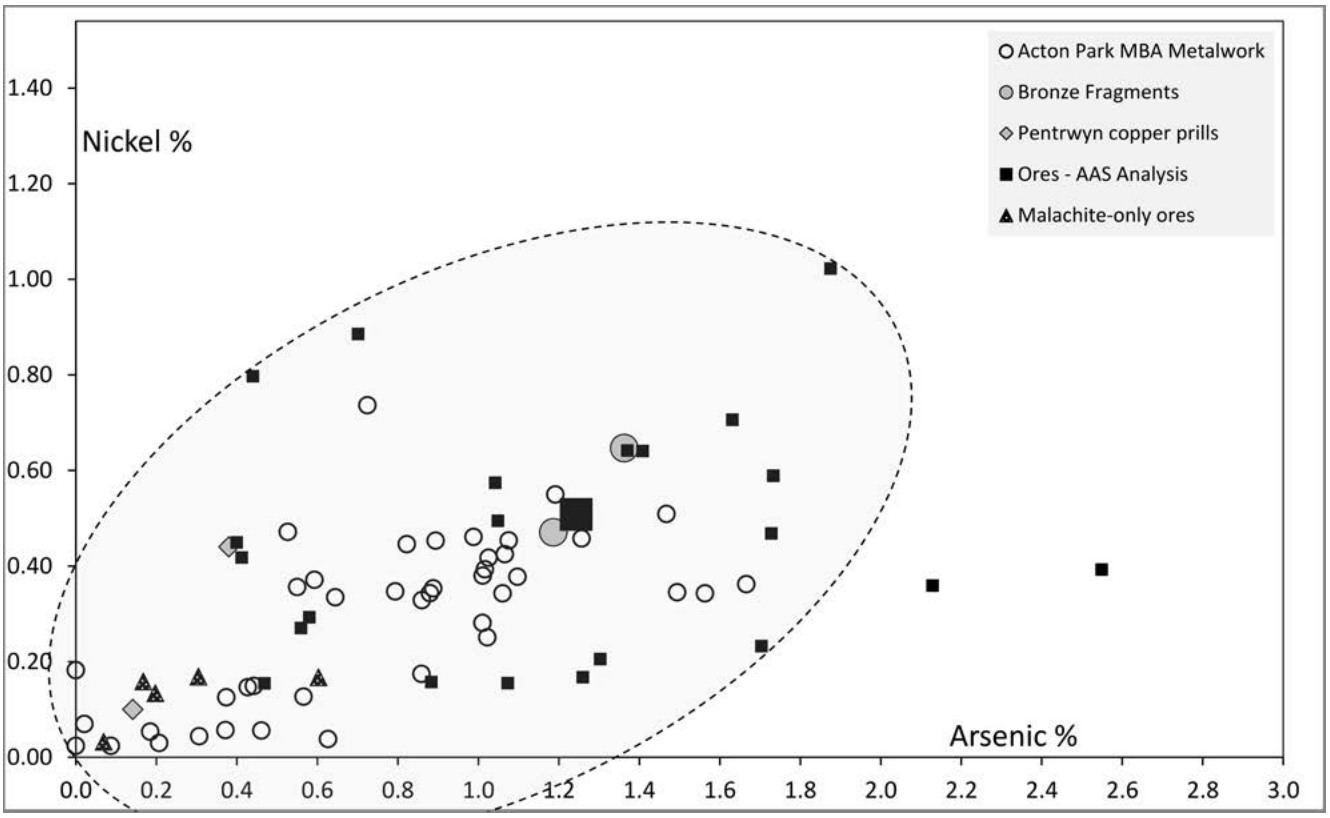


Fig 15 Arsenic and nickel plot of Figure 14 with the addition of the Acton Park metalwork analyses (data from OXALID; OXSAM; Rohl and Needham 1998)

split between metal and slag, and for this some smelting experiments are planned.

Antimony-Nickel. EBA metalwork data show no clear trend or relationship between these two elements, and this may reflect the metal coming from many different small British and Irish sources,[120] plus any imported metal sources. By contrast, the plots for the MBA and LBA (Fig 16) show two broad overlapping but discernible groups. This may reflect a shift from the MBA onwards to fewer larger copper sources, which may help in identifying recycling mixing lines. Broadly speaking, the data in Figure 16 suggest that the MBA metal had generally variable nickel levels (0.0 to 0.6 per cent) with low antimony levels (not detected or below 0.1 per cent). In contrast, the LBA metal had variable but generally higher antimony levels (0.0 to 0.6 per cent), which correlates with a modest increase in nickel. Whether movement along this correlation trend reflects mineralogical fahlore ore-source variation or recycling or both is unclear (see also isotope discussion).

So where do the Great Orme ores and related materials lie in the nickel-antimony plot? They are consistent with the plot of MBA material lying at or close to the nickel axis, due to markedly low antimony levels (all below 0.07 per cent). This low level of antimony is a very striking feature of the Great Orme ores, mine bronze fragments and copper-prill data. The MBA Acton Park metalwork would plot in the same nickel-low-antimony area as the Great Orme ores. Antimony values slightly above those seen in the Great Orme ores could be due to low-level Group A metal recycling or stem from another metal source, appearing after the Acton Park phase (see isotope discussion below).

Silver. The MBA metal is mainly less than 0.08 per cent silver, combined with low antimony levels. This fits all the Great Orme copper prills and bronze particles and most ores (albeit with some probable smelting loss in some cases). By contrast, there is a discernible trend in part of the LBA (and to a lesser extent in the EBA data) of silver increasing with antimony, as one might expect from fahlore ore sources.

Cobalt and Zinc. The MBA cobalt levels are consistent with the Great Orme bronze fragments in the mine, at around 0.05 per cent, and with the variable levels in the copper smelting prills. The Great Orme ore samples contain much higher levels of cobalt, up to 0.45 per cent (after normalizing for copper). However, it is well established in the literature that cobalt can partition more to the slag that the copper metal when smelting ores.[121] This view is supported by the high level of cobalt detected in some of the Pentrwyn slag phases.[122] In a similar way, the zinc present in the Great Orme ore, up to 0.6 per cent (after normalizing for copper),

[120] Timberlake and Marshall 2013a
[121] Hauptmann 2007, fig 6.37
[122] Williams 2013

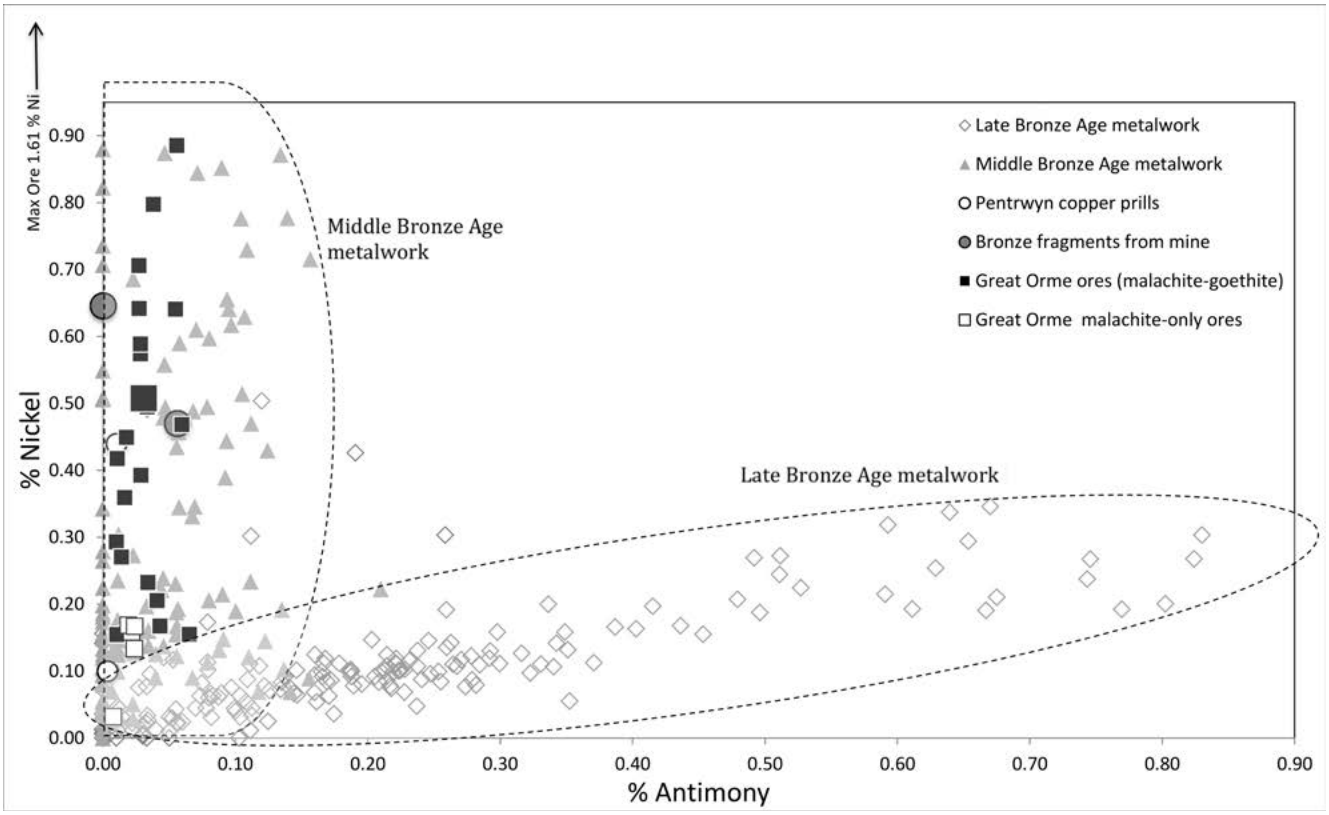


Fig 16 Antimony and nickel plot of MBA and LBA metalwork and the Great Orme materials: ores, bronze fragments from the mine and Pentrwyn copper prills (data from OXALID; OXSAM; Lewis 1996; Rohl and Needham 1998)

would probably be greatly reduced or lost during smelting, as was also demonstrated by Hauptmann.[123]

Lead. Great Orme ores, bronze fragments and prills lead levels are consistent with MBA metal. Lead levels below 1 per cent in EBA and MBA metalwork are believed to stem from accidental addition due to lead impurities in copper ores. However, some MBA objects, particular Acton Park artefacts, have higher lead levels (up to several per cent) and this has been claimed as an early case of deliberate lead alloying.[124] An alternative explanation is of more substantial accidental addition at the Great Orme mine, when the copper mineralization is enriched in lead when crossed by a lead (galena) vein (see also lead isotope discussion below).

ii) Linking ore to metal isotopically

Lead isotope analysis offers another independent route to link Great Orme materials (ores, smelting prills and bronze fragments from the mine) to Bronze Age metal artefacts. The principles behind the technique are described elsewhere.[125] There are four stable isotopes of lead (^{204}Pb, ^{206}Pb, ^{207}Pb and ^{208}Pb), with the last three being formed by the decay sequence of uranium (^{235}U and ^{238}U) and thorium. The precise abundances of the various lead isotopes in a mineral deposit depend on the geological history of the lead in that deposit. For example, if the mineralizing fluids have extracted lead with different isotopic histories from the large volumes of rock they have passed through, then the isotope signature of the ore deposit will reflect the result of mixing of all these different lead sources. Therefore, mineral deposits have distinct mixtures of the various lead isotopes, which means that – in principle – each mineral deposit will have its own lead isotope signature. These signatures remain constant when the ores are smelted into objects, as isotopic fractionation is assumed not to occur.

Complications include the imperfect mixing of the mineralizing fluids, causing a spread of results, and also when there are subsequent mineralizing events at the same location, involving different lead sources, resulting in a different isotopic mixture. Another complication is where there is uranium and / or thorium within the mineral deposit, as this can cause post-depositional enrichment in the corresponding lead isotope if the lead levels are low enough in the mineral deposit.[126]

The broad chronological divisions being used in this paper are Copper Age, EBA, MBA and LBA. There are various options for plotting the isotope ratios, and all of them need to be considered. In this paper, only the ^{207}Pb / ^{206}Pb versus ^{208}Pb / ^{206}Pb are shown due to space restrictions, but the other plots have been considered and they generally support the comments made below. In ideal cases the mineral deposit will occupy a tight area on the plots, with only a

[123] Hauptmann 2007, 205
[124] Northover 1980, 233
[125] Rohl and Needham 1998; Pernicka 2014
[126] Rohl and Needham 1998

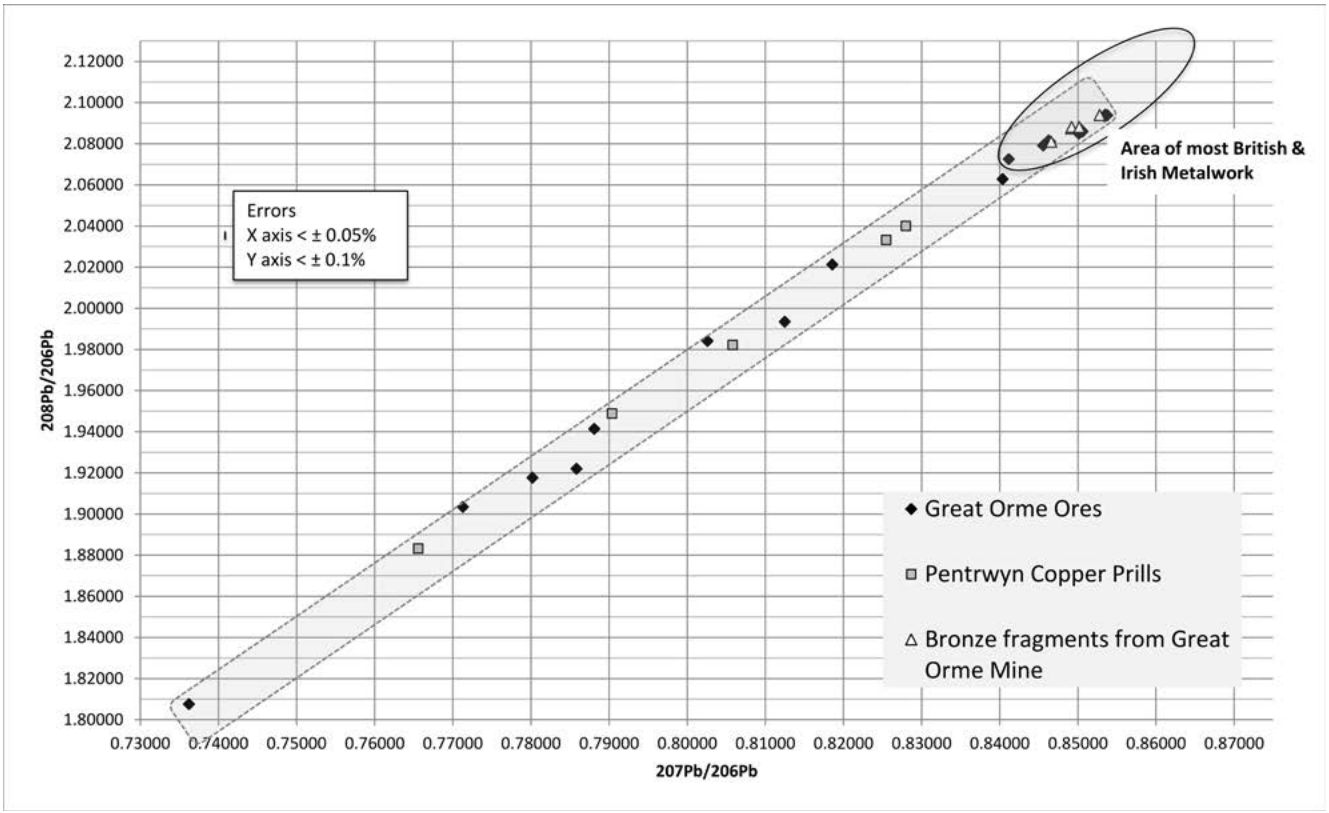


Fig 17 Lead isotope plot of ^{207}Pb / ^{206}Pb against ^{208}Pb / ^{206}Pb for Great Orme ores, bronze particles and Pentrwyn copper prills showing a radiogenic spread; note the main area of British Bronze Age metalwork data in the top right (data from Joel *et al* 1995; Rohl and Needham 1998; Williams 2013)

small spread, and many dated British and Irish mines do so, albeit with a slight spread. However, in the case of Great Orme mine there are two major complications that present challenges and opportunities.

The Great Orme ores are referred to as being 'radiogenic'. This is probably caused by the presence of uranium in the deposit, combined with copper ores low in lead. A bituminous material containing uranium, probably as uraninite, has been recorded in the mine's dolomite[127] and at the nearby Ty Gwyn mine.[128] Up to 193ppm uranium have been detected in a goethite next to copper minerals in the current study (see Table 5). Hence, the irregular presence of uranium, combined with copper mineralization low in lead, can give rise to local enrichment in the ^{206}Pb isotope from post-depositional radioactive decay, and this probably produces the linear spread of results (Fig 17).[129]

Crossing the Great Orme copper deposit is at least one lead vein which, according to Ixer and Davies,[130] is an earlier mineralizing event with a different lead isotope signature that due to its high lead content will not be significantly affected by low levels of uranium. This highlights the need to ensure a full geological understanding of any ore deposit is achieved before provenancing work is carried out.

The number of measurements needed to characterize a deposit is thought by many to be twenty,[131] but forty has also been suggested.[132] For the Great Orme-related material there are currently thirty measurements. These are from seventeen copper ores (malachite, azurite, chalcopyrite), three lead ores (galena), six copper prills from Pentrwyn smelting site, and four bronze fragments from the mine.[133] This includes six new measurements made for the current study, comprising three copper ores sampled *in situ* plus three copper prills from Pentrwyn, and carried out by the NERC Isotope Geosciences Laboratory.[134]

Figure 17 shows the long linear spread of results on Great Orme minerals, prills and bronze from the mine. All measurements on the smelting prills and the bronze fragments fall within the spread of the copper ores and so are consistent with being from those ores. The lead ores from the Great Orme lead vein plot in a tight area at the top right, along with a copper ore sample that was close to the lead vein. In addition, all the three bronze fragments from the mine also plot in or towards the top right area. This area also encompasses about half the data for British Bronze Age metal artefacts. While about half the Great Orme copper ores plot

[127] Lewis 1996

[128] Parnell and Swainbank 1990

[129] Radiogenic copper ores are also found in parts of Cornwall, but so far without identified prehistoric mines, Mount Gabriel in Ireland and in northern Spain (see Rohl and Needham 1998, Huelga-Suárez *et al* 2012; 2014)

[130] Ixer and Davies 1996

[131] Rohl and Needham 1998; Pernicka 2004

[132] Baxter *et al* 2000

[133] Joel *et al* 1997; Rohl and Needham 1998; Northover and Salter 1999

[134] Williams 2013

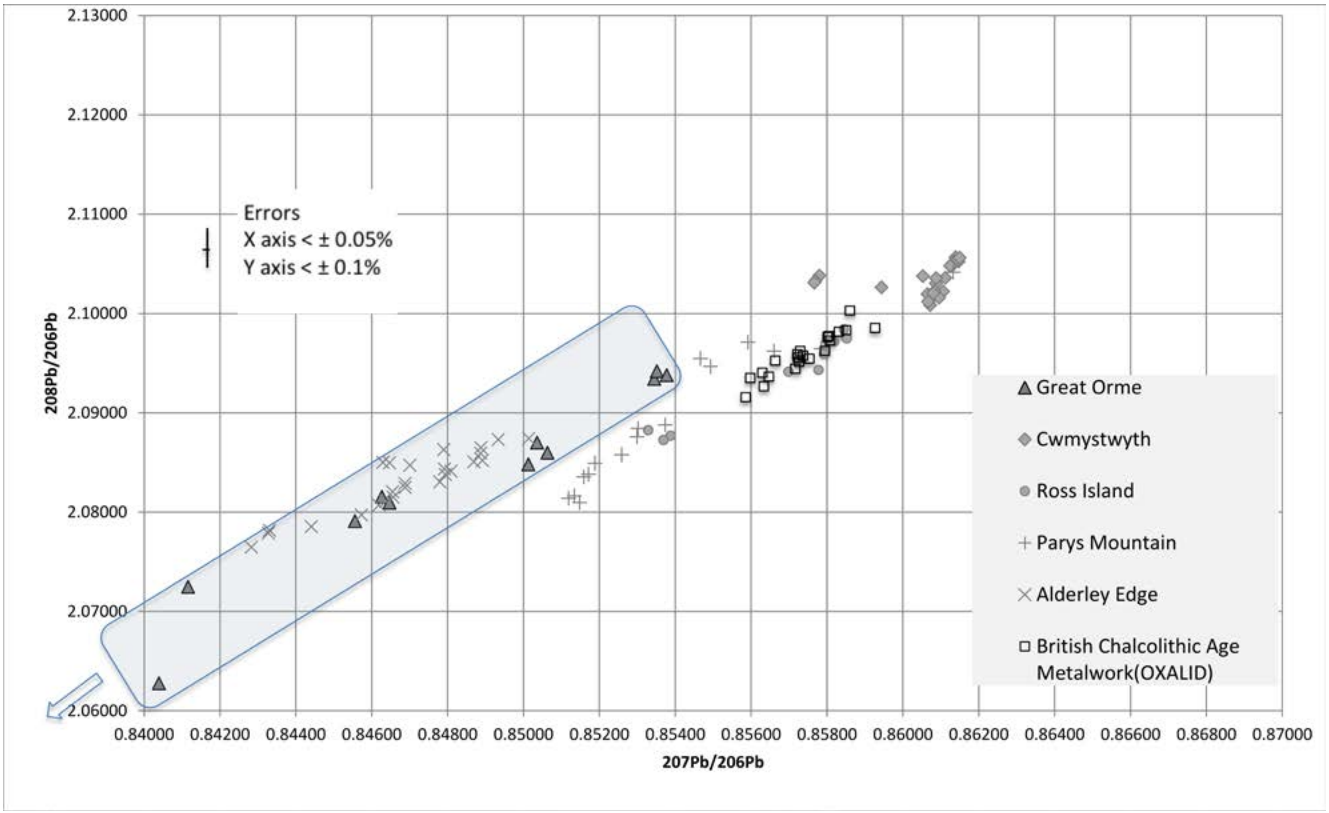


Fig 18 Lead isotope plot of ^{207}Pb / ^{206}Pb against ^{208}Pb / ^{206}Pb for Great Orme ores (top right area shown in Fig 17) with the other dated British and Irish Bronze Age copper mines; in addition, artefacts from the Chalcolithic / Copper Age are show (data from OXALID; Rohl and Needham 1998)

in this top right area, the other ores lie outside that area (see Fig 17). How then could these latter ores produce the metal artefacts consistent with the main area of Bronze Age artefacts? Table 5 shows the variability of the lead and uranium levels in individual minerals. Where the lead level is relatively low compared to the uranium level, radiogenic lead could significantly affect the lead isotope ratios, but where the lead is high, any effect of extra radiogenic lead from the uranium decay would be insignificant. The lead in the copper ore can be high when located near the lead vein(s) and also possibly when the ore has been affected by weathering solutions that have been in contact with the lead vein, with the goethite absorbing lead. Probably the amount of lead required to swamp the radiogenic lead is not very high, and so a general mixing of ores or metal could easily bring the lead isotope ratios into the main area of Bronze Age metalwork.

The enrichment in lead in the copper ore around the lead vein, discussed earlier, can shift the lead isotope result towards the top right area where most metalwork data lie. For example, the EOC 2 copper-ore sample from near to the lead vein (see Table 3) contained 1.7 per cent lead (before normalization for copper) and gave isotopic ratios matching the Great Orme lead-vein galena in the main metalwork area (see Fig 17).

All the Pentrwyn copper prills have lead isotope measurements that place them below the main Bronze Age metalwork area. The lead analyses of similar particles (Table 2) show that they have low lead levels (16 to 145ppm). There is one copper prill (P12B) that does have a high lead content (over 1.2 per cent), but unfortunately this prill has not yet been subject to lead isotope analysis.

Another possibility for the isotope-ratio shift in the metal is that is was the result of deliberate rather than accidental lead alloying where the copper ore lead signal is swamped by the added lead (which could have originated from the Great Orme lead veins). Significant lead levels are common in some but not all of the MBA Acton Park artefacts.

Figure 18 focuses on the top right area of the Great Orme results and also shows the results for all the copper and lead ores from the other dated British and Irish Bronze Age main mines, namely Ross Island, Parys Mountain, Cwmystwyth and Alderley Edge (Mount Gabriel is off scale to the bottom left). They all lie in the main area of Bronze Age metalwork, with no overlap with the Great Orme data in that area, except for ore from the Alderley Edge mines. This may indicate that there is an ore-genesis link in the source of the metals transported by the mineralizing fluids in both deposits. This overlap is not a major issue, as the Alderley Edge mines are dated 1950 to 1750 cal BC,[135] which is before the probable main period of Great Orme mine activity. Also the amount of ore produced at Alderley Edge is thought to have been small.[136]

The OXALID database contains over 400 lead isotope analyses of British Bronze Age metal artefacts and links in with the compositional data discussed earlier. Figure 18 also

[135] Timberlake, this volume

[136] *idem* 2009

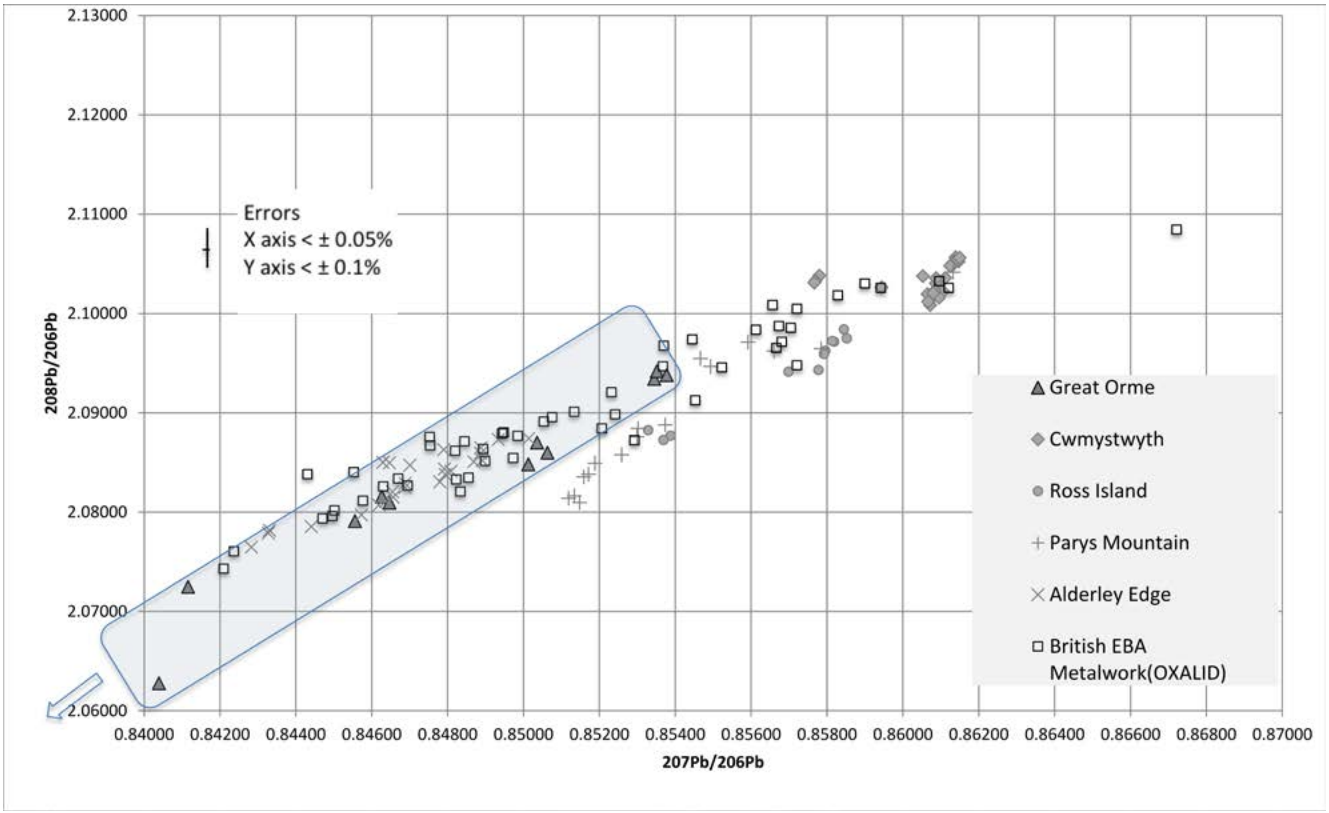


Fig 19 Lead isotope plot of $^{207}Pb/^{206}Pb$ against $^{208}Pb/^{206}Pb$ for British and Irish Bronze Age copper mines and artefacts from the Early Bronze Age (data from OXALID; Rohl and Needham 1998)

plots all the Copper Age / Chalcolithic metal artefact data, pre-dating any known activity at Great Orme. This shows a good correlation with the Ross Island mine, which is backed up with many artefacts having the As-Sb-Ag signature discussed earlier. There are some artefacts which are off scale in Figure 18, probably from radiogenic ores, and a Cornish source has been suggested as one possibility, although no prehistoric mine has yet been discovered there.[137]

Figure 19 plots Early Bronze Age artefacts and now shows fewer directly matching Ross Island mine, but does show possible matches with Cwmystwyth, Parys Mountain, Alderley Edge and Great Orme, which fits neatly with ^{14}C dates from this period.[138] Further work on the database needs to be carried out to see of the first signs of Great Orme metal production can be detected. Initial indications from Rohl and Needhman's work suggest that some of the Arreton metal might be consistent with the Great Orme radiogenic 'signature' and also some of the lower-impurity chemical analyses, while others could be mixed with recycled 'A' metal.[139]

Figure 20 plots Middle Bronze Age artefacts covering the Acton Park, Taunton and Penard metal assemblages. During this period, particularly its first half, the Great Orme mine is likely to have been at the height of its activity and probably the only British copper mine in operation. This is consistent with the isotope data, which show that many artefacts are in the Great Orme isotopic (and chemical) range.

Great Orme metal appears consistent with at least some metal in all three MBA metal assemblages, but unravelling which metal is consistent with the Great Orme and which is probably from imported and recycled sources requires further work. However, more detailed work has been done on the specific research question posed earlier, as to whether Great Orme ore could have been the source of the Acton Park metal assemblage of the early MBA, for which a source in north Wales has long been suspected.[140] Figure 21 plots all the isotopic data available from Acton Park metalwork, and there is a striking correlation of the majority of the points with the Great Orme ores and bronze fragments. Also, some of the Acton Park artefacts contain several per cent of lead, but still plot in the same area. This suggests that the lead, whether deliberately or accidently added, is isotopically consistent with Great Orme lead ore. A few points plot distinctly away from the main area, and while these are plausibly within the radiogenic range of the ores, mixing with another source is a possibility.

Combining the lead isotope evidence, the trace-element evidence described earlier and the dating and regional distribution evidence, there is a strong likelihood that Great Orme was the metal source for the British Acton Park assemblage. As mentioned earlier, this was the main British metal source

[137] Rohl and Needham 1998

[138] Timberlake, this volume

[139] Rohl and Needhman 1998

[140] Butler 1963; Northover 1980; 1982; 1989; Lynch *et al* 2000

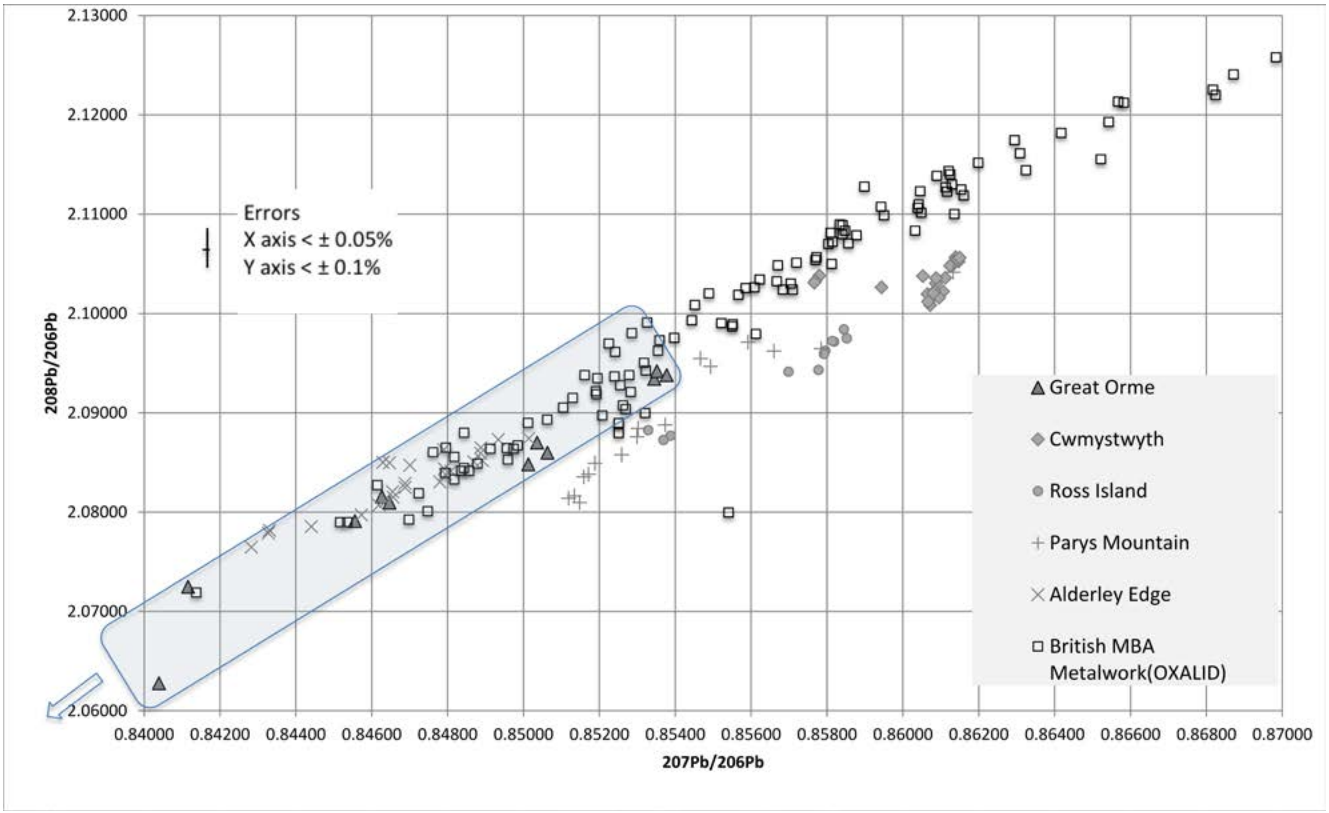


Fig 20 Lead isotope plot of $^{207}Pb/^{206}Pb$ against $^{208}Pb/^{206}Pb$ for British and Irish Bronze Age copper mines and artefacts from the Middle Bronze Age (data from OXALID; Rohl and Needham 1998)

in the first phase of the Middle Bronze Age, supplying Wales and much of Lowland Britain, as well as being exported.[141] Butler strongly linked the Acton Park type palstaves typologically with those in the Voorhout hoard on the South Holland coast and attributed them to 'a travelling smith from North Wales'.[142] These now appear to be more likely to have been traded or exchanged Acton Park metal objects, rather than smiths copying the style. Northover found close chemical and isotopic similarities between the Welsh and Voorhout Acton Park palstaves.[143] Acton Park metalwork has also been identified in Brittany and other continental locations[144]and will be reviewed against the Great Orme mine-based metal group in more detail when all planned analyses are complete.

In the following Taunton phase, the isotope data suggest that the same metal persists in the north and west, consistent with a continuing Great Orme production source, but in the south-east most of the metal is outside the limit of the Great Orme-only metal isotope signature.[145] A long linear line / zone is defined (see Fig 22) from the edge of the Great Orme range to an extreme well outside any British or Irish mineral deposit known geologically. This could represent a mixing line between Great Orme metal and a Continental source involving recycled metal, and possibly mixing of primary sources. Another option is that the new source is radiogenic and also contains nickel and arsenic impurities. However, unlike most Great Orme metal, nickel levels are greater than those of arsenic and the metal mostly has also a slightly higher antimony level, with a distinctively different isotopic range. Identifying the source of this new metal is an outstanding challenge and work is ongoing.[146]

There is a very radical change in metal composition at the end of the Penard phase and into the LBA Wilburton phase, with arsenic, antimony, silver and nickel all being impurities. The level of these elements means that if there was any contribution from Great Orme, it was very small. Figure 22 plots the isotope data for the Late Bronze Age artefacts that form a strikingly tight distribution within the Great Orme isotopic range. However, this tight range almost certainly reflects the lead source rather than the copper source, because these artefacts often contain several per cent lead (over 10 per cent in some cases), which suggests deliberate alloying. Identifying a source of the lead ore / metal used for alloying would help our understanding. Rohl and Needham suggested the Mendip lead mines,[147] which has recently been supported by lead analysis of a speleothem which indicated LBA activity.[148] However, Rohl and Needham's data show that there are other British mines with a similar isotopic composition, including Halkyn, 45km from Great Orme.

[141] Northover 1982, 54
[142] Butler 1963, 61
[143] Northover and Gale 1983
[144] See distribution maps in Lynch *et al* 2000; Northover 1982
[145] Northover 1982, 57; Rohl and Needham 1998, 179
[146] G Artioli pers comm
[147] Rohl and Needham 1998
[148] McFarlane *et al* 2014

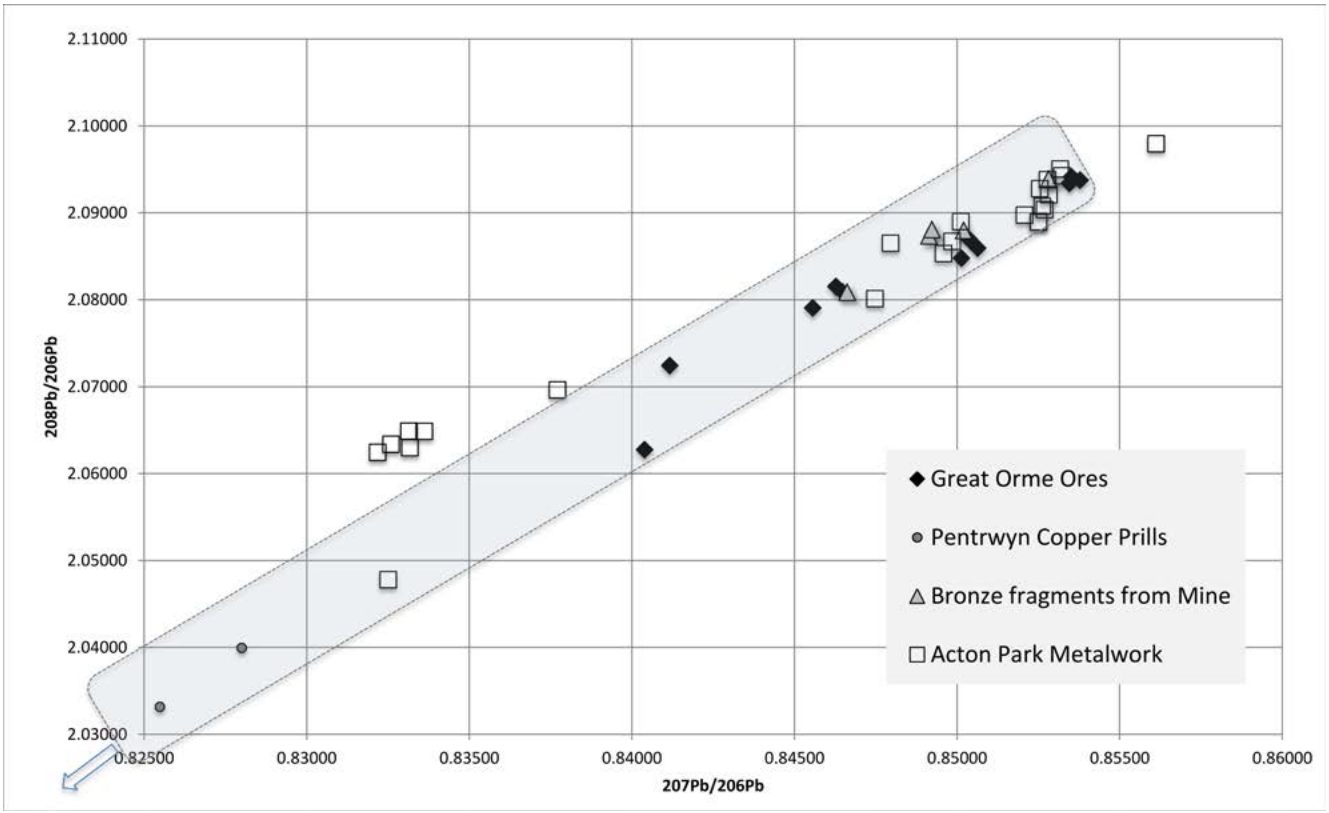


Fig 21 Lead isotope plot of ^{207}Pb / ^{206}Pb against ^{208}Pb / ^{206}Pb for Great Orme ores, bronze particles and Pentrwyn prills, plus the Acton Park metalwork assemblage data (data from OXALID; Joel *et al* 1995; Rohl and Needham 1998)

In marked contrast to the LBA artefacts, which mostly have high lead and high but variable antimony as well as other impurities, are the analyses of eleven LBA copper ingot fragments and prills from six different locations, which do not look like recycled metal.[149] They are all (with one exception) relatively pure copper, with impurities mostly less than 0.1 per cent, but have variable isotopic ratios. Could any of these ingots or prills be from Great Orme ore? Interestingly, nine of the ingots plot in the isotopic range of the Great Orme ores, and while they seem low in impurities they have some similarities to the analyses of the 2011 prills from the LBA Pentrwyn smelting site. Further consideration of the chemical and isotopic compositions of other potential metal sources is required, including possible Cornish sources.

Conclusions

The remarkable survival of one of the largest Bronze Age copper mines in Europe at the Great Orme in north Wales presents special archaeological opportunities. This is an ideal site to develop a new methodology of establishing a mine-based metal group, based on an extensive set of ore samples from over 6km of Bronze Age mine workings. The mine-based metal group defined by the ores (using geochemistry and lead isotope data in combination) is proving consistent with the analyses of the bronze fragments from the mine and the copper metal prills from the nearby smelting site, which in all probability contain the metal the mine ores produced. Contrary to an earlier influential study of the ores, suggesting that only low-impurity metal could be produced, this latest research is strongly suggesting that the Great Orme mine produced a metal with variable arsenic-nickel impurities, which is consistent with a lot of British Middle Bronze Age metalwork. In particular, this combination of data from two independent techniques provides strong evidence to support the proposal that the during the Acton Park MBA phase (1500 to 1400 BC) the metalwork, found across much of Britain and occasionally on the Continent, from Brittany to Holland, may have originated from the Great Orme mine.

Ore sampling throughout the extensive Bronze Age workings strongly indicates that the black-green oxidized ores were the principal ores mined, consisting of malachite and goethite with only residual sulphide. Predominantly sulphide ores, which are much more difficult to smelt, can be found in the harder rocks, even at the surface, but appear to have been deliberately left *in situ*. This is important because the smelting of predominantly oxide ores directly under reducing conditions avoids the oxidizing stage of ore roasting required for sulphide ores, which can cause loss of volatile elements like arsenic. Hence, in oxide ores a lower level of arsenic is likely to be required, relative to a sulphide ore, to give the same level in the copper metal. Another discovery

[149] Rohl and Needham 1998

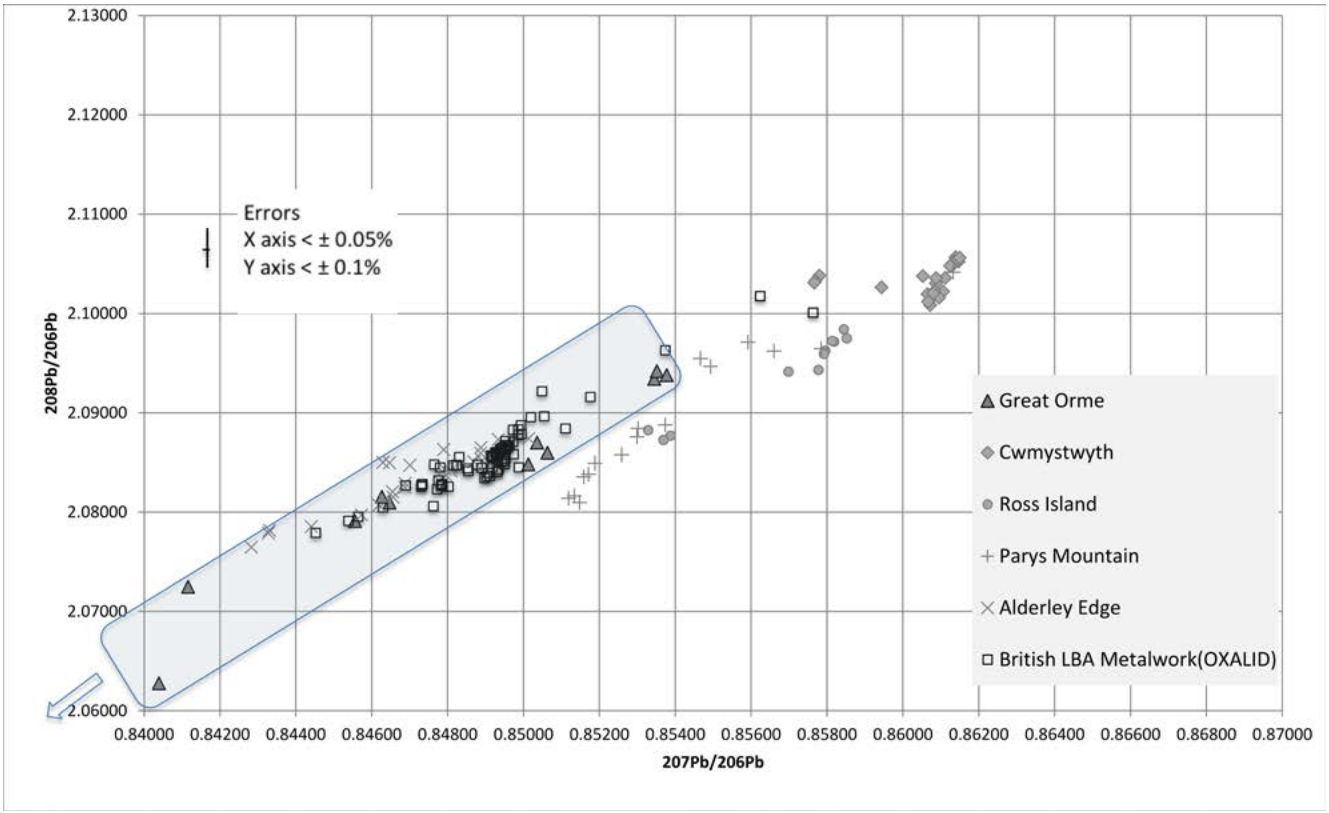


Fig 22 Lead isotope plot of $^{207}Pb/^{206}Pb$ against $^{208}Pb/^{206}Pb$ for British and Irish Bronze Age copper mines and artefacts from the Later Bronze Age (data from OXALID; Rohl and Needham 1998)

emerging from this work is the unsuspected role of goethite in the ore as a reservoir of trace elements, due to its unusual mineralogical structure accommodating many elements.

A larger set of ore samples is now being analysed geochemically and isotopically, to test these initial findings and to define more clearly a mine-based metal group which is encompassing a range of metal compositions. Based on the strong likelihood that the Great Orme mine was the dominant source during the MBA Acton Park phase, this will be used as a foundation to identify Great Orme metal in earlier and later periods, when the situation is complicated by more sources and more recycling. Overall, a clearer understanding of the mine's contribution to the metal supply, the reach of exchange networks and the extent of recycling are likely to emerge, along with the implications for the social organization of the mine.

Addendum

This 'work in progress' paper was written in 2014 and so excludes the additional research findings made in the following four years and which will be published shortly.

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Mining, making, and stone tools: the earliest metal objects in Britain and Ireland

Andrew P Fitzpatrick

In the context of early European metallurgy, Britain and Ireland are unusual in that they have produced evidence for most stages of the relevant chaîne opératoire*, from the mining of ores to the making of metal objects. Here we discuss the complex relationships between the extraction of ores, metalwork production, and the groups and individuals involved in the various stages of this process, with a particular focus on the stone tools used in early metallurgy.*

Introduction

Metal is central to the concept of the Bronze Age, but all across Europe the relationships between the extraction of ores, the making of metal objects, and the groups and individuals involved in the various stages of the *chaîne opératoire* remain poorly understood. In part this is due to the compartmentalization of research into separate fields such as mining, metallurgy or archaeology which employ different paradigms and research objectives. It is also partly due to the fact that few regions have evidence for all the stages in the making of metals and the making of objects.

Although Britain and Ireland constitute one of the last regions in Europe to adopt metallurgy when it was introduced by Continental Bell Beaker groups between *c* 2400–2300 BC, the region is unusual in a European context in that it has evidence for most stages of the *chaîne opératoire* for the mining of ores and the making of metal objects.[1] One thread that united this chain was the use of stone tools. These were employed in the mining and processing of ores, the making of moulds, and the final plastic shaping of metals and objects. Cobble stone mining hammers were used throughout Europe in the Copper and Bronze Ages, and in Britain and Ireland Early Bronze Age stone moulds are quite numerous. However, the practice of placing stone tools for metalworking in graves was largely restricted to Bell Beaker groups, and as a result of this the *chaîne opératoire* is visible for only a short time in Britain and Ireland towards the end of the third millennium BC, straddling what has been called the Chalcolithic[2] and the beginning of the Bronze Age, *c* 2200 BC. The processes in which these stone tools were employed, their archaeological contexts, and the type of objects that were made are set out below and a provisional list of stone tools for metalworking from contexts other than mines is given in Appendix 1.

Copper mining and processing

Prospecting and mining

Some of the best evidence for the mining of metals in prehistoric Europe comes from these islands. Over the last two decades, field survey has increased the number of certain or probable Bronze Age mines to approximately twenty. These mines are usually in upland or montane locations and all of them are in the west of these islands: in Ireland, Wales, the Isle of Man and north-west England. There is a notable concentration of mines in the Central Wales orefield (Fig 1).

As well as the distinctive profiles of the workings that were caused by pounding the surfaces with stone hammers after the rock had been weakened by lighting fires against the quarry face, a key element of the typical archaeological signature of these mines is the presence of the stone hammers (Figs 2 and 3). At many mines hammers can still be found on the surface and it is the discovery of these that has led directly to the identification and dating of many of the mines known in Britain. Most of the cobbles were collected from river beds or shores, and the carrying of them to the mines underlines the importance of suitable stones, something which is also seen in the choice of the smaller stones found in the graves of metalworkers which were used as tools in the plastic working of metals.

Although the presence of cobble stone mining tools has been central to the identification of mines across Europe,[3] it is now clear that some rocks are so soft that fire-setting was unnecessary and few if any stone hammers were needed,[4] and the implications of this are considered further below.

However, at most prehistoric copper mines in Britain and Ireland cobble stone mining tools are found in large numbers and thanks to major excavations on mines such as the Great Orme, Gwynedd, Wales;[5] Mount Gabriel, Co Cork, Ireland,[6] and Ross Island, Co Kerry, Ireland,[7] and the surveys, smaller excavations and experimental work undertaken by the Early Mining Research Group,[8] the mining methods used in hard rocks in several Copper Age and Bronze Age mines

[1] All radiocarbon measurements have been calculated using the calibration curve of Reimer *et al* 2004, and the computer program OxCal v4.0.5. The calibrated date ranges cited in the text are those for 95 per cent confidence. They are quoted with the end points rounded outwards to 10 years if the error term is greater than or equal to 25 radiocarbon years or to 5 years if it is less. The ranges quoted in italics are posterior density estimates derived from mathematical modelling of archaeological problems. Date ranges in plain type have been calculated according to the maximum intercept method

[2] Allen *et al* 2012

[3] eg De Pascale 2003; Montero-Ruiz and Rodríguez de la Esperanza 2004, 55–6; O'Brien 2013

[4] Timberlake 2014, 39–41

[5] Dutton and Fasham 1994

[6] O'Brien 1994

[7] *idem* 2004

[8] eg Timberlake 2002; 2003; 2007; 2009



Fig 1 Distribution of sites discussed (distribution of mines and stone hammers after Timberlake 2009, fig 7.1)

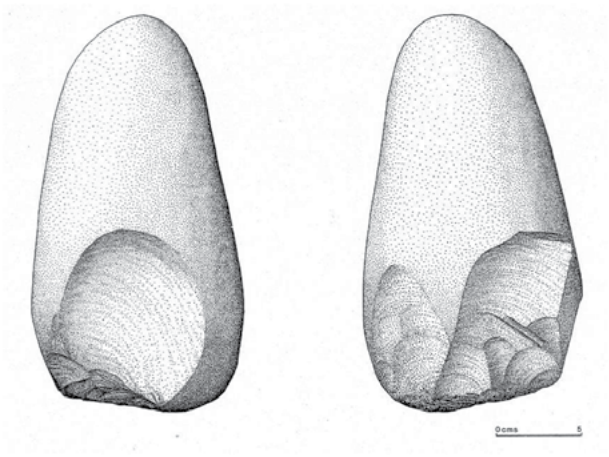


Fig 2 Bell Beaker cobble stone hammer from Cwmystwyth; a Type A single-end mining hammer (after Timberlake and Craddock 2013, fig 6)

in Britain and Ireland are now well understood. These conclusions of this work are consistent with those from elsewhere in Europe[9] and wider studies of early metallurgy.[10]

Prospection

The number of mines now identified in Britain and Ireland strongly suggests that by the Bronze Age outcrops of mineral-bearing strata, signs of secondary mineralization, the distinctive flora that metal lodes can support in upland areas, and perhaps also the colour and taste of water near a mineral source, were all readily recognizable to prospectors. The Bell Beaker groups who introduced mining for metal ores to these islands must also have possessed this knowledge, but the lands they came to were already well-known and explored by local people. If they shared their understanding of the landscape, it would have allowed the ready identification of strata that contained suitable ore deposits.[11] It has been suggested that mining in mainland Britain was undertaken seasonally by transhumant pastoralists[12] and while this may have been the case in the Bronze Age, the first miners in Britain and Ireland were probably also prospectors.

Roberts has suggested that prospection for metals was not undertaken systematically[13] and while this may be correct in the widest sense, individual prospecting trips will have been organized thoroughly. Even if undertaken in the company of knowledgeable locals, the first journeys by Bell Beaker groups into previously unknown territories will have been expeditions of exploration. Prospecting may leave only the most ephemeral of traces, but the grave of the Bell Beaker metalworker found at Kirkhaugh, Northumberland, while geographically isolated from other contemporary burials, lies on the edge of a major orefield, raising the possibility that the death occurred during a prospecting expedition.

The earliest prospectors' knowledge of what was a suitable ore was both precise and limited. For example, the copper mined at Copa Hill, Cymystwyth, in Wales was found alongside lead ores, but the lead, for which there was no known use in Britain at the time, was discarded at the mine. Exactly what types of copper ores were used, or could be used – perhaps the oxidized ores rather than primary sulphides – is the subject of detailed technical debate,[14] but it is likely that in the later third millennium BC the range of minerals that can produce copper was not appreciated fully. Initially rocks may have been selected as suitable sources because of their colours or their smells as they were crushed.[15] As a result it is possible that different types of ore were exploited at the same locations at different times as their individual attributes came to be recognized.

Mining

In hard rock mining (as opposed to 'soft rocks' such as the fluvial gravels and sands), once the decision had been taken to try and extract copper ore, quarries were dug either vertically as pits (or opencast) or laterally, as tunnels into the rock face (drift mining). Most of the mines are small, but there are larger workings, including the early opencast mine at Copa Hill and the early drift mine at Ross Island.

Fires were often lit against the exposed rock faces – fire-setting – in order to create fractures in the rock which would make mining easier. In Britain and Ireland the amount of moisture in the rocks may have been sufficient to cause the rock to crack and fracture without the need to try and create sudden thermal shock. The fumes from the minerals and the heat of the fire would have made throwing water on the heated rock to create thermal shock difficult even if it had been thought necessary.[16]

Cobble stone mining hammers were then used to loosen and remove the fractured rock. Antlers and bones were subsequently employed as gouges to prise free rocks, and these tools formed an essential part of the miner's tool kit. The rock surfaces in mines in which fire-setting was used are typically very smooth.

After a preliminary sorting of the ore-bearing rocks in the mine, the quality of the ore was improved by a further stage of processing. This stage of processing, known as 'beneficiation', involved the further breaking-up of the ore-bearing rocks by repeatedly hammering or pounding them with hammers and then crushing them with smaller stones. The copper ores were separated from the rocks that did not contain copper (the 'gangue') by constant hand sorting. This sorting steadily increased (concentrated) the proportion of metal ore in the material.

The mining tools were mainly unmodified cobble stones that were collected from sea shores, lakesides and river beds and brought to the mines. Experimental work and ethnographic analogies suggest that the cobble stone hammers

[9] Ottaway 2001; De Pascale 2003; Groer 2008; see now also the magisterial survey by O'Brien 2015

[10] Craddock 1995

[11] Timberlake 2002, 339; Groer 2008, 12–14

[12] eg Timberlake 2003, 112; *idem* 2009, 101–2

[13] Roberts 2009b, 133

[14] eg Timberlake 2010

[15] Bray 2012, 62

[16] Pickin and Timberlake 1988; Timberlake 2007



Fig 3 Bell Beaker cobble stone hammers from Ross Island (after O'Brien 2004, fig 156)

often had wooden or withy handles fixed to them, but these handles usually left little or no traces on the stones. The hammers from the mine at Ross Island and the later, Bronze Age, one at Alderley Edge are unusual in having grooves or rills pecked into most of the hammers to help fix the handle (see Fig 3); at most sites the cobble stones were not modified. The smaller hammers used to crush the ore concentrate are thought to have been hand-held and without handles. Flat rocks and natural outcrops of rock were used as anvils on which the ore concentrate was crushed. Although it is widely thought that the beneficiation of the ores would have been undertaken close to the mines, there is very little evidence for this stage of the process.

The small nodules of ores that were extracted by this process may have been heated (roasted) to drive off any sulphur. The ores were then either smelted by simply placing them on the ground or in a slight hollow and covering them with charcoal or in furnaces that were fanned by wind and blowing.[17] This smelting created an ore concentrate that contained small, irregular copper prills (or pieces of copper). This concentrate was then cracked and crushed and the copper prills separated. The small prills were melted in a crucible to form a small 'button' of copper. Several of these buttons would then have been melted to create copper ingots.

Evidence for the smelting of copper is rare. Depending on the technologies used, only furnaces might leave obvious archaeological traces as negative features, although fragments of clay crucibles used for smelting have been found occasionally in continental Europe.[18] A work camp is known adjacent to the low-lying Ross Island mine, but amongst the British mines the crushed slags and tiny copper prills of probable Early Bronze Age date found at Pentrwyn on the Great Orme are currently unique.[19] It is possible that for most mines, which were located in uplands, smelting was undertaken at a lower altitude, perhaps close to settlements.

The upland locations of the early copper mines in Wales and some evidence from Copa Hill which suggests that the timber used for fire-setting was collected in the spring, have lent support to the suggestion that mining there was a seasonal activity.[20] The Ross Island mine lies on the shore of Lough Learne, and the 'Blue Hole' mine would have been in danger of flooding when the level of the lake rose in the winter. Combined with the lack of evidence for domestic activity near to the mine, this has also led to the suggestion that the mining and processing at Ross Island was seasonal.

Cobble stone mining tools

Although cobble stone mining tools are found worldwide, and in central and western Europe they are the main method of identifying Copper and Bronze Age mines, there has been little standardization in the terminology used to describe them. In this respect the work undertaken in England and Wales by the Early Mining Research Group is notable in that it has recorded stone tools using a systematic and comparable methodology that is informed by experimental work.[21]

A range of tools has been identified: single-end mining hammers, double-end mining hammers, grooved mining hammers (where the groove helped seat the handle), crushing tools, picks or chisels, crushing anvils, pecking stones (used to create grooved hammers), saddle quern-type mortar stones, grooved mining hammers, and boulder battering stones. The identity (or archaeological context), dimensions, shape, petrology, completeness, type of fracture, wear analysis, modification, and a summary description are recorded for each stone.[22]

These studies have concluded that cobbles were collected for tools on the basis of their shape, size and weight rather than the specific type of stone, as all the cobbles would have been hard and flawless. It is also concluded that the mining technology was strictly utilitarian and the tool kits used in mining and processing were largely created *ad hoc*, and that broken tools were often reused.

Mining without cobble stone mining tools

Although hundreds, sometimes thousands, of hammerstones have been found at some mines in Britain and Ireland, the numbers found at some other mines is much smaller. While the number of hammerstones will reflect the duration and intensity of mining, it will also reflect the hardness of the ore-bearing strata. Although the Bronze Age mining at Ecton, Staffordshire, was recognized because of the discovery of cobble stone mining hammers,[23] it was suggested that the limestone is so thinly bedded and interleaved with thin strata of shale that fire-setting might have been unnecessary, and this could also have reduced the number of hammerstones needed.[24] Subsequent excavations did not reveal any evidence of fire-setting, and it was found that the ores could have been removed by simply scraping them off using bone tools, a number of which were found, and wooden levers. Most of the relatively small number of cobble stone tools found in the excavations appear to have been used in preparing the ore rather than in mining it.[25] Similar methods appear to have been used in the Bronze Age mines at the Great Orme where there was no evidence for fire-setting and a number of bone tools were also found. This suggests that Copper and Bronze Age mines in soft limestones and sandstones may have a different, and less obvious, archaeological signature.

As cobble stone mining hammers are widely taken as one of the key indicators of Copper and Bronze mining across Europe, the possibility that they may have been used in small numbers, and perhaps sometimes not at all, sounds a cautionary note in interpreting the distribution of early copper mines (see Fig 1). It is also notable that some of the most extensive copper and lead orefields in northern England and Scotland which were exploited commercially in the modern

[17] Possibly through wooden or reed pipes, as no clay *tuyères* from bellows of this date have been found in Britain and Ireland

[18] Cert 2005

[19] Chapman 1997

[20] Timberlake 2003

[21] Pickin 1990; Timberlake 2003; Timberlake and Pickin 1988; Timberlake and Craddock 2013

[22] Timberlake and Craddock 2013, 39–42, appendix 1

[23] Guilbert 1994a; 1994b; Pickin 1999

[24] Barnatt and Thomas 1998, 76; Barnatt 2000, 10–13

[25] Timberlake 2014, 26, 40

industrial age have yielded few, if any, cobble stone mining hammers.[26]

Bell Beaker mining in Ireland: Ross Island

The best explored of the early Irish copper mines, and one of the best explored in Europe, is Ross Island which lies almost at sea level amongst the Killarney Lakes of Co Kerry.[27] Compositional analyses of the ores found at the mine and of numerous objects from across Ireland and Britain suggest that Ross Island was the major source of copper in Ireland and much of western Britain in the Copper Age and the earlier part of the Early Bronze Age.[28]

Two ancient mines are known to have exploited the copper-rich horizons of sulphide mineralization found in the limestone at Ross Island: the Western Mine and the 'Blue Hole'. Excavations at the Western Mine have shown that it exploited a zone of mineralization comprising finely mixed chalcopyrite and grey (*fahlerz*) ores, although there is some uncertainty as to which ores were actually extracted and used. Thus it has been suggested that it was the oxidized ores that were mined rather than the chalcopyrite, but that the evidence for them has largely been removed.[29] Cobble stone mining tools occur in well stratified and dated contexts[30] and almost 90 per cent of the larger hammers have grooves to help seat the handle.

Stone tools also occur in the associated work camp in which a number of small buildings and shelters have been found. After preliminary sorting outside the mines to remove the charcoal and limestone that obviously did not contain copper, there was a second stage of ore concentration in which the rock was broken into walnut-sized fragments using hammers and anvil stones.

It has been suggested that the differential wear evident on the opposing ends of the hammers may have been caused by one end being used for extraction and the other for beneficiation. This might explain why hammers have grooves, as they would need to have been fixed very securely if they were used both underarm and overarm.

At present, the Ross Island work camp is the only early site in Britain and Ireland where there is evidence for the next stage on the process; the fine-crushing of the ore concentrate. Experimental archaeology based on the excavated evidence has shown how this may have been undertaken.

The ore concentrate was crushed or ground against sandstone blocks with hollowed surfaces using smaller hammers that did not have handles. A few saddle quern-type stones were found, as was what appears to be an actual quern, suggesting that they were mortars in which the ore was crushed by grinding. The smaller hammers are similar to some of those found in the graves of Bell Beaker metalworkers in continental Europe, and some of the smaller and more rounded stones that may have been used for grinding are also similar to those found in graves.[31]

Some animal bones found in the Ross Island work camp were used as tools. The cattle scapulae had evidence of use wear, possible as shovels, and the extremities of the pointed ends of some cattle ribs were polished and scratched. Although the ribs could have been used as gouges in the mine, the polishing is also consistent with the bones being worked against animal hide, hinting that the latter stages of processing could have been done on hides that were used to gather up the ore.

The next stages in the process will have been the roasting (heating) of the ore concentrate and then the smelting of the ore to turn it into metal. The roasting of the ore concentrate may have been necessary to drive off (remove) sulphur in these particular ores. A number of small pits were found in the work camp, and it is has been suggested that they were used for smelting ore, though the possibility that they were used to roast it is not excluded. Although it has been argued that because roasting will have created noxious fumes, it may have been done at a different place from beneficiation, this difficulty could have been avoided by simply undertaking the activities at different times. However, as no fired clay from hearths or furnaces or crucibles was found at Ross Island, the precise use of the pits remains uncertain.

Hardly any waste copper was found at Ross Island, just three fragments: i) a fragment of corroded ore; ii) a runlet of raw copper and matte (a semi-smelted product); and iii) a small slab. The latter is probably, but not certainly, of Bell Beaker date and was found in proximity to a fragment of copper smelting slag.[32] Slag was equally rare; only six pieces are thought to derive from the Bell Beaker metalworking.[33] This can be interpreted as showing either that oxidized ores produce little or no slag, or that the recovery of waste metal was very efficient, or that the smelting took place elsewhere.

Despite the uncertainties about the later stages of the process, it is clear that the mining and processing of the ores at Ross Island mainly used a simple lithic technology for which the associated archaeological evidence can be summarized as follows:

- Prospection
- Mining
  - fire-setting
  - mining using large stone hammers with handles; the hammers were carefully worked using smaller, harder, pecking stones to create grooves (or rills) that helped fix the bindings by which the handles were attached
  - antler picks and bone gouges were used to prise out ores
  - bone shovels made from cattle scapulae were used to move the ores
  - preliminary separation of the ore-bearing rocks outside the mine

[26] Pickin 1990, 41–2; *idem* 2008
[27] O'Brien 2004
[28] *idem* 2012; Bray 2012, 60
[29] cf Timberlake 2010, 293–4
[30] O'Brien 2004, 339
[31] *ibid*, 352, figs 161, 162
[32] *ibid*, 525
[33] *ibid*, 471

- Beneficiation
  - breaking-up of the rocks using hammers (possibly the same stones as above) to create an ore concentrate
  - grinding and crushing of the ore concentrate using smaller hammers without handles and crushing tools, anvils and mortars
  - bone shovels from cattle scapulae and cattle ribs used to help separate ores
- Roasting? And possibly smelting, although this may have been undertaken elsewhere.

As there were no stones suitable for use as hammers at Ross Island, they had to be brought to the mine and work camp. Suitable cobbles of Old Red Sandstone could have been collected from the beds of the River Flesk, 2km away, and the River Laune, 5km away, before being transported across Lough Learne by boat.

All the activities at Ross Island were associated with Bell Beaker pottery, and radiocarbon dating suggests that mining and processing started *c* 2400 BC, although the large standard deviations of the dates mean that statistical modelling of them cannot provide a more accurate start date for the mining. O'Brien has argued that the mining was instigated by Bell Beaker groups from continental Europe, probably from the Atlantic façade, and although a specific region cannot be suggested, the mining techniques and the types of stone tools have their best parallels in the Bell Beaker copper mines of southern France and, particularly, northern Spain.[34]

Third-millennium BC mining in England and Wales

Despite the long-held expectation that Cornish tin, gold and copper would have been exploited from the beginnings of metallurgy in these islands, there is little evidence for how they might have been extracted.[35] Although lead isotope analysis has identified a small group of copper objects whose composition is argued to be consistent with an origin in Cornwall,[36] they are unlikely to be much, if at all, earlier than 2200 BC.

The earliest dated metal objects from the Cornish tin streams are Early Bronze Age, including a flat axe from the Carnon streams, but there are many more finds of Middle and Late Bronze Age date.[37] While it has been argued that it is logical to expect the minerals of Cornwall to have been exploited at an early date,[38] the decisions whether to do so or not were cultural ones. At present, while there is circumstantial evidence that Cornish tin was exploited at the beginning of the Bronze Age, and recent work (discussed below) suggests that gold was too, it is not inevitable that copper, which will have required hard rock mining, was exploited as extensively.

In contrast, relatively small scale excavations at three of the eleven Welsh mines that were certainly or probably worked in the Bronze Age have yielded reliable radiocarbon dates in the third millennium. These sites are, Copa Hill, Tyn y fron and Erglodd, all of which are in Ceredigion in west-central Wales, close to the Irish Sea.

The earliest dated activity is from Erglodd, Talybont, though there is only a single date. Here, small sondages, carefully located in the earliest upstanding tips visible, identified an ore-crushing floor that also contained debris from fire-setting. The crushing floor yielded a radiocarbon date of 2340–2130 cal BC (Beta-214364: 3800±40 BP). This date and three early ones from Copa Hill (2270–1980 cal BC, Beta-192629: 3720±40 BP; 2190–1940 cal BC, Beta-192632: 3680±40 BP; 2190–1920 cal BC, Beta-192628: 3660±40 BP), and a single one from Tyn y fron (2200–1880 cal BC, Beta-120592: 3640±50 BP) all suggest that copper mining in Wales started in the later third millennium BC.[39] Modelling of the radiocarbon dates from all mines in Wales and England also estimates that mining most probably started in the last quarter of the third millennium cal BC: 2315–1995 cal BC at 95 per cent.[40]

The most extensively explored of the early Welsh mines is Copa Hill, where the outcrop of the copper bearing Comet lode was worked as an open cast mine into the Bronze Age. While most of the evidence from the mine is Bronze Age in date, there are no obvious differences between the techniques used then and the rarer Bell Beaker (Copper Age) evidence.[41] There is no evidence for processing or smelting at Copa Hill, only for the extraction of copper. The copper was identified and removed very carefully, leaving other metal ores behind, most notably lead. A small amount of evidence from tree-growth rings suggests that timber was collected in the spring, hinting that the mining was a seasonal activity.

Although the repeated reuse of the hammers for different purposes after they had broken complicates use-wear analysis, the hammers typically have a broad end that was the hammer face and which is usually worn, and a narrower, non-working, end. Some hammers have mineral staining, and chemical analyses of an anvil revealed enhanced levels of lead and zinc.[42]

Fragments of waterlogged Bronze Age wooden handles were found at Copa Hill, and subsequent experimental work based on a stone hammer found in the same layer as the famous mineral-preserved body of the sixth–seventh century AD 'Copper Man' miner at Chuquicamata, Chile,[43] suggest that the handles for the Copa Hill hammers would have been made from long, unbranching, and pliable woods such as willow, hazel or ash withy. The handles needed to be pliable

[34] Ambert and Vaquer 2005

[35] eg Craddock and Craddock 1996; Ixer and Pattrick 2003; O'Brien 2013, 445

[36] Bray 2012, 59–62, referring to Rohl and Needham's 'IMP-LI 2' group of early metal in Britain (1998); see now Needham 2015, 27–8, fig 31 on the date of the Castell Coch, Cardiff, hoard

[37] Penhallurick 1986, 173–224; for mining in the second millennium BC see Juleff and Bray 2007. O'Brien (2015, 154–5) suggests that exchanging tin may have been preferred

[38] eg Bray 2012, 59–61; see now the emerging evidence for tin: Ling *et al* 2014; Wang *et al* 2016; Borg and Pernicka 2017

[39] Timberlake 2006, 83–5; *idem* 2009, 104, table 7.1; Burrow 2012, 173–5, table 12.1, fig 12.1

[40] Timberlake and Marshall 2013; Timberlake 2014, 42, fig 25

[41] *idem* 2003; 2004

[42] *idem* 2003; Timberlake and Craddock 2013, 49

[43] Craddock *et al* 2003

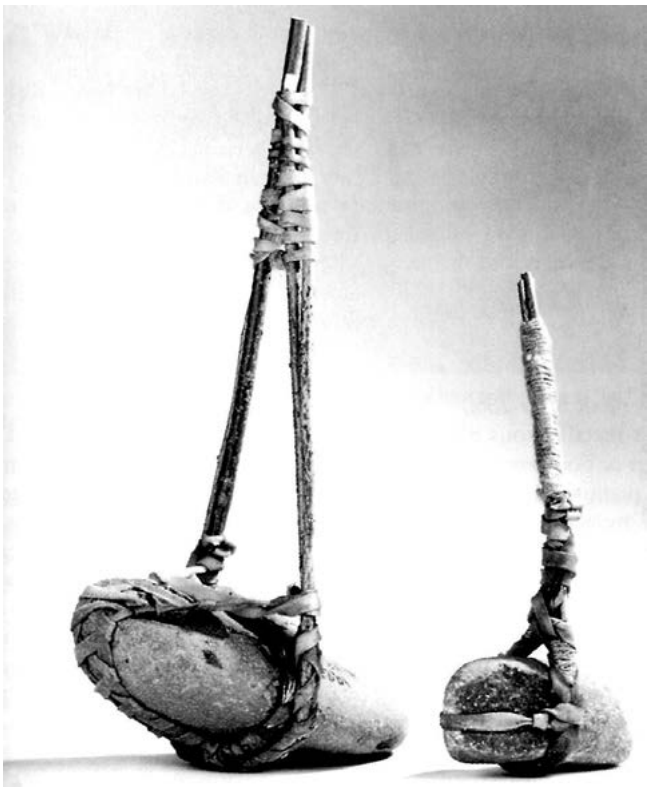


Fig 4 Replicas of Bronze Age mining hammers (photograph courtesy of Trustees of the British Museum)

to allow them to be bent right around the stone (Fig 4).[44] Very few of the Copa Hill hammers had been modified in order to ensure the goodness of fit of the handles, and because of this it seems likely that the handles were attached by bindings of rawhide or twisted vegetable fibres such as lime bast (a fibre made from the inner bark of the tree) or hemp, that also formed a supporting cradle for the stone.

Experimental work suggests that when hafted in this way, large hammers were probably used underarm. Even if there was enough space in the mines to swing them overarm, the hammers might fall out of their bindings.

As there were no stones suitable for use as hammers at or near to the mine, the thousand or more hammers found at it had to be carried to the top of the hill at 420m OD. Although the cobbles could have been collected from river beds, surveys of the modern river bed and analysis of the condition of the stones suggest that over 75 per cent could have been brought to the mine from storm beaches on the Irish Sea, some 25km to the west.[45]

In common with most other mines, none of these three early Welsh mines have direct evidence for which cultural group(s) the miners belonged to, but there is some inferential evidence from the grave at Banc Tynddol, at the foot of Copa Hill, where a small gold disc (a so-called 'sun-disc') was found. These discs are a characteristic Bell Beaker ornament, perhaps for clothing, that is found principally, in Ireland and has parallels elsewhere along the Atlantic façade.[46] The *pointillé* decoration around the edge of the Banc Tynddol disc is related to that on basket-shaped gold ornaments of twenty-fourth–third century BC date (below), and what is probably a slightly later disc was found with a Wessex / Middle Rhine type beaker in the Mere G6a, Wiltshire, grave. That type of beaker seems likely to date to the twenty-third and twenty-second centuries BC, and the Mere example is typologically later than the example from Chilbolton (below). This suggests that the Banc Tynddol grave is contemporary with the earliest mining on Copa Hill and hints that the miners belonged to Bell Beaker groups.

Ingots and moulds

Were there early copper ingots?

The shape of the ingots made from the ores mined at sites such as Ross Island and Copa Hill is not known, if indeed ingots were produced, as they arguably presuppose standard qualities and quantities of a material for exchange purposes. However, two early Irish hoards of copper objects, from Carrickshedoge, Co Wexford, and Monastery, Co Wicklow, both contain thick-butted Lough Ravel type axes that date to the second half of the third millennium BC and flat, circular, 'cakes' of copper.[47]

These 'cakes' could be early forms of ingots, but they were not cast in moulds. A good example of these 'cakes' was also found with a slightly later tin-bronze Killaha type axe head at Knockasarnet, Co Kerry (Fig 5). Both the 'cake' and the axe were made using copper from the Ross Island mine.

Another possible form of ingot found in Ireland is represented by small axe-shaped objects. In reviewing Early Bronze Age axes, Harbison suggested that the *circa* sixty small 'ovoid or trapezoidal shaped [axe-like objects] with flat or slightly rounded unhammered faces or sides' then known might be ingots.[48] These objects are too small to be typical Copper or Bronze Age flat axes, and it was suggested that the metal from several of them would have been needed to make a typical axe. This was challenged by Schmidt and Burgess who suggested that the objects might be unfinished axes, though as they also note, whether a finished copper axe of any size could actually have been used as a working tool or weapon is questionable.[49] Although it is possible that many full-size axes, over 90 per cent of which in Britain and Ireland are without associated finds, were as much ingots that were axe-shaped as functional axes,[50] they are usually carefully finished, and in view of the laborious process of grinding needed to do this, it seems unlikely that this would have been done if their prime purpose was to serve as ingots.

[44] cf Craddock *et al* 2002

[45] Timberlake 2003, 86–8

[46] Case 1977, 26; Taylor 1980, 24; Timberlake *et al* 2004; see now also Hunter and Woodward 2014, 209–10, fig 6.1.1; Timberlake 2016

[47] O'Brien 2004, 529

[48] Harbison 1969, 22

[49] Schmidt and Burgess 1981, 30; see now also Needham 2017, 38–9

[50] cf Briard and Roussot-Larroque 2002, 148

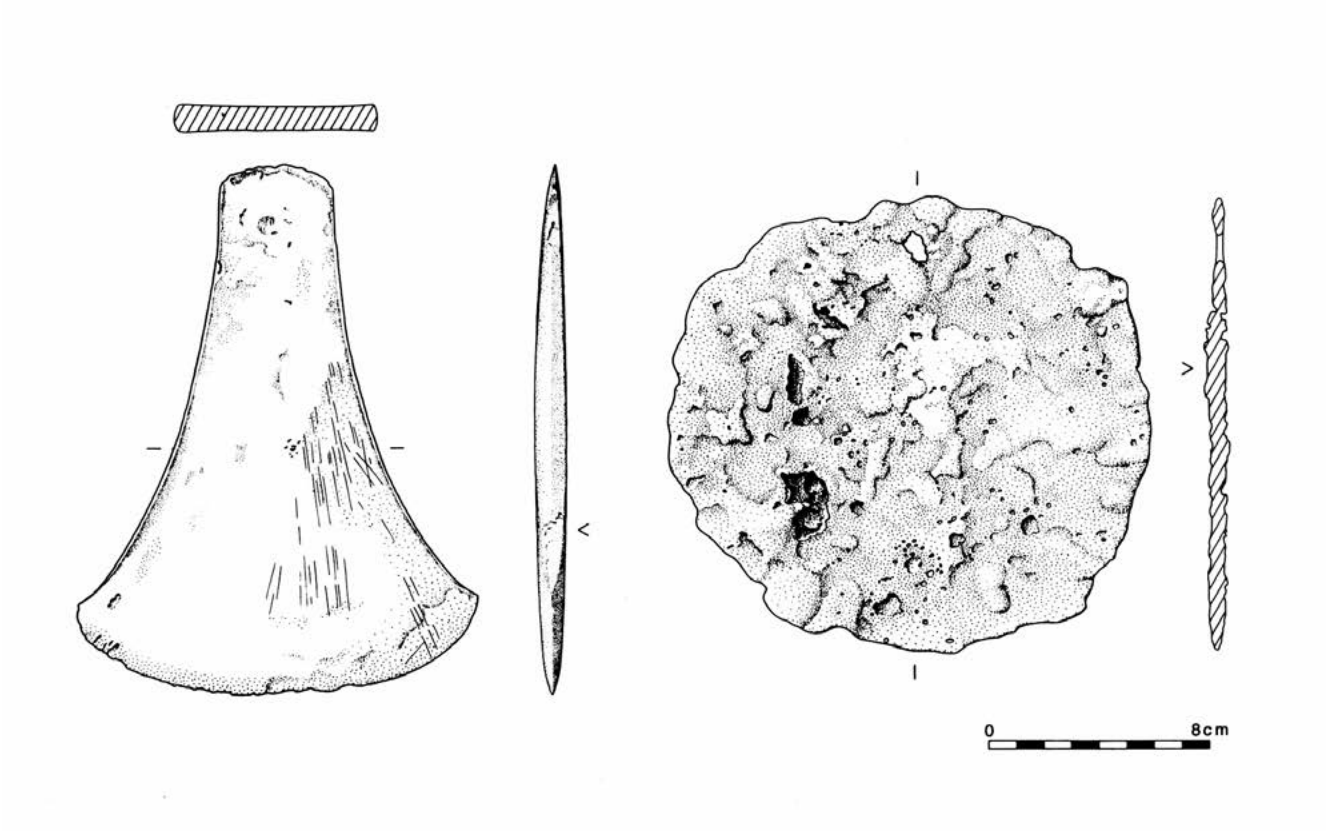


Fig 5 Bronze axe head and copper cake, possibly an ingot, from Knockasarnet, Co Kerry (after O'Brien 2004, fig 231)

Stone moulds

The earliest dated moulds for making metal objects in Britain and Ireland are of stone and many are for flat axes. Although a few of the earliest moulds may be Copper Age in date, the majority date to the Early Bronze Age.

Several stone moulds are known from Ireland,[51] and a number of these have multiple matrices on the same face. The example from Lough Guile, Co Antrim, has matrices for Early Bronze Age Killaha type axes, a small ingot, and a possible axe-shaped ingot.[52] No moulds for types of axes that were only made in copper are known from Ireland.

Most of the moulds known in Britain come from the north, with a particular concentration in north-east Scotland.[53] One mould has been found in south-west England, at Altarnun, Cornwall, which offers some evidence for the exploitation of Cornish ores, while an uncertainly provenanced mould has been ascribed to Suffolk in East Anglia.[54] The mould from East Cruchie, Aberdeenshire, is described as being made from a quern,[55] but it is also possible that the stone had been used as a mortar in ore processing or for grinding axes.

A small number of the earliest moulds from Scotland, which Needham has called the 'Burreldale series' (Fig 6), might have been used to cast copper axes.[56] However, the axes that were cast in the moulds, Schmidt and Burgess's 'Dunnottar type', were also made in bronze. This suggests that the use of stone moulds started in both Ireland and Britain in the Early Bronze Age and that earlier copper axes were cast in clay or sand moulds.[57]

All the moulds from Britain and Ireland, which in the case of the Irish finds are often of sandstone, are one-piece (or single-valve) moulds. The uneven upper surfaces of these moulds would have made it difficult for a tight fitting lid to be placed on them. As the lower faces of the moulds are usually curved, the lower surface of the casting would be curved but the upper surface would be flat, giving an asymmetric profile.

This asymmetric profile can be seen on several Irish axes, and as O'Kelly put it, 'the objects cast in such moulds can only have been rough-outs from which the finished blades were forged by hammering, grinding and polishing'.[58] One stage of this finishing is evident on an axe from Cookstown,

[51] eg Prendergast 1958; Coghlan and Raftery 1961, 225–6, pls I, II; O'Kelly 1969; 1970; Collins 1970; Flanagan 1979; Eogan 1993, 93–4, 105–6, figs 5–7

[52] Collins 1970, 25, fig 2; Eogan 1993, fig 6

[53] Hodges 1959, 130–1, 135, pls w; x; y; Britton 1963, 265–70, 319–25, fig 5; Schmidt and Burgess 1981, 52–9, pl 23 no. 295; pl 26B no. 307; pl 115; Needham 2004, 223–6, fig 19.8; Cowie and O'Connor 2009, fig 1

[54] Britton 1963, 319–20 nos 1, 5, figs 6, 7

[55] Cowie and O'Connor 2009, 317, fig 3

[56] Britton 1963, 265–70, 319–25; Needham 2004, 223, fig 19 nos 8–9

[57] It is possible that, despite the relatively large number of stone moulds found, some fifteen from north-east Scotland for example, that earlier, and presumably rarer, examples have yet to be found; see now also Needham 2017, 15

[58] O'Kelly 1970, 27



Fig 6 Stone Burreldale type mould from Glenrinnes, Moray (Banffshire); the mould for the axe is 140mm long (photograph courtesy of National Museums of Scotland)

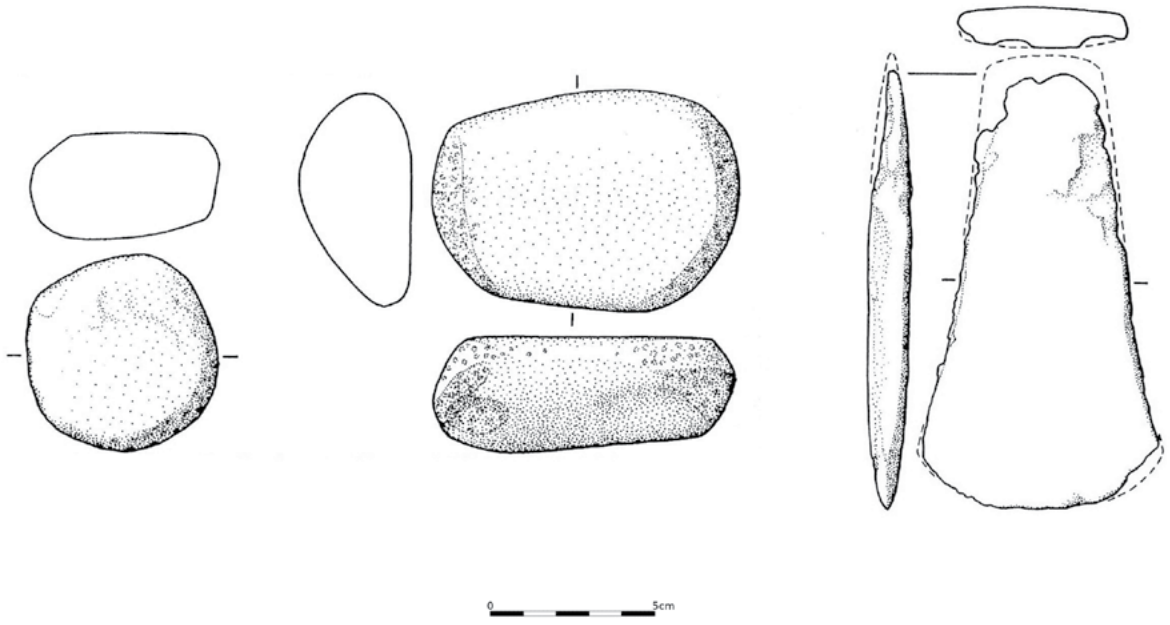


Fig 7 Stone tools and copper axe from Hindlow, Derbyshire (after Needham 1979, fig 4.3)

Co Kilkenny, which has been ground but not hammered.[59] In contrast, metallographic sections of an Early Bronze Age axe from Newgrange, Co Meath, show that it had been hammered. This axe was found close to several stone tools and two small boulders that may have been used as an anvil and a seat respectively. Although these finds are not a closed group, they may derive from a metal workshop.[60]

Manufacturing waste

The only direct evidence from Britain and Ireland for early manufacturing waste is from the settlement at Northton, Isle of Harris, in the Outer Hebrides of Scotland. A small splash of copper, presumably from casting an object, was found within a house, and although its precise context is not clear, it may date to the later third millennium BC. The metal may be from Ireland.[61]

Stone tools for finishing cast objects

The grinding and hammering in the finishing stage will have been done with stone tools. As noted above, some of the stone tools from Newgrange may have been used for this as may have been two tools from Hindlow, Derbyshire, in England (Fig 7).[62] Hindlow is the site of a modern limestone quarry and is only *c* 10km from the Ecton mine, and Alderley Edge is only slightly further away. To date, these are the only two copper mines in England at which Bronze Age mining has been firmly demonstrated.

As now known, the Hindlow group comprises a flat axe and two sandstone tools that could have been used in grinding and hammering. The end of the axe is damaged, but it seems likely that it was probably broad-butted. The sides of the smaller stone tool are abraded, and one surface is flat, with Needham suggesting that it had been used as a grinding stone; it may be compared to examples from Ross Island.[63] One of the shorter ends of the larger stone is facetted, suggesting that it may have been used as a cushion stone, but one large surface is also flat, suggesting that it could also have been used as a grinding stone.

It seems likely that some of the stone tools in the graves of Bell Beaker metalworkers in continental Europe, particularly ones made of sandstone or stones with similar abrasive properties, could have been used as grinding stones for finishing cast objects such as knives or axes.

Identifying stone tools found in domestic contexts as tools for metal processing is not straightforward, partly due to the rarity of evidence for benficiation at or near to mines. The group of early Bell Beaker tools found at Sennen, Cornwall, is unusual because of the number of tools and their early date. As copper may well have been extracted in Cornwall, even if only on a small scale, the possibility that some of the tools were used for ore processing was considered but eventually rejected.[64] However, in the absence of chemical analyses for traces of metal, the evidence of the stone tools themselves is not clear-cut and the most important factor is the absence of ore processing waste.[65] Beneficiation debris was found in almost every feature at the Ross Island 'work camp', and similar residues would be expected to be present at Sennen if ore processing was undertaken at the site. The assemblage still remains unusual because of its date and size, but this might be because it could be associated, for example, with the apparent re-emergence of cultivation.[66]

Gold and tin

One of the distinguishing features of the Irish Bronze Age is its wealth of gold objects, and it is usually assumed that the gold they are made of would have been collected by 'panning' in streams for small nuggets of gold that occur amongst other minerals in 'placer' deposits of heavy minerals. These minerals fall out of suspension in steams because they are heavier than the other sediments. The same technique, which leaves few, if any, permanent traces, is also assumed to have been used in Britain.[67] Even if there was a need to excavate, loose gravels and sediments could be removed with antler picks and timber shovels, so there would not have been any need to use cobble stone mining tools. The faces of any workings could collapse naturally or be easily destroyed by later prospecting.

The same explanation – ephemeral traces of extraction and their destruction by subsequent exploitation – is also usually being advanced to account for the rarity of evidence for prehistoric tin mining, particularly in south-west England. As this region was not glaciated, it is possible that surface deposits of cassiterite could have been easily worked, and in modern times gold has been found in some tin streams. Tin is much less common than either gold or copper and when considered alongside the known importance of Cornish tin deposits in the historic times, it seems likely that it was the exploitation of Cornish tin that enabled the rapid and comprehensive introduction of tin bronze alloys across Britain and Ireland *c* 2200 BC. Although evidence for the use of tin streams in the Early Bronze Age is restricted to a small number of objects, there appear to be no other viable options for the source of tin.

Locating the sources of the gold used in Ireland has proved equally problematic, and there are a number of possible sources of gold. Scientific provenance studies of gold face several difficulties, the biggest of which is the fact that the quantities of the major elements in gold (eg silver, copper and tin) are known to vary across individual nuggets. These proportions can also be changed when the gold is

[59] O'Kelly and Shell 1979, 133, fig 6, pl 8

[60] *ibid*; Appendix 1 here, A4 below

[61] Simpson *et al* 2006, 87, 139–40, 153, fig 12.2

[62] Needham 1979, 282, fig 4.3; Appendix A1 here

[63] O'Brien 2004, fig 162; see now Needham 2017, 13–16, fig 3, for a date around the twenty-fourth century BC for the axe

[64] Jones *et al* 2012, 25

[65] The objections to the stones being used in ore processing were their early date, the size of the tools, and the absence of modification. However, tools with some or all these characteristics are found regularly at mines

[66] cf Stevens and Fuller 2012, 715. It should be noted, however, that virtually nothing is known of the methods by which gold and tin were processed

[67] eg Eogan 1994, 8–12; Craddock and Craddock 1996; Timberlake 2009, 102–4; Armbruster 2013, 463–4

worked and by the burial environment. As a consequence it is difficult to identify individual gold sources using the major elements.[68] This is well illustrated by the way that at different times Hartmann identified different analytical groupings in the data collected in his Europe-wide analyses of prehistoric gold objects conducted in the 1960s.[69] As a result, a systematic survey of potential gold sources and a thorough programme of materials analyses were launched by the Irish Prehistoric Gold Project.[70] These analyses have demonstrated that many Early Bronze Age objects contain small quantities of tin, and although no native source contains any measurable quantities of tin, field survey showed that gold and tin both occur in the same streams in the Mourne Mountains in Co Down in the north-east of the island, albeit in small quantities. As a result, it is possible that the two metals could have been collected together in gold panning, with the tin being a 'by-catch'. The initial analyses of the major elements of the gold from the Mourne Mountains showed that it has a high level of silver which appears to closely match that found in the majority of Irish Bronze Age gold objects, notably the important series of Early Bronze Age lunulae.[71]

However, it has also been suggested that gold was imported into Ireland. Utilizing advances in analytical methods, recent research has concentrated on the ratios of the four stable isotopes that occur in lead rather than the major elements such as silver. The technique is not without its difficulties, such as the low abundance of lead and interference by mercury, and it does not provide a unique signature for every ore deposit. Of much greater importance than these limitations is the fact that lead isotope ratios allow many mineral deposits to be characterized, not just those that contain gold.[72] Standish acquired data on the lead isotope ratios of Irish gold sources through new fieldwork and utilized the information from all the mineral deposits in Ireland whose lead isotopes had been analysed. These data were then compared with new analyses of the lead isotopes of 50 gold objects and their major elements. The lead isotope ratios of the objects were not consistent with any known source of gold in Ireland.

Some comparable data are available for other European regions, and the only dataset with which the Irish data are consistent is that from south-west England, suggesting that Cornwall has the greatest potential as the primary source of the gold used in Irish objects. Some support for this interpretation comes from a small number of gold lunulae in Cornwall, of which the finds from Harlyn Bay were associated with a flat axe.[73]

It is not yet known if cobble stone tools were used in acquiring gold and tin, or in any processing that was necessary, but stone tools were certainly used in the plastic working of objects made of precious metal and copper.

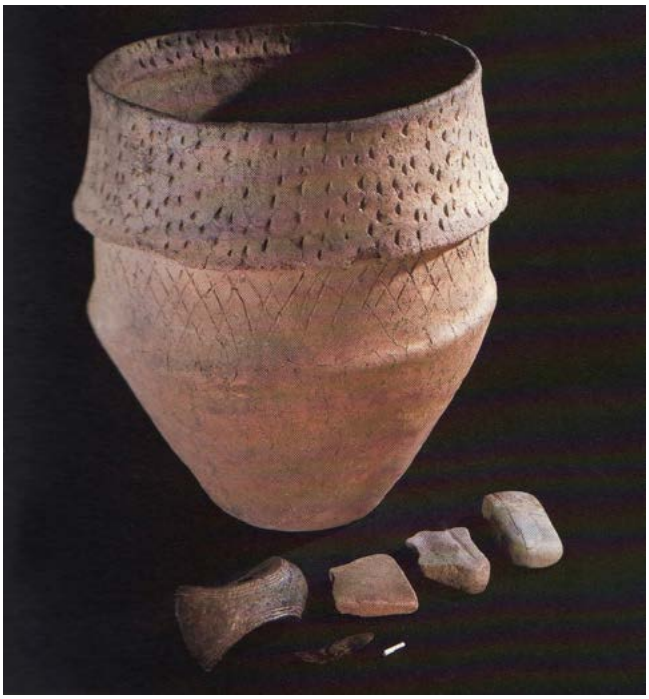


Fig 8 Grave group from Sandmill Farm, Dumfries and Galloway (Wigtownshire) (photograph courtesy of National Museums of Scotland)

Burials of early Bell Beaker metalworkers in Britain and Ireland

The evidence for the cultural identity of the people who mined the earliest copper in Britain and Ireland is modest, but what direct and indirect evidence there is suggests that they belonged to Bell Beaker groups. The same is true of the small number of early burials of metalworkers that are known.[74] These graves contain small stone tools that were used in the plastic shaping and finishing of objects of gold and copper. The function of these tools has been established by ethnographic analogy, experimental archaeology and analyses of metals residues in the surfaces of the tools.[75]

The tools found most commonly in these graves are small hammer-stones and anvils of a type that Butler and van der Waals christened 'cushion stones'.[76] Cushion stones were carefully shaped to provide flat surfaces and rounded edges that ensured that the soft copper and gold objects which

[68] Taylor 1999; 2001; Chapman *et al* 2006; Pernicka 2014a, 260–1; *idem* 2014b; Lockhoff and Pernicka 2014, 225–6

[69] Hartmann 1970; 1979. For critical comment see eg Briggs *et al* 1973; Warner 2004

[70] Chapman *et al* 2006

[71] Warner *et al* 2009; 2010

[72] Standish *et al* 2013; see now also Standish *et al* 2015

[73] Standish *et al* 2014, 217–9, fig 10; Mattingly *et al* 2009

[74] Appendix 1, A2–3

[75] eg Butler and van der Waals 1966; Freudenberg 2009; Fitzpatrick 2011, 219–21; many tools have traces of gold, vitiating the comments by Timberlake 2016, 132

[76] After the cushions used on sofas and chairs

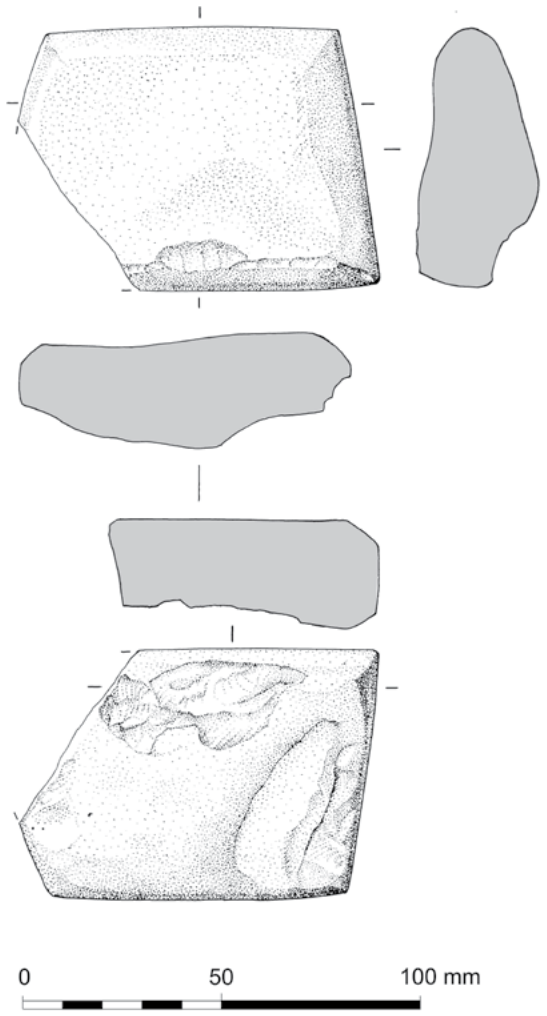


Fig 9 Cushion stone from the grave of the Amesbury Archer, Boscombe Down, Wiltshire (after Fitzpatrick 2011, fig 38)

were cold worked on them were not bent over when being hammered. Cushions stones and hammers occur regularly as a pair, though other tools are also found, including grinding stones / whetstones and, very occasionally, large cobble stone hammers. Up to seven tools have been found in a few graves, but most graves contain only one or two. Boar's tusks have been found in approximately one quarter of the graves with stone tools, often in direct association with them, suggesting that they were also metalworking tools, perhaps used for planishing or polishing.

Only two early Bell Beaker metalworker's burials are known from Britain; the Amesbury Archer who was buried at Boscombe Down in central southern England and the Kirkhaugh burial from Northumberland. These graves belong to a wider Bell Beaker tradition that marked metalworkers buried in single graves as having a high social status. Approximately fifty such early graves are now known across central and western Europe, but they are less well known in the western regions – Iberia, France and Ireland – that largely practised collective burial.[77] Three other graves with stone tools for metalworking are known from England, all from Wiltshire.[78] Two of them, at Amesbury and Winterbourne Monkton, contain later types of beakers, and there is a set of stone tools from the poorly published Early Bronze Age double grave at Upton Lovell. This important find is best known because of Stuart Piggott's suggestion that the perforated bone points associated with one of the burials indicate that the person was a shaman[79] and the twelve or more stone tools, one of which has traces of gold[80] are poorly known. *If* all objects are from the same burial, it could be interpreted in the ritualized context of metalworking set out by Budd and Taylor.[81] Early Bronze Age graves with stone tools for metalworking are less frequent all across Europe, but they include the grave at Sandmill, Wigtownshire, Scotland (Fig 8).[82]

In Ireland a range of Bell Beaker burial rites were practised, but one of the most common appears to have been collective burial in small megalithic graves known as 'wedge tombs.' No stone tools for metalworking have yet been identified in a grave in Ireland, but as many copper and gold objects are known, the presence of stone tools in other contexts should be anticipated. The recognition, therefore, of several unpublished examples in a preliminary survey is unsurprising and the topic deserves systematic study.[83]

The Amesbury Archer is one of the earliest Bell Beaker burials yet found in Britain. Modelling of the radiocarbon dates suggests that he died between *2380–2290 cal BC*,[84] and oxygen isotopes analyses show that when he was a teenager, the 35–45-year-old man had lived in a much colder climate before migrating to Wessex. The climatic zone stretches from the Alps to Scandinavia, but the strontium analyses exclude Scandinavia, while the objects that his mourners buried alongside him are most similar to those found in the sub-Alpine region, suggesting that these people had lived in this region before migrating.

The mourners placed a wide range of objects alongside the dead man. Some symbolized the status of a warrior, including seventeen arrows (and probably a bow), two archers' wristguards, three copper knives and numerous flint tools. In addition there were five beakers and a pair of gold basket-shaped ornaments that were probably used as tress rings. The copper knives and gold ornaments are the earliest dated examples from Britain. A single stone metalworking tool, a carefully shaped and worn cushion stone made from lydite (a form of chert), was found behind his back next to two boar's tusks (Fig 9). No traces of ancient metals were found in X-ray fluorescence analysis of the stone. Another two boar's tusks had been placed in front of the dead man.

A distinctive characteristic of the burial is was the placing of multiple objects, making it one of the most well-furnished

[77] cf Brandherm 2009

[78] Appendix 1, B2, 4–5

[79] Piggott 1962

[80] Shell 2000

[81] Budd and Taylor 1995

[82] Appendix 1, B6

[83] Appendix 1, C. The finds are not plotted on Figure 1 as they do not represent a systematic sample

[84] Fitzpatrick 2011

Bell Beaker burials in Europe. Although it has been suggested that some objects could have been added to the grave at a later date, the multiple objects are so similar as to suggest that they were made at the same time. Such 'overprovision' is commonly found in the graves of metalworkers in continental Europe and is as indicator of high status.[85]

An adjacent grave contained the burial of a 20–25-year-old man (called 'the Companion') who had died a generation or two after the Amesbury Archer, between (*2350–2260 cal BC*). A rare trait in their foot bones shows that the two men were related. The grave goods placed with younger man included a pair of basket-shaped gold ornaments, and a boar's tusk.

The Kirkhaugh, Northumberland, burial was excavated in 1935 and re-excavated in 2014.[86] The grave goods from both stages of work include an All-Over-Corded beaker, [87] two gold basked-shaped ornaments, jet buttons, four barbed and tanged arrowheads, and flint tools that include a fire-making set. There was also a small and carefully facetted cushion stone or a hammer, and a second stone tool, possibly a hammerstone. Although the burial did not survive, it was probably of a male, as arrowheads, basket-shaped ornaments and fire-making sets are almost invariably found in the graves of men.

As the grave could not be radiocarbon-dated directly, the best dating evidence comes from the All-Over-Corded beaker. This is one of the earliest types of beaker in Britain and may be no later in date than 2200 BC. This date is consistent with the typology of the gold ornaments. Although an absolute chronological sequence for the British gold ornaments has not yet been developed, the Kirkhaugh finds belong early in the sequence.[88]

In many ways the graves at Boscombe Down and Kirkhaugh are typical of single burials of Bell Beaker metalworkers in continental Europe.[89] They belong to an early phase of the local Bell Beaker sequence, they are certainly or probably of males, and the number and range of grave goods that were placed with them suggest that they were of a high social status which included the status of warrior. The stone tools placed in the grave were used in the finishing of metal objects. The earlier stages in the metalworking process such as mining or processing are not represented in the grave.

It has been proposed that the graves of Early Bronze Age metalworkers are not found close to mines and that there was an apparent discontinuity between the mining and processing of metals and the making and distribution of objects.[90] Although this interpretation can be applied to the burial of the Amesbury Archer,[91] Kirkhaugh is situated in an upland area that was mined extensively in the eighteenth–nineteenth centuries AD. This was primarily for lead, but smaller quantities of other minerals including copper were also mined on a commercial scale. As a result the Kirkhaugh burial can plausibly be interpreted as that of a Bell Beaker metal prospector or miner.[92] This would suggest that in Britain at least some metalworkers travelled to the sources of metal.

Early metal objects in Britain and Ireland

The copper that the knives in the grave of the Amesbury Archer were made of was imported, and it seems likely that they were brought as finished items. The gold used for the basket-shaped ornaments is also thought to have been imported. Although they are the earliest dated metal objects in Britain and Ireland, they are unlikely to be the very earliest. These may be anticipated to be copper axes that were imported before the introduction of metallurgy to the islands.[93] Such axes are found widely across Europe from the fourth millennium BC onwards,[94] but as noted above, in Britain and Ireland the overwhelming majority are either single finds or have been found only with other flat axes, meaning that there are few useful chronological associations. In typological terms early axes are quite simple objects, so the dating of single finds is likely to be on the basis of their metal composition.

The three small copper rings from grave 919 at Barrow Hills, Radley, Oxfordshire, have often been regarded as the earliest dated objects in Britain, as the radiocarbon dates from the grave are early and the metal the rings are made of has not been identified in early Bell Beaker objects.[95] This conclusion may be correct, but the standard deviations of the determinations are so large that the dates of 2630–2150 cal BC and 2860–2280 cal BC are now uninformative (OxA-1874: 3930±80 and OxA-1875: 3990±80). In addition, the two beakers associated with the two, apparently successive, burials are typologically much later than the earliest dated examples in England.[96] Thus, while the rings from Barrow Hills are the sort of simple object that may be anticipated to be amongst the earliest metal objects in Britain, an early date has not yet been demonstrated.

X-ray fluorescence analysis of the copper knives from the grave of the Amesbury Archer suggests that two of them were made from a copper whose lead isotopes suggest a northern Spanish source, while the third knife was made from a metal that has been identified widely in western France.

Although the basket-shaped ornaments from the grave are of distinctive insular type, the results of Energy Dispersive X-ray analysis (EDX) of the gold could not be matched with certainty with Irish gold objects, so it was suggested that the gold may have been imported from continental

[85] cf Hansen 2001

[86] Maryon 1936; Fitzpatrick *in preparation*

[87] Tait 1965, 16 no. 31; Clarke 1970, 491 no. 651, fig 3 no. 651

[88] O'Connor 2004, 207–8; Needham 2011, 134, see now also Fitzpatrick *et al* 2016

[89] Fitzpatrick 2011, 212–22

[90] Delgado-Raack and Risch 2006

[91] Fitzpatrick 2009, 182–3

[92] Fitzpatrick *in preparation*

[93] eg Case 1966, 166–8; Needham 1979, 281–2; Schmidt and Burgess 1981, 23; O'Brien 2004, 562; see now also Needham 2017, 12–13

[94] eg Klassen *et al* 2007

[95] eg Needham 1999; Northover 1999, 212; Bray 2012, 59

[96] Fitzpatrick 2011, 178



Fig 10 Gold ornament from Benraw, Co Down; length 70mm (photograph courtesy of the National Museum of Ireland)

Europe.[97] The ornaments were made from an onion-shaped piece of thin sheet gold whose edges were decorated with rows of *pointillé* decoration before the object was rolled up (including the stem or 'tang') to form a cylinder. The ornaments buried a generation or two later with the Companion are very similar, but the gold is from a different source which was suggested tentatively to be Irish,[98] although now might be suggested to be Cornish.

A similar shift in gold sources is seen in the ornaments from Chilbolton, Hampshire, *c* 25km to the north-east.[99] There was also a wooden chamber in the Chilbolton grave and it contained two successive burials, both of men. The primary burial was dated to 2460–1920 cal BC (OxA-1072: 3740±80 BP) and the secondary burial to 2470–1970 cal BC (OxA-1073: 3780±80 BP). Although these dates also have large standard deviations, it is clear that the burials were made within one or two generations of each other. In the excavation report two pairs of basket-shaped ornaments were attributed to the primary burial with which a copper knife and a Wessex / Middle Rhine type beaker were also associated, but Needham has plausibly suggested that a pair of ornaments was placed with each burial.[100] On typological grounds the ornaments are slightly later than those buried with the Amesbury Archer and Companion.

Metallurgical analyses using surface X-ray Fluorescence showed that the copper knife appears to be made from a continental European metal and not Irish 'A' or Ross Island metal. The smaller gold ornaments have a composition similar to those in the Amesbury Archer's grave and the metal may be continental European. In contrast, the larger gold ornaments and the gold bead from Chilbolton have a low copper composition that is similar to that of the ornaments found with the Companion, for which an insular source has been suggested. These three graves provide important dating evidence for the availability of insular metals at a distance from their sources within a few generations of the arrival of the Bell Beaker groups in Britain and Ireland.

The Continental parallels of the gold objects provide important evidence about the origins of the insular metalworking traditions, particularly as early Bell Beaker copper knives are very simple,[101] which means that it is not yet possible to suggest where imported knives might have been made. The connections of the earliest gold objects – George Eogan's 'Primary Bell Beaker Gold' – with the Atlantic façade are particularly noticeable.[102] Although the wealth of early gold ornaments from Iberia means that parallels are more likely to be found there than anywhere else, some of the similarities between the objects are very close. In the case of the basket-shaped ornament from Benraw (previously said to from Deehommed), *c* 12km north of the Mourne Mountains, Co Down (Fig 10),[103] the object may be an import. The ornament is a Bell Beaker type, and analyses confirm that the gold is not typical of Irish finds. As the best parallels for the ornament are from Estremoz, Évora, and Gruta da Ermegeira, Lisbon, both in Portugal,[104] it would seem likely that the Irish find was made on the Atlantic façade in the twenty-fourth or twenty-third century BC, even though the composition of the gold is apparently different from Iberian objects.[105]

The tangs of the Gruta da Ermegeira ornaments are bent over like hooks, suggesting that they could have been earrings. The tangs of the Estremoz and Benraw ornaments are now flat, but they could also originally have been bent over, and the tangs of the British find that resemble most closely the Gruta da Ermegeira pair, the pair said to be from Gilmorton, Leicestershire, are also hooked.[106]

[97] This allows for the well-known surface depletion of gold that causes its gold content to be over-represented and copper to be under-represented in surface X-ray Fluorescence

[98] Needham 2011, 136–8

[99] Russel 1990

[100] Needham 2011, 137

[101] eg Zimmermann 2007

[102] Eogan 1994, 13–22

[103] Cahill 2006, 267–8; cf Armstrong 1920, 38, 86 no. 350, pl xviii, 413; Taylor 1980, 22, pl 3, h–i; *eadem* 1994, 46; *eadem* 1999, 113, fig 14.2; O'Connor 2004, 209, fig 18.3

[104] Leisner 1965, 7, 265, pl 12.2, 10; Pingel 1992, 14, 291 no. 249c (2638); 295 no. 274 (2641–2), fig 3, pl 54 nos 11–12; 102 no. 6; Armbruster and Parreira 1993, 156–9

[105] Taylor 2001

[106] Needham 2008a

Simple gold discs are widely found,[107] but it seems likely that examples in Brittany and Iberia were the inspiration for the British and Irish series.[108] Although most finds are from Ireland, the best dating evidence comes from graves in Wessex. As noted above, the earliest of these is, on the basis of the type of beaker placed in in it, the Mere G6a, Wiltshire, grave.[109] The surviving disc from Mere has a cross on one side, but finds that do not have a cross and only have either only *pointillé* decoration around the edge, as at Kirk St Andrew, Isle of Man, or a combination of *pointillé* and incised circles, as at Banc Tynddol, might be earlier. The relative and absolute sequences for the different varieties of disc remain to be established, but some remarkable detective work has shown that two discs and a lunula were found together at Coggalbeg, Co Roscommon.[110]

There are also parallels in Iberia for other early gold objects from Britain. Tubular gold beads like the one in the Chilbolton grave are well known in Iberia,[111] and rather less certainly, an undated gold diadem said to be from nearby in the Winchester area has a high gold content which might suggest that it may be of Bell Beaker date. It is related to the plaque 'from Cavan', and several diadems are known from Armorica and Iberia.[112]

However, these 'primary Bell Beaker Gold' types rapidly developed an insular character. The crosses found on the Irish and British 'sun-discs' are not found on Continental discs, while the closed, cylindrical shape of the British basked-shaped ornaments is distinct from the broadly contemporary central and north-western European Bell Beaker *Lockenringe*.[113] These were worn either as tress rings or on headdresses and usually have a spiral stem and small, often rectangular, terminal plates.[114]

Seen in this context, the gold ornaments found in Britain and Ireland can be interpreted as insular adaptions of Atlantic types that probably originated in Iberia, which became distinctive regional variants in the European family of Bell Beaker precious-metal ornaments. Metallurgical analyses suggest a period in southern England in which imported copper knives, imported gold, and perhaps also insular gold were current, but the objects made from the gold were insular in style. As with copper from Ross Island, insular gold, perhaps from Cornwall, soon became dominant across Britain in the later third millennium BC.

Conclusion

The evidence for stone tools for early Bell Beaker metalworking in Britain and Ireland is unusual in a European context, insofar as it is possible to see the lithic technology used in all stages of the *chaîne opératoire*. One feature shared by the cobble stone mining hammers and the tools used for the plastic shaping of objects is the careful selection of suitable stones.

Most Copper and Bronze Age mines in Europe have been identified by the presence of cobble stone mining tools. These tools were used in mining and processing and were selected from beach or river cobbles and hundreds, probably thousands, of stones were transported to the mines, to be used after the stone faces of the mine had been weakened by fire-setting. Most cobble stone stools were not modified, and the grooves or rills that helped fix the handles or hafts of the hammers at Ross Island are not typical. However, the evidence from the Bronze Age mines at Ecton and Alderley Edge makes it clear that some 'hard rocks' are so soft that fire-setting was not necessary and very few stone tools were used in mining.

Smaller hammers and mortars were used in the subsequent processing of the ores by crushing and grinding. At Ross Island the mining and processing took place in the same location, but smelting may have been carried out elsewhere. The relatively low temperatures needed for smelting mean that the process may not have produced much durable slag and will have left few archaeological traces, making evidence for the process difficult to locate. Groups of stone tools used in finishing cast objects are known from Hindlow and Newgrange, but the numerous stone moulds from Ireland and northern Britain seem likely, on the evidence presently available, to date to the Early Bronze Age. The earliest objects that can be regarded with some confidence as ingots are small circular discs of unworked copper from south-west Ireland, while a single droplet of casting waste is known from Northton on the Isle of Harris in the Outer Hebrides.

Mining at Ross Island started in the twenty-fourth century BC, when the technology was introduced from continental Europe by Bell Beaker groups. Though copper mining in Wales may prove to have started shortly afterwards, Ross Island, and perhaps also other mines in south-west Ireland, rapidly became the most important source of copper in Britain and Ireland during the later third millennium BC.

Unlike copper, there is, as yet, no evidence for the sites at which early gold (or tin) was collected or extracted, but the most recent fieldwork and metallurgical analyses have suggested that Cornwall was the major source of the gold used in Ireland. In Wessex, insular-style Bell Beaker objects were being made in a gold that was apparently not imported, no later than the twenty-second century BC. New analyses are required to establish if the lead isotope ratios of the gold these objects were made of is consistent with a Cornish source. What, if any, stone tools were used in processing gold and tin remains to be determined, but in view of the lithic technology used in all other aspects of the *chaîne*

[107] Endrődi and Pásztor 2006

[108] eg Éluère 1977, 217, fig 20

[109] A fragment of a Wessex / Middle Rhine beaker was also associated with the disc found in the cist at Jugs Grave, Farleigh Wick, Wiltshire; Clarke 1970, 94–5

[110] Kelly and Cahill 2010

[111] eg from Gruta da Ermegeira: Leisner 1965, 7, 265, pl 12.2, 8–9; Pingel 1992, 12–14, 295 no. 274 (2639–40, 2643–5), fig 3, pl 54 nos. 11–12

[112] Needham 2008b; Needham and Sheridan 2014, 908–9, fig 6; Éluère 1977, 397, fig 6, 10; Nicolas *et al* 2013, 217, fig 20

[113] eg Hásek 1989; O'Connor 2004, 208; Küssner 2006; Meller 2014, 616–20

[114] The plate on the recent find from Eelde, Drenthe in the north Netherlands, is more circular, however, and closer to the British finds; Lanting 2013, 74; Drenth 2014; another pair of similar ornaments has also been reported subsequently from Tremelo, Brabant, Belgium (G Mulder pers comm)

opératoire for metal, the possibility that stone tools were used should not be dismissed.

Although only two early Bell Beaker burials of metalworkers are currently known in Britain, and none from Ireland, they share many characteristics with burials of metalworkers in continental Europe, in that they were ascribed a high social status, one aspect of which included being a warrior.

In the past, discussions of the origins of metalworking in Britain and Ireland have largely been based on the typology of objects[115] and to a lesser extent on their metal composition.[116] Now the mining technology can be shown to have its best parallels in the Bell Beaker copper mines of southern France and northern Spain,[117] and the parallels of the earliest gold ornaments found in Britain and Ireland are with finds from Iberia and western France. This is consistent with an origin for insular metallurgy along the Atlantic façade.[118] In contrast, the metalworkers' graves found in England are part of a Europe-wide Bell Beaker single burial rite that is best known in central Europe. These different strands of evidence for origins are consistent with the possibility that the earliest Bell Beaker groups to travel to Britain and Ireland came from different parts of continental Europe.[119]

The assumption that metalworking in the full Bronze Age was an elite activity has been challenged,[120] and there is no evidence to suggest that the mining undertaken by these earlier Bell Beaker groups was a full-time activity rather than one that was undertaken seasonally, particularly where the ores were in upland locations. It has been suggested that in the Bronze Age mining was undertaken seasonally by transhumant pastoralists,[121] and a similar view has been advanced for central Europe.[122] However, the situation when metallurgy was first introduced to these islands was rather different. In Ireland, the comprehensive technological knowledge of all stages of metallurgy displayed at Ross Island – prospection, mining, beneficiation, and perhaps roasting and / or smelting – is consistent with specialist knowledge[123] introduced directly from continental Europe. Metallurgy may also have been introduced directly to Wales; the gold 'sun disc' discovered at Banc Tynddol, below the Copa Hill mine, is a type of object that is found most frequently in Ireland.

While this evidence is consistent with the rapid and long-distance transfer of metallurgical knowledge across north-western Europe in the third millennium BC,[124] it does not, however, exclude the participation of indigenous pastoralist communities in the mining and processing of the ores.[125] In particular, the knowledge possessed by peoples with a long familiarity with the uplands could have been invaluable to Bell Beaker groups who were new to the territory. However, only the Bell Beaker groups will initially have had knowledge about making metal and making objects, and this might help explain why copper mining and ore processing and smelting appear to have been done in different places. Mining and processing may have been done with other groups, but smelting may only have been undertaken by Bell Beaker groups, though this shift in location is by no means unique to Britain and Ireland.[126]

The placing of stone tools for metalworking in graves was undoubtedly practised mainly by Bell Beaker groups, but the status of a metalworker was only one aspect of the *social persona* that was enacted in this burial rite; the status of a warrior was also portrayed prominently.[127] Given the small number of early metal objects that are known and the relative ease with which they could be made, it seems unlikely that these men were specialist smiths. Instead, the presence of stone tools in their graves may signify their ability to gain access to metals and to control the distribution of objects, in particular the small gold ornaments that were used to display social status.[128] The recognition that the Kirkhaugh burial is on the edge of a major orefield now suggests that some metalworkers travelled to the sources of metal, and although the Amesbury Archer was buried far from any source of metal, he had travelled far from his childhood residence. This mobility could have allowed metal to be both a *source* of status and a *means* of expressing it, and this seems to be typical of the value ascribed to the material by Bell Beaker groups in north-western Europe.[129]

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[115] eg Burgess 1979, 210–13, Harbison 1979, 99–103; Taylor 1979, 235–7
[116] eg Case 1966; Northover 1999; Needham 2002; Bray 2012
[117] Ambert and Vaquer 2005
[118] Ryan 1979; O'Brien 2005, 49; Roussot-Larroque 2005
[119] eg Fitzpatrick 2013
[120] eg Kienlin 2007; Kuijpers 2008
[121] eg Timberlake 2003, 112; *idem* 2009, 101–2
[122] eg Kienlin and Stöllner 2009
[123] eg Ottaway 2001
[124] eg Roberts 2008; 2009a; 2009b; Roberts *et al* 2009
[125] cf Kienlin 2010, 113
[126] Kienlin 2010, 17
[127] Fitzpatrick 2011, 208–29
[128] Turek 2004
[129] Fitzpatrick 2013

Bergbau-Museum and Frances Lynch (Bangor University), Brendan O'Connor (Edinburgh), and Julia Roussot-Larroque (Bordeaux) all provided copies of publications while Erik Drenth (Amersfoort) drew my attention to the gold ornament from Eelde, as did Guy de Mulder (Ghent) about the find from Tremelo. Peter Marshall advised on the modelling on radiocarbon dates, and Phil Andrews, Brenda Craddock, Paul Craddock, Ben Roberts and Simon Timberlake kindly commented on an earlier draft.

The illustrations are by Liz James, and the British Museum, the National Museum of Ireland, and the National Museum of Scotland kindly provided photographs.

Appendix 1

Stone Metalworking Tools in Britain and Ireland

In his *Beaker Pottery of Britain and Ireland*, David Clarke noted five late Bell Beaker graves (ie probably of early Bronze Age date), containing what he described as 'pebble hammers': Aberdeen, no. 1451; Amble, Northumberland, no. 652; Garton Slack, East Yorkshire, no. 1306 (N3); Rudston, East Yorkshire, nos 1368–9; Wick, Somerset, no. 820).[130]

None of these stones appear to be carefully-shaped tools, though this does not preclude them from being stone tools for metalworking. Clarke noted only two 'polished and faceted' hammerstones, the finds from Amesbury G54 and Winterbourne Monkton (B1 and B4 below).

The stones from Kirkhaugh, Northumberland, were not noted by Clarke but have since been identified as a cushion stone and a possible hammer. It is not clear if the stone or hammer from the second barrow at Kirkhaugh is worked.[131]

The largest group of stone tools for metalworking from Britain is from the Early Bronze Age grave at Upton Lovell, Wiltshire (B4 below). These were excavated in the nineteenth century but have never been fully published.

Some stones noted by Lynch as 'long, rectangular polishers', eg Rhos y Gath, Anglesey, Wales,[132] are not dissimilar to stones from Amesbury G54 and Winterbourne Monkton, but most of the ones that she illustrates have a cutting edge which suggests that they may be small axes. The function and date of these finds is unclear and few finds come from helpful contexts. Rather better dated are the stones that Lynch described as 'axe-shaped polishers.' Some of these have been found in graves with Early Bronze Age Food Vessels.[133]

Stones that appear to have been used as whetstones are found occasionally in bronze hoards, for example in the Adabroc, Isle of Lewis, hoard, and such finds are not included below.[134]

A – Bell Beaker / Copper Age

England

Derbyshire

A1 Hindlow

Context not known

Two stone blocks were apparently found with a copper flat axe (see Fig 7).[135] Needham proposes that the different grain sizes and qualities of the stones indicates that they were used in different stages in an abrasion and percussion process, probably plastic shaping.

[130] Clarke 1970

[131] Fitzpatrick 2011, 217; *in preparation*

[132] Lynch 2001, 399, fig 1.1, pl on p 402

[133] Simpson 1968, 206, fig 49; Lynch 2001, 402–3

[134] Anderson 1911, 28, 34; Coles 1959–60, 127 nos 15–16

[135] Needham 1979, 282, fig 4.3; *idem* 2011, 115

Northumberland

A2 Kirkhaugh

Grave

Two stone tools from the well-furnished Bell Beaker burial. One is a small cushion stone or hammer made from a sedimentary rock. The other is a hammerstone made from sandstone, which is likely to be local.[136] It is not clear if the stone from the second stone cairn at Kirkhaugh is worked.

Wiltshire

A3 Amesbury Archer, Boscombe Down

Grave

A cushion stone made of lydite, a form of chert, from the very well-furnished Bell Beaker burial (see Fig 9). Two boar's tusks were found next to the stone.[137]

Ireland

County Meath

A4 Newgrange

Settlement

Three stones found in Bell Beaker occupation debris are suggested to be metalworking tools: a quartzite hammerstone (probably a cushion stone),[138] a chert 'rubber' or 'polisher'[139] and a round pebble.[140] These tools were found close to two adjacent boulders.[141] The upper surface of one of the boulders was worn smooth and because of this it is suggested to be a seat. The upper surface of the other boulder has many small indentations and because of this it was suggested to be an anvil. A Killaha phase (Early Bronze Age) flat axe was also found nearby. Although these finds are from the same horizon and suggest that metalworking was taking place next to the by then ancient passage grave, they are not a closed group.

Other stone tools from the excavation were also suggested to be associated with metalworking: a chert 'rubbing stone' or 'burnisher' from Site 2,[142] a sandstone hone,[143] and a broken perforated hammer made of granite.[144] The Killaha type bronze axe dates to *c* 2000 BC[145] and is consistent with the radiocarbon dates from the site, but some of the beaker pottery from the area may well be earlier.

B – Early Bronze Age

England

Suffolk

B1 West Row, Mildenhall

Context unknown

A cushion stone made from a Group VIII Welsh axe.[146] Clough and Green also mention a small quartzite rubber from Back Row, Mildenhall, that they suggest might be a cushion stone.[147] A small sandstone block from Cambridge and bar of rhyolite from Wherstead, Suffolk, are also suggested to be cushion stones but are not illustrated. The context of all four of the stones is not given.

Wiltshire

B2 Amesbury G54

Grave

A later Bell Beaker inhumation burial was the primary burial at the Amesbury G54 barrow. A finely worked hammer may be from a siliceous hornstone.[148] The beaker is of Clarke's Southern 2 style (a 'Long-necked beaker' in Needham's scheme).[149] Interestingly there is a fine flint dagger from the burial, but no metal objects.[150]

B3 Teffont

Context unknown

A small rectangular block in Salisbury and South Wilshire Museum from Magna Down, Teffont (Accession number 71/1950), suggested to be of Jadeite, might be a small cushion stone.

B4 Upton Lovell G2a

Grave

Two successive burials were found in this barrow,[151] and there is some uncertainty about the attribution of the grave goods to the individual burials,[152] though Needham suggests that most may have been associated with the primary burial, which was of a man[153] and that he suggests probably dates to his Bronze Age Period 3, *c* 1950/1900–1750/1700 BC.[154] The thirty-six perforated bone points from the grave were famously interpreted by Piggott as being from the costume of a shaman.[155] The twelve or more stone tools from the grave have never been published satisfactorily and are usually omitted from publications, for example they are absent from Annable and Simpson's catalogue.[156] Most of the stones were found near the feet, but one of them was found on the chest of the man. These tools comprise up to nine 'rubbers', many of which

[136] Maryon 1936; Fitzpatrick 2011; *in preparation*
[137] Fitzpatrick 2011
[138] O'Kelly and Shell 1979, 130–1, fig 3, pl 3: E 56, 972
[139] *ibid*, 130–1, pl 3: E56, 965
[140] *ibid*, 130–1, pl 3: E56, 970
[141] *ibid*, 127, pl 2; O'Kelly *et al* 1983, 16, fig 4
[142] O'Kelly and Shell 1979, 130–1, fig 5: E126, 67
[143] *ibid*, 131, pl 3: E56, 559
[144] *ibid*, 131, fig 4: 130: ES 56, 973
[145] Needham 2011, 115
[146] Clough and Green 1972, 118–20, 127, 151, fig 13, S74; Lynch 2001, 399
[147] Clough and Green 1972, 127, 151, fig 13, S67
[148] Annable and Simpson 1964, 39, fig 69; Clarke 1970, 501 no. 1039, fig 890
[149] Needham 2005, 195–6
[150] Annable and Simpson 1964, 39 nos 67–9, figs 67–9; Clarke 1970, 501 no. 1039, fig 890; Piggott 1973, 343–4, fig 14, d; Harrison 1980, 103, fig 69
[151] Cunnington 1806
[152] Annable and Simpson 1964, 50
[153] Needham 2011, 115
[154] cf Needham and Woodward 2008, 6, fig 3
[155] Piggott 1962
[156] Annable and Simpson 1964, 49–50

are circular, two small hammerstones that may have been made from a Neolithic axe, a whetstone, and a slate object that has traces of gold.[157] There is also an arrow-shaft smoother,[158] four pierced boar's tusks, and four hollow flint nodules. Other finds from the grave include two Neolithic flint axes, two battle-axes, a bronze awl, a shale belt ring, three shale beads, a possible bone bead, and a bone plaque.

B5 Winterbourne Monkton
Grave
An inhumation burial with two late beakers also contained a hammerstone,[159] said by Clarke to be of serpentine.[160] Other grave goods were two shale buttons and a shale belt ring.[161]

Scotland

Dumfries and Galloway

B6 Sandmill, Wigtownshire
Grave
Three sandstone tools were found with the urned cremation burial of an adult (see Fig 8).[162] Two of the stones have been suggested to be cushion stones, the third a whetstone,[163] but it seems more likely that they are two whetstones and a possible cushion stone. The stones and the burial were within an inverted Collared Urn along with a stone battle axe, the blade of a bronze razor, and a bone pin.

C – Uncertain date

Ireland

Butler and van der Waals illustrated an unprovenanced cushion stone allegedly in the collections of the National Museum of Ireland.[164] A rapid preliminary assessment undertaken by the author in 2010 of some of the stones in the Reserve that have traditionally been identified as 'smoothers' indicated that many are likely to be stone tools for metalworking.

At this stage there is a bias towards the identification of cushion stones because the stones have been shaped and they often have clear signs of working, although in comparison to continental European Bell Beaker examples, several of the stones are very small. In view of the number of objects of gold, copper and bronze that were made in prehistoric Ireland, the presence of a wider range of stone tools for metalworking is to be expected and the material merits comprehensive study.

As work on cataloguing the Reserve Collection is currently in progress and many more possible stone have already been identified[165] the finds have not been plotted on Figure 1 and the following list should only be taken as a broad indication that tools may be found all across Ireland, from Co Antrim in the north-east to Co Limerick in the south-west and Co Wexford in the south-east.

The number of stones identified in the Keiller Knowles collection reflects the fact that it has been comparatively well-studied and is easily accessible. Most objects from the Collection (abbreviated as KK) are likely to be from Co Antrim or north-east Ireland more generally.[166]

Co Antrim[167]

C1 Cross (Moorfields)
KK 14, 851: Cushion stone

C2 Kanestown
NMI 1927.198: Hammer

C3 Three Towns/Braid. Kilnacolpagh
KK 14, 800: Cushion stone

C4 Tievebulliagh
NMI 1934.4559: Cushion stone

C5 Co Antrim
NMI 1927.202: Cushion stone

C6 Co Antrim
?KK NMI 1927.202 (1): Hammer

C7 Co Antrim
?KK NMI 1927 202 (2): Hammer

C8 Braid River Valley
NMI KK 2892: Hammer?

C9 Uncertain provenance, possibly north-east Ireland
?KK 13, 132: Cushion stone
?KK 14, 808: Cushion stone
?KK 14, 798: Cushion stone

Co Limerick

C10 Cappasmore
NMI 2004.22: Cushion stone

Co Wexford

C11 Millguarter, Old Ross
NMI X2109: Cushion stone

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[157] Shell 2000

[158] Annable and Simpson 1964, 49 no. 256, fig 256; see now Hunter and Woodward 2015, 73–5, fig 4.2.1–2 for this and some of the other grave goods

[159] Annable and Simpson 1964, 39 no. 75

[160] Clarke 1970, 504 no. 1185, fig 898

[161] Annable and Simpson 1964, 39 nos 70–6, figs 70–6

[162] Anderson 1941–42, 82, pl xxi, 2; Clarke *et al* 1985, 295–6, fig 7.31

[163] *ibid*

[164] Butler and van der Waals 1966, fig 17 right. This stone could not be located during the preliminary assessment undertaken by the author in the collections of the National Museum in 2010. It has since emerged that, although stated by Butler and van der Waals to be in the National Museum of Ireland, the two stones pictured in their fig 17 are in fact in the Ashmolean Museum, Oxford (L Boutoille pers comm)

[165] M Cahill, pers comm

[166] cf Woodman *et al* 2006

D – Finds not considered to be metalworking tools

England

Gloucestershire

D1 Somerford Keynes, Neigh Bridge

Settlement

A square stone with one smooth, flat face and four bevelled sides from a Romano-British context has been suggested to probably be a cushion stone,[168] but the stone is very small (68 × 66 × 43mm). Although the stone is from a Romano-British context, the stone may be a Cornish greenstone. If it is, it is likely to have been made from a Group I Neolithic axe. These axes were made in Cornwall and distributed very widely across Britain.

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Cushion stones and company: British and Irish finds of stone metalworking implements from the Bell Beaker period to the Late Bronze Age

Linda Boutoille

From the beginning of metallurgy, stone tools have been used in in the plastic shaping of metals. Due to their presence within Bell Beaker and Early Bronze Age graves, stone implements used for plastic shaping are often generically attributed to these periods, even were no dating evidence is available, obscuring their presence in later contexts. The aim of this contribution is to highlight the fact that stone hammers and stone anvils in Britain and Ireland were used throughout the Bronze Age and to offer further insights into their exact function.

Introduction

In 1966, Jay Butler and Diderik van der Waals published their seminal study of Bell Beaker burials in the Netherlands, where in some grave assemblages they identified stone tools possibly used for the plastic shaping of metal.[1] Based on the parallelepipedic shape of these implements, evoking the form of a sofa cushion, they called them 'cushion stones',[2] a label which stuck. Subsequently, similar implements were also identified in Bell Beaker and Early Bronze Age graves from central Europe.[3]

Butler and van der Waals in their discussion of the Dutch implements for comparison pictured two cushion stones from Northern Ireland,[4] but the first systematic survey of relevant Insular finds was undertaken by David Clarke in his corpus of Bell Beaker vessels from Great Britain and Ireland.[5] In his catalogue Clarke identified seven Bell Beaker burials with hammer stones.[6] Five of the relevant implements are described by him as 'pebble hammer stones' and the two last as a 'polished and facetted hammerstone'[7] and a 'smith's hammerstone' respectively,[8] although one of these is classified as 'no more than a personal whetstone' or a 'polisher' by Stuart Piggott.[9] Piggott seemed to deny the presence of metalworking stone tools in British Bell Beaker graves, but based on the stone implements found in two later Early Bronze Age burials he interpreted these as metalworker graves, the first at Upton Lovell and the second at Winterbourne Stoke 8, both in Wiltshire. For him, both of the relevant tools set must be interpreted in the same way as the tools described by Butler and van der Waals from Dutch Bell Beaker contexts.[10]

Subsequently, Frances Lynch identified several stone axeheads from England and Wales as possibly having been used in metalworking.[11] Some of these seem to be stone axes that were probably reused as polishers. None of them can definitely be ascribed a function in the *chaîne opératoire* of metalworking.

Other than the isolated foray into the topic by Lynch, following Clarke's and Piggott's studies, the subject of metalworking stone tools did not receive any further attention in British archaeology until the discovery of the Amesbury Archer in 2008 yielded a stone implement interpreted by the excavator as an anvil for metalworking.[12] The publication of the Amesbury Archer find provided Stuart Needham with an opportunity to update the catalogue of Bell Beaker and Early Bronze Age stone tools from Great Britain that possibly were used in metalworking.[13]

Due to the fact that the first stone tools for the plastic shaping of metal were identified among the grave goods from Bell Beaker and Early Bronze Age burials, subsequent research on these implements has very much focused on those early periods, with single finds often attributed to the Chalcolithic or Early Bronze Age without considering other possibilities, even were dating evidence is entirely lacking. More importantly, tools found in settlement contexts or hoards often remained unrecognized, masking the functional diversity of these specialized tools.

Drawing on an ongoing survey of the relevant material undertaken by the author, in the present contribution we will provide a short overview of a selection of stone implements used in the plastic shaping of metal from settlements, funerary contexts, hoards and single finds found in Britain and Ireland, expanding on the work by Butler and van der Waals,[14] Needham[15] and Fitzpatrick,[16] and adding information on some newly identified tools. We will discuss the morphological diversity of these tools and how their shape and size can provide valuable clues about their exact function in shaping objects from copper-base or precious metals.

[1] Butler and van der Waals 1966
[2] *ibid*, 63
[3] Moucha 1989; Bátora 2002
[4] Butler and van der Waals 1966, fig 17
[5] Clarke 1970
[6] *ibid*, 440, 442, 443, 445
[7] *ibid*, 445
[8] *ibid*, 388 no. 890, 389 no. 898
[9] Piggott 1938; 1973, 343–4
[10] *idem* 1973, 344
[11] Lynch 2001
[12] Fitzpatrick 2009; 2011; this volume
[13] Needham 2011
[14] Butler and van der Waals 1966
[15] Needham 2011
[16] Fitzpatrick, this volume

D Brandherm (ed): *Aspects of the Bronze Age in the Atlantic Archipelago and Beyond. Proceedings from the Belfast Bronze Age Forum, 9–10 November 2013.* Archæologia Atlantica – Monographiæ III (2019 [2025]): 203–217



Fig 1 Tool from the Amesbury G54 burial, Wiltshire; the highly polished active surface could indicate a function as a hammer for goldsmithing (© Wiltshire Museum)

Metalworking stone tools from the Bell Beaker period to the Late Bronze Age

Despite the sporadic attention that British and Irish finds of stone tools for the plastic shaping of metals have received in the literature,[17] there has been relatively little systematic research on these implements. No typological classification has been attempted, and we still ignore their exact function, chronological range and if some tools were destined to work specific metals. Depending on the metal worked, but also on the type of object produced and on the step of the *chaîne opératoire* in which an implement was employed, these tools can show considerable variation in terms of their size, mass and morphology. For example, tools for hammering gold sheets are normally different from tools for working bronze objects. Because the malleability of gold, silver and copper is considerably higher than that of bronze or iron, hammers used by a goldsmith generally have a lower mass than the corresponding tools used by a bronzesmith or blacksmith. For the same reason, goldsmith's tools also require a highly polished surface to avoid leaving tool traces on the finished gold object.

Analyses of metal residues on stone tools mainly from eastern and central Europe have given mixed results. Some stone implements, like the tool from the Amesbury Archer burial, have produced suspicious outcomes, indicating modern contamination.[18] Another stone tool that possibly appears to have suffered some modern contamination is one of the two hammers from a Bell Beaker grave at Zwenkau in Saxony, Germany, which has yielded metal traces with a relatively high content of zinc.[19] Two minuscule metal flakes identified on the other stone hammer from this burial show silver and gold in one instance and silver as well as copper in the other, which is much more in line with what we know about Bell Beaker metallurgy.[20] Traces of gold have also been found on a hammer from Turovice, Czech Republic,[21] and traces of silver on tools from Tira del Lienzo in Spain.[22] A hammer from grave 9 at Künzing-Bruck in Germany has yielded traces of gold with a high level of copper,[23] while drops of lead oxide identified on a hammer from Clohars-Carnoët in Finistère, France, probably do not relate directly to its use as a tool for the plastic shaping of metal but to it being kept in a workshop where lead-rich metal was handled in molten form.[24]

Even if metal traces often reveal that the same tool was used to work more than one metal, this does not mean that some metalworkers did not specialize as, for example, gold- or coppersmiths. Depending on need, a goldsmith can work with gold as well as silver or copper and still be considered

[17] Butler and van der Waals 1966; Clarke 1970; Piggott 1973; Lynch 2001
[18] Bertemes and Heyd 2002; Cowen and Middleton 2011, 117
[19] Conrad 2009–10, 72
[20] *ibid*; Drenth *et al* 2016, 48
[21] Bertemes and Heyd 2002, 216–17
[22] Delgado-Raack *et al* 2016
[23] Bertemes *et al* 2002, 216
[24] Boutoille 2015, 92–3

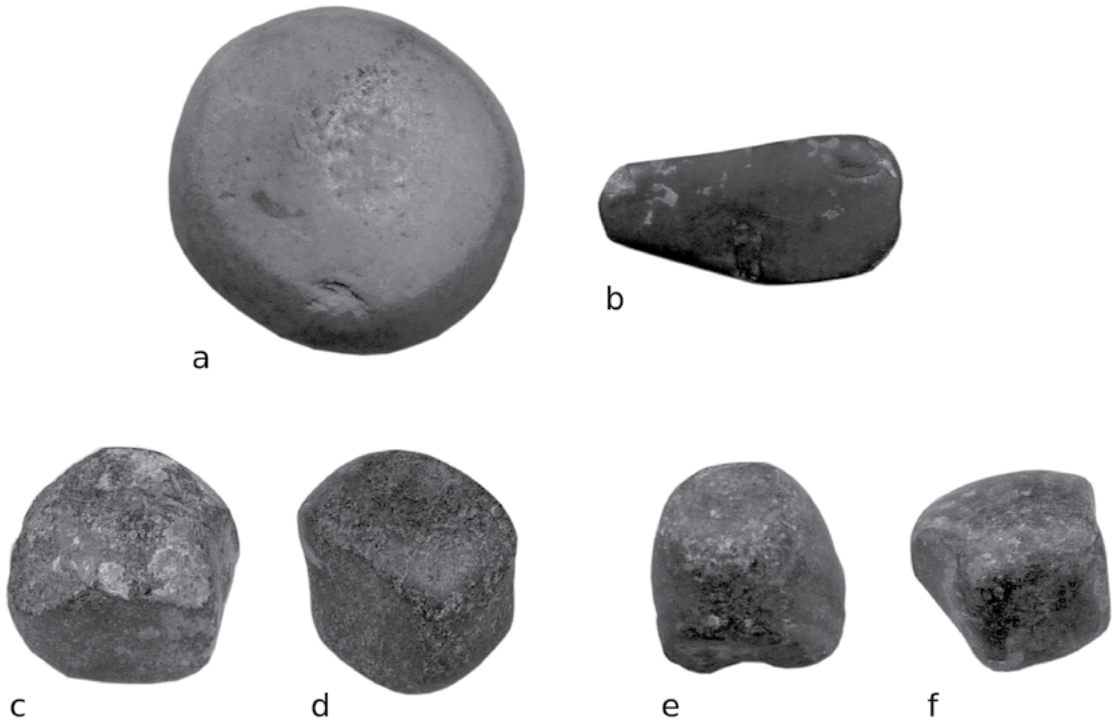


Fig 2 Tools from 'shaman-goldsmith' burial at Upton Lovell G2a, Wiltshire; the touchstone (**b**) used to test the quality of gold or precious-metal alloys indicates that the deceased was probably involved in goldworking (© Wiltshire Museum)

a goldsmith by their social group. Items combining gold and copper-base metal, such as the gold-wire studded dagger hilt from Wilsford G5 in Wiltshire,[25] or combining copper-base metal and bone, etc, could attest that metalworkers worked metal as well as other materials, eg bone, stone, wood or leather, despite being considered metalworking specialists, or even specialized goldsmiths by their community. In Great Britain and Ireland we currently have few analyses of metal traces on tools, and additional analytical work to identify and determine the make-up of such traces is urgently needed.

Metalworking stone tools from funerary contexts in Britain

Elsewhere in this volume, Andrew Fitzpatrick has already presented some graves containing metalworking stone tools, mainly from the Bell Beaker period.[26] Here we are going to expand on some burials with similar implements from the Early Bronze Age.

The tool from the Amesbury G54 barrow in Wiltshire has been described by Clarke as a 'smith's serpentine hammer'[27] but was interpreted as a whetstone by Piggott.[28] The object is of perfectly rectangular shape, with an oval, highly polished active surface at each end, one of which shows a tiny golden streak that has not yet been analysed. The upper and lower faces are slightly curved, while the sides are flat (Fig 1). Its size (111mm long by 31.5mm wide), its mass (181g) and the use of serpentine as a material clearly distinguish this object from other whetstones present in British Early Bronze Age graves, which are generally smaller.[29] The highly polished active surfaces could indicate a use as a goldsmithing tool.

The Winterbourne Stoke 8 burial, also in Wiltshire, has yielded two stone implements interpreted by Stuart Piggott as a metalworking tool set, similar to the sets present in Dutch Bell Beaker graves.[30] Recently, both stones from Winterbourne Stoke 8 have been analysed and identified as hones used for whetting metal blades.[31] If it seems obvious that neither of the two tools was used for hammering, they not only vary in overall size but, being made from different raw materials, they also show distinct grain sizes. This suggests different functions and places within the *chaîne opératoire* for these two implements. The tool with the larger grain size could, for example, have been used for deburring metal objects, while the second, more finely grained tool could have been used for the final sharpening of metal blades. Like the tool set from the aforementioned Zwenkau Bell Beaker grave, they might constitute an emery kit.[32] They also show another step in the *chaîne opératoire* of manufac-

[25] Needham *et al* 2015, 243, fig 6.2.4
[26] Fitzpatrick, this volume
[27] Clarke 1970, fig 898
[28] Piggott 1973, 344
[29] Woodward and Hunter 2015, 76–82
[30] Piggott 1973, 344
[31] Woodward and Hunter 2015, 81–2, fig 4.4.1
[32] cf Campen 2001, 50; Conrad 2009–10, 72, fig 36



Fig 3 Hammer from Newgrange, Co Meath; the tool would have been more suitable for working massive objects, such as axes, rather than sheet metal (© National Museum of Ireland)

turing metal objects which often receives less consideration than plastic shaping or casting.

The Early Bronze Age double burial from Upton Lovell G2a has been well known in the antiquarian and archaeological literature for more than two centuries. Unearthed by William Cunnington and Sir Richard Colt Hoare in 1801, and published five years later,[33] this is probably one of the most unusual burials known from the Wessex culture.[34] The barrow containing this burial was a circular mound on the downs of Upton Lovell parish, 10m in diameter and 0.3m in height. Cunnington and Colt Hoare encountered the central chalk-cut grave at a depth of 1m, with a primary inhumation of a 'skeleton lying on its back [...] head towards the north'.[35] Above, they found a second, crouched inhumation. The first inhumation contained a wide and rather original range of objects, mainly in stone and bone. By the feet of the deceased, the two discoverers identified nearly forty perforated bones points, three flint axes and several stone tools, as well as a broken battle axe. On his legs, several perforated boar's tusks and marcasite cups were placed. A shaft-hole dolerite axe and twenty-four perforated bone points were placed on his chest. Some of the bone points were likely sewn to the fringes of the clothing, while others were graded and formed a necklace.[36] Stuart Piggott recognized the various stones as part of a metalworking tool set and due to the unusual nature of the whole assemblage interpreted the grave as the burial of a 'metalworker-shaman'.[37]

The lithic assemblage includes a round stone with hexagonal section and part of its surface polished, with some traces of hammering and stripes (Fig 2a). A very thin golden streak is present on the surface but has not been analysed yet. The stone could have been used as an anvil. Two further sets of stone implements are present in this assemblage. These comprise two items reworked from a broken battle axe and two objects made from a grooved battle axe, all of which could have been used as hammers at different stages of the *chaîne opératoire* of metalworking (Fig 2c–f).

Apart from this toolkit possibly used for the plastic shaping of metals, a small slate implement with gold traces that show a composition similar to other Early Bronze Age gold items from Wessex also formed part of the Upton Lovell assemblage (Fig 2b).[38] Previously interpreted as a burnisher,[39] it is more likely to have been a touchstone used to test the quality of gold or precious-metal alloys. Touchstones provide an opportunity for adjusting the application of metalworking techniques in accordance with the composition of the metal. They are uncommon in Bronze Age contexts, and more so in Early Bronze Age graves. The Upton Lovell specimen it is probably the earliest touchstone so far identified in western Europe. The assemblage seems to constitute the belongings of someone involved in goldworking who knew how to determine the quality of gold and probably, depending on the outcome of that determination, knew how to adjust his or her techniques.

However, if stone tools may be a possible indicator for the identification of craftspeople's graves, metallurgical instruments and tools might also attest to the social status of the deceased or reflect symbolic beliefs. In central and eastern Europe, apart from lithic metalworking implements, blow pipes, crucibles and casting moulds are also present within graves and may be interpreted along similar lines.[40] A recent survey by Albrecht Jockenhövel identified twenty different types of artefacts that can be linked to metallurgical practices.[41] The presence of tools or instruments for smithing and casting in different graves could thus reflect distinct craft specialisms. For the Early Bronze Age of central and eastern Europe, Josef Bátora, based on the tool sets present within the burials, distinguishes between founder's graves and smith's graves.[42]

In Great Britain, two burials are recorded with clay tools possibly associated with metalworking and based on this have been interpreted as potential founder's graves.[43] The first is a grave from Woodhouse End (Gawsworth), near Macclesfield in Cheshire, which yielded a clay blow pipe in association with a food vessel, a small cup and two flint tools.[44] The second corresponds to a burial excavated at Ewanrigg-

[33] Cunnington 1806
[34] Piggott 1962
[35] Cunnington 1806, 123
[36] Piggott 1962; Woodward and Hunter 2015, 109
[37] Piggott 1962; 1973, 344, 362
[38] Shell 2000
[39] *ibid*
[40] Bátora 2002, 179–95, 217–21
[41] Jockenhövel 2018, 218–20, fig 1
[42] *ibid*, 179
[43] Kuijpers 2008, 58; Boutoille forthcoming
[44] Rowley 1977; Longworth 1984, 56, 67, 70, 161 no. 135

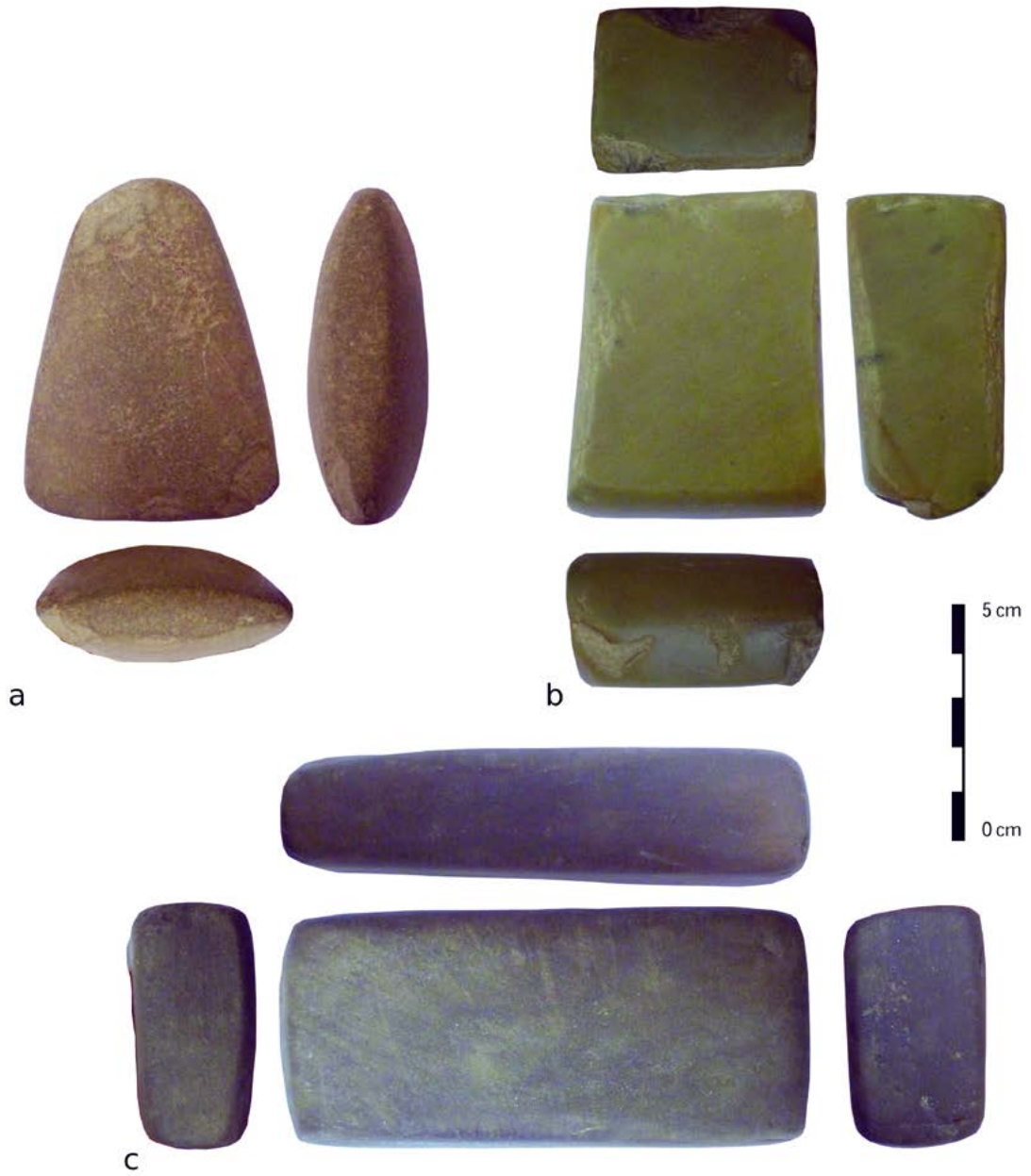


Fig 4 Tools from Rathgall, Co Wicklow; three distinct tools with probably different functions (author's photographs)

Maryport, Cumbria.[45] This grave yielded a collared urn, an accessory cup, a possible burnt arrowhead and a clay tube interpreted as part of a blowing system, although in this instance its interpretation as an instrument used in metallurgical activities seems less certain.

Bronze tools for the plastic shaping of metal, ie hammers and anvils, are extremely rare from funerary contexts anywhere in the European Bronze Age. Some of the few examples from graves are a bronze hammer from Migennes, Yonne, in France,[46] an anvil from Lachen-Speyerdorf, Rhineland-Palatinate,[47] and another hammer from Puls, Schleswig-Holstein, the latter two both in Germany.[48] With the possible exception of some repurposed flat axes, metal hammers and anvils only are introduced over the course of the Middle Bronze Age, so it is unsurprising that in line with the general dearth of metal objects from Middle and Late Bronze Age burials in Britain and Ireland, they are completely unknown from funerary contexts in these islands. However, Albrecht Jockenhövel,[49] Bianka Nessel[50] and Dirk Brandherm[51] have pointed out that some small tools like punches and chisels may also have been used for metalworking and not only for leather- or woodworking. It may even have been more common to place a small tool such as a chisel in a grave, symbolizing a complete metalworker

[45] Bewley *et al* 1992, 328–9, fig 7
[46] Roscio *et al* 2011, 178, fig 5
[47] Sperber 2000, 386–92, fig 2
[48] Nessel 2012, 58–61, fig 5
[49] Jockenhövel 2018, 218–20, fig 1
[50] Nessel 2012, 55–7, 61–4, figs 1, 9
[51] Brandherm 2010, 320–2 fig 4,3.4

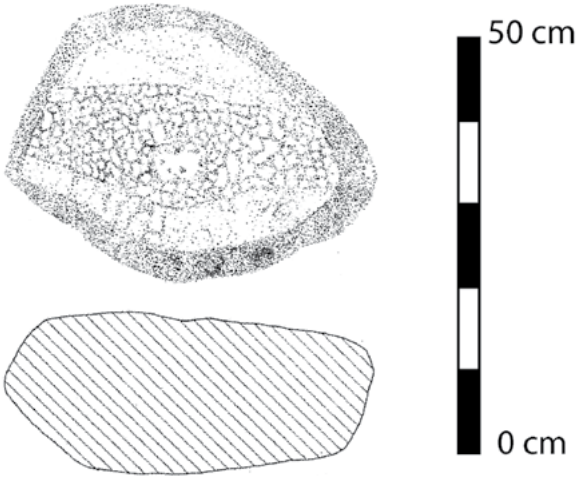


Fig 5 Stone anvil from Lough Eskragh, Co Tyrone; the size of the anvil and the use-wear seem to indicate that it was used in bronze-working (after William and Pilcher 1978, fig 9)

tool set as a *pars pro toto*, than one of the larger implements from that tool set.

If we accept this idea, some other burials may also contain possible metalworking tools. The following are not meant as an exhaustive list but just to provide some examples. The Early Bronze Age grave from Balneil, Wigtownshire, in Scotland consists of a cinerary urn containing cremated bones of two adults, along with a faïence bead, a bone pin and a lugged bronze chisel[52] which could have been used for metalworking. Chisels or small axehead are also present in some other graves like Snail Down, site XIX, SPTA 2207, and Wilsford G64, both in Wiltshire.[53] If the function of these objects as metalworking tools were confirmed, they might provide evidence for further social distinction.



Fig 6 Stone tool from the hoard of Killymaddy, Co Antrim; the shape of the active surface indicates a use as anvil, probably for shaping small metal artefacts (© National Museum of Ireland)



Fig 7 Tool from the hoard found at Donhead-Saint-Mary, Wiltshire (© Salisbury Museum)

In Great Britain, graves with metalworking tools then seem to be present from the Bell Beaker period through the Early Bronze Age, yielding stone tools but also blow pipes and metal chisels, which could attest to distinct craft specialisms. While some of the relevant stone tools, eg whetstones, are clearly associated with abrasive techniques, other tools appear to have been used for the plastic shaping of metal. The presence of gold traces on some of them, eg at Upton Lovell, and the high level of polishing seen on many active surfaces lends support to the idea that these tools were used mainly for goldsmithing.

Metalworking stone tools from settlements

The presence of stone tools used in metalworking is rarely mentioned in excavation reports relating to settlement sites, but they may simply be under-represented. A number of such tools have probably been found in Bronze Age settlements but have not been recognized and interpreted as generic hammer stones or polishers. However, in some instances metalworking tools from settlement contexts have been identified in the literature, mostly on sites in the Republic of Ireland.

Probably one of the first mentioned is a stone hammer found at Newgrange, Co Meath, in a Bell Beaker settlement extending on the periphery of the well-known passage tomb.[54] The settlement yielded a series of living floors with pottery but also traces of flint working, a bronze flat axe and three stone implements which might have been used in metalworking. The most significant item is a hammer stone in light-yellow quartzite with a trapezoidal shape

[52] Clarke *et al* 1985, 294 no. 130

[53] Thomas 2005, 226

[54] O'Kelly and Shell 1978, 127



Fig 8 Tool from Northern Ireland; the object had been interpreted by Jay Butler as a cushion stone for metalworking, but the use-wear on the different faces seems to correspond to various distinct functions (© Ashmolean Museum, University of Oxford)

and rectangular section (Fig 3). Its active surface is finely pecked, regularly shaped and could have been used for finishing metal objects.[55] With a mass of 300g and based on the shape of the active surface, it would have been more suitable for working massive objects, such as axes, rather than sheet metal.

Three other tools are from Rathgall near Tullow, Co Wicklow. Excavation of the site started at the end of the nineteen-sixties, under the direction of Barry Raftery. The site consists of a multivallate hillfort and yielded some metal workshop areas mainly dedicated to casting a large quantity of bronze weapons and tools, with a very substantial number of clay moulds along with many crucibles fragments.[56] Three stone implements from the site seem to be metalworking tools. The first is made from a small stone axehead, with the cutting edge reworked into a polished flat surface, and could have been used as a hammer for metalworking (Fig 4a). The two other stone tools are made from rectangular blocks, with traces of use on the shorter sides that could indicate a use as hammers (Fig 4b–c). The distinct shapes of the active surfaces and the different mass of the tools (153g, 193g and 350g respectively) seem to indicate different uses. Because of its lesser mass, the reworked axehead was probably used in the shaping of small objects rather than more massive items, such as small gold or bronze sheets.

Another object is reported from Lough Eskragh, Co Tyrone, a Late Bronze Age lake-platform settlement where metalworking activities are attested by the presence of a dozen clay mould fragments used for the casting of swords and socketed axeheads, and several crucibles like at Rathgall.[57] An oval sandstone boulder with a flat surface displaying an area of pecking has been interpreted as a probable anvil for metalworking (Fig 5).[58] The size of this implement, 450 by 310mm, would seem to correspond to a tool used for hammering large bronze objects, such as swords, rather than to a tool for manufacturing small items.

Bronze Age metalworking structures are extremely rare and when they are found often remain doubtful in their

[55] *ibid*, 130

[56] Ó Faoláin 2004, 59–60

[57] *ibid*, 64–5

[58] William and Pilcher 1978, 43, fig 9; Ó Faoláin 2004, 65, fig 4.16

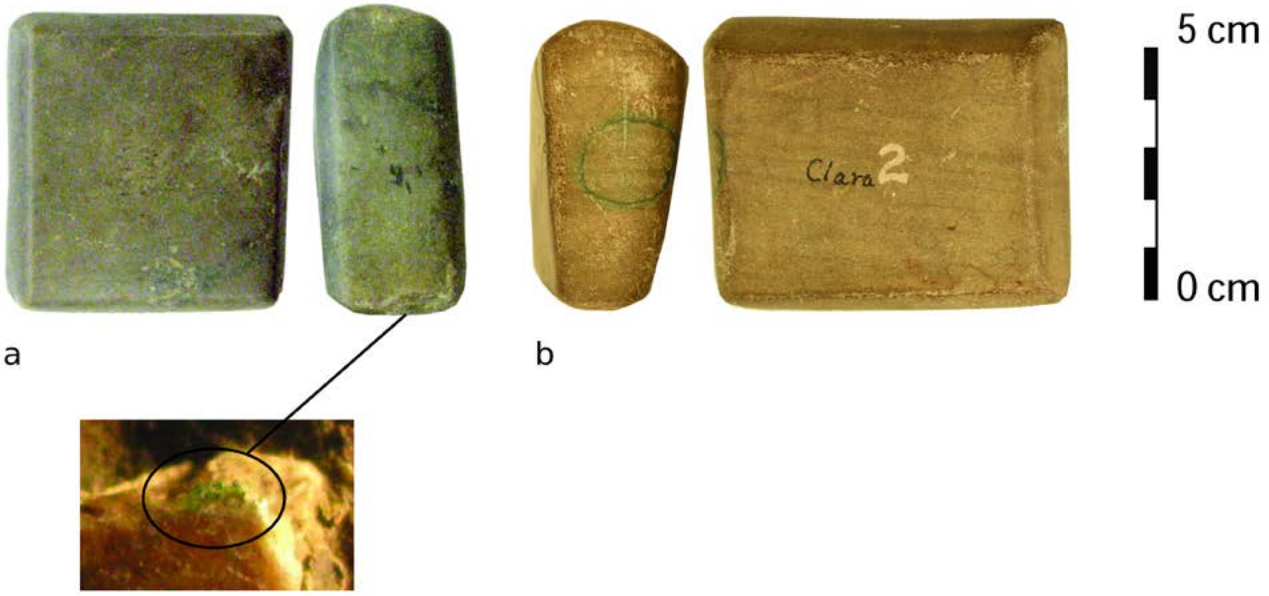


Fig 9 Cushion stones from Northern Ireland (**a**) and Clara (**b**), Co Offaly; both seem to show copper-alloy residues (© Ashmolean Museum, University of Oxford [**a**] and National Museum of Ireland [**b**])

identification, due to their poor state of preservation. The recognition of metalworking workshops frequently depends on the presence of broken moulds or bronze waste, all of which correspond to detritus from casting activities. In contrast, other metalworking activities, like smithing, goldworking or the finishing of cast objects, are rarely documented.

For the Late Bronze Age in Ireland, Simon Ó Faoláin listed eighteen sites where metalworking activities took place, divided in five different categories of site.[59] Three sites are undefended nucleated settlements, five are enclosed defended settlements, two are lake platforms and two more possible lake platforms. Metalworking activities illustrated by clay moulds have also been identified at four sites interpreted as ritual places and two sites of not clearly identified type.[60] Amongst these sites, only two count with the presence of metalworking stone tools (Rathgall and Lough Eskragh), despite a considerable quantity of stone tools for example from Dun Aengus, Co Galway, or from Killymoon, Co Tyrone.[61] Due to our lack of knowledge about these tools, it is possible that stone implements for metalworking among them have not been recognized. Further study of the assemblages from those sites would be helpful. It would provide an opportunity to identify metalworking tools, clarify their typology, specify the nature of metalworking activities undertaken at those sites and perhaps even identify metalworking sites without any trace of metal.

Metalworking stone tools in hoards

Metalworking stone tools are also present in hoard assemblages, in some cases entirely composed of lithic implements, in others comprising both stone and metal tools.[62] Because of their different composition from funerary assemblages, frequently containing a larger number of tools, these assemblages provide important additional information about the make-up of metalworking tool sets. Continental hoard finds with metalworking implements in chronological terms range from the Bell Beaker period to the Late Bronze Age, and some of these are referred to below for purposes of comparison.

Among the earliest assemblages of this type is a find of twenty-three stones found at Hengelo, province of Gelderland in the Netherlands, described by Erik Drenth and Mechtild Freudenberg, and interpreted as a Late Neolithic / Bell Beaker hoard.[63] Discovered in a pit and probably placed in an organic container, the assemblage includes two arrow-shaft smoothers, one axe, two cushion stones, four hammer stones, one of which was clearly intended for the plastic shaping of metals, two rubbing stones and seven whetstones. The hammer, as well as both cushion stones, would have been suitable for making and planishing sheet metal. With a mass of 415g, the hammer is quite heavy and could have been used for beating out metal sheets rather than shaping small items.

Neutron activation analysis has shown the presences of traces of gold and copper on both cushion stones and on one of the whetstones.[64] A ^{14}C date on a charcoal sample from a pit intersected by the feature containing the assemblage gave a result of 2289–2111/2104–2036 BC (Ua-36482: 3755±40 BP; 2-sigma calibration with OxCal 4.2) and suggests an attribution to the Bell Beaker period. Strictly speaking of course, due to the context of the charcoal sample, the

[59] Ó Faoláin 2004, 52–74
[60] *ibid*, 34
[61] Clarke and Newton 2012, 57
[62] Drenth *et al* 2016; Boutoille forthcoming
[63] Drenth *et al* 2016
[64] *ibid*, 48



Fig 10 Tool from Teffont Magna, Wiltshire, made from an Alpine stone axehead (© Salisbury Museum)

date provides only a *terminus post quem* for the pit and thus for the deposition of the tools.[65] In conclusion, the hoard seems to be composed partially of stone tools linked to metalwork production and partially of implements relating to archery. Both of these activities held a deep significance for Bell Beaker people and are often associated with individuals of high social status, eg the Amesbury Archer.[66] Both aspects also seem to have been closely linked more widely during the Bell Beaker period.[67]

A much later Continental assemblage containing a stone metalworking tool is the hoard from La Petite Laugère at Génelard in Saône-et-Loire, France.[68] This Late Bronze Age hoard comprises a metalworking tool kit including one stone hammer, four metal hammers, two metal anvils, a bronze mould valve, a set of chisels and punches, as well as a whetstone. A spearhead, two knives, two pins and various other items also form part of this assemblage. The hoard is usually interpreted as the belongings of a smith.[69] One of the most interesting points about this hoard is that it demonstrates how during the later stages of the Bronze Age metal hammers and stone hammers were used together, and how both uses are not incompatible. It also shows that metalworkers were probably looking for tools with different properties, to be used at different stages of the *chaîne opératoire* of metalwork production. We know from metal analyses that some metal hammers and anvils had widely diverging compositions, some with a very high tin content, influencing their mechanical properties.[70]

Metalworking stone tools in British and Irish hoard assemblages are rare but not altogether lacking. They are attested from the beginning of the Early Bronze Age to the Late Bronze Age in a range of different hoards. Stuart Needham has already pointed out the presence of two stones probably used for finishing, grinding and hammering metal in the hoard from Hindlow, near Buxton in Derbyshire,

[65] Drenth *et al* 2016, 44
[66] Fitzpatrick, this volume
[67] cf Bertemes and Heyd 2002
[68] Thevenot 1998
[69] *ibid*
[70] Boutoille forthcoming



Fig 11 Probable hammer from Blackbrook Farm, Westmeston, Sussex; the tool is made from a serpentine axehead (© Lewes Castle and Barbican House Museum)



Fig 12 Stone hammers from Ballyvourney (**a**), Co Cork, and from Esker South near Dublin (**b**); both are made from repurposed stone axeheads (© National Museum of Ireland)

which also contained a copper flat axe. The stone tools from this hoard correspond to two modified pebbles with a finely pecked active surface[71] and seem comparable to the stone hammer found at Newgrange, probably also used for hammering metal axes.

Another stone implement for the plastic shaping of metal is known from the Killymaddy hoard, Co Antrim, found in December 1910, by a farmer while ploughing. Acquired in 1911, it is now housed at the National Museum of Ireland in Dublin. The hoard consists of three bivalve moulds, three single valves and four mould fragments that were used for manufacturing looped and socketed spearheads, dirks, tanged knifes, dagger and sickles.[72] The typology of the objects produced corresponds to the beginning of the Middle Bronze Age, ie between the 16th and the 15th century BC.[73] Alongside the moulds, three further stone tools were found, two whetstones and one implement referred to as a tool for 'hammering or smoothing'.[74] This last item seems to correspond to the butt end of a stone axe head with a polished, angled active surface (Fig 6), similar to that found on a metal anvil from the hoard of Fresné-la-Mère, Calvados in France.[75] Based on the size of the implement and on the shape of the active surface, the tool is probably more an anvil than a hammer and could have been used for folding small metal sheets and a range of related purposes. It could also have been used as an anvil for sharpening metal blades[76] and in association with the two whetstones from this hoard could constitute a kind of sharpening kit used for honing the blades produced with the moulds.

In May 1896, while digging for chert at Donhead-Saint-Mary, Wiltshire, the labourer M L Lewis discovered a 'curious collection of bronze implements', including one complete bronze mould, three socketed axes, eight winged palstaves, one socketed hammer, one thin socketed gouge, a large bronze ring, two lumps of bronze, various bumbles of wire and a whetstone described as dark green, with flat sides and a ground round edge.[77] The stone is a parallelepipedic block (Fig 7). The upper face is flat and has a smoothly polished surface, with traces of wear at the centre. The lower face is convex and also smoothly polished. Like the tool from the Amesbury Archer burial, this implement could have been used as an anvil.

In conclusion, metalworking stone tools are present in hoards throughout the Bronze Age and served both active and passive uses in the plastic shaping of metals, as well as for abrasive actions. While metalworking stone tools from funerary contexts in Britain are limited to implements used in the plastic shaping of small items only, in hoard assemblages we also encounter stone hammers seemingly used for forging massive bronze objects or sharpening blades, attesting the diversity of lithic implements used in metalworking. The lithic metalworking tools found in hoards also indicate the use of stone and metal tools alongside each other within the same *chaîne opératoire* and thus demonstrate their complementary nature. The choice of tools from different materials for distinct purposes within the same *chaîne opératoire* demonstrates a high level of knowledge of the properties of the metal worked and employed but also of the stone used for the lithic implements. It further suggests that metalworkers probably used tools from other materials as well, such as bone, wood, etc.

[71] Needham 1979, 282, 269, fig 4.3; *idem* 2011, 115; Fitzpatrick, this volume

[72] Ó Faoláin 2004, 157-8

[73] Roberts *et al* 2013; Boutoille 2012, 8

[74] Milligan 1911, 384

[75] Boutoille 2017, 83–4

[76] *eadem* 2011, 88; *eadem* 2017, 82–3

[77] Passmore 1931, 375

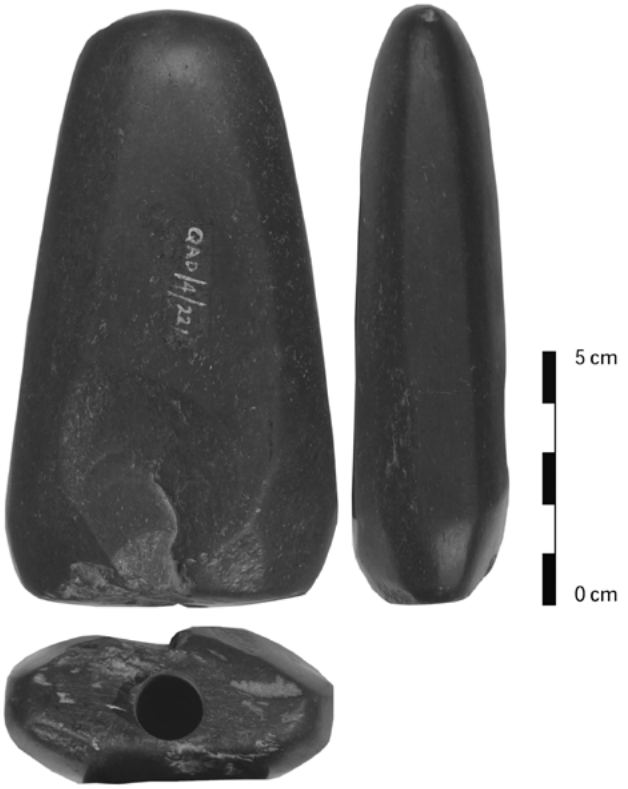


Fig 13 Probable hammer made from porcellanite axehead from Monkstown, Co Antrim (author's photograph)

Some single finds

The majority of stone metalworking implements from Britain and Ireland do not come from burial contexts, settlements or hoards but constitute single finds without any well-defined context. Here we discuss some of those finds which for one reason or the other are of particular interest.

In their seminal 1966 publication about Bell Beaker graves from the Netherlands, Butler and van der Waals already mentioned and illustrated two stone metalworking tools from Northern Ireland that do appear to be single finds.[78] The first is a pebble with four oval polished surfaces on its different faces (Fig 8). The polish differs between faces. On one face, the surface shows deep streaks, whereas on the other faces it is perfectly polished. This seems to indicate distinct uses, the surface with the deep streaks might have been used eg as a linen smoother. Further use-wear analysis would be needed to determine its exact function. A tiny copper-alloy stain is present on one of the other faces. The second implement is a perfectly polished quadrangular object that could have been used as an anvil (Fig 9a). One of its corners is broken and shows copper-alloy residues. This tool resembles an object from Clara, Co Offaly (Fig 9b), housed at the National Museum of Ireland in Dublin, for which no precise context of discovery is known. On one face, the object shows a circular green stain which gives the impression that it has been in prolonged contact with a circular copper-alloy object, such as a ring. The shape of its faces suggests that the tool could have been used both as an anvil and a hammer.

From across Britain and Ireland we also know a number of metalworking tools that were manufactured from reworked stone axeheads. All known specimens of this kind so far are single finds, and they form a much smaller proportion amongst British and Irish stone metalworking tools than do comparable pieces elsewhere in western Europe.

One such implement was found around 1900 in Teffont Magna, Wiltshire, and is now preserved in the Salisbury and South Wiltshire Museum, where it was initially described as an 'unperforated Neolithic polished greenstone macehead' (Fig 10). Subsequent inquiries undertaken in 1974 by M Fletcher for the Ordnance Survey Archaeological Division were unable to obtain more accurate information relating to the find spot or the context of discovery. More recently, the object has been studied and analysed as part of the Jade Project led by Pierre Pétrequin, demonstrating that it was made from a Type Puy Alpine axehead.[79] With 153 specimens, this type of axehead is the most common variety of Alpine greenstone axehead in France, but with only five known pieces to-date it remains rare in the United Kingdom. It first appears during the Chasséen and sees a rapid diffusion to the north-west of France; by 3600 BC it is found across much of continental north-west Europe.[80] Type Puy axeheads seem to have been inspired by the first metal axes and heralded the demise of the production of Alpine greenstone axeheads. The spectroradiometric analysis has identified the material as a dark green jadeitite, possibly from Voltri in the Monte Beigua massif, where this kind of rock is normally rarer than at Monte Viso.[81] In its present form the tool has a trapezoidal shape, 58mm long by 23.3mm wide, with a mass of 152g, and could be a small cushion stone.

The identification of the next object we owe to Fiona Roe, who unfortunately was not left with enough time to publish the implement. The tool is from Blackbrook Farm, Westmeston, in Sussex (Fig 11), with no further information regarding its find circumstances. It is now housed at the Lewes Castle and Barbican House Museum at Lewes. The implement was reworked from a small serpentinite axehead,[82] whose raw material Fiona Roe suspected to come from the Lizard peninsula in Cornwall.[83] The object has a trapezoidal shape and measures 61.5mm long by 37mm wide, with a mass of 182g. The butt is imperfectly polished and some traces of pecking remain. The edges are polished but also with some imperfections. The active surface is of a shiny polish, straight, with a slightly convex profile. Like the implement from Teffont Magna, it is a small tool with a perfectly polished active surface, and thus probably more suitable for shaping small gold items than, for example, bronze axes.

Metalworking implements made from modified stone axeheads have also been identified in Ireland. One such

[78] Butler and van der Waals 1966, fig 17; the authors at the time referred to those two objects as housed at the National Museum of Ireland (*ibid*, 72), but they are indeed kept at the Ashmolean Museum in Oxford

[79] Sheridan *et al* 2010, 28, fig 7 no. 4

[80] Pétrequin *et al* 2012, 690

[81] *ibid*

[82] Clough and Cummins 1988, 165 no. 64

[83] F Roe pers comm



Fig 14 Two hammers made from modified stone axeheads, Ireland, no exact provenance; both tools have differently shaped active surfaces, suggesting distinct functions (© National Museums of Northern Ireland)

object has been found near Ballyvourney, Co Cork, and is now housed at the National Museum of Ireland in Dublin (Fig 12a). Like the tool from Teffont Magna, it seems to be made from a Type Puy Alpine axehead, but in this case the analysis undertaken by Pierre Pétrequin indicates a probable eclogite from Monte Viso in Italy as raw material. With a mass of only 82g and a length of 60mm it is also a very small tool, probably best suited for shaping small metal objects.

Another implement comes from Esker South near Dublin. It is made from a small stone axehead, but the exact raw material has not been identified (Fig 12b). Its shape is trapezoidal with a rectangular section, 60mm long by 42mm wide, with a mass of 97g.

One final provenanced object to be presented here comes from Monkstown, Co Antrim, in Northern Ireland, and is kept in the archaeological teaching collection of Queen's University Belfast. It is made from a porcellanite axehead, originally with an oval section, but subsequently had its lateral, ventral and dorsal faces polished down and reworked to give it a hexagonal section (Fig 13). The active surface is polished but marred by ancient impact damage and a recent borehole for petrological analysis, whose author and results remain unknown. Prior to sustaining this damage, the shape of the active surface was probably oval and flat. With a length of 112mm and a mass of 416g, this is a heavy tool, probably intended for working larger objects than the tools made from modified axeheads that we have discussed previously.

Two other objects from Ireland, but without an exact provenance, are housed at the Ulster Museum in Belfast. These are two reworked stone axeheads with a polished and flat active surface. In the first of these modified axeheads, the active surface adopts an oval shape (Fig 14a). This kind of active surface is common in metalworking implements from France, where it constitutes the most frequently found type, corresponding to hammers used for shaping metal sheets.[84] The second axehead is quite different. In this piece the active surface adopts a near-rectangular shape, and more interestingly the two extremities of the original cutting edge have each been modified and replaced by a polished square face (Fig 14b). This kind of modification is rare but present on

[84] Boutoille forthcoming

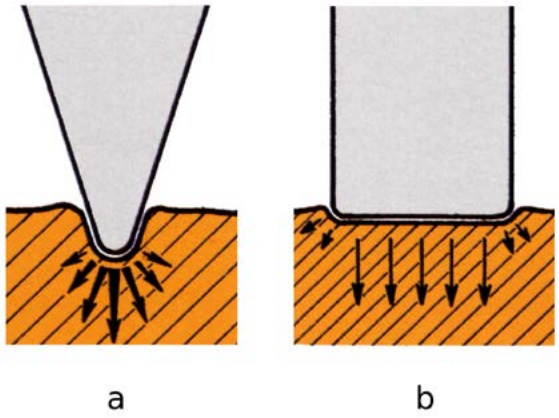


Fig 15 Representation of the distinct forces generated by different shapes of hammers (after Brepohl 2015, fig 5.54)

another tool from Donges, Loire-Atlantique in France, and might be associated with a specific function.[85]

The tools discussed here feature different shapes and sizes of their active surface(s), which attests distinct functions within the *chaîne opératoire* of metalworking. In a workshop, a metalworker uses different tools which vary in the shape of their active surface but also in their mass. Tools with a low mass are often employed for hammering small sheet-metal objects, eg personal ornaments, or for shaping very small items, whereas tools with a higher mass are generally used for shaping more substantial objects. Variation in the size and shape of the active surface also usually indicates different functions. A large active surface is normally found in tools used for planishing sheet metal and smoothing the surface of cast metal objects, while a narrow active surface indicates a function that involves more pronounced plastic shaping of the metal being worked and thus changing the morphology of an object (Fig 15).

Conclusion

This brief review of stone tools potentially used in metalworking, found in Great Britain and Ireland, demonstrates that they are present from the Bell Beaker period to the Late Bronze Age, and that they occur in different types of context: graves, hoards and settlements. Not all types of context, however, are represented over the entire duration of the period for which stone metalworking implements are attested.

Graves with metalworking tools in Britain are present during the Bell Beaker period and the Early Bronze Age, but have not been identified for the later Bronze Age. This is almost certainly due to the general dearth of formal burials following the end of the Early Bronze Age, and particularly to the lack of burials accompanied by any kind of grave goods after the expiry of the urn burial tradition.

For the Early Bronze Age, some the burials we do have relate metalworking to high-status individuals or to individuals that may have been attributed with privileged access to the otherworld (the proverbial 'faerie smith'). However, both are isolated instances and do not necessarily define a general pattern.

Interestingly, no burials with metalworking implements have so far come to light in Ireland. For the Bell Beaker period this is perhaps unsurprising, given the different depositional treatment of 'Beaker package' items in this island. However, the complete lack of stone metalworking tools in Irish Early Bronze Age graves is less easily explained, save perhaps as a consequence of a lack of any tradition from the preceding period of placing such implements in graves.

That, in contrast, settlement finds of stone metalworking tools so far have only been identified in Ireland, but not in Great Britain, is even more difficult to explain. Particularly with the boom in development-driven archaeology over recent decades, it is hard to imagine that this could be a true reflection of the state of affairs. One can only assume that relevant implements so far simply have not been recognized, probably because macrolithic finds still remain a stepchild of much post-excavation work.

It is also notable that, except for the Newgrange assemblage, which is dated to the Bell Beaker period, all stone metalworking tools identified on settlement sites are Late Bronze Age in date. This demonstrates that stone hammers and anvils continued in use after the introduction of homologous bronze tools, something that is also borne out by some of the hoard assemblages which combine lithic metalworking implements with Middle or Late Bronze Age metal objects.

Hoards with lithic metalworking tools are attested from the Bell Beaker period to the Late Bronze Age. Their composition takes different forms, from the Bell Beaker-period/Early Bronze Age Hindlow hoard, containing a forging kit, to the relevant hoards of the Middle and Late Bronze Age, combining tools for the plastic shaping of metals with casting implements and illustrating the passage to a different technological tradition. They also constitute an original part of the Bronze Age hoarding phenomenon which is generally less well known than the hoards comprising only metal objects.

The funerary, settlement and hoard finds of stone metalworking tools so far identified in Great Britain and Ireland, however, do not provide a full picture of the entire range of tool types for the plastic shaping of metals which were used in these islands from the Bell Beaker period to the Late Bronze Age. A number of tool types so far are only attested as single finds. In particular, except for the two implements manufactured from modified battle axes found with the Upton Lovell G2a burial, metalworking hammers and potential anvils reworked from Neolithic stone axes are known only as single finds. With the caveat that the brief overview given in these pages is drawn from work in progress, what also seems to be emerging is that metalworking tools manufactured from reworked stone axeheads still form a much smaller proportion among British and Irish stone metalworking implements than in most other parts of western Europe.

[85] *eadem* 2015, fig 4 no. 5

With the same caveat, the range of different shapes of active surfaces among the Insular material seems to be more limited than among similar stone metalworking tools from the Near Continent. In a survey of the relevant French material undertaken by the author, thirteen distinct functional types of stone implements for the plastic shaping of metal could be identified.[86] So far, not all of them seem to be represented among the British and Irish finds.

Still, the stone metalworking tools presently known from Britain and Ireland show a broad variety of shapes which likely attests different functions in metalworking. Some tools have perfectly polished active surfaces and appear most suitable for shaping small objects from very malleable metal, probably gold, whereas others are clearly intended for shaping more substantial objects from copper or bronze. Further study is needed to develop a fuller picture of the use of these implements. A better understanding of their typology and function will provide important information not only about Bronze Age technology but also about the organization of workshops and about the role of metallurgy and metalworkers in society.

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Once unburied, yet unfound: a survey of the moulds for casting swords in Late Bronze Age Britain

Tobias Mörtz

This paper sets out to give an overview of the presently available evidence for sword production during the Late Bronze Age in Britain. The number of known casting moulds, all made out of clay, has significantly increased over the last decades, and more contextual information is thus at hand. It becomes apparent that the survival of this relatively fragile kind of artefacts depends on their intentional concealment below ground in antiquity. The pits that were used for this purpose are conspicuously located, for example at the entrance / exit of settlements, and often contain only moulds. Because of these circumstances, a ritual interpretation is suggested for most of the features, and the treatment of the moulds can be related to the contemporary abandonment of weapons in the course of cultic acts. The question of a connection between ore deposits and sword production is also addressed and answered negatively. The distribution of mould finds instead reflects regional differences in the state of research on Late Bronze Age settlement sites.

'*The moulds formed of burnt clay have but rarely lasted to our times, though some have been found on the continent of Europe.*' John Evans[1]

Introduction[2]

The British Late Bronze Age (*c* 1150 to 800 BC) is not only characterized by an extraordinary quantity of sword finds, but also of clay moulds which were used for their manufacture. These are relatively numerous compared to similar artefacts from contemporary continental Europe. However, for many decades evidence for casting was only known in remote parts of the island and not connected to the main centres of weapon distribution in the south. Due to the intensification of development-led archaeology since the 1980s, many more settlement sites have been documented in the English lowlands, and with them an increasing number of metal casting debris came to light. This continuing flow of new discoveries has brought about a significant shift in the distribution of the moulds, which is now much more in accordance with the core areas of sword finds. The present contribution attempts a contextual interpretation of this special kind of metalworking waste and questions its value for reconstructing prehistoric craft and trade networks.

Finds of sword casting moulds until the 1970s

Prior to the 1970s only four sites had produced evidence for the casting of Late Bronze Age swords in Britain. Some of the earliest finds of clay moulds were discovered between 1914 and 1923 in several layers at the hilltop settlement of Traprain Law in lowland Scotland (appendix: no. 15). The careful, but inappropriate, excavation technique and disturbances caused by later Iron Age habitation mean that these artefacts can no longer be assigned to specific features. Reassembly of the relatively numerous fragments has not yet been attempted, so it also remains unclear how many different moulds are present. The clay used for their manufacture has recently been identified as probably local, ie coming from a distance of less than 1km.[3] In their subsequent publication, James E Cree and Alexander O Curle treated the finds as unique in Britain, but referred to similar discoveries in Ireland.[4] In addition to the moulds, some Bronze Age metal artefacts came to light. However, no weapons, except for a small fragment of a spearhead, were found.[5]

Some years later, Curle also conducted fieldwork at the multi-period site of Jarlshof near the southern tip of the Shetland Mainland. The prehistoric stone dwellings were exposed by a heavy storm in the late nineteenth century and excavations began in 1931, producing a remarkable quantity of Late Bronze Age moulds in different contexts (appendix: no. 7). The predominance of those intended for the casting of swords (Fig 1) is noteworthy but also explainable by the larger dimensions of the final product in comparison to those for spearheads and axeheads, which also form part of the assemblage from Jarlshof. As is the case of Traprain Law, no modern analysis of the material has been carried out so far. Insights into the frequency and total number of casting procedures thus remain vague.

Due to a building technique with loosely layered stones, the recognition of architectural structures was relatively easy at Jarlshof. Most of the more than 200 different mould fragments were associated with Dwelling III, which was

[1] Evans 1881, 428

[2] This paper is a slightly rearranged, revised and updated version of a German-language article published as 'Erz und Erzeugnis. Bemerkungen zu den Gießformen für Schwerter der späten Bronzezeit Großbritanniens', in *Ressourcen und Rohstoffe in der Bronzezeit. Nutzung – Distribution – Kontrolle. Beiträge zur Sitzung der Arbeitsgemeinschaft Bronzezeit auf der Jahrestagung des Mittel- und Ostdeutschen Verbandes für Altertumsforschung in Brandenburg an der Havel, 16. bis 17. April 2012*, (ed B Nessel, I Heske and D Brandherm), 61–73, Arbeitsberichte zur Bodendenkmalpflege in Brandenburg 26, Brandenburgisches Landesamt für Denkmalpflege und Archäologisches Landesmuseum, Wünsdorf (Mörtz 2014)

[3] Sahlén 2012; 2013

[4] Cree and Curle 1921–22, 213, Eogan 1993, 95, and Ó Faoláin 2004, 31–41, give an overview of the Bronze Age moulds from Ireland

[5] Cree and Curle 1921–22, 212; Burley 1955–56, 146, table 10



Fig 1 Fragments of sword moulds from the settlement at Jarlshof, Shetland, including the matrix of a hilt and a cross-section showing the different structural layers (author's photograph, © National Museums Scotland)

identified as a Bronze Age smithy for this reason. The presence of unused pieces and the existence of a hearth support this explanation. However, the casting debris was apparently discarded within and outside the building only at the end of its utilization, probably as a closure deposit.[6] This reading does not contradict the interpretation of the structure as a smithy, but may denote its short-lived existence in that capacity. A similar situation, including the rearrangement of a former domestic space and a dense cluster of mould fragments, was encountered at the Early Bronze Age settlement of Feudvar in Vojvodina (Serbia).[7]

No Bronze Age sword has hitherto been found on the Shetland Islands[8] and the only two socketed axeheads[9] do not match with moulds from Jarlshof, which testify to the production of Type Meldreth.[10] Corresponding specimens are rare in Scotland. The dearth of Bronze Age metal finds in the archipelago could be explained either by heavy recycling, which left no archaeological traces, or a ritual deposition in the sea. Aside from Dwellings III and IVa, further mould fragments were discovered as part of middens in the immediate surroundings of the buildings. Unfortunately, a full assessment of the contexts at Jarlshof is no longer possible.

Four fitting fragments of a clay mould for casting a sword were discovered during the excavation of the Neolithic stone circle at Loanhead of Daviot in 1935 (appendix: no. 8). These were deposited in a ditch surrounding an Early Bronze Age cemetery, which itself was situated adjacent to the older monument. The moulds certainly do not belong to the inventory of one of the urn graves, dating to the first half of the second millennium BC,[11] and their appearance is best explained by cultic activities carried out in later times. Most likely, the standing stones also attracted people, during the Late Bronze Age, to conduct ritual performances and deposit significant artefacts in their periphery, as can be demonstrated for other comparable places.[12]

In June 1869, at the foot of a hill near Fimber in East Yorkshire (appendix: no. 4), clay artefacts, burnt substances, carbonized wood, ceramics and animal bones in an isolated pit were accidentally uncovered by a labourer. John Robert Mortimer, who at the time was conducting fieldwork on later burial mounds in the region, organized a short salvage excavation and saved the finds.[13] However, the moulds were not identified as such until a re-examination in 1930, ie only after the pieces from Traprain Law had been published and thus served as a decisive reference.[14] The assemblage from Fimber includes matrices for swords, chapes and axeheads.

All of the moulds mentioned so far were discovered during archaeological excavations but were unexpected, since the respective projects aimed at periods earlier or later than the Late Bronze Age. Typically, and in the absence of modern survey methods, early research concentrated on places with prehistoric features still visible or exposed by chance. This is not the case with the Late Bronze Age settlement sites in the lowlands of southern Britain.

Finds of sword casting moulds since the 1970s

It was only with the excavations on the Breiddin hill-fort in Wales (appendix: no. 1), during the 1970s, that clay fragments of moulds for casting Late Bronze Age swords were first discovered south of the River Trent. Unfortunately, the artefacts originated either from layers below the Iron Age fortification or were unstratified and offer just limited contextual information. The moulds are all broken into very small sections, which complicates any functional designation. In assuming that the identification of sword matrices is correct, the Breiddin represents the only place where both the casting debris and the finished products, in the shape of a hilt fragment and the tip of a blade, possibly belonging to the same weapon, have been found.[15] Whether these items were manufactured using the associated moulds cannot be determined. Interestingly, the blade was discovered in the packing of an Iron Age posthole, and the only iron weapon from the site was also stuck vertically in a cut feature.[16] The Bronze Age sword thus represents a small group of ancient artefacts which were deliberately deposited in much later times.[17] The old artefacts could have been handed down over several generations, found during the construction of the Iron Age hill-fort, or brought to the place from elsewhere.

So far, besides Traprain Law and Breiddin, the only other hilltop site in Britain that has produced evidence for sword casting is Norton Fitzwarren in Somerset (appendix: no. 9). Nearly 70 fragments, probably belonging to just one mould, were discovered in a pit together with two complete ceramic vessels, during the late 1960s and early 1970s. On account of the limited area investigated and the excavation methods of the time, employing narrow trenches, the feature was only partly recorded. However, it appears likely that the mould deposit was situated at the butt end of an enclosure ditch next to the entrance / exit of the settlement. The good condition of the fragments indicates that they were buried swiftly after use. Taking into consideration this circumstance, the intact state of the pots and the possibly symbolic placing, a ritual interpretation of the pit is suggested. No additional traces of Late Bronze Age casting activities are known from Norton Fitzwarren.

The assemblage from Dainton in Devon (appendix: no. 3), also excavated in the 1970s, served as a starting point for the first in-depth analysis of Late Bronze Age clay moulds

[6] Needham and Bridgford 2013, 73

[7] Hänsel and Medović 2004

[8] Coles 1959–60, 82–6; Colquhoun and Burgess 1988

[9] Coles 1959–60, 73; Schmidt and Burgess 1981, 215 no. 1293, and 221–2 no. 1345

[10] Schmidt and Burgess 1981, 209 no. 1253

[11] For the chronological assessment of similar discoveries see Sheridan 2007

[12] Bradley 2005

[13] Mortimer 1905, 188–9

[14] Sheppard 1930

[15] Colquhoun and Burgess 1988, 88 no. 457; Coombs 1991, 134–5 nos 142–3; Hingley 2009, 163

[16] Saunders 1991, 144 no. 196

[17] Hingley 2009

by Stuart Needham.[18] The debris from casting swords, spearheads, ferrules and small rings was found partially inside and partially scattered around a pit, together with tiny pieces of bronze and fragments of a crucible. The discovery of the feature followed salvage excavations at the edge of a cairn, situated within the larger context of a prehistoric field system. Traces of a settlement could not be detected. Besides technological aspects, discussed in detail by Needham, the Dainton assemblage offers a good reference for a critical assessment of the circumstances of preservation of the fragile clay moulds. Firstly, the condition and size of the fragments from within the pit are significantly better and greater compared to those from the ancient surface. Lacking any kind of protection from weathering, the latter are heavily eroded. Secondly, since the character of the finds was already obvious during excavation, the clay fabrics escaped the usual washing, which can destroy their tender surfaces.

The inception of development-led archaeology resulted in the remedy of one of the most long-standing desiderata in British Late Bronze Age studies, namely the lack of habitation sites in the southern lowlands. Over the last decades many new settlements and field systems were discovered,[19] and with them further mould evidence came to light. At first, fortified structures, so called 'ring-works', attracted special attention and, in analogy to the hill-forts, were conceived as central places. One of these sites is Springfield Lyons in Essex (appendix: no. 13). Measuring 60m in diameter, the enclosure was completely excavated in the 1980s. A great number of mould fragments were found in two caches within the enclosure ditch, situated opposite one another at the eastern and western entrances / exits, in a manner reminiscent of the situation at Norton Fitzwarren.

The features were taken out of the ground in blocks and later carefully examined indoors. A recent publication by Stuart Needham and Sue Bridgford allows for a detailed description of the deposits.[20] In all, a minimum number of ten moulds for casting swords could be assessed, with only one dubious matrix of a sickle present. They were associated with fragments of crucibles, sufficient to hold the melt needed for the casting of large, bladed weapons, charcoal, some pottery sherds, animal remains, flints and two very small pieces of bronze. The moulds were evenly spread between the two deposits, but no conjoining fragments could be identified. An accumulation of clay close to the western assemblage may have served as raw material for the manufacture of the moulds. Despite the large-scale research, which encompassed the wider environs of the ring-work, no further traces of metalworking or contemporary copper-alloy artefacts were discovered.

Salvage excavations, carried out in advance of gravel extraction along the Thames River at South Hornchurch, east of London, uncovered an entire Late Bronze Age landscape, including settlement features and field systems. A pit inside Structure 8, identified as a roundhouse, contained seventy-one fragments of an incomplete sword mould (appendix: no. 12). The chronological relation between both features remains unclear. However, unlike at Norton Fitzwarren and Springfield Lyons, the deposition of the mould did not take place at the neighbouring ring-work. Further evidence of metalworking is again lacking.

More than 500 mould fragments, exceeding a total weight of 2kg, were discovered together with pottery sherds and animal bones in the lowest stratum of a natural hollow at Find Spot 28 near Greenfields in Essex (appendix: no. 5). Information is limited, but the selection again appears to be restricted to swords. With reference to the different characteristics of the fragments, Lorraine Mepham argues in favour of multiple depositions.[21] Several pits, postholes and a fireplace were found in the surroundings of the hollow, but the existence of a regular settlement is disputed.[22]

A wider typological spectrum of mould fragments has recently been encountered in a rectangular enclosure at Sigwells, close to the hill-fort of Cadbury (appendix: no. 11a). So far, no detailed publication is available. The excavator interprets the site as a seasonal meeting place for the execution of different crafts, in particular metalworking.[23] According to the results of an extended geophysical survey, the closest contemporary settlement lay at a distance of at least 3km. The production of weapons, tools and ornaments can be attested. A single pit, located *c* 150m away from the enclosure, also contained heterogeneous mould debris of a slightly later date (appendix: no. 11b). In combination, the features at Sigwells clearly have the potential of being interpreted as one of the very few Late Bronze Age workshop sites in Britain.

Only a short note refers to the discovery of moulds for swords and other artefacts at Holborough Quarry, near Snodland, in Kent (appendix: no. 6). They were mainly recovered from a deep pit south of an enclosure ditch of a Late Bronze Age habitation site. No associations are given, though neighbouring features contained what is labelled 'domestic refuse'.[24] Needham and Bridgford mention a wide spectrum of different casting debris, including matrices of weapons, tools and ornaments.[25]

A single sword mould fragment was found in an isolated pit together with fifty-six sherds of pottery, three pieces of slag and one worked stone during the development of the Richard Lander School at Threemilestone in Cornwall (appendix: no. 14). Two roundhouse structures in the vicinity may indicate the existence of a contemporary settlement.

The list of Late Bronze Age sword moulds from England is completed by finds from Halfhide Lane in Turnford (appendix: no. 16), which are lacking a detailed publication but said to come from a settlement context.[26]

New evidence of casting debris has also been discovered in Scotland during recent decades. Two fragments, from one or perhaps two sword moulds, were found deposited in different pits at Seafield West, near Inverness (appendix: no. 10). One feature was probably the central posthole of a

[18] Needham 1980

[19] *idem* 1992; Brück 2007; Yates 2007

[20] Needham and Bridgford 2013

[21] Mepham 2007

[22] Timby *et al* 2007, 38–45

[23] Tabor 2008, 61–9

[24] Boden 2004–05, 42

[25] Needham and Bridgford 2013, 71

[26] *ibid*, 70; drawings and photographs of the moulds from Halfhide Lane in Turnford are reproduced by Quilliec 2007, pls 28, 34

roundhouse. Alternatively, both pits may have been related to the surroundings of another, partly overlapping structure. The moulds were stabilized by wooden sticks in their outer wrap. A similar design feature appears on the pieces from Jarlshof. Radiocarbon dating of charcoal from one of the pits generated a result of 1260–920 cal BC (2 sigma; AA-35528: 2890±50 BP),[27] which conforms to the typo-chronological attribution of the swords cast in these moulds. Due to the limits of the fieldwork not all settlement features were excavated and the existence of further mould fragments cannot be ruled out. The area is also known for Iron Age blacksmithing activity.[28]

A comparable situation was documented at Birnie in Moray. Whereas the Iron Age settlement included a substantial workshop,[29] no architectural features could be identified in the surroundings of the pits containing fragments of Late Bronze Age crucibles and moulds.[30] A single piece may belong to a sword mould,[31] but due to the very small size and inconclusive identification it has been disregarded in the present list of finds. Further fragments show matrices of axeheads, bangles, pins und spearheads.

The excavations at Cladh Hallan on South Uist (appendix: no. 2) produced a varied and extensive ensemble of metalworking evidence. The results are awaiting full publication and only limited information is currently available. In addition to sword moulds, matrices for spearheads and chapes can also be identified. Like at Jarlshof, the settlement consisted of stone-built dwellings, which allowed for good preservation of the floor deposits. Despite its peripheral location, and in contrast to the Shetlands, some Late Bronze Age swords are known from South Uist, eg the hoard from Iochdar (now Eochar).[32]

Contextual characteristics and interpretation of the sword mould deposits

More than fifty years ago, Henry W M Hodges summarized the state of research on Bronze Age moulds from Britain in a series of articles.[33] Pieces made out of clay were only known from the north, whereas in the south metal ones dominated. The latter appeared in hoards and mainly served for the production of axeheads.[34] Stone moulds, nearly all dating to the Early and Middle Bronze Age, still show an even distribution all over the island. Only the finds from Bodwen in Cornwall[35] and Knighton in Devon[36] testify to the employment of such a casting technique for very long, bladed implements. To date, there is no evidence that stone or copper-alloy moulds were used for the casting of swords during the Late Bronze Age in Britain.

Recent excavations have significantly changed the distribution described by Hodges. There are now at least sixteen find spots with fragments of clay moulds for swords, covering all parts of the island (Fig 2). Two major clusters can be identified, one in the lower Thames region and the other on the south-western peninsula. The earliest discoveries in Fimber, Jarlshof, Loanhead and Traprain Law, later also Breiddin, were unforeseen finds during fieldwork at sites and monuments of other than Late Bronze Age date; though, because of indicators above ground, such as standing stones or ramparts and ditches, the existence of prehistoric features was known and expected. From the 1970s, moulds have also come to light at places where the archaeology could not directly be observed without the help of modern surveying methods. The settlement at Seafield West, for example, was identified by aerial photography.

The clay fabrics at Jarlshof and Cladh Hallan only survived because of the protective stone architecture, whereas in the remaining cases their concealment underground within cut features was crucial. This assessment is confirmed by a recently published overview of Late Bronze Age moulds from Britain.[37] Without the well preserved fragments from the pit, the finds from Dainton would probably not have been recognized as such. Also, a careful working method appears decisive for their identification. Since no clay moulds have so far been discovered under other circumstances, this requirement evidently can only be met by professional archaeological excavation. It follows that our knowledge of Late Bronze Age casting with clay moulds is directly dependent on the current state of research on contemporary settlement sites.

The typological attribution of the moulds depends on the availability of hilt matrices. Where these are missing, only associated artefacts or scientific dating methods can help to put the pieces in their proper chronological position, and some remain uncertain. However, most of the clay moulds described above are clearly linked to Ewart Park swords of the tenth to ninth centuries BC, the eponymous object type for the corresponding metalworking stage.[38] The earlier Wilburton type, which has lend its name to the preceding metalworking stage,[39] can only be identified at Dainton, Fimber, the enclosure at Sigwells and, according to Needham and Bridgford[40] also at Holborough Quarry and Threemilestone. This mismatch is in accordance with the overall numerical prevalence of Ewart Park over Wilburton swords.[41] In contrast to the earlier pieces, nearly all features with sword casting moulds from the beginning of the first millennium BC are connected to habitation structures. This can tentatively be taken as an indication of a reorganization of metalworking during the course of the Late Bronze Age, though the limited number of finds restricts the scope for further definitive statements.

[27] Cowie and Eremin 2011, 24

[28] Heald *et al* 2011

[29] Hunter 2007, 24–8

[30] *idem* 2006, 22–7; *idem* 2007, 13–5; Sahlén 2012; 2013

[31] Hunter 2007, 30

[32] Anderson 1878–79, 327–8; Evans 1881, 289; Coles 1959–60, 111; Colquhoun and Burgess 1988, 99–100 no. 579; Maraszek 2006, 377 SCO/HI8; Cowie and O'Connor 2007, 328–30

[33] Hodges 1958–59; 1960

[34] For an updated review see Webley and Adams 2016

[35] Pearce 1983, 413 no. 80; Knight 2014, 39, table 1 no. 5

[36] Evans 1881, 434–5; Burgess and Gerloff 1981, 115 nos 6–7; Pearce 1983, 447 no. 263; Knight 2014, 40, table 1 no. 28

[37] Needham and Bridgford 2013, 68–73

[38] Colquhoun and Burgess 1988, 55–108; Needham *et al* 1997, 93–8

[39] Colquhoun and Burgess 1988, 40–53; Needham *et al* 1997, 90–3

[40] Needham and Bridgford 2013, 73

[41] Colquhoun and Burgess 1988

Find spot	Context	Dating
Category 1 – Single fragments		
Loanhead of Daviot	earlier stone circle and urn cemetery	Wilburton/Ewart Park
Seafield West	unenclosed settlement	Ewart Park
Threemilestone	unenclosed settlement	Wilburton
Category 2 – Pure sword mould deposits		
Greenfields	natural hollow	Ewart Park
Norton Fitzwarren	hill-fort	Ewart Park
South Hornchurch	unenclosed settlement	Ewart Park
Springfield Lyons	ring-work	Ewart Park
Turnford	unenclosed settlement (?)	Ewart Park
Category 3 – Mixed assemblages		
Breiddin	hill-fort	Ewart Park
Cladh Hallan	unenclosed settlement	Ewart Park
Dainton	cairn and field-system	Wilburton
Fimber	isolated pit	Wilburton
Holborough Quarry	outside an unenclosed settlement	Wilburton
Jarlshof	unenclosed settlement	Ewart Park
Sigwells	enclosure	Wilburton
	isolated pit	Ewart Park
Traprain Law	hill-fort	Ewart Park

Table 1 Find contexts of the clay moulds for casting Late Bronze Age swords in Britain

All clay moulds for swords were found during professional archaeological fieldwork, but the published data are incomplete. Nevertheless, contexts of clay moulds for swords can be grouped into three principal categories (Table 1). First, solitary fragments were uncovered in features within settlement sites at Seafield West and Threemilestone. The existence of further metalworking debris in the surrounding, unexplored areas appears possible. This also applies to the other single piece from a ditch close to the stone circle at Loanhead of Daviot. Secondly, complete or near complete collections exclusively of sword mould fragments formed distinct deposits at the entrance / exit of the hill-fort at Norton Fitzwarren, the ring-work at Springfield Lyons, and inside Structure 8 at South Hornchurch. The lowest fill of the natural hollow at Greenfields, also reportedly included sword-only casting debris in great quantities. In addition, the finds from Turnford may belong to this category.[42] Thirdly, a wider spectrum of different moulds, including other weapons, tools and ornaments, was recovered both from the hill-forts at Breiddin and Traprain Law and the potential workshops at Jarlshof and Sigwells. Though lacking a detailed publication, Cladh Hallan and Holborough Quarry should be grouped with this category of evidence because of the varied composition of their casting-debris assemblages.[43] The finds from the isolated pits at Dainton and Fimber, both dating to the Wilburton phase, mainly comprised matrices of weaponry, ie swords, chapes, spearheads, ferrules and small rings, which served to attach the scabbard to a belt.[44]

Only the last mentioned category qualifies for classification as common waste from specialized or universal metalworking activities. At Dainton and Fimber extensive production of weaponry took place away from settlements. In the latter case, deposition of the moulds was accompanied by material not directly related to metallurgical crafts, especially animal bones, which challenges a purely mundane interpretation. Contextual information for the hill-forts of Breiddin and Traprain Law is very limited and will thus not be further explored here.

Since Cladh Hallan, Holborough Quarry and Sigwells await full publication, Jarlshof currently remains the only potential workshop with the possibility for a further assessment. As already mentioned, most of the moulds were probably part of a secondary backfill deposited at the end of the last phase of use of Dwelling III, explaining their good condition and the stratigraphic position on top of blown sediments. A pit of *c* 30cm depth in the centre of the distribution contained only sand and three very small pieces of bronze.[45] This sloping installation could have been utilized to stabilize the moulds at an angle of 30° to ease the discharging of gases during the pouring of the melt.[46] However, the construction, or use, of already existing pits is not a necessary element of the casting process, because a fixation would have been equally possible with the help of upright standing, sand-filled containers, as proven by experimental archaeology.[47] Finding casting waste in pits should thus not be taken as an immediate indicator for specific technological activities. In contrast, the feature at Jarlshof, irrespective of its interpretation, was not cleared out for the disposal of refuse. At the workshop of Feudvar, too, the broken moulds lay scattered on the floor and had not been buried.[48]

[42] Needham and Bridgford 2013, 72
[43] *ibid*, 69, 72
[44] Mörtz 2012
[45] Curle 1932–33, 91–2; Hamilton 1956, 23
[46] Ó Faoláin and Northover 1998, 73; Ó Faoláin 2004, 84
[47] Siedlaczek 2011, 114–15
[48] Hänsel and Medović 2004, 92

The very selective concealment of single fragments or almost complete sword moulds (Categories 1 and 2) questions a direct relation to metalworking activities. The conspicuous setting of the deposits at the entrance / exit of an enclosed space at Norton Fitzwarren und Springfield Lyons is best understood in terms of ritual activities.[49] This also applies to one fragment at Seafield West, which was probably buried in the central posthole of a roundhouse, and the find from Loanhead of Daviot, found close to a Neolithic stone circle and an Early Bronze Age cemetery.[50] If metalworking took place on the spot, only a selection of the casting debris was concealed in cut features. Alternatively, single fragments may have been brought to the earlier monuments to be deliberately buried.

Bernhard Hänsel identified some Bronze Age stone-mould assemblages from south-eastern Europe as ritual deposits.[51] While, in contrast to clay fabrics, these metallurgical tools were reusable, deliberate damage can be identified on some of them, and functionally important parts, like conjoint valves or cores, are frequently missing.[52] The pieces thus were deliberately rendered inoperable prior to deposition. Their selection and treatment recalls the condition of contemporary metal deposits.

Although the destruction of the clay moulds is a functional necessity to extract the final product and not the outcome of ritual activities, the selection of the buried sword moulds in Late Bronze Age Britain can be compared to the fragmentation of weapons in contemporary hoards. Despite the problems in refitting the fragile pieces, even the most extensive assemblages appear to be incomplete, eg in the case of South Hornchurch. Smaller fragments, especially at the tip and grip, are also regularly missing from swords in weapon hoards. Most of this damage did not result from fighting but from deliberate acts to render the artefacts useless.[53] The mould deposits and metal hoards are thus connected by the intentional removal of certain fragments, which were kept or possibly buried elsewhere, as at Dainton, Seafield West or Threemilestone. Since copper-alloy finds only rarely appear in settlements, the clay moulds with their matrices may have acted as a substitute for the abandonment of real swords in these contexts. The strict selection of weaponry at Dainton and Fimber could also be explained with reference to the dominance of similarly composed metalwork hoards during the Wilburton phase, in contrast to the more heterogeneous composition of the later Ewart Park metal assemblages.

A ritual concealment of casting waste does not represent the regular way in which Late Bronze Age metalworking debris was discarded, as is indicated by the small number of finds discussed here. Evidently, smashed moulds were usually treated like other rubbish, ie left to decay above ground, consequently becoming invisible to archaeology. Where midden sites have survived, these occasionally yielded a few mould fragments, eg at Jarlshof and Cladh Hallan, but also at Runnymede Bridge in Berkshire[54] or Potterne in Wiltshire.[55] Such contexts stand in sharp contrast to the selective handling described above for South Hornchurch or Springfield Lyons. Now and then, already existing pits, which had gone out of use, were filled with waste material.[56] If this happened within a short time after the employment of the moulds, they could have survived and became part of what Duncan Garrow recently termed 'material culture patterning'.[57] Indicative of this are pits with a very mixed, though not necessarily unstructured fill. Such a treatment has been suggested by Detlef Jantzen for the Bronze Age clay mould fragments from northern Europe.[58]

In Britain, however, even the features not only containing casting debris show conspicuous peculiarities, which rather support a reading as 'odd deposits' connected to ritual activities.[59] In Norton Fitzwarren, for example, two complete pots were found together with the sword moulds. The pit was perhaps only dug at the butt end of the enclosure ditch to hold an offering, and this also applies to the similar discovery from Springfield Lyons. In the case of Greenfields, no signs of habitation structures could be detected around the hollow containing the metalworking debris. Granted that the accompanying animal bones and pottery sherds were deposited together with the mould fragments at the same time, these could possibly be interpreted as leftovers of sacrificial meals. At any rate, it appears unlikely that only weapons were produced at these sites, though no other casting waste was obviously considered appropriate for deposition. At Birnie, where the identification of sword production remains dubious, just a minor portion of the moulds and crucibles ended up in pits, and this may have been accidental.[60] On the other hand, one feature also contained three quern fragments, suggesting a structured ritual deposit. Even if the pits were used for casting, their final fill resulted from activities other than the purely technological.

Manufacturing specialized artefacts was thus the starting point for a ritualized burial of the employed clay fabrics at special occasions in particular settings. Bearing in mind the many hundreds of Late Bronze Age swords from Britain, the number of moulds must have been at least equal, probably even higher, and much more densely distributed, but in being discarded and not buried, the bulk of the material simply degraded, leaving no trace. In view of the limited information on some of the recently discovered moulds, future work will hopefully allow for a better assessment of the ritual as well as craft activities which led to their deposition. The possibility that other kinds of moulds were treated according to similar patterns as those described here for swords also remains to be explored.

[49] Needham 1992, 61; Brück 2006, 299; Needham and Bridgford 2013, 73–4

[50] For comparable discoveries in Ireland see Ó Faoláin 2004, 116–18

[51] Hänsel 2007; 2011

[52] For comparable observations on Irish stone casting mould hoards see Boutoille 2012

[53] Molloy 2011; Mörtz 2013

[54] Spence and Needham 1996

[55] Bayley and Morris 2000

[56] Brudenell and Cooper 2008; Jervis 2014

[57] Garrow 2012

[58] Jantzen 2008, 277

[59] Brück 1999; Garrow 2012

[60] Hunter 2006, 22–7; *idem* 2007, 13–15

Organization of Late Bronze Age sword production

Recent and ongoing fieldwork at Late Bronze Age sites has radically shifted the distribution of clay moulds for casting swords from the north to the south of Britain, where two clusters can currently be identified (see Fig 2). The first, in the lower Thames region, was densely settled even in prehistory and represents the continued focus of development-led archaeology.[61] The increasing mould evidence is consistent with this situation and with the high number of sword finds from the Thames catchment area.[62] In contrast, a corresponding explanation does not apply to the second cluster on the south-western peninsula, where modern construction works are comparatively limited and only a few Bronze Age weapons have come to light.[63] However, the region is rich in ore deposits of copper and tin. Has the production of swords thus been concentrated close to the required resources?

For several reasons, I consider this scenario unlikely. First, the overall distribution of the mould evidence covers nearly all parts of Britain and even remote places like Cladh Hallan or Jarlshof, where raw materials had to be imported from afar. Secondly, during the Late Bronze Age sufficient metal was in circulation, so that the production of new artefacts could mainly rely on recycling, though the partial addition of fresh copper and tin arguably never became obsolete.[64] Thirdly, because of its excellent preservation, eg at Dartmoor,[65] modern research on prehistoric land-use, including field systems, pasture and settlement, began in Cornwall, Devon and Somerset considerably earlier than elsewhere in the study area. These pioneering investigations and the ongoing fieldwork they initiated, rather than the existence of metallurgical resources, are in my view the crucial factor for the remarkable quantity of sword moulds in south-western Britain.

Wales, with its rich deposits of copper ore, in contrast is largely devoid of clay moulds.[66] Only the Breiddin hill-fort produced such evidence. However, the state of research on Late Bronze Age settlements in this region is still relatively limited, and once this situation has changed, more finds are likely to be discovered. In Scotland the prehistoric exploitation of copper deposits generally remains doubtful[67] and, thus, also any possible correlation with the casting debris found there.

The accumulation of bronzes in large hoards provides evidence for the customary availability of metals even in regions without ore deposits. The cluster of sword moulds in south-eastern England illustrates that the production of new artefacts was not a problem at all. Nevertheless, where workshops can be identified in the archaeological record, eg at Jarlshof or Sigwells, stocks of raw or scrap metal are conspicuously missing. Collections of worn und broken artefacts, those finds which Sir John Evans traditionally termed 'founder's hoards',[68] should be especially expected. Of course, if these caches ever existed, they could have been completely used or retrieved before abandoning the workshop. However, copper-alloy items seldom appear on settlement sites in greater quantity and basically never together with casting evidence. In view of this mutual exclusion of metal hoards and clay moulds, a direct connection to metal-working activities of both kinds of deposits must be questioned, and a ritual explanation is suggested instead.[69]

The number of Late Bronze Age swords in Britain by far exceeds the evidence for their casting and they are known from all over the island. Nonetheless, their survival is likewise tied to specific contexts, primarily hoards and river finds, which show different chronological and spatial patterns.[70] The bulk of the material comes from south-eastern England, with the Thames playing a major role as being the most important British river in both past and present times. It attracted large-scale ritual abandonment of metal artefacts, which is especially well-known in the area around modern-day London, due to massive improvement measures since the nineteenth century. In contrast, extensive weapon hoards have only been discovered in neighbouring regions, ie the Fenlands, East Anglia and along the Channel coast, where no mould evidence has yet come to light. Smaller deposits comprising no more than ten swords and / or spearheads cluster in northern England and the Scottish lowlands.

The increase in known clay sword mould fragments goes along with a trend towards rather unspectacular circumstances of discovery. Their appearance is in no way restricted to fortified and outstanding places like hill-forts and ring-works. As Joanna Brück already observed, finds indicative of bronze casting mainly occur in unenclosed settlements.[71] The various contexts, also obvious in Matthew Knight's recent assessment of the Bronze Age metalworking evidence from Cornwall and Devon, contradict the idea of a pronounced centralization of this craft.[72] The existence of specialized regional workshops, as proposed for example by Michael J Rowlands,[73] must thus be questioned. However, the ritual motives behind the deposition of the majority of clay moulds advise caution. Single fragments or even whole moulds could have been transported over longer distances from the places of their use to the pits where they are found today. In view of their fragility this dislocation was certainly restricted to a regional level. Where exactly the casting was executed, in many cases remains difficult to determine.

In identifying the prehistoric and modern filters on which the present distribution of the clay sword moulds is based, it has become clear that the data cannot be taken as direct indication for the intensity and spatial organization of Late Bronze Age metalworking. Therefore, trying to establish a hierarchy of settlements according to the existence of

[61] Last 2012

[62] Burgess and Needham 1980; Ehrenberg 1980; Colquhoun and Burgess 1988; Thomas 1999; York 2002

[63] Pearce 1983; Colquhoun and Burgess 1988; Knight *et al* 2015

[64] Needham 1998; 2007; Bray and Pollard 2012

[65] Fleming 2008; Wickstead 2008; Newman 2012, 60–82

[66] Needham and Bridgford 2013, 68–73

[67] Timberlake 2002; Hunter *et al* 2006, 50

[68] Evans 1881, 456–9

[69] Mörtz 2013

[70] Coombs 1975; York 2002; Maraszek 2006, 166–70, 179–82, 194–209; Mörtz 2010

[71] Brück 2007, 34

[72] Knight 2014

[73] Rowlands 1976

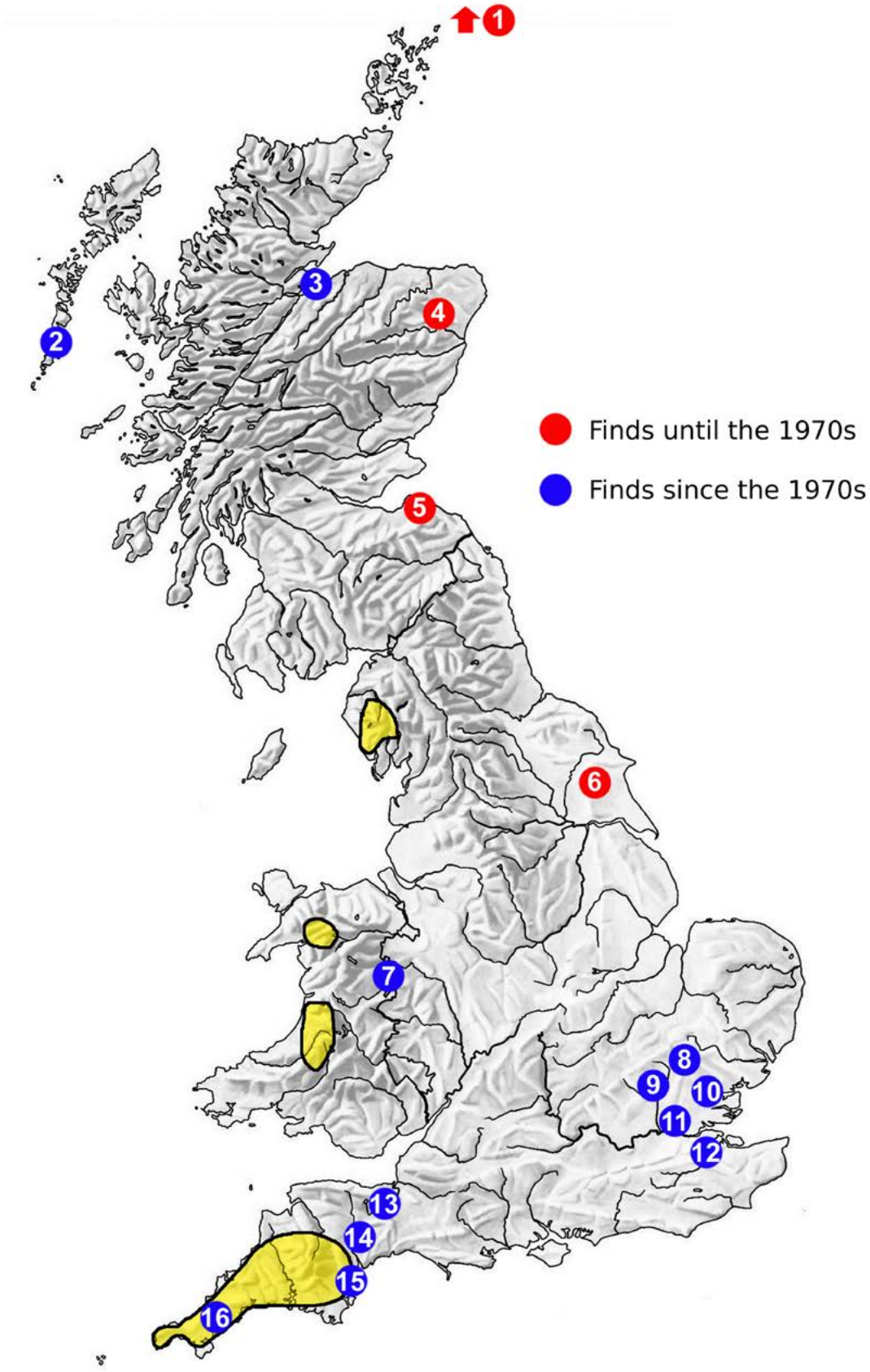


Fig 2 Distribution of clay moulds for casting Late Bronze Age swords in Britain; yellow shading: old mining areas (according to Colman and Cooper 2000, fig 23); individual sites: 1 Jarlshof; 2 Cladh Hallan; 3 Seafield West; 4 Loanhead; 5 Traprain Law; 6 Fimber; 7 Breiddin; 8 Greenfields; 9 Turnford; 10 Springfield Lyons; 11 South Hornchurch; 12 Holborough Quarry; 13 Norton Fitzwarren; 14 Sigwells; 15 Dainton; 16 Threemilestone

casting debris appears too simple, as has already been highlighted for northern Europe[74] and the Carpathian Basin.[75] The prominence of sword moulds can probably be ascribed to the importance of weaponry in the deposition of metal artefacts. The technically demanding skills required in their production were perhaps another factor for their preferential selection.

Conclusion

Several factors were identified as crucial for our present knowledge of the clay moulds for casting swords in Late Bronze Age Britain. First, their survival depends on swift burial after employment. Without being concealed underground, or otherwise protected from weathering agents, the fragile fabrics usually decay easily and leave no traces detectable by archaeology. What can be found today thus comprises just a tiny portion of the artefacts existing at the time. Secondly, their deposition in cut features, like pits or ditches, frequently proves to be very selective and not indicative of a random disposal of casting debris. This is supported by curious associations (eg with complete pots) and conspicuous settings (eg at the entrance / exit of enclosed settlements). A deliberate, socially legitimized concept of dealing with the sword moulds becomes apparent, which was limited to special occasions and certain places. Therefore, a ritual explanation is suggested for most cases. From this it follows that the existence of such casting debris cannot always be taken as a direct indicator of metallurgical activities in the past. Thirdly, only professional archaeological fieldwork provides for the discovery and identification of clay moulds. The diversified state of research on Late Bronze Age habitation and work sites thus accounts for their known distribution. With the inception of development-led archaeology many more finds came to light over recent decades, especially in southern Britain, and a further rise is expected in the future. The production of swords was undertaken in a wide variety of locations and shows no dependency on the proximity of ore deposits or on a socially privileged group of people. If the weapons were not manufactured in centralized workshops, then it remains to be investigated how their astonishing similarity over the whole study area was achieved.

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Appendix: list of Late Bronze Age clay sword moulds from Britain

1. Breiddin near Welshpool, Powys, Wales
   Dating: Ewart Park phase
   Reference: Musson *et al* 1991, 147–9; Howard 1991
2. Cladh Hallan near Daliburgh, South Uist, Western Isles, Scotland
   Dating: Ewart Park phase
   Reference: Parker Pearson *et al* 2004, 76
3. Dainton near Torquay, Devon, England
   Dating: Wilburton phase
   Reference: Needham 1980; Pearce 1983, 445–6 no. 255; Knight 2014, 33
4. Fimber, East Yorkshire, England
   Dating: Wilburton phase
   Reference: Mortimer 1905, 188–9; Sheppard 1930; Burgess 1968, 63–4, appendix 3 no. 1; Manby 1980, 358; Schmidt and Burgess 1981, 177 no. 1006
5. Greenfields (Find Spot 28) near Great Dunmow, Essex, England
   Dating: Ewart Park phase
   Reference: Mepham 2007
6. Holborough Quarry near Snodland, Kent, England
   Dating: Ewart Park phase
   Reference: Boden 2004–05, 42
7. Jarlshof near Sumburgh, Mainland, Shetland Islands, Scotland
   Dating: Ewart Park phase
   Reference: Curle 1932–33, 114–6; *idem* 1933–34, 278–83; Hamilton 1956, 29
8. Loanhead near Daviot, Aberdeenshire, Scotland
   Dating: Wilburton / Ewart Park phase
   Reference: Kilbride-Jones 1935–36, 290, 302–3
9. Norton Fitzwarren, Somerset, England
   Dating: Ewart Park phase
   Reference: Needham 1989
10. Seafield West near Inverness, Highlands, Scotland
    Dating: Ewart Park phase
    Reference: Cowie and Eremin 2011
11. Sigwells near Cadbury, Somerset, England
    a) Enclosure
    Dating: Wilburton phase
    Reference: Tabor 2008, 66–7; Knight *et al* 2015, 69–70 no. 428
    b) Pit
    Dating: Ewart Park phase
    Reference: Tabor 2008, 79; Knight *et al* 2015, 69–70 no. 428
12. South Hornchurch near London, Essex, England
    Dating: Ewart Park phase
    Reference: Harrison and Guttmann 2000
13. Springfield Lyons near Chelmsford, Essex, England
    Dating: Eart Park phase
    Reference: Needham 1987; Needham and Bridgford 2013

[74] Jantzen 2008, 303–5

[75] Dietrich 2011

14. Threemilestone (Richard Lander School) near Truro, Cornwall, England
Dating: Wilburton phase
Reference: Gossip 2005, 16; Knight 2014, 32; Knight *et al* 2015, 32–3 no. 31

15. Traprain Law near East Linton, East Lothian, Scotland
Dating: Ewart Park phase
Reference: Cree and Curle 1921–22, 213–15; Burley 1955–56, 153–4, table 47-54

16. Turnford (Halfhide Lane), Hertfordshire, England
Dating: Ewart Park phase
Reference: unpublished

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Commensality and casting: a discussion of Irish Late Bronze Age cauldrons

Katherine Leonard

This paper outlines the current state of knowledge of European Bronze Age cauldrons and discusses observations made during a preliminary examination of some of the intact Bronze Age cauldrons held by the National Museum of Ireland. In particular, the focus is on the use and ritual deposition of cauldrons in later Bronze Age Atlantic Europe and how this may be reflected in changes to the type and quality of repairs conducted. Some of the earlier cauldrons seem to have been repaired with a lower quality of craftsmanship than their initial production, resulting in a 'patchy' appearance, while many of the later cauldrons have repairs which are almost indistinguishable from their original crafting. Possible socio-cultural explanations for this change over time are explored. For instance, likely ritual function(s) of the cauldrons are discussed, as well as their possible use as mechanisms for the overt display of social and symbolic capital in an Irish later Bronze Age context.

'*There were seven doors in that hall, and seven passages through it, and seven hearths in it, and seven cauldrons, and an ox and a salted pig in each cauldron. Every man who came along the passage used to thrust the flesh-fork into a cauldron, and whatever he brought out at the first catch was his portion. If he did not obtain anything at the first attempt he did not have another*'. Scéla mucce Meic Da Thó[1]

Introduction

The above excerpt from the Irish saga *Scéla mucce Meic Da Thó*, or the 'Story of Mac Dathó's Pig', includes the two broad categories of artefacts that have been considered characteristic of later prehistoric European feasting activity: metallic vessels and metallic meat cooking implements. The metallic vessels include cauldrons, buckets, cups or bowls and are sometimes associated with strainers. The meat cooking implements are specifically flesh-hooks (or flesh-forks) and spits which are associated with boiling and roasting respectively. The artefactual evidence (especially cauldrons) has long supported the belief that formalized feasts took place in prehistoric Ireland and Atlantic Europe, as perhaps a precursor to the renowned 'chiefly' and otherworldly feasts recorded in the early Irish literature. For instance, cauldron fragments were recently found in the context of immense later prehistoric middens in Llanmaes, Wales, which closely links their use to large-scale communal feasting.[2]

Although ritual feasting was extant throughout Irish prehistory, a dramatic change may be seen in Ireland during its Late Bronze Age (LBA), *c* 1200–500 BC, with the use of intricately crafted bronze feasting equipment. McCormick[3] suggests that the highly elaborate and lavish nature of Irish ritual feasting paraphernalia reveals that food consumption had far surpassed a purely functional procedure by the LBA, and it has long been maintained that the use and display of special equipment for the preparation and consumption of foods may be indicative of ritual feasting.[4] However, while there are various arguments as to how archaeologists can identify prehistoric feasting activity, in most cases all that is available for analysis is the refuse. In very rare instances this is left *in situ* where the feast was consumed and archaeologists are able to examine its distribution for patterns that might indicate what was eaten and perhaps even by whom.

As the archaeological evidence of LBA feasting from Ireland is mainly restricted to high-status feasting equipment found in isolated deliberate depositions (with exceptions), speculation is limited in regard to individual or communal 'possession' of these objects and the etiquette and circumstances of their use. It is possible that feasting equipment was used in a variety of ceremonial and ritual contexts, from large-scale community gatherings to small segregated assemblies.[5] There are very few Irish LBA sites that display clear evidence of feasting in the faunal assemblage (and in almost no case in terms of the artefactual assemblage). Nevertheless, in general the material culture evidence, such as bronze cauldrons found as isolated deposits primarily in wetlands, indicates that exceptional commensality took place in later prehistoric Ireland, as does the evidence for a continuation of some food consumption customs from the LBA into the Iron Age. However, much in the same way as luxury foods, the artefacts themselves do not necessarily indicate that a feast has taken place, and therefore speculation regarding pre-depositional usage of these items must be done by situating them in their broader cultural and temporal context. By considering the various traces of feasting activity present from the archaeological record, situating the artefactual evidence within its broader socio-cultural context(s) and relating them to contemporary evidence from elsewhere in Europe, it seems quite likely that feasting was an important social and ritual practice during the LBA in Ireland.[6]

This paper will discuss a main category of material-culture evidence associated with prehistoric feasting in Europe: the bronze cauldron. More intact later Bronze Age cauldrons have been recovered from Ireland than from anywhere else in Europe.[7] Although this may be indicative of

[1] Chadwick 1927, 16
[2] Madgwick *et al* 2012, 127
[3] McCormick 2009, 406
[4] Appadurai 1986, 38–40; Hayden 2001; Van der Veen 2003, 409
[5] cf Armada 2011
[6] Leonard 2015, 52–8
[7] Gerloff 2010

D Brandherm (ed): *Aspects of the Bronze Age in the Atlantic Archipelago and Beyond. Proceedings from the Belfast Bronze Age Forum, 9–10 November 2013.* Archæologia Atlantica – Monographiæ III (2019 [2025]): 233–247

differential preservation due to ritual deposition in wet locations, cauldrons also have strong magico-religious associations in later myth and legend which suggests a long-held symbolic significance.

As stated above, to create a full and nuanced understanding of a prehistoric object it must be contextualized. The discussion will therefore begin with a review of our current understanding of Atlantic and Irish Bronze Age cauldrons before considering specific examples in more detail. Gerloff[8] has comprehensively re-examined the previous categorization of the Atlantic buckets and cauldrons and made some adjustments and changes based on their structural elements, such as number of body plates and the form of handles and handle fittings. Her categorization will be adhered to in the following. Observations made by the author during a preliminary examination of some of the intact LBA cauldrons held by the National Museum of Ireland will be summarized. The focus of investigation was on changes in the types and quality of the ancient repairs conducted on Bronze Age Irish cauldrons. Some of the earlier cauldrons seem to have been repaired with a lower quality of craftsmanship than is evident in their initial production, resulting in a somewhat 'patchy' appearance, while many of the later cauldrons show repairs that are almost indistinguishable from their original crafting. Cauldrons in general will then be considered in relation to the more general evidence for feasting in Bronze Age Atlantic Europe, and possible socio-cultural implications of the archaeological evidence for the use of specialized feasting equipment in later prehistoric Europe will be put forward.

Late Bronze Age Atlantic Cauldrons

Of all the items of feasting equipment in use, it is the cauldron in particular which seems to have embodied many symbolic associations and ideals in the more westerly areas of later prehistoric Europe. For instance, Posidonius mentions meat being cooked in cauldrons in Gaul, and in Irish mythology the narrative often centres on the cauldron's magico-religious restorative properties and its role as a symbol of abundance.[9] This is also reflected in Gerloff's captivating interpretation of the introduction of Atlantic cauldrons to Ireland at the beginning of the LBA:

> From an archaeological point of view, therefore, it seems feasible that the myth of the cauldron's and also the sword's introduction into Ireland by some 'godlike' or heroic foreign 'invaders' who were in the possession of superior weapons and equipment may contain some elements of historical truth and may indeed be placed at the beginning of the Late Bronze Age in western Europe. This period, which is contemporary with the rise of the Urnfield culture in Central Europe and with the collapse of Bronze Age civilisations in the Mediterranean and the Near East, must have involved the movements of peoples, skilled in superior bronze metalworking techniques, from the 'declining' civilizations of the East to the metalliferous regions of 'barbarian' Europe. The legends of the wanderings of the Tuatha Dé Danann, therefore, from East to West and their finally settling in the extreme West of Europe, may possibly reflect this period of unrest which saw the introduction of advanced technology, of new settlement sites and burial rites resulting in the formation of the newly formed, rich Late Bronze Age cultures and élite societies in various parts of Europe.[10]

The traditional understanding of cauldron function is that they were élite cooking vessels used over a fire, evidenced by damage and / or repairs to basal sheets as well as indications of burning in the same area.[11] Alternatively, hot stones could have been placed into the vessels to heat their contents, also a potential source of basal-plate damage.[12] As the bottoms of cauldrons are rounded, they could not have stood alone and would have had to be either propped up, with stone or earth, or suspended by the handles (the aspect of the cauldrons which displays the most damage). Alternatively they could have been placed in a sort of clay 'stove' with a round opening at the top where the cauldron would have sat; however, no such supports have as yet been found in western Europe.[13] It is mentioned in Posidonius' *History* that meat from 'steaming cauldrons' is consumed by 'Celts', a statement which has informed this traditional interpretation of the Bronze Age cauldrons.[14] The ring handles and the interior of the handle attachments of many cauldrons do have wear marks from being suspended over a fire or from being carried.[15] There are also wear marks on the upper surfaces of the staples, which reveals that the cauldrons were stored in an inverted position when not in use.[16]

Both Class A and B Atlantic cauldrons have similar distribution patterns and are found in Ireland, Britain, western France and the Iberian Peninsula (with one from Denmark). Based on similarities in cauldron construction Gerloff suggests that the immediate predecessors of the Atlantic cauldrons are most likely to be found in central and south-eastern Europe.[17] For example, a multi-sheet bronze cauldron uncovered in 1987 at Sipbachzell, Austria (Fig 1), has been securely dated and is a likely model for the first insular British cauldrons of Type Colchester / A0 which are dated to the late thirteenth or early twelfth century BC.[18] Further back, the ancestor of the European cauldron form may be traced to the Bronze Age Aegean which influenced continental European production of bronze vessels.[19] As Gerloff states, 'It is beyond doubt, therefore, that the origin of sheet metal working in Britain, which resulted in the

[8] Gerloff 2010
[9] Craven 2007; Fitzpatrick 2009
[10] Gerloff 2010, 3
[11] *ibid*, 336
[12] Gerloff 1986, 87
[13] *eadem* 2010, 118
[14] Craven 2007, 56
[15] Gerloff 1986, 87
[16] *eadem* 2010, 336
[17] *ibid*, 334
[18] Gerloff 2004, 128
[19] *eadem* 2010, 335



Fig 1 Cauldron from Sipbachzell, Austria (after Gerloff 2010, pl 163)



Fig 2 Class B0 Atlantic Cauldron, Type Cloonta (after Gerloff 2010, pl 49)

manufacture of Insular cauldrons, buckets and also shields, has to be sought in early Urnfield Europe, where in turn it may be derived from the Mycenaean world'.[20] These earliest Atlantic cauldrons from Britain arguably were highly influential on the use and manufacturing of the Irish cauldrons examined below. Other items of feasting paraphernalia, such as flesh-hooks, rotary spits and chariot-stands, may also be Aegean in derivation.[21]

Long distance interaction in the Irish LBA can be perceived in material culture and archaeologically discernible practices, both of which may display exotic influences while maintaining a regional character. Aegean influences, including the introduction of cauldrons, buckets and flesh-hooks to Atlantic Europe via south-eastern Europe in the later part of the Bronze Age,[22] can be perceived across Europe in the Bronze Age and possibly reached Ireland via not one singular but a number of active channels. Novel types of material culture introduced to Ireland from other areas of Europe were likely accompanied by the knowledge of their use. For example, the early Class B cauldrons of Type Cloonta / B0 (Fig 2) have been dated to *c* 950–750 BC and are considered to be contemporary to the final Class A Type Portglenone. They also have many similarities to the Spanish cauldrons of Type Cabárceno, perhaps demonstrating a connection. It is likely that commensality etiquette accompanied cauldrons, buckets, and flesh-hooks into Ireland. However, it is important to acknowledge that the uptake of new forms of material culture and social practice was not a passive process. Knowledge of the protocols and etiquettes of other cultures undoubtedly facilitated the development and maintenance of long-distance socio-political interactions, and therefore formalized feasting may be viewed as inherently political and strategic.

It is very tempting to make direct connections between Bronze Age Mediterranean and Irish feasting because of the high status and highly formalized nature of the assemblages in both areas. It is not suggested here that a direct analogy be made between LBA Ireland and Iron Age Europe, the Classical world, and / or Early Medieval Europe / Ireland. However, it is useful to consider these sources in relation to the Irish LBA material as a means of widening our interpretive horizons. This may especially be the case with material culture utilized or contextualized differently than similar modern objects (ie cauldrons), where manner of use in recent history may inadvertently influence interpretation. Therefore, while it is tempting to make direct connections between the way that similar objects / materials were understood and used in different socio-cultural and temporal contexts, the interpretations presented here of the Irish Bronze Age cauldrons rests on the evidence available from the archaeological record, with other types of information, such as myth or pseud-historical documents, considered as highly useful but not primary data sources. Nevertheless, it is quite likely that commensality was highly formalized in *all* European regions at this time, and since feasts are an ideal venue at which to (re)establish long-distance connections through fêting visitors, exchanging gifts, and subtly negotiating alliances, the modes of conducting these types of feasts were transmitted through participation. Regardless of the motivation, as Dietler states, the 'critical point to retain is that commensal hospitality centring on food and drink distribution and consumption is a practice, which, like the exchange of gifts, serves to establish and reproduce social relations'.[23]

Although outside influences continue, it seems that once introduced to the Atlantic regions of Europe, cauldron development and production became insular.[24] The insular nature of the archaeological evidence has led to Class A cauldrons being considered an Irish type by some authors;[25] however, Gerloff is more cautious, stating that although the majority

[20] Gerloff 2010, 110
[21] Almagro Gorbea 1995, 142
[22] *ibid*; Gerloff 2010, 335, 348; Armada 2011
[23] Dietler 2001, 74
[24] Gerloff 1986, 107
[25] cf Almagro Gorbea 1995

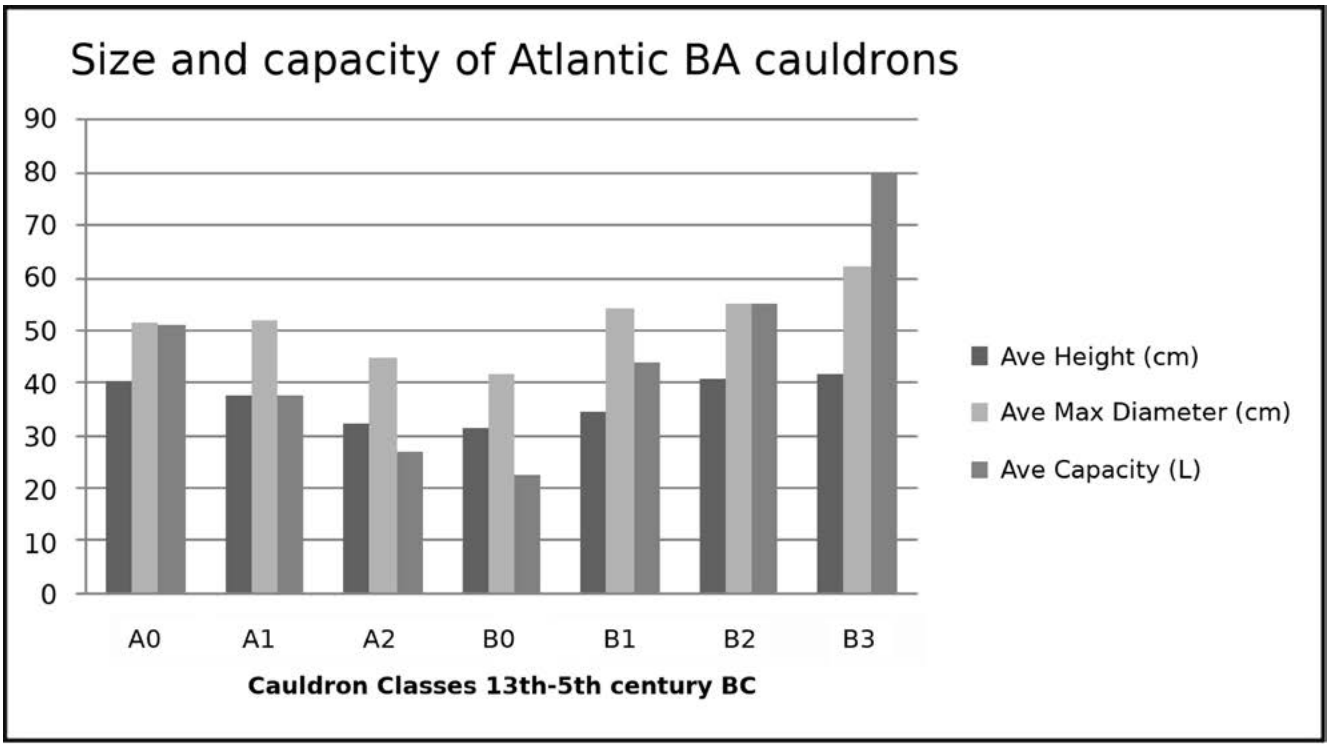


Fig 3 Size and capacity of Bronze Age Atlantic cauldrons (dimensions from Gerloff 2010)

of intact examples come from Ireland, this is a reflection of depositional practices: Ireland was not the 'home' of the earliest types and may not even have been a main production centre at this time.[26] Nevertheless, it is interesting that the majority of those cauldrons which transition between Class A and B (late tenth to ninth century BC), come from Ireland. For Gerloff this pattern suggests that cauldron production, and perhaps use, may have been limited to Ireland at this time.[27] Although structural elements of the cauldrons, such as number of body plates and types of rivets used, changes from Class A to Class B,[28] as the context of their final ritual depositions remains very similar, it is unclear if these structural and stylistic differences are indicative of adaptations to the cauldron's socio-cultural function, a question which is explored in more detail below.

An interesting item of Atlantic Bronze Age feasting equipment which does not occur in Ireland is the metallic spit. Rotary spits occur in regions where no flesh-hooks are found, but where cauldrons and buckets do occur, predominantly in the Iberian Peninsula. This mutual exclusivity may imply that the rotary spits are not a component of the 'Atlantic heroic society', but represent a completely separate social development.[29] Alternatively, this may indicate a regional preference for one type of ritual food preparation over another; therefore a difference in ritual practice is implied without necessitating major differences in underlying cosmology or symbolism.[30] The two types of feasting equipment do overlap in western France; however, as they most often occur as fragments in scrap hoards their depositional distribution may not necessarily correspond to the distribution of their use in feasts.[31] This also suggests that neither flesh-hooks nor rotary spits were fundamentally necessary for the use of cauldrons which occur in the same regions as both (though cauldron distribution overlaps more consistently with flesh-hooks).

Therefore, although both flesh-hooks and rotary spits occur in the same regions as cauldrons, and while they may have been connected in some way, it is clear that the cauldrons could be associated with either (or neither). It is interesting that the two categories of Atlantic feasting paraphernalia (meat implements and vessels) were ritually deposited in very similar ways and yet not usually together as one would expect if they were viewed as a unit. Gerloff cites only four instances where Atlantic flesh-hooks have been found in association with cauldrons, two from England, one from Spain and one from France.[32] Of these the only concrete example of an intact Atlantic cauldron and flesh-hook found together is from Feltwell, Norfolk.[33] The Class 2 single-pronged socketed flesh-hook still retained a portion of its wooden handle which was radiocarbon dated to 1390–1120 cal BC (OxA10859: 3013±36 BP). When the site was investigated, impressions of reeds were found in the copper-impregnated clay which had surrounded the lower half of the cauldron. Gerloff suggests that the cauldron may have been placed in a hollow which had been deliberately lined with reeds.[34] This implies careful placement,

[26] Gerloff 2004, 126
[27] *eadem* 1986, 100
[28] *eadem* 2010, 340
[29] Burgess and O'Connor 2004, 190
[30] Needham and Bowman 2005, 95, 126
[31] *ibid*, 124
[32] Gerloff 2010
[33] Needham and Bowman 2005, 100
[34] Gerloff 2010, 50

and the peaty environment suggests a location which may have been bog or fen in the LBA, a type of location consistently associated with ritual deposition. Nevertheless, this single known exception to the general pattern suggests that the two types of feasting equipment are not as inextricably linked as has been traditionally understood. Furthermore, although cauldrons and flesh-hooks were possibly introduced to Atlantic Europe at the same time, the use of cauldrons continues for centuries after flesh-hooks cease to be produced. There are also many more buckets and cauldrons known than flesh-hooks and rotary spits, perhaps indicating that the vessels were the principal element of ritualized feasting and the meat implements were secondary.

A shared trend which can be observed in the meat-implement and vessel types discussed above is the shift from a utilitarian role to a more symbolic role. For instance, the flesh-hooks change from simple undecorated pronged implements to highly elaborate objects of ostentatious display. Bowman and Needham suggest that the elaboration seen in Class 3 and 4 flesh-hooks, in contrast to the simpler Classes 1 and 2, may indicate that their symbolic role had begun to overshadow their practical role: 'the whole process of elaboration speaks of social elevation of the kind that often leads to the creation of symbolic regalia, the objects still understood by society in terms of their original utilitarian function, but now serving it in an obscure or token way at celebratory festivals or in propitiation to the gods'.[35] The Atlantic bronze cauldrons possess decorative elements even in their initial forms, but they also become more ornamental over time, and the introduced decorative elements are arguably less directly linked to improved function than those on earlier cauldrons, such as the use of conical rivets which project outwards from the body of the cauldron like spikes. There also seem to be some Class B cauldrons which may never have been used but were instead manufactured specifically for ritual deposition.[36] Interestingly, as flesh-hooks become more intricately made there is a corresponding reduction in size of cauldrons, perhaps indicating greater exclusivity of those participating in feasting rituals[37] or the preparation of a token meal alongside or in replacement of a larger-scale communal feast. However, the reduction in cauldron size noted by Needham and Bowman[38] is only evident from Class A0 to Class B0. The later Class B cauldrons progressively increase in size and capacity (Fig 3). Of course, simply because a cauldron could hold a large volume does not indicate that it did, especially since the physical evidence indicates that the cauldrons were suspended by their handles, and these were the part of the cauldron most susceptible to damage through tearing. Relatedly, it is possible that the change from three-tier Class A to five-tier Class B cauldrons was primarily meant to increase the sturdiness of the vessel and thus was a functional adaptation. This increase in the size of Class B cauldrons seems to take place when the production of Atlantic flesh-hooks ceases, perhaps another indication of change to feasting rituals during the mid-eighth to seventh century BC.

So what do these trends suggest? That the focus of specialist object production seemingly changes from function to form across Atlantic Europe suggests that it is linked to an underlying concurrent social change. The fact that Ireland, the northern half of the island in particular, is the location of the majority of ritually deposited intact cauldrons indicates that it was heavily involved in this pan-European development. Gerloff goes so far as to suggest that the social and 'religious' customs surrounding the deposition of cauldrons may have accompanied the introduction of the vessel form into western Europe from central Europe at the beginning of the LBA.[39] While the elaborate flesh-hooks are unique (no two share the same decorative elements) their underlying structure does conform to a general blueprint and the vessels seem to have been manufactured according to a similarly strict pattern, as can be seen in the change from the Class A three-tier construction to Class B five-tier construction. This suggests the practice of similar types of feasting across Bronze Age Europe: if there is a model for the way to construct a flesh-hook or cauldron then it is not unreasonable to assume that there was also an underlying model for how and when to use this equipment.

Irish Bronze Age Cauldrons

The Irish archaeological record has revealed more intact Atlantic feasting vessels than anywhere else in Europe. This may be due to the prevalence of prehistoric deliberate and ritualized deposition in wet environments in Ireland, a practice seemingly not conducted as extensively elsewhere in Europe. However, the active historic and modern exploitation of turf for fuel is also a likely factor in the numbers of cauldrons recovered from Irish bogs. Forty-two Atlantic bronze cauldrons have been found in Ireland, twenty-eight of which are largely intact, a pattern which is in contrast to the find circumstances of buckets and cauldrons from other Atlantic regions, where they are generally found in a fragmentary condition in 'scrap' hoards.[40] The evidence for Bronze Age cauldron usage in Ireland spans from the thirteenth to the fifth century BC, and it could be argued that forty-two is a small sample on which to base an understanding of wider socio-cultural change over hundreds of years. However, a number of factors indicate increased social stratification in Bronze Age Ireland, and so the production and use of luxurious feasting equipment is but one facet of a multi-dimensional and dynamic socio-cultural environment. It is suggested here that changes in cauldron design and repair can be used as a marker of socio-cultural change because these objects likely reflect specialized usage and can tell us about a specific social ritual and how that changes over time.

It seems that the Irish, and to a certain degree Northern British, cauldrons are predominantly found complete due to their purposeful deposition at wet locations in Ireland and elsewhere in Europe. The vast majority of Irish feasting equipment has been found as isolated depositions, and those

[35] Bowman and Needham 2007, 98
[36] Gerloff 2010, 337
[37] Needham and Bowman 2005, 127
[38] *ibid*
[39] Gerloff 2010, 336
[40] *ibid*, 332

with details of recovery have usually been found mid-way through the bog (average depth of two to three metres from the surface). Furthermore, many of those with unknown find circumstances display a patina which is suggestive of their having been found in boggy environments. Cauldrons are not generally recorded as sitting on mineral soil or sand or amongst tree stumps as other artefacts often are (ie at the base of the bog). This suggests that cauldrons were deposited in a wet bog or fen landscape where there were open pools of water amongst the bog growth, and it was into the open pools that the cauldrons were deposited, thus allowing them to rest at the base of the pool on the formed peat.[41]

As is also seen with the deposition of weaponry in other types of wet locations, the consistency in this depositional practice, from the late Middle Bronze Age into the Iron Age (and in some instances beyond), indicates that this practice of deliberate deposition is formal, repetitive and stable over a long period of time. It may be that competitive displays (perhaps enacted at formal feasting events) became so extreme in later Bronze Age Europe that eventually the objects used at such events were ritually deposited to end the cycle of competitive reciprocal obligation. As will be discussed below, displays of 'wealth' at feasts are thus closely linked with social interactions and social status, since community events can highlight an individual's relative status and thus compel them to participate. These types of social conventions do not need to be explicit to be powerful.

Factors such as location, audience and participants, choice of objects / materials, and the activities surrounding the deposition all combine to create the final result of the depositional act of which we find evidence in the archaeological record. Clear choices were made regarding what materials were deposited together, if the objects / materials were processed prior to deposition (ie fragmented, decommissioned, burnt, etc), where the deposition took place, how the objects / materials were deposited (ie structured, layered, dumped, arranged, contained, etc), and how the deposition was left (ie marked or unmarked). This degree of detail cannot be accessed for each deposition, often due to the circumstance of modern recovery. However, when possible it is very informative to consider the enactment of depositions, as it allows the focus to shift away from the 'value' of the goods towards the wider socio-cultural / political concerns which may have directed each depositional event. Irish LBA depositions exhibit intentionality and are undoubtedly purposeful actions, if this notion of *purpose* is kept in mind when considering the variety of expressions of ritual deposition, the variability may begin to be understood as *choice*. Following from this, if the immediate aspects of a ritual deposition reflect distinct choices then the more secondary aspects may have been directed / managed as well. For instance, it is possible to discuss the manner in which locations of deposition were accessed (ie traversing a bog, fording a river, etc), how this may have affected the audience composition (ie group volume) and whether or not this was a known location (ie returned to many times vs a discrete event).

It is significant that cauldrons are a type of object likely used during communal feasting and yet almost always deposited singly in isolated locations in seemingly uninhabited (and undomesticated) landscapes, a manner of deposition that completely removes the cauldron from its sphere of use. This phenomenon can be seen in two separate deposits of Irish cauldrons in Co Clare, in the townland of Moyree Commons and in the Lack East Bog to the west-north-west of Goulburn Bridge.[42] These are the only cauldrons found in Co Clare and were isolated depositions in peripheral zones in the landscape in relation to the core zone around Mooghaun hillfort. Significantly, both depositional locations are near to potential riverine routes through the county, perhaps indicating that the depositors travelled along rivers to these peripheral zones from more settled areas in the landscape. The close proximity of a main route could also conceivably affect the size of the audience who could observe the ritual deposition, as a more isolated location in a potentially unsafe / unstable fenland would not be accessible to many. Correspondingly, the cauldrons examined by the author at the National Museum of Ireland and discussed below were generally recovered from bog or wetland contexts. One case of a complete Atlantic cauldron recovered from a river is the eponymous specimen of Type Shipton-on-Cherwell, discovered on the bed of the River Cherwell, a tributary of the Thames in England. Gerloff states that 'it is highly probable that the river deposition was deliberate and not due to accidental loss' as almost all 'of the probably more or less contemporary shields of Type Eynsham found in Britain have come from rivers, and further they were nearly all found in the Upper Thames or its tributaries'.[43]

Following this, it is significant that the largely complete Bronze Age cauldrons found deposited in Irish bogs show signs of having been used, repaired and reused for long periods of time. Instead of designating such cauldrons as at the end of their use-life, the patching and repairing can be interpreted as reflecting the importance of the continued use of these objects, perhaps by multiple generations. Although the timespan in which cauldrons were in use is not possible to discern, wear on the upper side of the handles indicates that they were stored 'upside down' often enough to create a lasting mark. This could be taken to suggest that they were not in everyday use. However, a metal object not used daily that comes to eventually exhibit the degree of repair seen on some Atlantic cauldrons was likely intermittently used over a significant amount of time. The eventual decision to deliberately deposit an item with such a lengthy object biography would not have been taken lightly and so may reflect the marking of an important event in the lifecycle of a community, lineage or social-group. Thus, as is generally the case with the archaeological record, it is more straightforward to reconstruct the final action associated with cauldrons than interpret the circumstances of their common usage. Nevertheless, as many of the Irish Bronze Age cauldrons are in a largely complete state, their repeated repairs can be examined in a manner not possible with the fragmented cauldrons found elsewhere in the Atlantic zone. In particular, the earlier Irish cauldrons seem to have been repaired

[41] Leonard 2015, 82

[42] Gibbons *et al* 1999, 274

[43] Gerloff 2010, 60

with a lower quality of craftsmanship than their initial production, resulting in a 'patchy' appearance, while many of the later cauldrons have repairs which are almost indistinguishable from their original crafting. It is suggested here that by investigating these repairs to cauldrons, a more nuanced understanding of their use and socio-cultural significance can be developed.

Cauldrons assessed at the National Museum of Ireland

To more fully observe the repairs to Irish LBA cauldrons, a preliminary investigation of the examples held by the National Museum of Ireland (NMI), was carried out by the author over a two-day period in 2012. While much desk-based research regarding the construction, find circumstances and theories concerning the use of prehistoric cauldrons had been conducted, images are generally used to display artefacts at their best, and in this case the main aspects under examination were the faults and blemishes. The catalogue produced by Gerloff is an excellent resource which was an important starting point in this investigation, especially since the drawings of the cauldrons did not try to hide the repairs.[44] However, only so much can be gleaned from two dimensional representations, and thus for the present author to begin to speculate on the use and reuse of cauldrons prior to their eventual ritual deposition it was imperative to interact with them first-hand.

Although the NMI holds both complete cauldrons and fragments of cauldrons, it was decided that since the primary aim was to investigate the repairs in order to develop a hypothesis on cauldron usage, only whole cauldrons would be considered. As noted above, the degree of skill necessary to construct a later prehistoric bronze cauldron would have required a master craftsperson. However, the repairs to cauldrons often appear haphazard and of a significantly lower quality than their initial construction. Two possible explanations for this discrepancy in bronze-working are that the overtness of the patches was deliberate evidence of the age and past use of such an important object, or that the highly skilled craftsperson(s) who initially manufactured the cauldrons were not available to conduct the repairs. During the Dowris phase of the LBA in Ireland (*c* 1000–600 BC) several advances in bronze-working occurred, for instance lead was deliberately added to the alloy to slow the rate at which the molten metal hardened and thus improve the casting process.[45] Also the technique of 'casting-on', using molten metal to fuse together a broken object, was first employed during this phase and is known from about seventy of Eogan's Class 4 swords and only one Class 3 sword, further evidence for the swift comprehension and application of these novel techniques.[46] The volume and variety of metallic object types from Dowris Phase contexts as well as the clear evidence of insular object types such as bronze horns (which are stylistically similar to Class B cauldrons) and gold ornaments, such as gorgets, further demonstrates that gold- and bronze-smiths of a very high calibre were working in LBA Ireland. In other words, there is strong evidence to support the argument that by the latter half of the LBA highly specialized objects like cauldrons were being manufactured in Ireland and not solely imported from abroad, even though foreign stylistic and structural influences can be discerned.

There are fourteen complete (or largely complete) cauldrons currently held in the NMI, twelve of which were investigated by the author, as two were on display: the cauldron from the Dowris hoard, Co Offaly, and the Kincardine Moss cauldron from Ballyedmond, Co Galway (Fig 4). The Kincardine Moss cauldron is very large and delicate and belongs to the final Bronze Age Atlantic cauldron Class B3, dating to the earlier sixth to fifth century BC, towards the end of the author's period of study.[47] The Dowris cauldron is a Type Tul-na-cros / A1, of which three others were examined, so it was decided to begin the investigation without including them. While twelve cauldrons were examined in detail as part of this preliminary investigation, to avoid unnecessarily repeating the information supplied in the catalogue produced by Gerloff,[48] the details of only four will be outlined below. These four examples were chosen as they span the spectrum of Irish LBA cauldrons from an early Class A to a later Class B example and thus give a general sense of the types of repairs observed on all the cauldrons over the duration of their use in LBA Ireland.

The cauldrons examined span from the Class A0 Type Shipton-on-Cherwell, Variant Dereen, which dates to the eleventh to tenth century BC, to the Class B1 Type Ballyshannon which dates to the seventh century BC. The first, Class A0, Type Shipton-on-Cherwell, Variant Dereen, is considered by Gerloff to represent the final stage in the transition from Class A0 to A1 and is typologically the earliest cauldron discovered in Ireland, although as Gerloff notes it is not possible to identify on which side of the Irish Sea it was manufactured.[49] The latest cauldron discussed here, the Class B1 Type Ballyshannon, was chosen to discuss in more detail out of the four Class B1 cauldrons examined because this example had more evident repairs than the other three and thus provided more evidence to compare with the earlier Class A cauldrons. Even with this rudimentary analysis it was evident that there was a change in the quality of repairs over time, which was not necessarily of the same quality as that of the cauldron's original manufacturing. Furthermore, it seems that the earlier cauldrons of Class A displayed more overt patching than the later Class B cauldrons. This was not necessarily reflective of the functionality of either the overt or more subtle patching, as there was obvious re-patching of patches on all of the cauldrons assessed.

Class A cauldron examples

The earliest cauldron examined, and the earliest held by the National Museum of Ireland, is the Class A0, Type Shipton-on-Cherwell, Variant Dereen example from Asky Bog, Kilcorkey, Castlerea barony, Co Roscommon, which was found

[44] Gerloff 2010

[45] Mallory and McNeill 1991; Ó Faoláin 2004, 265

[46] Ó Faoláin 2004, 12

[47] Gerloff 2010, 340

[48] Gerloff 2010

[49] *ibid*, 62



Fig 4 Kincardine Moss Class B3 cauldron (after Gerloff 2010, pl 69)



Fig 5 Detail of Class A0, Type Shipton-on-Cherwell, Variant Dereen example from Asky Bog, Kilcorkey, Castlerea barony, Co Roscommon (NMI 1905:283; Gerloff 2010, no. 5)

in or before 1905 (NMI 1905:283).[50] The cauldron dates to the eleventh to tenth century BC, and unfortunately no details of its recovery have been retained. Gerloff describes this cauldron as a 'standard Class A three-sheet construction, the spheroidal body and vertical neck with three corrugations and vestigial shoulder', it is a relatively small cauldron, and while the base is buckled, it was likely slightly conical in shape.[51] In this example the patching seems to have been effective, but also very overt: there was no attempt to hide the damage or the repairs. The main evidence for repair includes the base which is heavily repaired in a manner and of a quality similar to the original manufacturing. However, the bronze used for the base repair is much thinner than the original plates, prompting the author to question whether the damaged portion of the base could have been cut out and recast as the patch. Gerloff comments that as the rivets used to secure this replacement base have large flat heads similar to the rivets in the original seams, this suggests 'repair by craftsmen skilled in cauldrons production'.[52] Furthermore, the metallurgical analysis conducted by Northover indicated that 'the repair components come from the same piece of metal'.[53] The casting-on of the handle attachments is a bit 'messy' and the attachments are of a rougher casting than either the handles themselves or the cauldron rim (Figs 5, 6 and 7).

A later Class A cauldron examined was the Class A2, Type Portglenone cauldron from Ramelton (or Rathmelton), Tullyfern, Kilmarenan, Co Donegal (NMI 1927:48).[54] This was found in a bog near Ramelton on the west side of Lough Swilly and dates to the eighth century BC. Again, this cauldron is described by Gerloff as a standard three-sheet construction with a shoulder at the base of the corrugated neck.[55] The Ramelton cauldron was extensively repaired, and only the uppermost register, including the rim and ring handles, seems to be original. In fact, of the twelve cauldrons investigated this was the most thoroughly damaged and repaired. Even Gerloff states that the crumpling and extent of repair 'prevent accurate estimate of dimensions'.[56] Like the Derreen cauldron described above, the Ramelton cauldron has a large circular basal repair sheet. The handle attachment appears to have been removed and replaced at some point; however, as a result of the degree

[50] Gerloff 2010, 57–8 no. 5
[51] *ibid*, 57
[52] *ibid*, 58
[53] Northover in Gerloff 2010, 62
[54] Gerloff 2010, 85–6 no. 19
[55] *ibid*, 85
[56] *ibid*, 85–6



Fig 6 Inverted view of Class A0, Type Shipton-on-Cherwell, Variant Dereen example from Asky Bog, Kilcorkey, Castlerea barony, Co Roscommon (NMI 1905:283; Gerloff 2010, no. 5)

to which the cauldron was repaired it was impossible to discern the sequence of repairs without a more thorough investigation. The patches are also very irregularly shaped and affixed in a way that almost suggests a surplus of bronze used to cover a small defect, perhaps an indication of a lack of experience in bronze-working as opposed to a lack of raw material. As some patches are placed on the exterior of the vessel and some on the interior, and different types of rivets are used, it is possible that these repairs were performed by a number of different individuals with differing degrees of skill (Figs 8, 9 and 10).

Class B cauldron examples

Although some of the Class B cauldrons have obvious repairs, they are generally more in line with the original manufacturing, unlike the Class A cauldrons where the repairs almost overshadowed the cauldron itself. The Class B0, Type Cloonta cauldron examined is of unknown find circumstances and dates to the eighth to seventh century BC (NMI W.13).[57] Gerloff describes this cauldron as having three tiers of sheets comprising a conical lower body with the upper body sloping inwards towards the everted rim, all cast components are decorated and all seams held by conical rivets.[58] This cauldron is generally not as nicely fashioned as the other cauldrons examined. For instance, although the different plates appear to be firmly attached to each other, the edges are irregular and not cut neatly, and the original conical rivets are not as crisp or attached as skilfully as was seen on the other cauldrons examined. Interestingly, the base has been repaired and the new base plate / patch is actually more finely cut than the plates to which it is affixed. However, the rivets attaching this basal repair patch are blunt, not conical like those holding the original seams. The patches on the base are also finely cut and adhered. As with many of the other cauldrons examined, the casting-on has not been cleanly done and decorative incising is not very well executed on the handle attachments. There are some small repairs on the upper register which are as well executed as the basal repairs (Figs 11, 12 and 13).

The final example outlined here is a Class B1, Type Ballyshannon cauldron of unknown find circumstances, found before 1857–61 (as listed by Wilde) and dating to the seventh century BC (NMI W.12).[59] Like in the case of many cauldrons

[57] Gerloff 2010, 130–1 no. 32

[58] *ibid*, 131

[59] *ibid*, 139–40 no. 35



Fig 7 Handle attachment from Class A0, Type Shipton-on-Cherwell, Variant Dereen from Asky Bog, Kilcorkey, Castlerea barony, Co Roscommon (NMI 1905:283; Gerloff 2010, no. 5)



Fig 8 Class A2, Type Portglenone cauldron from Ramelton (or Rathmelton), Tullyfern, Kilmarenan, Co Donegal (NMI 1927:48; Gerloff 2010, no. 19)

with unknown find circumstances the patina suggests a bog find. Gerloff describes this Type Ballyshannon cauldron as having five tiers which comprise an oblate globular body leading to an everted rim with ribbed and embossed decoration; conical rivets both hold together the plates and create 'false decorative seams'.[60] This cauldron exhibits very minimal repairs, and those that have been conducted are very similar in style to the original construction. The handle attachments are finely wrought, and although there are wear marks from the ring rubbing the handle attachment it still appears to be strong. The base plate has been completely replaced, but unlike other cauldrons examined which have misshapen patches, this one is perfectly round. Further, according to Gerloff the 'secondary A sheet [base] is itself repaired; a circular piece has been cut out and replaced with a roughly circular patch (R1 = 270 mm dia.) with fifty-two flat headed rivets (dia. = 6 mm) in the seam; the seam traps one edge of a trapezoidal repair patch (R2 = 46/25×46 mm) with four rivets exposed; the A sheet has a third, subrectangular repair patch (R3 = 95×42 mm) with eight rivets'.[61] Similarly, over the body of the cauldron the patches are nicely shaped, not irregular or roughly cut like those seen on earlier cauldrons, and the replacement rivets are very neat (uniformly spaced and cleanly inserted). The replacement plates and patches are affixed with flat rivets, and as the replacement plates do not have the vertical striations observed on the upper plates, they are clearly distinguishable from the originals which are affixed with conical rivets. Although the repairs in this case seem to be very subtle, there are small patches 'peeking out' from under both the base plate and the plate above, which perhaps indicates that both these plates are repairs of repairs, and thus like the earlier Class A cauldrons examined this later vessel underwent a series of repairs. However, in this later example the repairs were more deliberately 'hidden' or integrated into the body of the cauldron (Figs 14, 15 and 16).

Feasting in later prehistoric Europe

Consuming food is a basic human necessity and can be a mechanism for facilitating a variety of socio-political objectives such as building alliances, affecting competitiveness, creating indebtedness, organizing a workforce, and generating exclusiveness or inclusiveness.[62] Dietler goes so far as to suggest that feasts are innately political, simultaneously as the vehicle and venue for political manoeuvring,[63] as feasts assert and maintain existing hierarchies, both social and ontological. The formality of an established feast can facilitate the creation and maintenance of exchange partners (goods, bride-wealth, etc), provide a venue for societal control (dispute settlement, exercising laws and public sanctions, etc), offer a sense of connection (to the past, gods, ancestors, etc),

[60] Gerloff 2010, 140
[61] *ibid*, 141
[62] deFrance 2009, 141
[63] Dietler 2001, 66



Fig 9 Detail of base of Class A2, Type Portglenone cauldron from Ramelton (or Rathmelton), Tullyfern, Kilmarenan, Co Donegal (NMI 1927:48; Gerloff 2010, no. 19)



Fig 10 Detail of handle attachment on the Class A2, Type Portglenone cauldron from Ramelton (or Rathmelton), Tullyfern, Kilmarenan, Co Donegal (NMI 1927:48; Gerloff 2010, no. 19)

and (re)establish the social positions of group members.[64] The political, and therefore potentially competitive, character of feasting is linked to reciprocal obligation and thus asymmetrical power relations. By holding a feast the host is not simply providing food for a gathering of people; they are entering into a reciprocal obligation whereby the guests are provided with the feast and are therefore indebted to the host and in some manner inferior to the host until the debt is paid.[65] To procure symbolic capital through the organization of feasts, a host must make potential guests feel that attending the feast is worth the reciprocal obligation incurred, either due to the networking potential of a large gathering, by providing luxurious foods or by employing ritual and / or venerative displays.[66]

Public events like feasts can also be used as a method of upholding the social status quo in favour of the élite strata of society. The preparation of a large-scale feast is not a casual undertaking, it requires long-term planning and the intensification or augmentation of subsistence activities for the accumulation of surpluses.[67] Although the use of surplus food in order to avoid waste is possibly one aspect of the development of feasting activity, a purely economic motivation for instituting a formal feasting event seems overly simplistic. Instead, there are a variety of socio-cultural motivations for feasting. Even if these appear outwardly to be driven by economics, for instance the redistribution of agricultural produce, there is often also a closely related (underlying or dominant) social influence. Furthermore, preparing a communal feast, especially one with a ritual element, often involves the production of unusual specialist items such as ceremonial clothing or serving-ware, like the cauldrons under discussion here, which create demand for skilled labour and can lead to craft specialization and patronage, therefore involving the efforts of the whole community.[68]

What seems to be underlying the activity of feasting is the way in which relationships between individuals and groups are built and maintained. The sharing of food is one of the universal aspects of human culture, and may be utilized as a mechanism for facilitating social interaction, whether this is motivated by a desire to maintain the status quo, elevate one's own status, or subjugate another's. As a result of its more public nature and the amount of time and resources invested in preparation and execution, formal feasting heightens these social interactions and negotiations by providing a structured and socially accepted arena for the enactment of commensal politics. This can often be expressed through reciprocal obligation which may become highly competitive. Thus feasting would not only have highlighted relative status in terms of foods eaten and public social manoeuvring, but the equipment used at feasts would have overtly demonstrated the strength / prosperity of those who controlled its use.

A custom which can often extend beyond the relatively formal reciprocal obligation of host and guest is hospitality. In Bronze Age Greece and Iron Age Gaul it was obligatory to provide hospitality (food, accommodation) even to unannounced outsiders, without receiving anything in return except perhaps information.[69] The occurrence and / or format of hospitality in LBA Ireland is unknown; however, its formality in contemporary Europe and later Ireland (eg Medieval Irish institution of *coe*)[70] hints at the longevity and importance of such customs. The importance of feasting and reciprocal obligation for the establishment of political relationships may be seen in a fourth-century BC account of the Thracians by Xenophon, whereby the Thracian political leaders are observed sharing food and distributing wealth to their subordinates: 'An exchange of gifts had to be made to his guests to signify equality in relationship and as a pact of friendship and co-operation; a practice which by then was only a vague folk memory to the Greeks who had come ill-

[64] *ibid*, 69
[65] *idem* 1990, 363; Hayden 2001, 35
[66] Hayden 2001, 30
[67] Spielmann 2002, 197
[68] *ibid*
[69] Craven 2007, 38
[70] McCormick 2002, 26



Fig 11 Class B0, Type Cloonta cauldron of unknown find circumstances (NMI W.13; Gerloff 2010, no. 32)



Fig 12 Detail of replacement body plates of Class B0, Type Cloonta cauldron of unknown find circumstances (NMI W.13; Gerloff 2010, no. 32)



Fig 13 Detail of handle attachment on Class B0, Type Cloonta cauldron of unknown find circumstances (NMI W.13; Gerloff 2010, no. 32)

prepared for such an exchange.[71] Such social customs heavily stress the perception of generosity and *transparency in social relations, while also providing a mechanism for upward social mobility* or the maintenance of social status, for instance through celebrating changes in the lives of group members (ie marriages, deaths, etc), touting group stability and strength through practices like 'potlatch' and reciprocal hospitality, and engaging group members in raiding or other forms of combat.[72]

Archaeological evidence for feasting may also provide a glimpse of other social processes indicative of the increasing complexity of the social hierarchy present in LBA Ireland. In addition to the contents of the feasting vessels, the production of vessels would have been a statement of individual and / or community affluence. It has been estimated that it would have taken three to four months to produce a LBA cauldron,[73] a whole season during which a master smith would have had to be supported by a community or an influential individual. The ability to facilitate the production of feasting equipment and the status and social capital it entailed would have been implicitly communicated whenever a cauldron was used. Feasting in LBA Ireland may therefore have been highly instrumental in defining relational and categorical identity within and between communities.

Social stratification in LBA Ireland is evidenced by an increase in the construction of enclosures, from simple stake-built palisades to substantial banks, ditches and revetments enclosing settlements.[74] The variety and location of the LBA settlements may be further indication of the emergence of strong social hierarchies and even the development of regional identities and territorial divisions.[75] Small enclosures are often located adjacent to burnt mounds, ceremonial or funerary monuments and agricultural field systems, and characteristically enclose one or two roundhouses and smaller stake-built features.[76] In some cases it appears that the settlements are occupied for extended periods of time, perhaps a few generations, and that groupings of contemporary structures may indicate extended family or kin groups living together.[77] There is congruency in the archaeological record from across the entire island of Ireland, but there are also regional differences which suggest the existence of local group identities that were in some cases outwardly expressed in styles of material culture.[78] Furthermore, differential access to particular objects and materials (eg amber, swords, etc) in combination with large-scale construction projects (eg hillforts) indicating organized communal labour under the direction of a particular individual or social group, together demonstrate formalized social stratification and group organization in LBA Ireland.

[71] Xen Anab VII. Iii; cf Rowlands 1980, 30
[72] Craven 2007, 38
[73] Northover in Gerloff 2010, 40
[74] cf Waddell 2010; Cooney and Grogan 1994; Mallory and McNeill 1991
[75] Cooney and Grogan 1994, 144; Bradley 2007
[76] O'Sullivan and Breen 2007, 80
[77] Brindley 1995, 10
[78] Leonard 2015, 168–72



Fig 14 Class B1, Type Ballyshannon cauldron of unknown find circumstances (NMI W.12; Gerloff 2010, no. 35)



Fig 15 Detail of replacement base plate on the Class B1, Type Ballyshannon cauldron of unknown find circumstances (NMI W.12; Gerloff 2010, no. 35)

Discussion

Atlantic bronze cauldrons possess decorative elements even in their initial forms, but they also become more ornamental over time, and the introduced decorative elements are not necessarily directly linked to improved function, as for example with the conical / spiked rivets used on the Class B cauldrons. Although each cauldron is unique, they were nevertheless manufactured according to a general archetype and in accordance with a particular style, as can be seen in the change from three-tier to five-tier construction. If an underlying model exists for the 'proper' way to construct a cauldron then it is not unreasonable to assume that there was also an underlying model for how and when to 'properly' use this feasting equipment. This may also be reflected in the concurrent increase in the size of Atlantic Class B cauldrons when the production of Atlantic flesh-hooks ceases, perhaps an indication of changes in feasting rituals during the mid-eighth to seventh century BC, as discussed above. Therefore, the cauldrons become more decorative over time and increase in size, a parallel development to the discontinuation in the use of flesh-hooks. Class B cauldrons also display more subtle repairs and patching than the earlier Class A cauldrons, a modification perhaps related to changes in the socio-cultural significance of feasting at this time.

If the later Class B cauldrons were the primary item of formalized feasting equipment in Atlantic Europe, as the flesh-hooks were going out of 'fashion', perhaps this increased prominence is reflected in the subtleness of the repairs which demonstrate the need for the cauldrons to appear unblemished. But it remains to be asked whether the earlier overt patching was deliberate, or if the less overt and better executed repairs of the later cauldrons simply indicate an increased availability of well-trained smiths. If there were very few smiths with the experience and skill to create a cauldron during the first centuries after their introduction to Ireland, it may be that smiths were in high demand and moved according to where their services were required. In later periods smiths may have been attached to particular communities and / or patrons and were therefore onsite and available to perform repair work as well as to construct new objects. This change may conceivably reflect an increased stability in the social hierarchy of LBA Ireland. Such a pattern may be discernible through the production of regionally distinct objects in south-west Ireland which are suggestive of a broad regional identity, such as gold gorgets and bronze Class II horns. The tight distribution of such high status objects indicates that there were smiths present in south-west Ireland who were schooled in a particular tradition of producing objects.

Conversely, a decrease in the overtness of repairs to Bronze Age cauldrons may be reflective of changes to the social conventions of politicized hospitality outlined above and communicated when the vessels were in use. Earlier overt patching could have signified a mnemonic practice of marking feasting events, object biographies or long-held traditions within a particular group. In this case the overt patching may not reflect the availability of well-trained smiths but instead may reflect a degree of intentional 'messiness'. As was discussed above, the ability to execute a successful feast is an indication of the social capital and status held by the host and those associated with the host. Thus, visible signs of the lengthy use of an object like a cauldron (ie repairs and patches) may have communicated important



Fig 16 Detail of patching on Class B1, Type Ballyshannon cauldron of unknown find circumstances (NMI W.12; Gerloff 2010, no. 35)

socio-cultural information related to the host, their lineage (or social role), and / or the importance of the event to those attending the feast. It is possible that with the exponential increase in the types and variability of bronze object types seen in Ireland towards the end of the Bronze Age,[79] the focus shifted from 'heirloom' objects with long histories to objects which fit with the idea of an unblemished ideal.

In either case, the change from overt repairing to subtle repairs is evident on those cauldrons considered by the author in her preliminary investigation conducted at the National Museum of Ireland. Furthermore, it is clear from the artefactual evidence in the archaeological record that there were smiths of a very high skill in Ireland during the entire sequence of cauldron production and that the original production of the cauldrons seems to have been of high quality generally. Yet the patches on the Class A cauldrons are consistently messy and obvious, and those on the Class B cauldrons become less and less obvious over time. In the case of both interpretations presented here, this change could be connected to an increase in the importance of high-status overt expressions of social capital, as the cauldrons in themselves are objects which advertise status through the ability to host feasts which involved the use of luxurious serving equipment. The major change therefore seems to be that the later cauldrons needed to appear 'whole' or perfect; there was less of a need to advertise their past use. Thus, the change from the earlier overt repairs and patching of Atlantic Bronze Age Class A cauldrons from Ireland to the later subtle repairing of the Class B cauldrons may be interpreted as a change from evidence of use (ie patches as mnemonic devices indicating repeated use of perhaps ancestral ritual objects) to the representation of an archetype (ie the ideal equipment for the ideal feast).

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Bronze Age halberds: use-wear and functionality

David Bell

Copper alloy halberds played a central role in the panoply of Bronze Age weaponry from southern Scandinavia to North Africa, yet their primary function has long been the subject of debate. Were they practical weapons of war or were they some form of ceremonial standard? A variant which was developed in central Europe saw the blade and upper portion of the shaft cast as one piece, allowing for the determination of the angle at which these intersected with each other. These metal-shafted halberds were also examined for evidence of metal-loss, possibly due to re-sharpening following combat damage. The existence of any particular edge dominance might, therefore, be inferred. It has been argued, on grounds of experimental archaeology and use-ware analysis, that this should be seen on the lower edge of the blade. However, analysis of the profiles of metal-shafted halberds, and those Irish wooden-shafted examples where a residual hafting trace remains, suggests that combatants lead with what was the upper edge of these weapons. This thrusting-stroke hypothesis is further supported by the pattern of damage to rivet-holes on blades from across Europe. The flat or bulbous terminals of prehistoric halberds, in stark contrast to designs from later periods, coupled with the complete lack of contemporary sharp force cranial trauma, is also interpreted as evidence of a weapon designed and used for non-lethal, stylized tournaments. The popularity of these bouts might be attested by the relatively high levels of blade asymmetry, suggesting that frequent re-sharpening was made necessary.

Introduction

Interpersonal violence is undoubtedly as old as humanity itself, with the first tool-users, on occasion, turning their simple hand-axes and hunting sticks against each other with lethal intent. Osteological evidence of human aggression stretches back in time to the Middle Paleolithic and beyond.[1] Perhaps surprisingly, therefore, it is not until the Middle Bronze Age, with the development of the metal sword, that we see what many regard as the first true weapon, an implement specifically designed to kill people.[2] Others, however, have argued that this dubious distinction belongs to the Early Bronze Age halberd.[3] This paper will reflect on the previous work done to assess the functionality of the halberd and propose a fresh technique for determining its intended use.

Prior research

Halberds

In Briard's[4] oft-quoted view[5] halberds were a '*poignard amélioré*' which, as Macalister observed, offered 'the advantage of keeping an adversary at more than arms' length while perforating him with a dagger'.[6] Due mainly to a perceived inherent weakness in their hafting, however, it has also been widely argued that halberds were primarily intended to perform some ceremonial function, rather than serve any practical purpose.[7] Yet for many the halberd was regarded as a fully functional combat weapon.[8] Trials by O'Flaherty,[9] involving twenty sheep sculls, persuasively demonstrated that a well-delivered blow with a halberd blade would have been perfectly capable of inflicting a mortal injury.

Halberds are a relatively common relic of the Early Bronze Age throughout much of continental Europe and the British Isles, second only to swords in terms of their profusion.[10] There are over 700[11] known examples of this copper alloy weapon (Fig 1) with almost 100 of these in the collection of the National Museum (NMI) of Ireland. Ryan noted of these that many 'show considerable wear such as is consistent with heavy use'.[12] He also observed signs of re-sharpening on the 'cutting', presumably concave, edge of a 'sickle-shaped' halberd found in 1976 in Lavally, Co Galway.[13] O'Flaherty *et al*[14] also felt that Irish halberds showed substantial levels of wear, particularly in comparison to the metal-shafted types, which, they suggest, demonstrated the latter's function as objects of display.

Metal-shafted halberds (Fig 2), where the head and shaft are cast as one piece, were a variant with a distribution which was restricted to central Europe. They also appear to have been relatively short-lived, but their precise chronology has been the subject of frequent revision. For De Navarro,[15] this brief horizon, spanning perhaps only two generations, fell at the end of the first quarter of the fourteenth century, in what was then perceived as the closing years of the Early Bronze Age, *c* 1325 BC. Other, now likewise

[1] Thorpe 2003, 151; Tut 2003, 118
[2] Trump 1959, 15; Treherne 1995, 109; Fontijn 2001–02, 221; Mödlinger 2011, 166; Schulting and Fibiger 2012, 10
[3] O'Flaherty 2007, 428; Hansen 2010, 45; Dolfini 2011, 1947
[4] Briard 1965, 287
[5] De Lumley *et al* 1976, 67; Chenorkian 1988, 130; *idem* 2000
[6] Macalister 1921, 137
[7] Ó Ríordáin 1946; Butler 1963; Mallory and McNeil 1991; Northover in Vandkilde 1996; Fontijn 2001–02; Skak-Nielsen 2009
[8] Mercer 2007; Horn 2013; Ralph 2013
[9] O'Flaherty 2002
[10] Brandherm 2011, 23
[11] Horn 2014, 6
[12] Ryan 1976, 152–3
[13] *ibid*
[14] O'Flaherty *et al* 2002, 31
[15] De Navarro 1950, 102

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Fig 1 Early Bronze Age halberd from Carn, Co Mayo, with reconstructed wooden shaft (author's photograph)



Fig 2 Metal-shafted halberd from Trieplatz, Germany (author's photograph)

superseded estimations placed the metal-shafted halberds of Pomerania and Saxony, which represented the 'floruit of typological development', at the earlier and broader period of 1700–1400 BC.[16] More recently, however, based on fresh radiocarbon evidence they were assigned the much earlier date range of 2100–1900 BC.[17]

Metal-shafted halberds were undoubtedly a derivative of wooden shafted types, as is clear from the presence of such redundant features as highly stylized fastening rivets. While halberds in general have been described as ineffectual armaments, the metal-shafted variety have been singled out as 'especially unpractical as war-weapons',[18] due to their added weight and purportedly inadequate construction. They were manufactured from bronze with unusually high levels of tin that gave them a rich silver hue but, it has been argued, also made them too brittle for any practical use.[19] In addition to the halberd's inherent clumsiness, for some this placed them firmly in the category of ritual paraphernalia, as 'doubtless ceremonial weapons'.[20]

Several authors have seen parallels between European Bronze Age halberds and those found in China from various early periods.[21] The Chinese halberd, or *ji*, is associated mainly with the Western Zhou Dynasty. It was developed by the combination of elements from two other bronze weapons, the dagger-axe, *ge*, and the spear, *mao* (Fig 3).[22] The increased popularity of the *ji* over the *ge* may be attributed to the addition of a spear-point which allowed massed infantry units to successfully fend off chariot attacks.[23] Presumably it was used in a similar fashion to the 2.44m long

[16] Mercer 2007, 127
[17] Schwenzer 2002; Rassmann 2010, 807
[18] Macalister 1928, 133–4
[19] *ibid*
[20] Hawkes 1940, 330
[21] Evans 1881, 263; Ó Ríordáin 1937, 290-3; O'Flaherty 2002, 340
[22] Hong 1992, 77
[23] Lorge 2012, 27



Fig 3 Eastern Zhou dynasty bronze dagger-axe, ge, 27.3 × 12.4cm (Metropolitan Museum, accession number 1985.214.29)

halberds of the fourteenth century Swiss infantry, before these were superseded by the much longer, but less versatile pike.[24] In any event, the key feature with all of these weapons is that, in addition to an axe-like blade, they were tipped with a thrusting spear-head or spike. The distinctive square hole which is left by the top-spike of a medieval halberd can be seen in the skull of Skeleton 9 from the medieval Battle of Towton[25] and Skeletons 74, 76 and 77 from medieval and Renaissance Turin.[26]

Re-sharpening

It has been argued that the degree of any observable asymmetry in sharp-edged tools, such as axes, can be indicative of the amount of re-sharpening they were subjected to and, by extension, the amount of practical use that they saw.[27] Oakeshott[28] was one of the earliest to comment on the visible effects of re-sharpening on the edges of weapon blades. He drew a clear distinction between Scandinavian Bronze Age swords, where he saw no signs at all of grinding or re-sharpening, and those found in other parts of Europe, which tended to be heavily damaged. Indeed, in his view, few Scandinavian weapons of any kind exhibited signs of damage from use. This he attributed to the 'generally agreed' hypothesis that this period was a 'Golden Age' for Scandinavian society, with swords serving only as symbols of ceremony and indicators of status. Later studies, however, arrived at very different conclusions.

Kristiansen's study of the use-wear and re-sharpening of Danish and Hungarian swords identified two distinct sets of weapons, solid-hilted swords and flange-hilted swords. At the end of the Early Bronze Age, decorative solid-hilted swords appeared to show only light use, rarely having required re-sharpening. Some were never re-sharpened at all. This Kristiansen attributed to the fact that these weapons had been the property of chiefly elites and therefore saw little, if any, active service. The more utilitarian flange-hilted sword, on the other hand, carried signs of frequent use, as manifest by considerable damage and heavy re-sharpening. This he put down to the fact that these weapons had been the workaday tools of a warrior class. Re-sharpening of these swords occurred most noticeably beneath the hilt, as a result of defensive parrying, and at the point, due to damage sustained in thrusting attacks.[29]

A recent study of Italian Bronze Age metalwork noted that a Type Montemerano[30] halberd from Pianizzoli, in Tuscany, displayed a number of marks at a location which was interpreted as the point where the inner edge intersected with the wooden shaft. These were described as 'a tight sequence of nicks followed by a flattened and partly bent area', possibly combat damage (Fig 4a).[31] A second halberd

[24] Ellis 1978, 65
[25] Novac 2000, 98–9
[26] Giuffra *et al* 2013
[27] Roberts and Ottaway 2003, 127
[28] Oakeshott 1960, 33
[29] Kristiansen 1998, 117–9; Kristiansen and Larsson 2005, 218
[30] Bianco Peroni 1994, 35–6 no. 271
[31] Dolfini 2011, 1046, fig 12

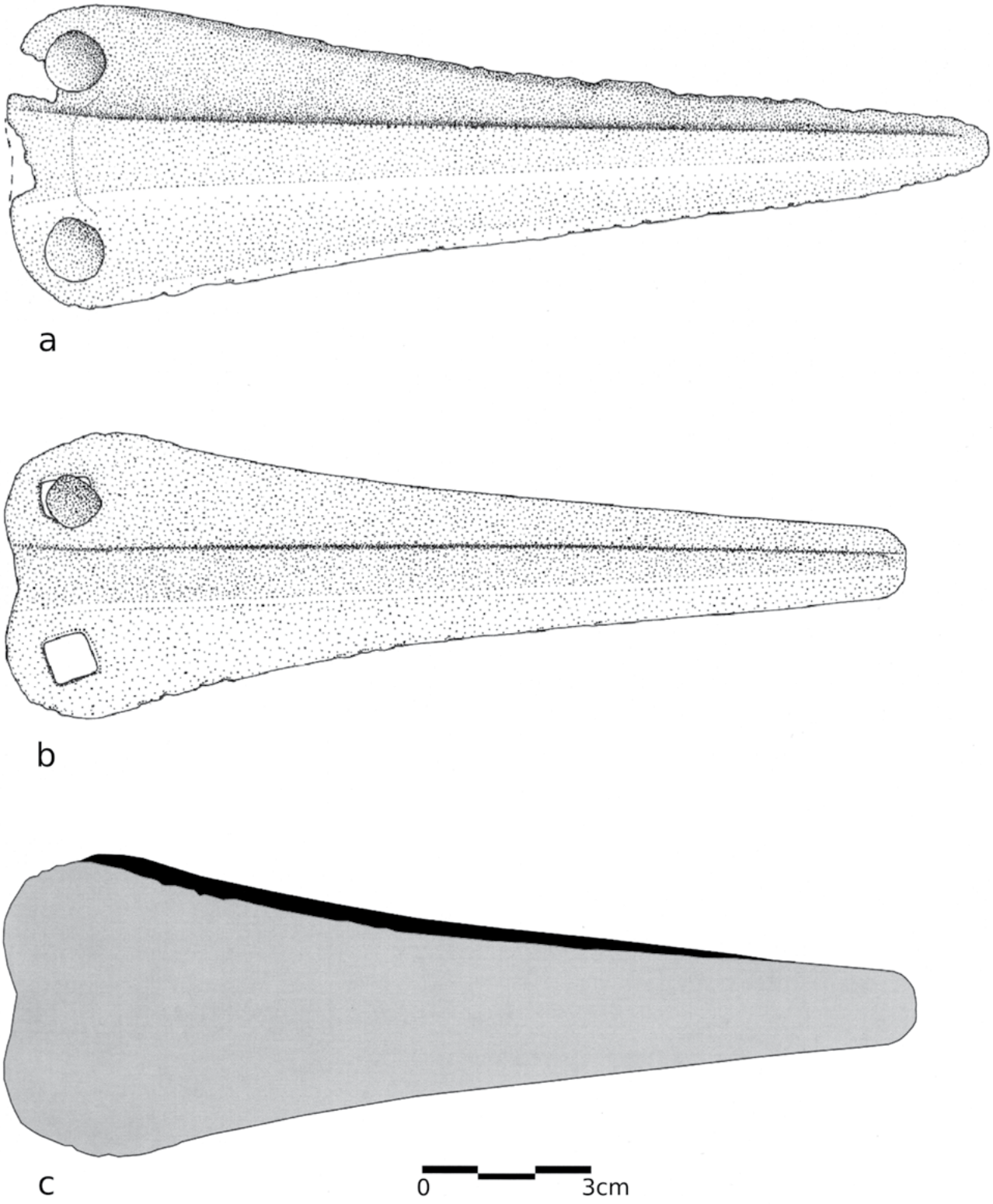


Fig 4 Type Montemerano halberds from Pianizzoli, Italy (after Bianco Peroni 1994, pl 18 nos 271 and 272)

from Pianizzoli does not display similar marks but a distinct concavity on one edge, inviting speculation that this asymmetry is the result of the removal of earlier damage, through expedient re-sharpening. The extent of the possible metal loss would suggest that this had been a recurrent process (Fig 4b).[32]

In his study of Bronze Age implements from the Netherlands, including spears, axes, daggers, rapiers and swords, Fontijn[33] observed that many of these had been re-sharpened, with the consequential development of an asymmetric profile. With Early Bronze Age halberds, this would tend to manifest as a slight concavity on one edge.[34]

Brandherm,[35] however, noted the difficulties in distinguishing between what he referred to as 'secondary asymmetry', that which was the product of differential re-sharpening, and the inherent asymmetry of some styles of halberd blades. Based on his observations of Iberian halberds, and drawing on his earlier work in this field, Brandherm[36] concluded that any obvious concavity on a halberd blade would be seen on the lower or proximal edge. The reason for this lay in the proposed combat style employed by the Bronze Age exponents of this particular type of weapon.

The use of a sweeping, scythe-like action, it was suggested, would result in frequent clinches of the opponents' blades at the lowest point where these met with their wooden shafts. This distal section of the blade would, therefore, have been prone to more frequent damage and re-sharpening.[37] For O'Flaherty,[38] on the other hand, the halberd could be wielded in much the same fashion as an axe when splitting logs, with the impact of the blow travelling along the central axis of the blade. Drawing on contemporary treatise describing combat techniques for medieval pole-arms, Horn[39] added a hooking stroke to the repertoire of three basic manoeuvres that could have been used with Bronze Age halberds.

These hypotheses, however, can only be supported by the examination of damage on blades and rivets, as no complete or near complete examples of a wooden shaft have survived to the present day. In a number of cases all that has survived, trapped firmly between the fastening rivets, are fragments of the original wooden hafting and these suggest that a wide variety of hardwood species were utilized, ranging from oak (*Quercus*) to apple (*Maloideae*).[40] Nevertheless, without an extant shaft it is impossible to establish the distal and the proximal edges of a wooden shafted halberd blade. With the thirty or so known examples of metal-shafted halberds, on the other hand, the orientation of the blade in relation to the shaft is plain to see.

Methods and materials

Drawings

A heavy reliance on graphic representations for the determination of asymmetry, rather than photography and direct observation, raises obvious concerns about accuracy. It may be, as in the case of the Worsaae Drawings, that a likeness is produced to serve largely as a work of art. Named after the prominent Danish archaeologist who recognized the significance of many of the artefacts they depict, these almost full-scale watercolours were executed at the behest of the Royal Commission for the Preservation of Antiquities, founded in 1807 by King Christian VIII of Denmark. They were described as a 'valuable gift of twelve large sheets of drawings of the most important objects of antiquity to be found in the collection of the Irish Academy'.[41] Each carries the caption 'Presented to the Royal Museum of Northern Antiquities of Copenhagen by the Royal Irish Academy. Dublin 11th January 1847'.[42] While they are undoubtedly things of artistic merit, close comparison with original photographs reveals that the veracity of these drawings is less than would be desirable for any study of use-ware.

The Worsaae Drawings highlight a further hazard associated with a reliance on graphic illustrations alone. Drawing II in the series shows an assortment of Bronze Age daggers, dirks, rapiers, swords, and halberds, including the eponymous Type Lissane rapier, found in a bog in the townland of Lissane, Co Derry. However, at the time these drawings were executed this particular piece was held in a private collection with only a display copy available at the Royal Irish Academy. Wilde[43] stressed that the illustration of the Lissane rapier which appears in his slightly later catalogue was drawn with reference to the original.

A further example of such artistic hearsay evidence involves Wilde's drawing[44] of a small rapier with a hollow-cast hilt, purportedly found in Co Tipperary. Here again the piece was in the hands of a private collector, Petrie, who on this occasion made his own drawings available for the production of the required wood-cut printing block. This situation descended into something akin to Chinese whispers when Evans[45] then reproduced an enlarged copy of Wilde's copy of Petrie's presumably original drawing. It is not clear if the drawing of this rapier that was later reproduced by Coffey[46] was taken from the original artefact or one of the several drawings of it by then available. A still later drawing published by Macalister,[47] however, appears to be closer in appearance to the original than anything previously produced.

Now with a Kanturk, Co Cork, provenance, this piece was catalogued by Harbison[48] as a bronze-hilted dagger, while a later recording by Burgess and Gerloff[49] describes it as

[32] Bianco Peroni 1994, 36 no. 272
[33] Fontijn 2001–02, 33
[34] Horn 2014, 32
[35] Brandherm 2011, 28
[36] *idem* 2003; 2011; 2012, 94
[37] *idem* 2004, 322; *idem* 2011, 35
[38] O'Flaherty 2007, 426
[39] Horn 2014, 174–83
[40] Bell and Brandherm 2013, 55
[41] Frederik *et al* 1850, 4–5
[42] *ibid*
[43] Wilde 1861, 442
[44] *ibid*, 458
[45] Evans 1881, 254
[46] Coffey 1913, 60
[47] Macalister 1921, 158
[48] Harbison 1969, 15, pl 5 no. 81
[49] Burgess and Gerloff 1981, 21, pl 11 no. 72



Fig 5 A halberd from Grave 42 in El Oficio, Spain, displaying a minimum loss of 1.59 per cent (drawing after Brandherm 2003, pl 105 no. 1435)

a Group II rapier. Both publications are from the Prähistorische Bronzefunde (PBF) stable and both contain drawings of this weapon. The German PBF catalogues, an international series established in 1966, have become the preeminent repository of information on European Bronze Age artefacts and set the standard for archaeological illustration in this field.[50] Metal objects are rendered using a stipple technique. Dot size is consistent but a decrease in dot density is used to indicate light areas and an increase in density suggests shade. Line drawing is used for organic material, such as timber, as this method better suggests the appearance of woodgrain.[51] The front elevation of an artefact may be augmented with a plan view, which appears above, and a cross-section, which can appear either to the side, at the point of the section, or above.[52] Simple line drawings of the type reproduced by Eogan[53] and Rowlands[54] on the other hand, convey only a general impression of the artefact they depict which does not stand up to close scrutiny.

Notwithstanding the added rigour which the PBF series introduced to the production of graphic images of metal artefacts, the two versions of the Kanturk dagger / rapier drawing highlight the fact that considerable divergence can still occur, depending on the quality of the source material available to the PBF draughtspeople when preparing drawings for publication. While the Burgess and Gerloff[55] drawing is remarkably true to the original, the earlier Harbison[56] version would be of little use for any analytical purposes, as it is significantly different in several respects. However, following the comparison of a representative sample of PBF drawings with photographs of original artefacts it would seem possible, with due caution, to make limited use of good quality drawings for macro use-wear analysis. This approach would be particularly useful for studies of possible metal-loss due to re-sharpening, where only the outline of the artefact is of concern. A recent study of European halberds by Horn[57] considered over 600 of the *c* 700 known examples of this weapon. For approximately 480, or 75 per cent, of these pieces, drawings alone were consulted when determining the extent of ancient edge-damage, including nicks.

For the present work, illustrations of a total of twenty-eight metal-shafted halberds were sourced in two PBF catalogues, the works of Wüstemann,[58] covering eastern Germany, and Gedl,[59] for the Polish material. A further example was provided by a metal-shafted halberd from Trieplatz, Germany, now housed in the British Museum with the assigned accession number 1898,0617.1 (see Fig 2).

Calculations

The catalogue drawings were digitized as greyscale pictures with a resolution of 600 dots per inch using a flatbed scan-

[50] Brindley 2008, 3
[51] Gedl 1980, pl 9 no. 57
[52] cf Brandherm 2003, pl 50 no. 805; Harbison 1969, pl 10, no. 166
[53] Eogan 1965
[54] Rowlands 1976
[55] Burgess and Gerloff 1981, 21, pl 11 no. 72
[56] Harbison 1969, 15, pl 5 no. 81
[57] Horn 2014, 182
[58] Wüstemann 2004
[59] Gedl 1980

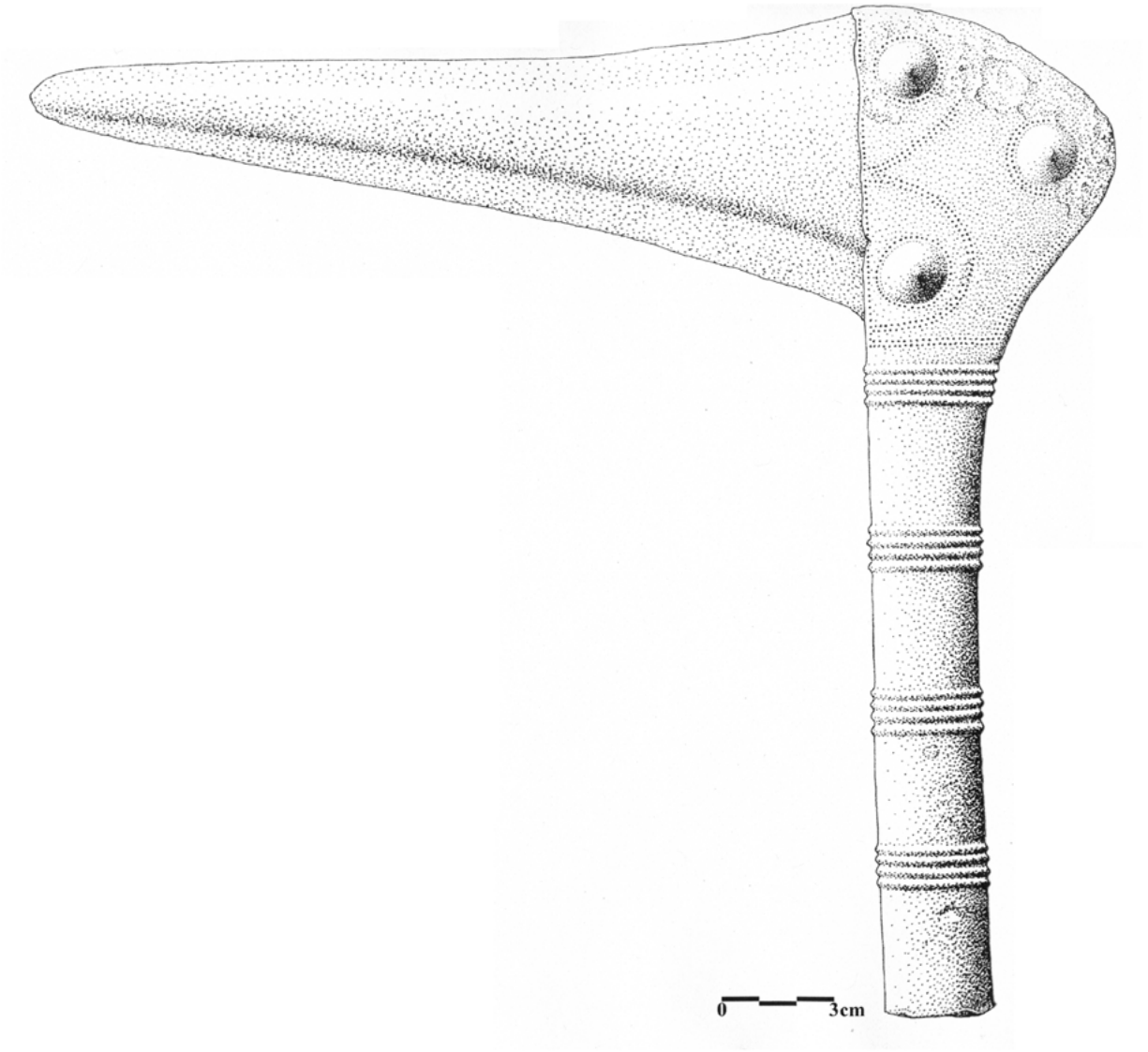


Fig 6 Early metal shafted halberd of Sächsischer type (after Wüstemann 2004, pl 12 no. 97)

ner, and stored as *Tagged Image File Format* (TIFF) files. Individual subjects were cropped and retouched as necessary using Microsoft Windows Paint software. Using Inkscape, an open-source vector graphics editor, each image was aligned horizontally along its central axis and the blade outline traced using a Wacom digitizing tablet. The outline was then flipped horizontally and, if necessary, realigned over the original image. Any negative discrepancies between the two were then outlined and given a black fill. These areas were imported into another open-source image editor, *GNU Image Manipulation Program* (GIMP), where the number of black pixels was calculated. The main outline of the blade was treated in the same manner and the relative percentage of any negative portion was then calculated. Much the same process was followed when photographs were used (Fig 5).

An alternative method might be employed for curved blades which carry decorative fluting running parallel to the cutting edge, such as the Irish Type Cotton halberds. The long axis of the blade is aligned horizontally and a number of evenly spaced lines drawn from the fluting to the outer edge on the upper half of artefact. These are then mirrored by lines drawn on the lower half. Any difference in length between the two sets of lines can then be used to estimate the extent of possible metal loss due to re-sharpening. The result will be a relative figure, as the entire cutting edge will most likely have been subject to re-sharpening at some stage. However, any favoured leading edge, that was used most frequently to attack with, would have required more frequent remedial attention.

Angle of blade attachment

When considering what combat styles might have been employed when using an Early Bronze Age halberd, it would seem necessary to establish the orientation of the blade in relation to the shaft. Only then would it be possible to attribute

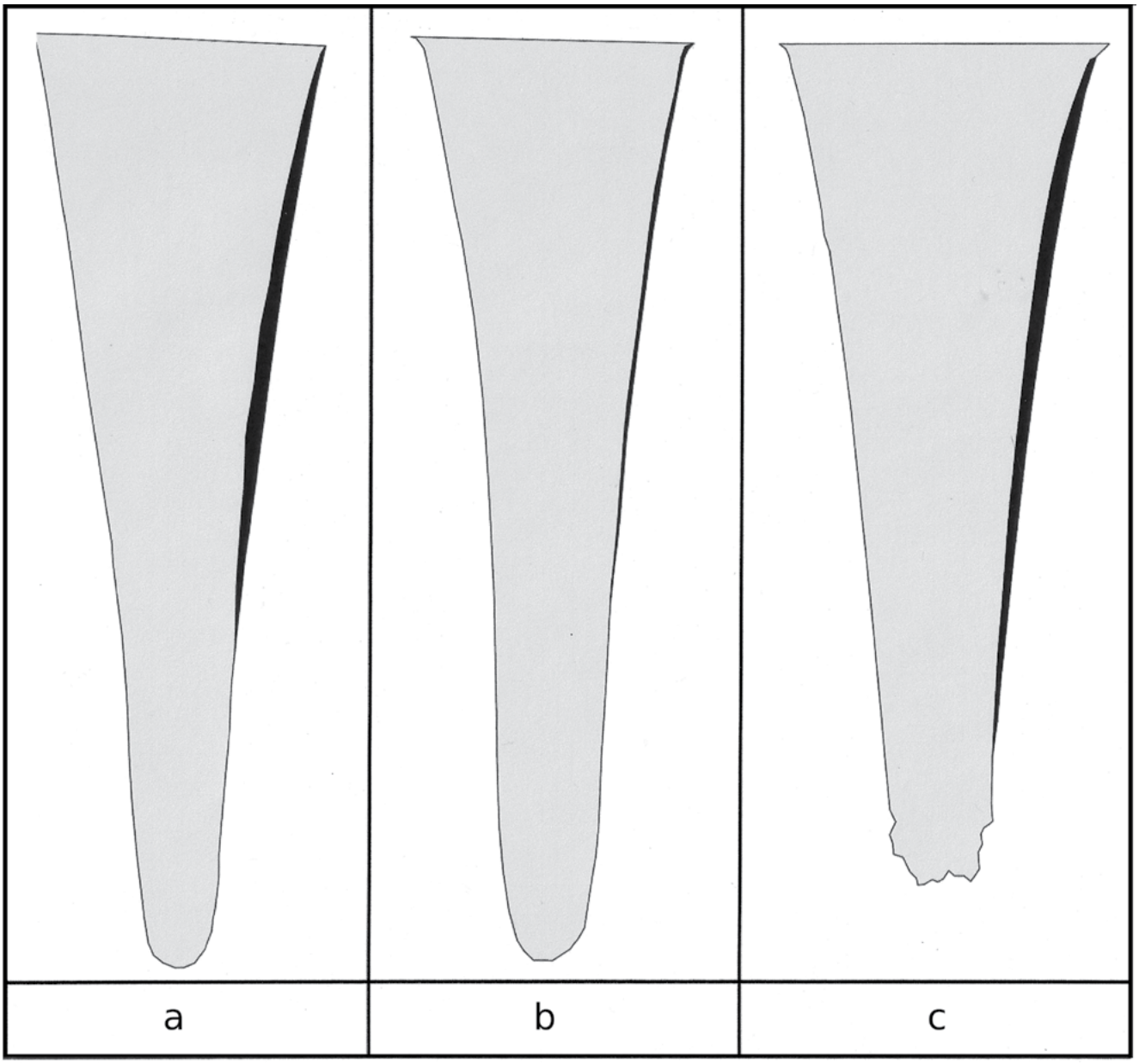


Fig 7 Examples of edge loss and degrees off right angle for Irish wooden shafted halberds

any concavity due to re-sharpening to the distal or proximal edge with any degree of confidence. It is clear from extant examples that the blades of metal-shafted halberds had a tendency to tilt upwards with respect to the user. This is particularly true of Sächsischer type halberds,[60] which most closely resemble wooden shafted types (Fig 6). Unlike metal-shafted blades, however, where terms such as distal and proximal naturally apply, the orientation of a wooden shafted blade can only be inferred.

It would seem reasonable to assume that if metal-shafted halberds tilted upwards, in imitation of wooden shafted halberds, then wooden shafted halberds had an obvious tendency to tilt upwards. Therefore, using any remaining hafting traces, or where these are not available, the line of attachment suggested by the location of rivet-holes, it should be possible to estimate an approximate angle of attachment between blade and shaft. This would mean that the edge of the blade that formed an obtuse internal angle with any hafting trace had been the upper, or distal, edge. Conversely, the acute internal angle would have been associated with the lower, or proximal, edge.

Osteological evidence

A high incidence of cranial trauma has come to be regarded as evidence of interpersonal violence, with most postcranial trauma being caused by accidents.[61] It has been suggested that this pattern of human behaviour transcends both spatial

[60] Wüstemann 2004, pl 12 nos 97–100

[61] Walker 2001, 317; Robb 1997, 124

No.	Source:	Loss indicated by asymmetry (%)	Edge loss observed on:	
	Wüstemann 2004		Distal	Proximal
1	pl 12 no. 97	2.85	X	–
2	pl 12 no. 98	4.88	X	–
3	pl 12 no. 99	0.74	X	–
4	pl 12 no. 100	1.01	X	–
5	pl 13 no. 102	1.62	X	–
6	pl 13 no. 104	4.22	X	–
7	pl 14 no. 103	0	–	–
8	pl 14 no. 105	2.48	X	–
9	pl 14 no. 107	1.29	X	–
10	pl 15 no. 106	1.90	X	–
11	pl 16 no. 109	4.03	X	–
12	pl 16 no. 110	0.93	X	–
13	pl 16 no. 111	4.30	–	X
14	pl 17 no. 112	1.37	X	–
15	pl 18 no. 115	1.28	X	–
16	pl 18 no. 116	0.53	X	–
17	pl 19 no. 123	2.15	X	–
18	pl 20 no. 124	0.59	X	–
19	pl 20 no. 126	2.15	X	–
20	pl 21 no. 128	5.10	X	–
21	pl 21 no. 129	5.40	X	–
22	pl 21 no. 130	2.16	X	–
23	pl 21 no. 131	4.06	X	–
	Gedl 1980			
24	pl 8 no. 52	1.16	–	X
25	pl 8 no. 53	4.56	X	–
26	pl 9 no. 54	1.83	X	–
27	pl 9 no. 56	0.80	X	–
28	pl 10 no. 58	1.86	X	–
	Author's photograph			
29	BM*	4.78	X	–
Average		2.39		

Table 1 Possible material loss due to re-sharpening of Central European metal-shafted halberd blades (*British Museum acquisition number 1898,0617.1)

No.	Source:	Loss indicated by asymmetry (%)	Edge loss observed on:	
	Harbison 1969		Obtuse	Acute
1	pl 8 no. 143	3.23	X	–
2	pl 8 no. 144	2.12	–	X
3	pl 8 no. 146	7.80	–	X
4	pl 8 no. 147	2.32	X	–
5	pl 8 no. 151	2.77	X	–
6	pl 9 no. 157	3.79	X	–
7	pl 9 no. 161	5.20	X	–
8	pl 10 no. 165	4.11	X	–
9	pl 10 no. 168	2.88	–	X
10	pl 10 no. 170	5.58	X	–
11	pl 11 no. 182	3.04	X	–
12	pl 11 no. 185	0.04	–	X
13	pl 12 no. 191	10.08	X	–
14	pl 21 no. 281	3.21	X	–
15	pl 21 no. 282	1.89	X	–
16	pl 22 no. 288	4.15	X	–
17	pl 23 no. 297	3.65	X	–
18	pl 23 no. 300	3.38	X	–
19	pl 23 no. 304	2.12	X	–
Average		3.75		

Table 2 Possible material loss due to re-sharpening of Irish wooden-shafted halberd blades

and temporal boundaries.[62] A recent analysis of a large medieval cemetery in Mannheim-Seckenheim, Germany, concluded that the distribution of sharp force cranial trauma was highly sex-specific, concentrated among young, high status adult males. There was a similar, but less pronounced pattern for blunt force trauma. Postcranial trauma, on the other hand, appeared to be of a type that might be expected of day-to-day rural life in that period.[63] The only postcranial trauma which is regarded as indicative of interpersonal violence is the parry fracture of the lower arm. All other postcranial skeletal injuries tend to be accidental, or possibly occupation-related.[64]

Some forms of non-lethal interpersonal violence equally are more likely to result in cranial injuries rather than in post-cranial skeletal trauma. A high incidence of nonlethal violence has been observed in the pre-contact osteological records from Australia, Easter Island and the Santa Barbara Channel[65] where 17 per cent of the population had healed cranial injuries.[66] Similar injury patterns were observed in Andean skeletal populations and were attributed to the practice of *tinku*, a form of ritualized battle, or conflict resolution by physical means.[67] The use of long wooden clubs typically resulted in a concentration of healed anterior head wounds on adult male skulls.[68] Killing is prohibited in these encounters and it is only permissible to inflict injury to one's opponent.[69]

Patterns of cranial trauma observed in prehistoric populations then can provide evidence for different types of interpersonal violence, both lethal and non-lethal, and this evidence needs to be considered in conjunction with damage and use-wear patterns on prehistoric weaponry.

Results

Using the methods described above, figures for the loss of material due to re-sharpening of metal-shafted halberds, as indicated by any asymmetry present on a blade's profile, were of values between zero and 5.50 per cent, with an average value of 2.39 per cent. The edge of the blade most affected by any loss of material due to re-sharpening, either

[62] Silva *et al* 2012, 338
[63] Meyer and Alt 2012, 165
[64] Larsen 1997, 112–3; Baustian *et al* 2012, 107
[65] Larsen 1997, 158
[66] Walker 2001, 316
[67] Tung 2007, 942
[68] Arkush and Tung 2013
[69] Conklin 2001, 40–1

Provenance	Total with drawing available	Total with discernible hafting angle	Total with hafting angle off right angle	Degrees off right angle (average)	Edge with discernible rivet-hole damage	
					Oblique	Acute
East Germany*	36	27 (75%)	10 (28%)	1	–	–
Poland**	10	10 (100%)	0	0	–	–

Table 3 Angle of attachment for Central European metal-shafted halberds (*after Wüstemann 2004; **after Gedl 1980)

Provenance	Total with drawing available	Total with discernible hafting angle	Total with hafting angle off right angle	Degrees off right angle (average)	Edge with discernible rivet-hole damage	
					Oblique	Acute
East Germany*	54	48 (89%)	41 (76%)	3.00	5	1
France**	42	40 (95%)	37 (88%)	4.25	4	4
Iberia§	89	80 (90%)	71 (80%)	3.27	5	3
Ireland†	167	146 (87%)	135 (81%)	3.60	11	9
Italy‡	58	22 (38%)	18 (31%)	4.90	2	3

Table 4 Angle of attachment and rivet-hole damage orientation for European wooden-shafted halberds (*after Wüstemann 2004; **after Gallay 1981; §after Brandherm 2003; †after Harbison 1969; ‡after Bianco Peroni 1994)

distal or proximal with respect to the user, was also recorded. In twenty six cases, or 93 per cent of the total which showed a loss of material, re-sharpening was most noticeable at the distal edge. Of the total of twenty nine examples of metal-shafted halberds all but one display some degree of asymmetry and of the twenty eight that do, in all but two cases the diminished portion of the blade is on the depicted upper edge. Indeed, it would appear highly probable that these two exceptional blades, both having been found free from their shafts, were inadvertently drawn upside down (Table 1).

A similar approach was used to determine a figure for the possible loss of material due to re-sharpening seen on Irish wooden-shafted halberd blades. However, due to factors including a high incidence of innate asymmetry and corrosion, it was only possible to consider nineteen (11 per cent) of the pieces listed by Harbison. This resulted in values of between 0.04 and 10.08 per cent, with an average of 3.75 per cent. Fifteen (79 per cent) of these blades displayed a loss of material on the obtuse, probably distal edge (Fig 7). It is a peculiarity of Irish halberds that so many display an innate asymmetry, giving them the scythe-like profile noted by Wilde.[70] Indeed, only thirty seven (30 per cent) do not show a marked asymmetry due to their design. Of these, thirty two (86 per cent) have suffered an apparent loss of material on the acute edge, presumably the result of differential re-sharpening (Table 2).

For all those European wooden-shafted halberds for which an angle of attachment could be determined, this figure had an average value of 3.80 degrees, compared with an average of only 1 degree for East German metal-shafted halberds and a complete absence of rake for Polish metal-shafted types (Table 3). There is also a substantial difference in the quantity and quality of material from the different European regions. With Irish halberds, for example, of the 167 pieces illustrated by Harbison it was possible to use 146 (87 per cent) of these to gain reliable detail regarding hafting angles. Italy, on the other hand, provided only fifty eight pieces, or 14 per cent of the total corpus of 410 wooden-shafted halberd blades, of which as few as twenty two (38 per cent) revealed useful information on a possible angle of attachment (Table 4).

It was possible, in a limited number of cases (forty seven), to determine if there was any particular orientation associated with visible damage to the rivet-holes of European wooden-shafted halberd blades. In the majority of cases, 74 per cent, such damage was present at the edge which formed an oblique internal angle with the shaft. As argued above, this probably represented the distal edge of the blade. This exercise was not applicable to metal-shafted halberds, as their skeuomorphic rivets served only an aesthetic function.

In attempting to determine possible material loss due to re-sharpening, angle of attachment and rivet-hole damage orientation, 100 per cent of the material available throughout continental Europe and the British Isles was considered. However, in some cases the information sought was not discernible by examination of an artefact's graphic representation. It is not clear to what extent matters would have been improved by *in situ* inspection of the material.

Discussion

It has been argued that, in reaction to blows that tended to impact on the proximal edge of wooden-shafted halberds, the forces on the fastening rivets would have acted in an anti-clockwise direction.[71] This would result in more frequent damage to the rivet-holes on the proximal edges of halberd blades. However, the available evidence for rivet-hole damage, viewed in combination with the interpret-

[70] Wilde 1861, 449

[71] Horn 2014, 176

ation of re-sharpening evidence offered in this paper, suggests that blows were more frequently impacting on the distal edge of Bronze Age halberds. If, as seems reasonable, the asymmetry clearly evident on Central European metal-shafted halberds is due to metal lost as a result of re-sharpening, it follows that the upper edges of halberd blades were impacting more frequently with other hard objects, presumably in combat, than was the lower edges. This could have implications for the fighting style employed when using these particular weapons. It suggests that they were not used in any of the ways suggested above but rather with a thrusting action, similar to that used by modern infantry soldiers with fixed bayonets.

A War Department manual of bayonet exercises prepared for the United States Army during the American Civil War recommends the basic thrusting blow. This is delivered by moving forward from an on-guard stance and rapidly extending the arms towards the opponent.[72] This natural posture offers defence from attack, not exposing the torso as would any form of swinging action, while allowing for an opportune strike at an opponent. It continues to be regarded as the most effective combat technique for this type of weapon.[73] Prehistoric halberds, however, lacked any foreword-pointing blade. Indeed, rather than the lethally effective top spike seen on medieval halberds or the deadly spear tip of the Chinese *ji*, the Chalcolithic and Early Bronze Age wooden-shafted halberds depicted in Iberian anthropomorphic stelae and Alpine rock art[74] show a distinctly bulbous terminal (Fig 8). The flat, anvil-like terminal common to metal-shafted halberds is similarly the antithesis of a feature designed to inflict fatal injury.

As the act of killing people in the heat of battle with hard, sharp metal weapons will inevitably leave its mark, the osteological record can provide another valuable source of information. Indeed, the 'physical evidence of wounds, fatal or healed, is the *sine qua non* of warfare and its results'.[75] However, the stark absence of sharp force trauma on human crania from the Early and Middle Bronze Age, of a type that might be attributed to the lethal use of bladed weapons such as halberds has, therefore, caused some to question the primary function of these artefacts.[76]

After examining over 156 individuals from the El Argar culture, Jiménez-Brobeil *et al* observed that 'swords and halberds are present in the male El Argar tombs, but there was no evidence of injuries produced by this type of weapon, either cranial or post-cranial'.[77] In common with other such sites, this reflected a 'complete absence' of blade induced injury.[78] Healed blunt force cranial trauma, on the other hand, has been detected among adult males at a statistically significant level. These injuries take the form of round or oval depressed fractures to the front, usually the right hand side, of the head.[79] Similar injuries have been noted in other regions in Europe. About 500 individuals have so far been recovered from a late LBK site at Herxheim in Rhineland-Palatinate, Germany. Several adult skulls displayed oval-shaped blunt force trauma, some elongated and some squat, but all of which had healed.[80]

Warfare is not the only form of interpersonal violence which can leave a lasting osteological signature. There are also vendettas and other ritualized forms of violence such as duelling, which grew out of the medieval practice of trial by combat. In the early modern period duels were popular with aristocrats who viewed them as a means of restoring their good name after some or another perceived insult from a social equal. The primary aim was not to kill one's opponent, but to have the alleged slighting of one's honour and dignity publicly acknowledged and expunged. Never popular with the Church or Crown, who were always keen to maintain a monopoly over trial and retribution, by the end of the nineteenth century it had been outlawed throughout all of Europe.

Swords, and later rapiers, a development of the Spanish *espada ropera*,[81] had been the preferred weapons of the duellist.[82] It has been suggested that, rather than serve as basic weaponry for the rank and file warrior, Bronze Age halberds were similarly reserved for highly stylized duels between high-status individuals.[83] If the aim of such duels was to inflict non-lethal injury on one's opponent, this should result in injury patterns more closely comparable to the pre-contact osteological records from Australia, Easter Island, the Santa Barbara Channel and the Andes, referred to above, then in sharp-edge cranial injuries, which tend to be lethal.

Summary and conclusions

There are two broad strands of evidence which run through this study, that which can be seen on the remaining artefacts and that which comes from the contemporary osteological record. The artefactual evidence falls under the wider heading of use-wear, not those notches and dents to the cutting edge which usually form the focus of this approach but the loss of material which comes about as a result of their removal. It is clear from the concavity which tends to form more noticeably on one side of the blade that differential re-sharpening was a practice common with many Bronze Age halberd blades. This edge was also that were most rivet-hole damage is found. In the case of Central European metal-shafted halberds it is possible to say that the loss of metal due to re-sharpening occurred mainly, probably exclusively, on the upper edge of the blade. This allows inferences to be drawn about the combat style employed with these weapons.

In any halberd-on-halberd confrontation, to sustain damage in the locations indicated by re-sharpening, opponents must have engaged mainly in thrusting attacks and on-guard counters. These are not a consequence of the reck-

[72] McClellan 1862, 54
[73] Mills 2011, 2-21
[74] Almagro Basch 1966, 109; Peña Santos 1981, 123–5; Chenorkian 2000
[75] Knüsel 2005, 49
[76] Aranda Jiménez *et al* 2009, 1047; Thorpe 2013, 235
[77] Jiménez-Brobeil *et al* 2009, 473
[78] Aranda Jiménez 2011, 262
[79] Aranda-Jiménez *et al* 2009, 1045
[80] Orschiedt and Haidle 2007, 48
[81] Oakeshott 1960, 133
[82] Ruff 2001, 77–80; Muir 2005, 149
[83] Dolfini 2011, 1045–7

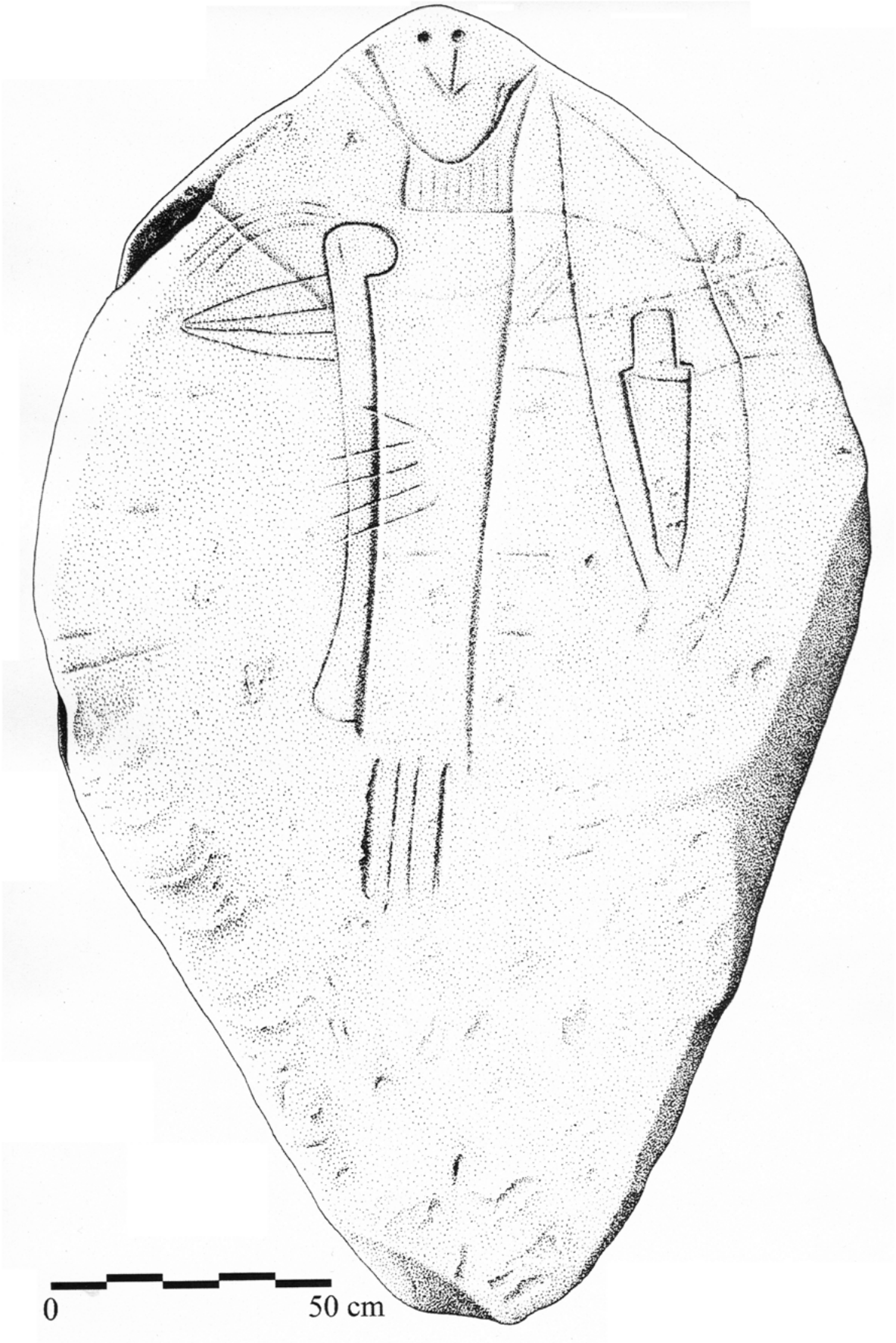


Fig 8 Longroiva stelae, Guarda, Portugal (after Brandherm 2003, pl 194)

less flailings of some frenzied warrior in the heat of battle, but rather appear to be the result of cautious and measured sparring between two more-or-less evenly matched antagonists. And what would be the consequence for the victim if one of these attacks were to strike home? In the case of a forceful thrusting blow to the cranium with a metal-shafted halberd, the flat, oval shaped terminal would leave a signature oval-shaped blunt force lesion. Based on their rock-art depiction, wooden-shafted halberds would also leave signs of blunt force trauma, in the form of an oval or round depressed fracture, depending upon the particular profile of a weapon's terminal. Furthermore, the force of any impact would be somewhat increased due to the added momentum imparted by the choice of dense, hardwood shafts.

The osteological evidence that would have been left by both metal and wooden-shafted halberds, used in the manor suggested above, is a close match for that which is seen in the record. This does not exclude the use of the halberd blade to deliver a lethal slicing stroke to the throat of a felled opponent, or to pierce the roof of their exposed skull, but there is simply no existing evidence to support the suggestion that such behaviour was the norm. A picture of two champions engaged in a ritual, highly stylized form of non-lethal duel, on the other hand, is supported not only by the available osteological evidence but also that suggested by the re-sharpening and rivet-hole damage seen on extant material.

The halberd's decline is paralleled by the rise of the sword, which makes it an obvious candidate for its replacement. However, the circumstantial evidence available from sources such as rock art and the osteological record is complex. It is possibly the case, therefore, that nothing short of a pan-European survey of use-wear on Early and Middle Bronze Age halberds, swords and rapiers will resolve the issue of their functionality.

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Return to the source: the use of stone in pottery in later Bronze Age Britain

David Mullin

Changes in ceramic technology during the later Bronze Age, with the frequent utilization of stone inclusions within the clay, seem to go hand in hand, at some sites at least, with an apparent choice of rock from specific sources for these inclusions. This deliberate choice by the potters may reflect the significance of certain parts of the landscape during the later Bronze Age.

Introduction

During the British Bronze Age, the use of stone for tool production becomes uncommon, with the use of upland sources of rock for the manufacture of stone axeheads over by the end of the first quarter of the second millennium BC,[1] although axe-hammers continue to be produced in the Welsh borderland well into the Bronze Age.[2] The decline in the production and use of flaked and polished axes from sources in upland Britain also coincides with a general downturn in the use of flint for everyday tools and a concomitant lack of skill and control in flint knapping.[3] This decline is also associated with the development of the agricultural landscape organized around farming and settlement, as well as an increasing concern with the production, circulation and, especially, the deposition of metalwork.[4] During the later Bronze Age (*c* 1500–650 cal BC) there is also a change in ceramic technology with wider standardization of forms and distinctively coarse fabric. Rock and flint inclusions are frequently utilized as inclusions within the clay, often giving a rough outer surface to the finished vessel. At some sites, rock from specific sources appears to have been chosen for inclusion within the fabric of pottery: this appears to represent deliberate choice by the potters, potentially reflecting the significance of certain parts of the landscape during the later Bronze Age. This paper will explore some of the reasons why this may have been the case.



Fig 1 Sites mentioned in the text: 1 Bromfield, 2 Malvern Hills, 3 Titterstone Clee, 4 Bredon, 5 Tewkesbury, 6 Worcester, 7 Lizard peninsula, 8 Langdale, 9 Graig Llwyd, 10 Mynydd Rhiw, 11 Mountsorrel, 12 Grimes Graves

Rock of Ages

Perhaps the best known Middle to Late Bronze Age site in the English Midlands is Bromfield, Shropshire (Fig 1: 1), where excavations by Stan Stanford and Birmingham University in advance of gravel extraction between the 1960s and 1990s uncovered evidence for 140 cremation burials, many of which were accompanied by pottery.[5] This pottery contained inclusions of crushed igneous rock (Fig 2), identified by David Peacock[6] as dolerite from Titterstone Clee Hill, Shropshire, which is visible from the site and located *c* 12km to the east (Fig 1: 3). Analysis of thin sections carried out by Rox Ixer for the author[7] has shown that some of this material is indeed tempered with West Midlands Dolerite, including P16, radiocarbon dated to 1190 to 810 cal BC (Birm-63: 2800±71 BP), but some of the vessels from the site have inclusions of uralitized gabbro, possibly from Wales, and sherds containing rock from the Malvern Hills are also present.[8] More work is needed on the source of the gabbro (although it is known not to be of Cornish origin), but West Midlands Dolerite outcrops only at Titterstone Clee Hill in Shropshire, where there is an extensive scree field. The exact source of

[1] Smith 1979, 15
[2] Shotton *et al* 1951
[3] Butler 2005, 179–82
[4] See Bradley 1998
[5] Stanford 1982; Buteux and Hughes 1995; Hughes and Woodward 1995; Hughes *et al* 1995
[6] Peacock in Stanford 1982
[7] For a detailed analysis see Mullin 2012
[8] *ibid*



Fig 2 Middle Bronze Age pottery from Bromfield, Shropshire (photo: author)

the Malvernian rock is also unclear, but is ultimately derived from this distinctive ridge of hills which divides the Severn valley from Wales (Fig 1: 2).

Although the use of Malvernian rock is known in Iron Age pottery from the Welsh Marches,[9] the identification of this material at Bromfield pushes the exploitation of this source back into the later Bronze Age. This is supported by recent work at further sites in the English midlands, including excavations at Bredon, Worcestershire (Fig 1: 4) in 2004. Here, the ditch of a henge, identified from aerial photographs, had been recut in the Middle Bronze Age and cremation burials deposited in the bank.[10] A palisade, running along the top of the bank, was also constructed at about the same time. The only finds from the ditch recut were a small number of sherds of pottery with large clasts of Malvernian rock. Short-lived charcoal from this feature returned a radiocarbon date of 1610 to 1350 cal BC (OxA-17216: 3239±30 BP). Similar pottery was recovered from Rudgeway Lane, Tewkesbury, Gloucestershire[11] (Fig 1: 5) where radiocarbon dates on food residues on the pottery returned almost contemporary dates of 1530 to 1410 cal BC (Wk-20711: 3202±32 BP) and 1440 to 1260 cal BC (Wk-21274: 3098±34 BP). At Perdiswell, Worcester[12] (Fig 1: 6), pottery was recovered from a palisade trench associated with a ring ditch, which returned a radiocarbon date of 1410 to 1190 cal BC (Beta-149927: 3040±40 BP). This is slightly later than the recut of the ditch at Bredon, but contemporary with the cremations inserted into the bank here. Petrographic analysis of the pottery from Perdiswell,[13] confirmed that this material contained inclusions of Malvernian rock. A small number of sherds of similar pottery was also recovered from archaeological work at DERA, Malvern, Worcestershire in 2000.[14]

The exploitation of rock from the Malverns and Titterstone Clee for use as inclusions within the fabric of later Bronze Age pottery appears to represent the deliberate selection of particular rocks. There is a wide range of other rocks available locally, which have a variety of properties (hardness and softness) and colour. These include limestone (light brown, soft) sandstone (red, soft) quartzite (white, hard) and Precambrian (pink, hard). Indeed, the geological diversity of the Malverns and Shropshire Hills is reflected in their designation as Geoparks, and if any rock were suitable for this use, greater diversity of rock types would be present in the fabrics of locally occurring pottery. It appears, then, that a degree of selection was exercised in the Middle Bronze Age, at least in this region. This would not necessarily be remarkable if it were only a local practice, but there is good evidence to suggest that alongside these specific kinds of rock being deployed in this way in the later Bronze Age, sources previously used for the production of Neolithic stone axes were also being revisited across Britain.

The use of Cornish gabbro in Trevisker style pottery is a well-known phenomenon: it is a fairly long-lived tradition which spans the Early and Middle Bronze Age, utilizing clays containing gabbro from the Lizard peninsula, Cornwall (Fig 1: 7). Recent work on Middle Bronze Age ceramics from south-west England[15] suggests that gabbroic clay was used extensively across this area and examples have also been recovered from as far afield as Monkton Thanet in Kent, where it was associated with a radiocarbon date of 1600 to 1320 cal BC (OxA-6141: 3175±50 BP).[16] Pottery containing Cornish gabbro was also recovered from the excavations at Bredon, Worcestershire (see above), where it was found alongside material with Malvernian fabric in a context and associated with a radiocarbon date contemporary with that of the Kentish material. Whilst the widespread distribution of pottery containing gabbroic clays is, in itself, a phenomenon worthy of note, the location of the source of the clay echoes that of the rock used to manufacture Neolithic Group I axeheads.

The re-use of locations which had previously acted as quarries for stone axes is also visible at other locations. One of the sources for stone utilized for Early Bronze Age bracers appears to correspond with the source of Group VI axeheads in the English Lake District[17] (Fig 1: 8), with bracer roughouts known from Pike O'Sickle and Loft Crag above the

[9] Peacock 1968
[10] Lewis and Mullin 2016
[11] Hart and McSloy 2009
[12] Griffin *et al* 2002
[13] Mullin and Ixer 2010
[14] Griffin *et al* 2000; for a full summary of these sites see Mullin and Ixer 2010
[15] Quinell 2012, 163–7
[16] Gibson *et al* 1997
[17] Woodward and Hunter 2011, 19

Langdale Valley.[18] The production of bracers occurred after a lengthy period during which this source was not utilized and may represent the return to a location with historical, or ancestral, importance.[19] Bracers appear to have a currency across the Early Bronze Age[20] and radiocarbon dates from bracer-associated contexts[21] are contemporary with a clearance episode in Langdale Combe which returned a radiocarbon date of 2050 to1750 cal BC (OxA-2180: 3510±70 BP).[22] Although little work has been carried out on the identification of Bronze Age pottery fabrics from the Lake District,[23] it is worth considering that tuff inclusions known from northwest England, usually attributed to the use of glacial erratics or boulders from beaches[24] may actually reflect the utilization of the Langdale source itself. This is difficult to prove, but a degree of selection for stone used within the fabrics of this pottery, possibly for its visual and tactile properties, has been noted by Freestone[25] and these properties may have been one of the reasons why rock from Langdale was chosen as a raw material for stone axeheads.

In north Wales, Group VII rock from Graig Llwyd, Penmaenmawr (Fig 1: 9) is present within Bronze Age pottery from Anglesey. The source is roughly 30km to the south-east of the findspot of the pottery, and the use of this rock does not appear to represent the use of glacial erratics, as it is the only material from outside the island present in thin sections carried out by Williams and Jenkins.[26] Also in north Wales, recent excavations by Steve Burrow[27] and the National Museum of Wales at Mynydd Rhiw, the source of Group XXI axeheads (Fig 1: 10), have returned two Middle Bronze Age dates of 1440 to 1220 and 1530 to 1120 cal BC (UBA-7802: 3081±42 BP; Q-387: 3094±90 BP) from hearths within one of the quarries. Burrow can see 'no obvious explanation' for activity of this date at the quarries,[28] but it is possible to suggest that, as at Langdale, they reflect a renewed interest in the site in the Bronze Age. The use of Group VII stone (a 'baked shale'[29]) in pottery of this period is difficult to see, however, as few sites in Wales have produced material of this date and fewer have had thorough, petrographic analysis.

In the English East Midlands, the use of igneous rock in Bronze Age pottery has recently been identified, with petrological work suggesting that this may derive from the Mountsorrel granodiorite, a small exposure of igneous rock located between Leicester and Loughborough (Fig 1: 11).[30] This outcrop was also utilized for Group XX axeheads, although a production site has not yet been discovered.[31] Late Bronze Age pottery containing this material is known from Lockington,[32] approximately 10km north of the source, whilst at Cossington, Barrows 1 and 2 contained Early Bronze Age pottery with igneous inclusions.[33] These were described as being very coarse and showing through the surface of the vessels, and a link was made between the use of this variety of rock and the Mountsorrel region, 10km to the west.[34] The Middle and Late Bronze Age pottery from Eye Kettleby, Leicestershire[35] was predominantly grog-tempered, but sherds containing igneous granitic rocks, suggested to be Mountsorrel granodiorite, were also present.[36] This site is located 16km to the south-west of the source of these rocks. A recent discussion by Woodward[37] has pointed out that, although it is relatively scarce, the use of igneous-rock temper in the East Midlands is significant and requires further analysis, whilst Knight *et al*[38] have carried out limited re-analysis of Iron Age pottery with these inclusions and have pointed out the possible social significance of the use of this rock type.

Outside the uplands of the west of Britain, the well known Middle Bronze Age activity at Grimes Graves, Norfolk (Fig 1: 12), involved the deposition of a large number of sherds of Middle Bronze Age pottery associated with charcoal, flint and animal bone within the upper fills of Shaft X.[39] The pottery here includes material to which flint was deliberately added. Barber *et al* discuss the later life of the flint mines of southern England, point out Bronze Age activity at Blackpatch, Sussex and go on to suggest that flint from the southern English mines continued to be of significance during this period.[40] Flint is a very common inclusion in later Bronze Age pottery in southern England. Unlike igneous rocks from upland Britain, it is difficult to assign definite sources for flint utilized in the fabric of pottery, but the volume in which it was added to the clay, and the effect this had on the texture of the finished pot, seem to have been an aesthetic, rather than practical choice. Indeed, Hamilton has previously suggested that, although flint is generally locally available in southern Britain, this should not be taken to indicate local production.[41] It remains a possibility, given the interest in other sources of stone axes illustrated above, that there was a similar renewal of interest in southern English flint mines in the Bronze Age and the flint used in pottery may have been derived from (possibly waste material associated with) Neolithic flint mines.

Whilst the renewal of interest in the sources of stone axes in the Bronze Age is a previously overlooked area, and might reflect an interest in sites with an ancestral, mythological or semi-industrial past, there is no evidence that the Malvern or Clee Hills were utilized as a source for stone axes in the Neolithic. The exploitation of these

[18] *ibid*, 35
[19] *ibid*, 35–6
[20] *ibid*, 88
[21] *ibid*, chapter 7
[22] Bradley and Edmonds 1993, 139
[23] But see Wild 2003 and James 2006
[24] Wild 2003, 35
[25] Freestone 1992, 340
[26] Williams and Jenkins 1999
[27] Burrow 2011
[28] *ibid*, 255
[29] Clough and Cummins 1979
[30] Knight 2002, 138–40; Knight *et al* 2003
[31] Clough and Cummins 1988
[32] Hughes 2000
[33] Thomas 2008
[34] Allen 2008, 28
[35] Finn 2011
[36] Woodward 2011, 68
[37] *ibid*
[38] Knight *et al* 2003
[39] Longworth *et al* 1988
[40] Barber *et al* 1999, 70–1
[41] Hamilton 2002a, 179–80

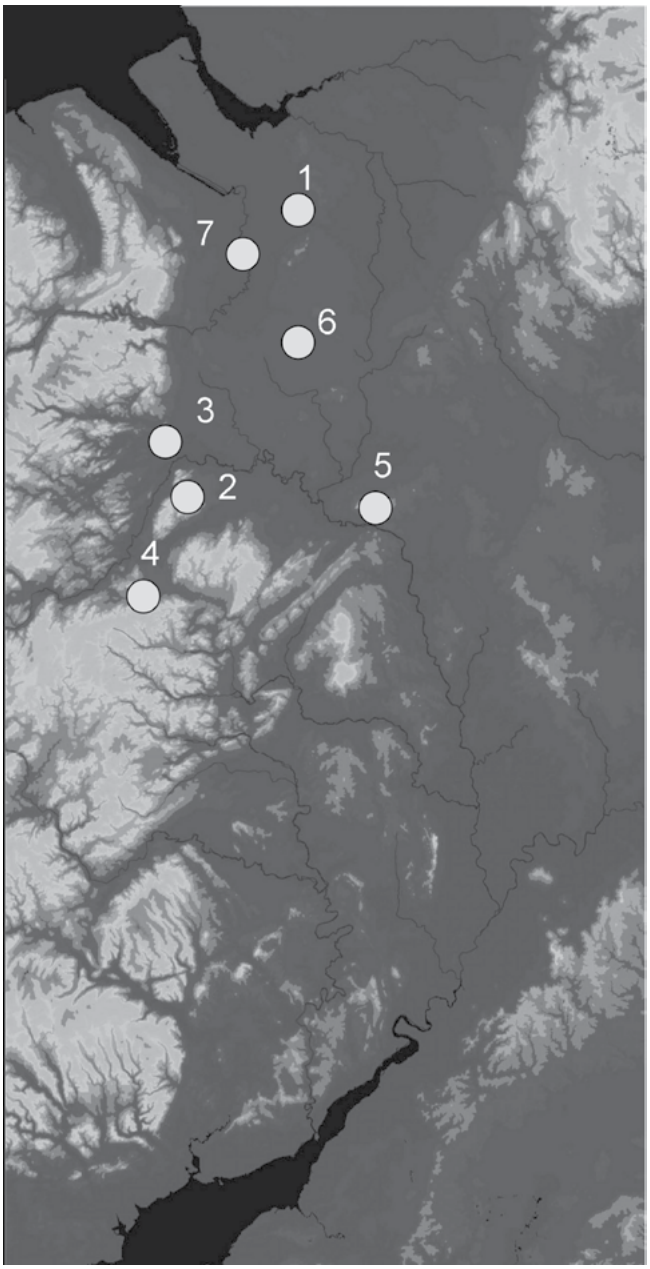


Fig 3 Sites from which pottery with rhyolite inclusions has been recovered: 1 Beeston Castle, 2 The Breiddin, 3 Four Crosses, 4 Glanfeinon, 5 The Wrekin, 6 Bury Walls, 7 Chester

rocks appears to have been exclusively for use as inclusions within pottery, commencing in the Middle Bronze Age. Similarly, rhyolite was also used in later Bronze Age pottery in the Welsh borderland (Fig 3), with examples known from Beeston Castle, Cheshire[42] and from a number of sites in Powys including the Breiddin,[43] Four Crosses[44] and Glanfeinon.[45] Pottery with rhyolite inclusions has also been reported from two sites in Shropshire: the Wrekin[46] and Bury Walls, Shropshire.[47] Further unpublished pottery[48] was recovered from excavations at Abbey Green, Chester,[49] and analysis by Elaine Morris[50] suggests the fabric contains inclusions of rhyolite, which make up 50 to 70 per cent of the matrix. Although the source of this rock is not known, Britnell *et al* have suggested that the rhyolite utilized at Glanfeinon was 'exotic', possibly with a source in the mountains of central Wales.[51] Morris, however, suggests that, along with the Conwy region of north Wales, the rhyolite from Abbey Green may have originated from the volcanic rocks of the Wrekin.[52] It is not impossible that a common source of rhyolite was exploited for all of the pottery containing this material throughout the region, although this requires further fieldwork. In any case, rhyolite is an uncommon material for Neolithic axe production in Wales and the Midlands and it seems likely that, wherever the source is located, this was also a location exploited anew in the Bronze Age.

Discussion

This paper has demonstrated that there appears to be a renewed interest in places which were used as a source of rock for Neolithic axes during the Early Bronze Age. This interest expressed itself in the use of the rock, not as axes, but as a material which was added to the clay from which pots were made. Whilst it could be argued that the presence of these varieties of rock in pottery represents the use of axes as a raw material, there is very little evidence for the continuing use, or indeed presence, of Neolithic axes in later Bronze Age contexts. Furthermore, in the later Bronze Age, there is an opening-up of new sources of stone which were never used for axes. Some of these sources, such as Titterstone Clee Hill, the Malvern Hills and the Wrekin are very distinctive landmarks and visible from far away (Wales, the Cotswolds). These latter three are also intervisible. Whilst the Mountsorrel outcrop may not be as dramatic, it has been described as 'topographically distinct'.[53] These high places may have held their own significance and may have been local landmarks which were involved in the construction of local identities and feelings of belonging: as Lovell has pointed out, loyalty to a particular place can be expressed through various mechanisms which may include myth and ritual, as well as certain ways of doing things.[54] These may have involved the physical incorporation of elements of the landscape into material culture as a symbolic way of connecting people and place. Hamilton has also pointed out the importance of resources from 'ideologically meaningful places [...] which were difficult to access' for the maintenance of group identity.[55] Whilst the decoration of Middle Bronze Age pottery is fairly restricted and stylized, it is the inclusions within the

[42] Ellis 1993
[43] Musson 1991
[44] Warrilow *et al* 1986
[45] Britnell *et al* 1997
[46] Stanford 1984
[47] *ibid*, 85
[48] But see Mullin 2003
[49] McPeake and Bulmer 1980
[50] Unpublished report in Grosvenor Museum, Chester
[51] Britnell *et al* 1997
[52] Unpublished report in Grosvenor Museum, Chester
[53] Knight *et al* 2003, 120
[54] Lovell 1998, 1
[55] Hamilton 2002b, 39

fabric which mark out the pottery as distinctive, and this is the one property that all sherds possess.[56] Indeed, the inclusion of different kinds of rock has allowed archaeologists, in the present, to differentiate between Bronze Age pottery from different sources.

The addition of 'filler' materials to clay is often described in functional terms, such as opening the clay body to help firing and increasing resistance to thermal shock. Whilst this may be the case for some materials, such as sand and shell, the inclusion of coarse rock in purely functional terms is difficult to understand. Knight *el al* discuss the use of Mountsorrel granodiorite in relation to thermal shock resistance and find its use problematic, pointing out that there may be wider, cultural significance to the use of this particular rock.[57] Ongoing experiments with clay and stone from Titterstone Clee at the University of Worcester suggest that the addition of crushed stone to the clay makes little difference to either firing or drying. Indeed, the stone makes the clay slightly more difficult to handle, the formation of good joins between the clay coils used to construct the pots more difficult and the fired finish of the pottery much rougher. There does not appear to be a firm functional reason for the inclusion of rock in the clay body of this pottery, at least. It is similarly difficult to see the practicality of including crushed flint in the vessels from southern Britain, and Woodward has drawn parallels with its inclusion within pottery and the processes of processing and cooking grain.[58]

It could well be the case, then, that in the later Bronze Age, there was a continuing interest in hills and rocks as sources of locally significant materials. The use of specific rock types from distinctive parts of the landscape and the deployment of this material in pottery suggests the expression of local identities which are strongly bound to these particular pieces of landscape.

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[56] *ibid*, 40

[57] Knight *el al* 2003

[58] Woodward 2008, 295

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Well shaved travellers: Irish and Scottish Early Bronze Age razors

Ros Ó Maoldúin

This paper considers Early Bronze Age razors from Ireland and Scotland. It reviews their dating and ceramic associations, and suggests that a motif which occasionally occurs on them may be an abstract representation of a boat and discusses the ramifications of that potential interpretation.

Introduction

Objects interpreted as razors have been found in Bronze Age contexts across Europe[1] and tests carried out with experimental copies have shown them to be equal to the task of shaving.[2] When discovered in burials they have been almost exclusively found with males, and various depictions, such as the statuettes from the Grevensvaenge hoard in Denmark and painting on Mycenaean vases from Greece,[3] suggest a variety of facial hair styles were widely employed across Bronze Age Europe to express aspects of male identity. Decorated razors from northern Europe feature motifs that form part of a complex religious iconography within an altogether more figurative tradition than the outwardly more geometric decoration featuring on the Irish and Scottish Early Bronze Age razors considered in this paper.[4]

The form and typology of Irish and Scottish Early Bronze Age razors

There are two basic forms of Irish and British Early Bronze Age razor. In Ireland, these have sometimes been referred to as 'razors' and 'razor-knives'.[5] Razors are distinguished by their distinctive oval shape and narrow projecting tangs, while razor-knives can be triangular or oval, but have short broad tangs (Fig 1). Jockenhövel further divided razor-knives into two groups, based on the blade form and hafting area (*mit Griffplatte* / *mit breiter, durchlochter Griffangel*), and razors into two variants, based on the presence or absence of decoration.[6] Kavanagh preferred to classify them only based on whether they were originally designed as razors or were adapted from some previous object to that use.[7] For the purposes of this study, the original terminology of 'razors' and 'razor-knives' is deemed sufficient, but since Jockenhövel's distinction between those razors that are decorated and those that are not is distributionally significant, its importance is acknowledged.[8]

Both razors and razor-knives have been found throughout Britain and Ireland; however, moulds for their production have only been found in Ireland, or on the Scottish coast adjacent to Ireland (Campbelltown, Argyll).[9] In the Atlantic Archipelago, finds of decorated razors are restricted to Ireland and Scotland.

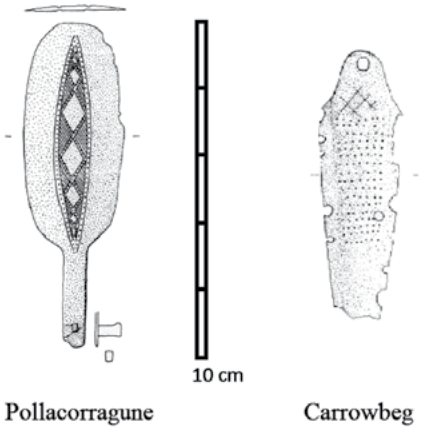


Fig 1 An Early Bronze Age razor (Pollacorragune, Co Galway) and razor-knife (Carrowbeg, Co Mayo) (after Kavanagh 1991, fig 24 nos 11, 13)

The dating of Irish and Scottish Early Bronze Age razors

Radiocarbon dates of material associated with Irish and Scottish razors and razor-knives (Table 1) suggest that the main period of their use was between 1700 and 1500 cal BC.[10] However, one Irish date for a razor-knife from Keenoge, Co Meath, Ireland, does suggest they were in use before 1888 cal BC.[11] Two late dates of charcoal associated with a razor found in Urbalreagh, Co Antrim (1412–1131 cal BC and 1392–1118 cal BC) are likely to be the result of old

[1] Jockenhövel 1971; 1980; Bianco Peroni 1979; Weber 1996
[2] Kavanagh 1991, 85; Kaul 1998, 150
[3] Treherne 1995, 131
[4] eg Malmer 1981; Kaul 1998; Ling 2012
[5] Binchy 1967
[6] Jockenhövel 1980, 32–7
[7] Kavanagh 1991, 85
[8] Jockenhövel 1980, pl 45
[9] *ibid*
[10] Brindley 2007, 371–2
[11] Lab refs and further details for all radiocarbon dates are given in Table 1



Fig 2 The distribution of Cordoned Urns in Ireland and Scotland (after Waddell 1995, fig 11.3)

wood effect. Bayesian analysis of the Irish dates, carried out by Alex Balyiss,[12] suggests razors began to appear in burials between 1885 and 1615 BC and disappeared sometime between 1680 and 1395 BC.[13]

Typological dating of ceramics associated with razors and razor-knives support this general chronology. The majority of Irish and Scottish razors and razor-knives have been found with burials of cremation deposits accompanied by Cordoned Urn tradition pottery (Table 2), a ceramic tradition particular to Ireland and Scotland (Fig 2). The available Irish dates associated with Cordoned Urn tradition pottery suggest it was current between 1740 and 1500 cal BC.[14] Dates from Scotland suggest the tradition may have originated a little earlier, perhaps by the end of the nineteenth century BC.[15] Differences between the date ranges may be exaggerated by different approaches to interpreting radiocarbon dates,[16] but either way do not suggest a different sequence.

Several razors have also been found associated with pottery of earlier traditions. The razor-knife at Keenoge was found in a grave with two Bowl tradition pots, a crouched inhumation and a cremation deposit.[17] The razor was found adjacent to the cremation, which may have been a secondary deposit in the grave. However, it was probably asso-

[12] After Mount 2013

[13] Radiocarbon ranges at 95.4% probability (2 sigma)

[14] Brindley 2007, 328

[15] Sheridan 2007, 170

[16] cf Sheridan and Bayliss 2008

[17] Mount and Buckley 1997

Site	Date BP	Lab ref	Sample	Source	2σ cal BC
Keenoge, Co Meath, b3	3640±50	GrA-17385	Carbonate	Brindley 2007, 76	2188–1888
Kilcroagh, Co Antrim, b2	3460±40	GrA-14816	Carbonate	Brindley 2007, 153	1890–1688
Cush, Co Limerick	3430±100	GrN-10633	Charcoal	Brindley 2007, 153	2014–1503
Gortrighy, Co Antrim	3410±40	GrA-14813	Carbonate	Brindley 2007, 153	1876–1617
Tara, Co Meath, b30	3370±60	GrA-19180	Carbonate	Brindley 2007, 372	1874–1507
Kilcroagh, Co Antrim, b1	3310±40	GrA-14815	Carbonate	Brindley 2007, 372	1687–1503
Pollacorragune, Co Galway	3280±40	GrA-14818	Carbonate	Brindley 2007, 372	1658–1453
Newcastle, Co Wicklow	3280±40	GrA-14776	Carbonate	Brindley 2007, 372	1658–1453
Carrig, Co Wicklow, 64	3220±50	GrA-23420	Carbonate	Brindley 2007, 372	1610–1418
Urbalreagh, Co Antrim	3035±45 3005±40	GrA-24664 GrA-25777	Charcoal	Brindley 2007, 152	1412–1131 1392–1118
Peafield II, Co Limerick	3320±40	Beta-292723	Carbonate	Mount 2013	1727–1503
Gilchorn Farm EQ 225, Angus	3370±60	GrA-18693	Carbonate	Sheridan 2007, 183	1874–1507

Table 1 Radiocarbon dates associated with Irish and Scottish razors; calibrated with OxCal v4.2.3 (Bronk Ramsey 2013); r:5; IntCal13 atmospheric curve (Reimer *et al* 2013)

Irish razor ceramic associations	
Site	**Ceramic association**
Gortrighy, Co Antrim	Cordoned Urn
Urbalreagh, Co Antrim	Cordoned Urn
Moneyrannel, Co Derry	Cordoned Urn
Pollacorragune, Co Galway	Cordoned Urn
Cush I, Co Limerick	Cordoned Urn
Cush II, Co Limerick	Cordoned Urn
Glenaree, Co Limerick	Cordoned Urn
Rath, Co Louth	Cordoned Urn
Carrowjames I, Co Mayo	Cordoned Urn
Carrowjames II, Co Mayo	Cordoned Urn
Carrowjames III, Co Mayo	Cordoned Urn
Keenoge, Co Meath, b3	Bowl tradition
Longstone, Co Tipperary	Vase tradition
Harristown, Co Waterford	Cordoned Urn
Kilmore I, Co Westmeath	Cordoned Urn
Kilmore II, Co Westmeath	Cordoned Urn
Knockast I, Co Westmeath	Cordoned Urn
Knockast II, Co Westmeath	Cordoned Urn
Carrig, Co Wicklow	Cordoned Urn
Peafield, Co Limerick	Cordoned Urn
Scottish razor ceramic associations	
Gilchorn Farm, Arbroath, Angus	Collared Urn
Shuttlefield, Lockerbie, Dumfries	Cordoned Urn
Lawpark (a), St Andrews, Fife	Cordoned Urn
Lawpark (b), St Andrews, Fife	Cordoned Urn
Magdalen Bridge, Joppa, Midlothian	Cordoned Urn
Sandmill Farm, Stranraer, Wigtown	Collared Urn
Stobshiel Farm, Humbie, East Lothian	Cordoned Urn
Edderton, Ross, Highland	Cordoned Urn
Horsburgh Castle Farm, Innerleithen, Peebles	Cordoned Urn
Southfield, Leuchars, Fife	Cordoned Urn

Table 2 Irish and Scottish razor ceramic associations

ciated with one of the Bowl tradition pots which dates to between 2160 BC and 1930 / 20 BC.[18] The radiocarbon date range, 2188 to 1888 cal BC, supports the early date suggested by the pottery. A razor was also found in association with a Vase tradition tripartite vase in Longstone, Co Tipperary.[19] Although the site remains unpublished and the radiocarbon dates retrieved from associated charcoal are considered aberrant,[20] from its association with a Vase tradition vessel we can determine that the razor is likely to have been deposited prior to 1740 cal BC.[21]

Two Scottish razors (Gilchorn and Sandmill Farm: see Table 2) have been found with Collared Urns. The dates associated with Collared Urns overlap with Cordoned Urns, but start and finish considerably earlier. According to Sheridan,[22] Collared Urns in Scotland were in use from *c* 2000 / 1950 BC to 1600 / 1550 BC, and according to Brindley,[23] they were in use in Ireland from 1850 / 1830 BC to some time after 1700 BC. The typo-chronology of Collared Urns has been the subject of much debate. Longworth proposed a broad two-stage typology.[24] However, the earlier stage is not represented outside southern Britain and therefore offers little chronological precision for razors accompanying Collared Urns from Scotland. Burgess proposed a more graduated typology,[25] but it does not appear to be supported by recent radiocarbon dates.[26] If one follows Brindley's Irish typology, based predominantly on the decoration, both of these urns would fall under her Stage 2 Collared Urns (pers obs) and accordingly be dated to between 1800 and 1700 BC.[27]

In summary, it seems that bronze razors were in use in Ireland and Scotland from around 1900 BC, but that the main period of use / deposition was, as Brindley concluded, between 1700 and 1500 BC.[28]

[18] Brindley 2007, 328
[19] *ibid*, 92
[20] *ibid*, 99
[21] As per Brindley's 2007, 328, typological dating schema
[22] Sheridan 2007
[23] Brindley 2007, 328
[24] Longworth 1984
[25] Burgess 1986
[26] Sheridan 2007
[27] Brindley 2007, 328
[28] *ibid*, 372

1	Dundrum, Co Down, Ireland	Kavanagh 1991, 91 no. 9; Jockenhövel 1980, 42 no. 93	Pointed oval motif-filled by lozenges	Razor
2	Pollacorragune, Co Galway, Ireland	Kavanagh 1991, 91–2 no. 13; Jockenhövel 1980, 41 no. 88	Pointed oval motif-filled by lozenges and pointillé decoration around its edge	Razor
3	Co Kilkenny	Kavanagh 1991, 92 no. 14; Jockenhövel 1980, no. 12	Incised lines emphasizing the hafted area	Razor-knife
4	Knockast I, Co Westmeath, Ireland	Kavanagh 1991, 98 no. 33; Jockenhövel 1980, 41 no. 85	Pointed oval motif-unfilled	Razor
5	Knockast II, Co Westmeath, Ireland	Kavanagh 1991, 100 no. 34; Jockenhövel 1980, 33 no. 9	Partial pointed oval motif-filled by lozenges	Razor (partial)
6	Newcastle, Co Wicklow, Ireland	Kavanagh 1991, 100–2 no. 39; Jockenhövel 1980, 42 no. 95	Parallel sided lattice pattern	Razor-knife
7	Ireland	Kavanagh 1991, 102 no. 40; Jockenhövel 1980, 33 no. 8	Incised triangles extending from a band at the haft-related to dagger decoration	Razor-knife
8	Peafield, Co Limerick, Ireland	Mount 2013, 46	Parallel sided lattice pattern	Razor (partial)
9	Shanwell House, Milnathort, Kinross, Scotland	Jockenhövel 1980, 36 no. 39	Parallel sided lattice pattern	Razor-knife
10	Magdalen Bridge, Joppa, Midlothian, Scotland	Jockenhövel 1980, 41 no. 86	Pointed oval motif-filled by lozenges	Razor
11	Tullochvenus, Aberdeen, Scotland	Jockenhövel 1980, 41 no. 87	Pointed oval motif-filled by lozenges	Razor
12	Rogart, Sutherland, Scotland	Jockenhövel 1980, 41 no. 89	Pointed oval motif-filled by lozenges	Razor
13	Balblair, Sutherland, Scotland	Jockenhövel 1980, 41 no. 90	Pointed oval motif-filled by lozenges	Razor
14	Balinalick, Glen Urquhardt, Highland, Scotland	Jockenhövel 1980, 41 no. 91	Parallel sided lattice pattern	Razor
15	Newbigging, Angus, Scotland	Jockenhövel 1980, 41–2 no. 92	Pointed oval motif-filled by lozenges and pointillé decoration around its edge	Razor
16	Kinnesswood, Kinross, Scotland	Cowie and Hall 2009, 158	Parallel sided lattice pattern	Razor
17	Southfield, Leuchars, Fife, Scotland	Coutts 1971, 43	Pointed motif-filled by triangles	Razor (partial)

Table 3 Decorated Irish and Scottish Early Bronze Age razors and razor-knives

The origins of the tradition

Razors and the tradition of shaving are often supposed to have spread to northern and western Europe from 'more sophisticated' cultures of the Mediterranean region.[29] However, the dates of Irish and Scottish metal razors, reviewed above, suggest they may have been in use in north-western Europe as early, if not earlier, as elsewhere within Europe.[30] Furthermore, the tradition of razors in Irish and Scottish burials appears to replace an earlier tradition in which burials were accompanied by plano-convex lithic blades.[31] This direct replacement suggests that the lithic blades may have had a similar function to razors, and there is no reason to suppose that the shaving, or at least trimming, of facial hair was not carried out in Ireland, Scotland and elsewhere within north-western Europe from a considerably earlier date.

Decoration on Irish and Scottish Early Bronze Age razors

There are seventeen decorated razors or razor-knives from Ireland and Scotland (Table 3). The decoration is predominantly incised but is sometimes accompanied by pointillé impressions. A pointed oval motif appears on eleven razors (Fig 3), four from Ireland and seven from Scotland (Fig 4). An alternate but related motif, with parallel sides, occurs on two razor-knives and three razors. One of each is from Ireland and one razor-knife and two razors are from Scotland. Finally, there are two razor-knifes from Ireland, which may have been adapted from daggers, that bear decoration either related to their former function or added to accentuate their new shapes.

No two executions of the pointed oval motif are the same (see Fig 3), yet the shape of the motif and how it was elaborated remains remarkably consistent. The outlines are delineated by one or more incised lines, between which pointillé (Fig 3, Pollacorragune and Newbigging) or cross-hatching (Fig 3, Balblair) is sometimes placed. On one razor the interior of the oval was left blank (Fig 3, Knockast I), but in all other cases it was filled with variations of incised lozenge or triangular patterns, a style of ornamentation that further supports links with Cordoned Urn tradition pottery, and which is also found on ogival daggers and socket-looped spearheads.[32]

A figurative interpretation

Figurative representations are uncommon in Irish or British prehistoric art, and the exceptions are notable by their rarity. However, it is suggested here that the pointed oval motif that commonly occurs on Irish and Scottish Early Bronze Age razors might represent a canoe-shaped boat, as seen from above.

[29] Jockenhövel 1971, 25; *idem* 1980, 27; Kavanagh 1991, 85; Kaul 2013, 462

[30] cf Kaul 2013

[31] Brindley 1980, 202

[32] Binchy 1967, 49

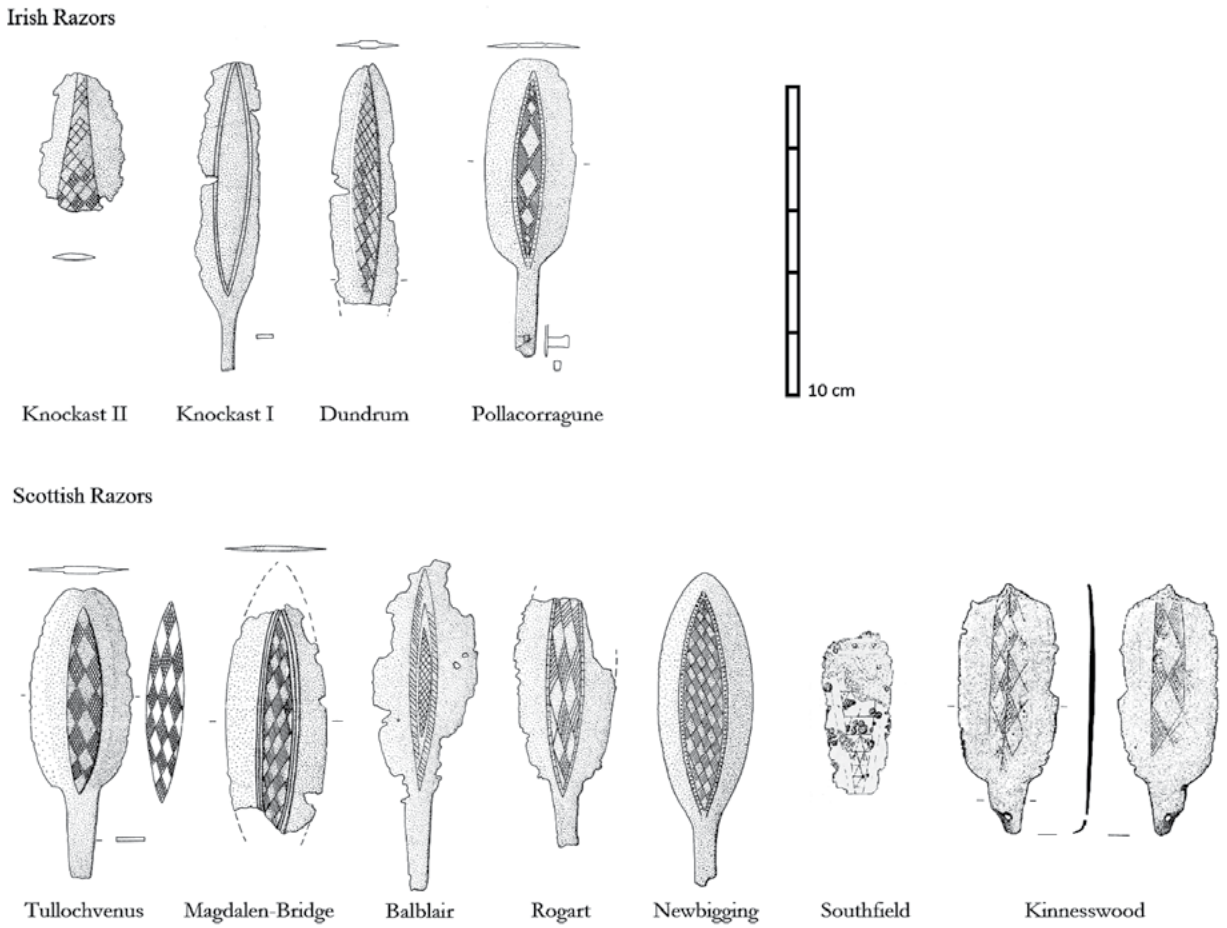


Fig 3 The pointed oval motif on Irish and Scottish razors (after Jockenhövel 1980, pl 1 no. 9, pl 4 nos 85–90, 92, 93; Coutts 1971, fig 14; Cowie and Hall 2009, 158)

It could be argued that this motif was designed simply to fit or demarcate an area not to be honed down in the production or maintenance of the fine thin razor edges. That interpretation could find support in the close match between the un-honed area and the motifs on some razors (eg Fig 3, Dundrum). However, on others, the motif does not extend to meet this juncture, and on some, the pointed ends of the motif extend onto the haft and would be superfluous to such a function. Either way, it is likely that such a motif might have served multiple intertwined functional and symbolic purposes.

Obvious representations of boats, or 'ships', commonly occur on Nordic Bronze Age metalwork.[33] Indeed, they are the dominant motif of a complex religious iconography in what is an altogether more figurative tradition[34] than most Irish or British prehistoric art.[35] Significantly for this argument, the most common Nordic artefacts on which boats are depicted are Late Bronze Age razors that are sometimes found accompanying male burials.[36] The shape, form and perspective of the boats depicted on Nordic razors (Fig 5) differs from the postulated boat on earlier Irish and Scottish razors and arguably illustrates influence from the Bronze Age Aegean.[37] In addition to these differences, there are geographical and temporal gaps between the Irish and Nordic razors to consider. However, several similar razors bearing pointed oval motifs (Fig 6) have been found in what could be considered intermediary areas on the Continent. Furthermore, the occurrence of a pointed oval on razors does not disappear with this early form of razor. It also occurs on blades and in the form of handles on later, differently shaped razors on the Continent (Fig 7), and in these cases it certainly has nothing to do with defining an un-honed area. On some particularly elaborate examples, the postulated boat shape appears on the handle, beneath a lunate-shaped blade with depictions of what are likely to be nipples (Fig 8), potentially reflecting a conflation of the razor, boat and male form.

That a pointed oval depiction of boats, as seen from above, would have been recognizable to some Bronze Age peoples is offered support from Scandinavian boat-shaped

[33] Kaul 1998
[34] eg Malmer 1981; Kaul 1998; Ling 2012
[35] cf Shee Twohig 1981; Bradley 1997
[36] Kaul 1998, 146, 154–6
[37] *idem* 1998; 2013



Fig 4 The Tullochvenus razor (photograph courtesy of Aberdeen Museums, © University of Aberdeen)

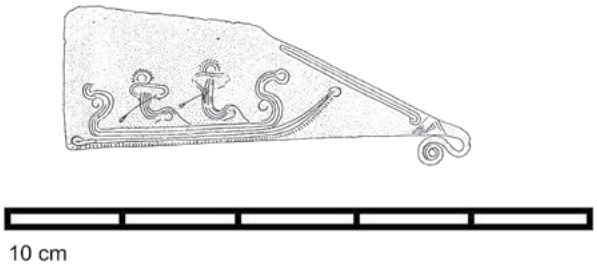


Fig 5 Danish Late Bronze Age razor with no known provenance (after Kaul 1998, 149)

burials.[38] These consist of pointed oval settings of upright stone, which can be perceived in plan from a standing viewpoint, and offer an interesting parallel of clearly depicted boats associated with burials for our motif. The association between boats and burials is a reoccurring feature of Nordic archaeology,[39] which can be traced back to the Mesolithic, when burials were sometimes placed in dugout canoes.[40]

Other boat symbolism in Bronze Age burials

There is only one known example of an actual boat burial from Early Bronze Age Ireland. Found under the centre of a ring-barrow in Lissard, Co Limerick, during the 1930s. It survived only as an east-west 'grey outline about 16 feet long [and] 3 feet wide at the centre';[41] too long for a log-coffin burial and with tapering ends, the excavator was almost certainly correct to interpret it as the remains of a logboat.[42] The rim of an inverted Vase Urn was found on its northern side and three, possibly four, postholes were located on its southern side.[43] Only vestiges of cremated bone survived, in part due to the acidic nature of the soil and in part to later site truncation. The upper edges of the boat were charred, suggesting that when it was only partially covered, a fire was lit on the centre of what was to be the barrow.[44]

The Lissard barrow was located on the shores of a glacial lake, a connection that Cross has argued is emphasized in the uniqueness of this find.[45] While the inclusion of an actual boat in a burial is unique in an Irish context, similar finds are known from other parts of the Atlantic Archipelago. Around 40 log-coffins, several of which have been identified as boats or boat-shaped, are known from Britain.[46] The earliest are Chalcolithic in date and are sometimes accompanied by Beaker pottery; the latest are Middle Bronze Age in date. The main concentrations occur in northeast England and Wessex, but five examples are also known from Scotland. One of a pair of Scottish wooden coffins, found inside a ring ditch at a Bronze Age cemetery in Seafield West, near Inverness, appears to have been a boat-burial.[47] A connection between boats and burials in an Irish-Scottish milieu predating the razors with the postulated boat motif can therefore be clearly demonstrated.

Other portable artefacts have been interpreted as potentially representing boats. Notably, boat-shaped stone battle axes occur in association with material of the so called 'Corded Ware' or 'Single Grave' culture, a 'cultural continuum' that extended across a large part of northern Europe between 2900 and 2400 BC.[48] The stone battle axes are most commonly found associated with male burials and are mostly interpreted, along with the beaker-shaped pots with which they are found, as representing a combination of hospitality and authority.[49] Later stone battle axes, of the earlier British Bronze Age, have also been noted as being boat-shaped.[50] The most obviously boat-shaped is an English type of battle axe, the Loose-Howe type, most often found with Collared Urns in particularly rich assemblages.[51] The only example of this class known from Ireland accompanied a cremation burial with an early-series Cordoned Urn from Ballintubbrid, Co Wexford.[52] The cremated remains were identified as adult; however, the sex and precise age were indeterminable.[53]

Interpreting burials and 'grave goods'

Traditionally, the practice of single burial in the Earlier Bronze Age has been interpreted as signalling the emer-

[38] Capelle 1995
[39] Crumlin-Pedersen and Thye 1995
[40] Skaarup 1995
[41] Ó Ríordáin 1936, 174
[42] *ibid*, 175
[43] The pottery was subsequently identified by Brindley 2007, 343
[44] Ó Ríordáin 1936, 175
[45] Cross 2001, 210
[46] Ashbee 1960; Smith 1994; Mowat 1996; Cressey and Sheridan 2003
[47] Cressey and Sheridan 2003
[48] Cunliffe 2008, 167–8
[49] *ibid*
[50] Simpson 1990
[51] Roe 1966, 212
[52] Brindley 2007, 371; Kavanagh 1976, 325
[53] Ryan 1975

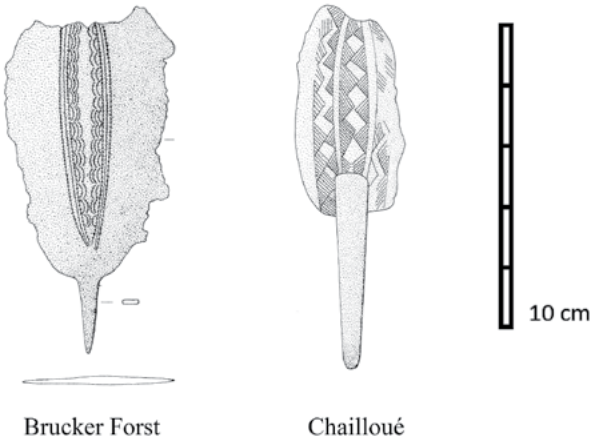


Fig 6 Razors similar to Irish and Scottish razors from Chailloué, France, and Brucker Forst at Weichering, Germany (after Jockenhövel 1980, pl 4 no. 94; *idem* 1971, pl 1 no. 4)

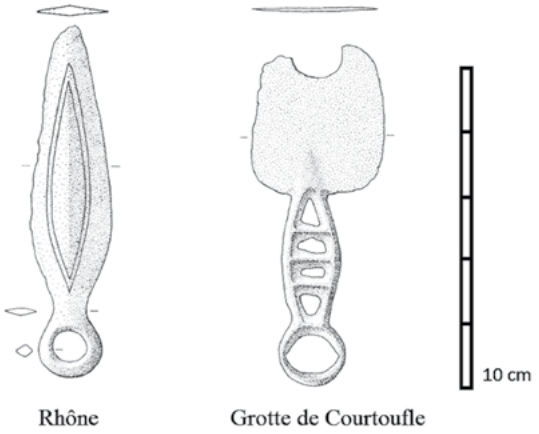


Fig 7 The pointed oval motif on two later Continental razors, from the Rhône valley and Grotte de Courtoufle, France (after Jockenhövel 1980, pl 13 no. 240, pl 17 no. 299)

gence of concepts of individual identity.[54] In addition, accompanying grave goods have most often been interpreted as personal possessions of the deceased, directly reflecting the individual's identity and status, deployed at burial in some form of competitive display.[55] Recently, however, many authors have argued that these models are far too simplistic and that through viewing the self as a bounded homogenous entity, archaeologists have been guilty of projecting ethnocentric ideals, such as Cartesian concepts of self and modern concepts of ownership, onto peoples in the past.[56]

Through consideration of other conceptions of self, or 'personhood', drawn from Social Anthropology, convincing arguments have been made that a more 'dividual' or 'relational' concept of the self is likely to have predominated during many periods of prehistory.[57] Viewed through this perspective, persons are defined through their relationships with others and not as bounded homogenous entities. Grave goods have also been shown to not always relate directly to the lived life of the deceased. Fowler has, for example, shown how artefacts deposited in burials by the Mesolithic Ertebølle communities of Denmark cannot all be seen as direct indicators of the lives of the deceased; 'several infants and even a dog were provided with tools'.[58]

As an alternative, a number of authors argue that grave goods are open to a more nuanced relational interpretation that allowed mourners to comment metaphorically on relationships between the living and deceased, and on the changes wrought by the death.[59] Such concepts of identity and the relational aspects of exchange need to be amalgamated into our general understanding. However, the process of argument has led almost all grave goods to be interpreted as either gifts from the mourners or items primarily associated with the funerary rites.[60] While this may be true of some items, we must be careful not to allow the pendulum of opinion swing too far. It is argued here that certain items, such as razors, were likely to have been personal.

Many razors show evidence of extensive use, repair and refashioning, suggesting they were put to more frequent use and their inclusion in the burial rite was only one stage of their object biographies. Such an interpretation need not conflict with dividual concepts of the self, nor imply modern concepts of ownership. In fact, the bestowing of such an item on a person by a community, for example on their initiation to adulthood or marriage, could equally be used to argue for a relational conception of the self. Such a bestowal could be viewed as a form of gift exchange in which the object, being inalienable,[61] might metaphorically retain something of the community from which it was bestowed, and forge, or bolster, a link with the person to whom it was given. It may be for this very reason that certain items became physically inalienable. To remove one from a person at death might have been to sever relations with their community.

The fact that during the Early Bronze Age in Ireland and Scotland razors are found with burials, as opposed to in hoards or single depositions, as most metal items are, might furthermore be construed as suggesting they were considered personal items. In Scandinavian Bronze Age burials, there is a discernible distinction between the way toilet articles, such as razors, were placed directly beside or on the body, and swords, which were frequently placed outside a cow hide used to wrap the corpse.[62]

[54] Renfrew 1974; Shennan 1982
[55] Randsborg 1973
[56] eg Brück 2004
[57] Brück 2004; Fowler 2004; 2001; Damm 2012
[58] Fowler 2004, 134
[59] Brück 2004
[60] cf Barrett 1994, 116–21
[61] Weiner 1992
[62] Treherne 1995, 121

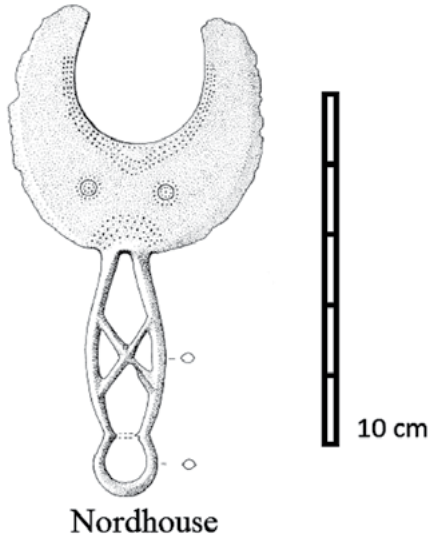


Fig 8 Conflation of the pointed oval and the male body on a razor from Nordhouse, France (after Jockenhövel 1980, pl 18 no. 314)

Razors and identity

The way in which people wear or shave their hair often signifies membership of a particular group or cult.[63] Paul Treherne argued that Bronze Age razors were part of a set of toilet equipment associated with membership of a warrior fraternity whose outward appearance was part of a 'life style'.[64] Stone moulds for the Irish / Scottish razors have been found with matrices for spears and other weapons, perhaps reinforcing this martial connection.[65] Kaul makes a strong case that in later Bronze Age Scandinavia razors decorated with ships may have been emblematic of cultic knowledge or religious power and that the large undecorated razors were emblematic of socio-political status.[66] However, in the Irish and Scottish Early Bronze Age at least, it seems unlikely that there was such a strict division between the sacred and profane. In his analyses of prehistoric Europe, Richard Bradley made convincing arguments against too strictly separating the two.[67] It seems more likely that symbols of power would have been intrinsically linked 'total' (in the Maussian sense), ie 'religious, legal, moral and economic' phenomena.[68]

The functional and symbolic importance of boats in Ireland and Scotland during the Early Bronze Age

Boats would have provided one of the main modes of travel and transport in the Early Bronze Age. Travel within and between Scotland and Ireland in the Early Bronze Age would have been particularly important for the exchange of metal. At least initially, all of the copper was procured in the south-west of Ireland[69] and by *c* 2200 BC a flourishing metal industry was underway in eastern Scotland.[70] Throughout the Bronze Age, it is likely that partaking in this exchange, or dominating the various routes between these areas, would have offered opportunities to emerging elites. Various 'rich' burials, from a Beaker burial from Culduthel, Highland,[71] to users of the Cordoned Urn tradition pottery,[72] have been identified as possible players in that exchange. Those buried with the razors discussed in this paper are likely to have been significant participants.

Given the prevalence of boats associated with burials, already noted, it would be remiss to explain the importance of Bronze Age boats in simply functional terms. As Briard noted many years ago 'we see appearing in the religious myths of the very early Bronze Age, objects that glorify travel – boats, canoes, and a little later, wheels, carts and horses'.[73] A number of archaeologists have recently drawn upon the work of anthropologist Mary Helms to help explain this phenomenon.[74] In her book *Ulysses' Sail*, Helms argued that geographical distance is often perceived as a supernatural distance, becoming increasingly different, supernatural, mythical and powerful the further away it is.[75] In the ethnographic examples she cited, knowledge of distant places, things or people could attach an aura of prestige and awe to specialists or elites. Control of access to this esoteric knowledge could in turn become a major means of effecting political and ideological distancing in society. In Early Bronze Age Ireland and Scotland boats may, in both a symbolic and real sense, have been vehicles which allowed emerging elites to compete for power.

Conclusions

Irish and Scottish Early Bronze Age razors are earlier in date than many of their European continental counterparts and may replace a native tradition of placing plano-convex blades alongside male burials. They are likely to have been personal items employed to visually distinguish their users and may have signalled that they were initiates of an elite fraternity. The suggestion that the motif on Irish and Scottish Bronze Age razors might represent a boat may initially seem very speculative. However, when one considers the intimate symbolic relationship between male identity, razors and boats deployed in various combinations in Bronze Age Europe, it is given some credence. If it does represent a boat, it is likely to have signified both real and symbolic knowledge of distant places along routes of exchange.

[63] Peterkin 2001
[64] Treherne 1995
[65] Jockenhövel 1980, 113–26
[66] Kaul 1998, 154–6, 173
[67] Bradley 2005
[68] Mauss 1970, 1
[69] O'Brien 2004
[70] Needham 2004; Cowie and O'Connor 2009
[71] Sheridan 2012, 48
[72] Waddell 1995, 121
[73] Briard 1979, 14
[74] eg Kristiansen and Larsson 2005
[75] Helms 1988

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Sockets full of scrap? Remarks on deliberate fragmentation in Late Bronze Age metal deposits in south-eastern and north-western Europe

Oliver Dietrich and Tobias Mörtz

This paper discusses the practice of stuffing the sockets of metalwork implements prior to deposition with other objects, mostly fragments of other metal items but on occasion also non-metallic objects. In the Carpathian Basin it is found during the earlier part of the Late Bronze Age and in Britain and Ireland towards the end of this period. Seen against the backdrop of wider, pan-European depositional practices, this peculiar custom in most cases can be interpreted as an attempt at preserving the integrity of individual sets of items within larger communal offerings.

Introduction

Svend Hansen was first to call attention to purposefully arranged fragments of metal artefacts wedged inside the sockets or wings of Late Bronze Age axes.[1] He identified 38 socketed axes treated that way between the Atlantic coast and the Carpathian Basin, with two distinct clusters of finds in south-eastern and north-western Europe (Fig 1). The first group dates mainly to the thirteenth and twelfth centuries BC and the latter to the tenth and ninth centuries BC. Although the general pattern remains the same, an increased number of blocked axes, thanks not only to a raised awareness and a reinvestigation of old finds, but also to new discoveries, makes this a subject worth revisiting. Hansen stressed the care evident in these arrangements and rejected a purely functional explanation relating to recycling practice, instead interpreting these intentional combinations as a way of protecting their integrity as ritual deposits, which may thus be termed 'miniature hoards'.[2]

The present contribution includes updated lists of deliberately blocked socketed axes from the Carpathian Basin and from Britain and Ireland. An analysis of the peculiarities of these special metal depositions provides further insights into the performance of Late Bronze Age rituals. The question of whether both clusters should be understood in a similar way, despite their geographical and chronological separation, will also be addressed. It is argued that in south-eastern Europe these combinations of artefacts were probably conceptualized as personal sets, in a manner that has a long history which can be traced back to the Chalcolithic. In contrast, the purposeful blocking of sockets in north-western Europe appears to be connected to a long-term tradition of single- and multi-piece axe-only depositions.

Axes with blocked sockets in the Carpathian Basin

To date, 31 axes with fragments and / or molten metal wedged into their sockets are known from south-eastern Europe. These occur in a clear cluster in the Carpathian Basin (see Fig 1). With the exception of two unprovenanced specimens and a settlement find (list 4), all come from hoards (lists 1–3). The majority of these are dated to the Hallstatt A phase (thirteenth to twelfth centuries BC), which in this area is generally characterized by exceptionally large deposits of predominantly fragmented metalwork. It is in this class of finds that most instances of blocked axes appear (list 3).

The hoards can be categorized by size into: 1) small hoards with less than twenty artefacts, 2) hoards of medium size (between twenty and 100 artefacts) and 3) large hoards with more than 100 artefacts. Most discoveries with blocked axes fall into Categories 2 and 3 (lists 1–4). Regardless of their different sizes, all these deposits are heterogeneous in character and contain high percentages of fragmented items. In any case, the blocking of axe sockets is always restricted to one or few pieces within these assemblages. For example, only six of approximately 260 axes in the Uioara de Sus hoard (list 3.11), which includes more than 5800 artefacts, are affected by this treatment. Traces of use on these specimens suggest that they share a biography of a longer employment as tools before being transformed into containers for various fragments and, finally, being deposited.

The details, especially of the last steps, seem to differ from artefact to artefact. In some cases the axes were used as complete objects, in others they underwent considerable re-working, including fragmentation. A good example of the latter is an axe from Şpălnaca II (Fig 2.1, list 3.10). The most radical form of artefact combinations are those where the fragment of the axe is so small that the socket can no longer serve as a container without being compressed by hammer blows, as for example in the case of Dipşa (Fig 2.2–3, list 3.6). More fragmented axes have been used in this manner than complete ones (ten complete, fifteen fragmented), damaged specimens are less frequent (six cases). Most often pieces of raw metal or ingots, which are a characteristic component of large Late Bronze Age hoards in the Carpathian Basin, were employed as blocking implements (Tables 1 and 2).

Occasionally, items made of materials other than bronze have been found in the sockets. These include amber beads in the hoard of Debeli vrh (list 3.5) or gold artefacts in the hoard of Napkor (list 2.3). Lead or tin were also sometimes deliberately poured into the axes, as is the case for Aiud (list 3.1) and Dipşa (list 3.6). These combinations would not be

[1] Hansen 1996–98, 10–23

[2] *ibid*, 18–9; *idem* 2016, 186

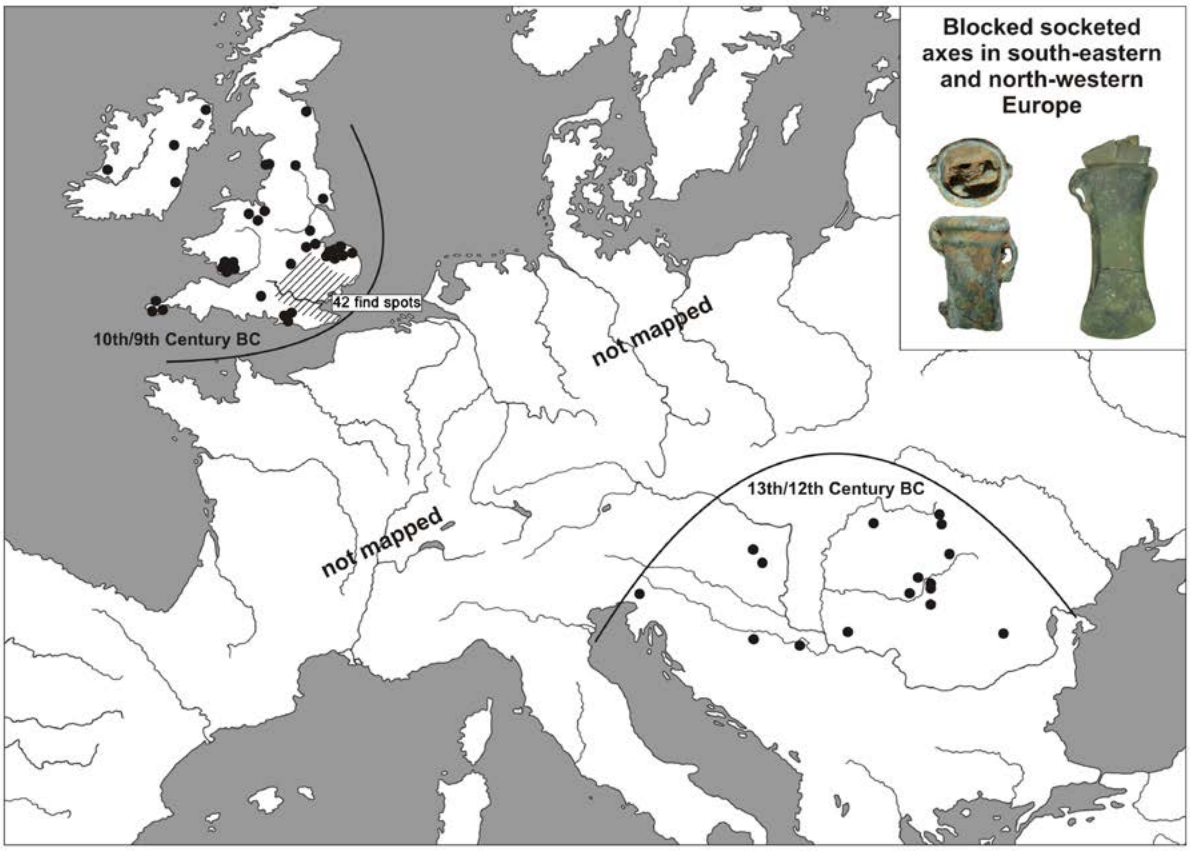


Fig 1 Distribution map of Late Bronze Age axes with blocked sockets in south-eastern and north-western Europe

suitable for re-melting and suggest a non-technological purpose. Further proof comes from finds closely related to the phenomenon discussed here. A hoard found at Pustakovec in Croatia contains a very special arrangement of a fragment of a socketed axe together with other artefacts strung on a wire,[3] a combination completely useless from a metallurgical point of view.

It is difficult to infer regularities in the combinations of items inside the sockets, as in many cases not all are visible. Nevertheless, finds like the axe from Guşteriţa II (Fig 2.4, list 3.8), which is densely stuffed with fragments of sickles and saws, do in themselves constitute period-specific hoard associations. When contextualized within the history of hoarding in the Carpathian Basin, blocked axes ought to be understood as a long-term cultic phenomenon.[4] Earlier occurrences similar to the 'miniature hoards' can be identified in the form of combinations of complete artefacts. To name just two characteristic examples from Romania, the gold rings in the hoard of Bătarci originally belonged to a chain, which was fixed to the loop of a socketed axe,[5] and the hoard from Crăciuneşti contains a bronze bar attached to a bracelet.[6] Both discoveries belong to phase Bronze D in the Reinecke scheme and thus predate most of the blocked axes described here. If one situates both phenomena within the development of regional Bronze Age hoarding practices, a quite coherent picture emerges.

From the Early and Middle Bronze Age of the Carpathian Basin relatively few deposits are known. These finds are small, usually containing around ten bronzes, with a very limited and canonical range of artefacts, consisting mostly of weapons and personal ornaments, with tools largely missing.[7] The axes and swords were given a unique character through the application of complicated and distinct decorations.[8] The low number of items included, their individual character and matching numbers of weapons and ornaments suggest that we are dealing with the personal possessions of individual warriors. In hoards from this phase, the assembly of artefacts into physical combinations is largely absent, with the exception of golden ornaments, predominantly lock rings, which are often found arranged into bundles or chains.[9]

At the beginning of the Late Bronze Age (Bz D), the hoarding patterns change abruptly.[10] There are marked regional differences, but generally hoard assemblages not only become considerably larger, but also significantly more var-

[3] Hänsel 1999, 80 no. 44, fig 6.1–5
[4] Dietrich 2014
[5] Macrea and Kacsó 1972, 101
[6] Nistor and Vulpe 1974, fig 4.29
[7] Mozsolics 1967; Soroceanu 2012
[8] For the composition and possible interpretation of Apa type hoards see David 2002, 399–416
[9] Hänsel and Weihermann 2000
[10] Hansen 1994, 304–70; *idem* 2005; Bratu 2009, 139–48



Fig 2 Blocked axes from hoards in Romania: 1 Şpălnaca II (Museum de Istorie Aiud reg-no. 266); 2–3 Dipşa (Muzeul Naţional Brukenthal Sibiu reg-nos A2409, A2403); 4 Guşteriţa II (Muzeul Naţional Brukenthal Sibiu reg-no. A386)

ied regarding the artefacts included.[11] This implies a shift to less restricted rules of deposition. Tools, such as sickles and socketed axes, in many regions now form the major constituents of the hoards, while weapons (mostly axes, but also swords and spearheads) remain of importance. Furthermore, raw material makes its first appearance with the inclusion of bronze, copper and (rarely) tin ingots. Associations which could be interpreted as 'personal' hoards are very scarce and the finds give the impression of communal offerings by larger groups. It is precisely during this shift towards de-individualization that combinations of complete artefacts are most numerous and mark the connectedness of certain objects within the hoards. In Hallstatt A, the hoarding customs change again.[12] The compositions of the finds become more complex and extensive.[13] Most artefacts are now deposited in a damaged or fragmented state.[14] It is these, at first sight unstructured, assemblages that include the blocked socketed axes.

Keeping the earlier artefact combinations in mind, it becomes evident that such manipulations are not novel at all, but that they translate an earlier hoarding pattern into new period-specific forms of ritual expression. Instead of intact artefacts, fragments were now combined. A development from complete, functional items, deposited as a gifts to superhuman beings, towards *pars pro toto* offerings becomes discernible. Significantly, in Hallstatt B, when hoards get smaller and contain largely complete items again, artefact associations which may be interpreted as personal sets are attested once more.[15] The hoard from Prejmer, including a solid-hilted sword, two spearheads and a socketed axe,[16] the find from Predeal II, containing a sword, a fragment of a knife and a richly decorated socketed axe,[17] and the

[11] Mozsolics 1973; Petrescu-Dîmboviţa 1978, 97–113; Hansen 1994; Bratu 2009

[12] Hansen 1994, 304–70; *idem* 2005; Bratu 2009, 139–48

[13] Mozsolics 1985; Petrescu-Dîmboviţa 1978, 113–39; Hansen 1994; Bratu 2009

[14] Hansen 2016

[15] Petrescu-Dîmboviţa 1978, 139–48; Mozsolics 2000; Metzner-Nebelsick 2002, 62–3

[16] Petrescu-Dîmboviţa 1978, 138 no. 203

[17] *ibid*, no. 202

assemblage from Brad, consisting of a spearhead, two bracelets and a socketed axe,[18] are just three examples. In the latter case the artefacts' interconnection is further enhanced by similar decorations, but all cited finds give the impression of personal belongings of individual warriors.

At the same time, physical combinations of different artefacts diminish in number. Discoveries like the socketed axe from Suatu, with a fragment of a bronze ring in its loop, are reminiscent of earlier traditions[19] but now become scarce. Over the course of Hallstatt B, a trend towards miniaturization is discernible, for example, in socketed axes,[20] leading to clearly non-functional forms. Reduction in size to some degree seems to substitute fragmentation within hoards. Overall, the occurrence of blocked axes in the Carpathian Basin should be understood as a relatively short-lived phenomenon, lasting approximately two centuries, which is at once a historically specific hoarding practice and embedded in a long-term tradition of ritually combined artefacts. A very early example for such an arrangement is the Chalcolithic hoard from Szegedin in Hungary, where two chisels and a flat axe were found sticking in a fragmented shaft-hole axe.[21]

Axes with blocked sockets in Britain and Ireland

In his seminal paper Hansen recorded five hoards with blocked axes from Britain.[22] Ten years later Regine Maraszek listed seventeen finds from England and a further three from Ireland.[23] At the time of writing, this figure has multiplied. Even though it must be assumed that many such associations were disassembled without having been recorded, there is now a remarkable total of seventy-eight deposits with one or more blocked axes from Britain and Ireland (lists 5–9). Less frequently, fragments of other artefacts were also inserted into the sockets of gouges, knives and spearheads. Most of these are part of large hoards which also contained blocked axes. One reason for the considerable increase in known finds is the thorough reporting and recording of prehistoric bronzes within the framework of the Portable Antiquities Scheme that operates in England and Wales.[24]

In Britain, blocked axes appear in five different depositional categories: 1) single axes (list 5); 2) pure axe hoards (list 6); 3) small hoards with less than twenty artefacts and mostly of limited complexity (list 7); 4) hoards of medium size, ie those comprising between twenty and 100 artefacts and heterogeneous in composition (list 8); 5) large hoards with more than 100 artefacts (list 9). The majority of cases fall under Category 4. Deposits of medium size with complex make-up dominate the archaeological record of the British Late Bronze Age in general, so that their higher frequency comes as no surprise. One of the very few professionally excavated finds, the well-known hoard(s) from Petters Sports Field in Egham (list 8.15), belongs to this category. In this case just one damaged axe was blocked by a folded fragment of sheet metal and the tip of a knife blade. None of the remaining 14, better preserved specimens shows a corresponding manipulation. This very selective treatment is representative of the whole phenomenon. Only in the Wakering hoard (list 8.31) all the axes are reported to have been blocked.

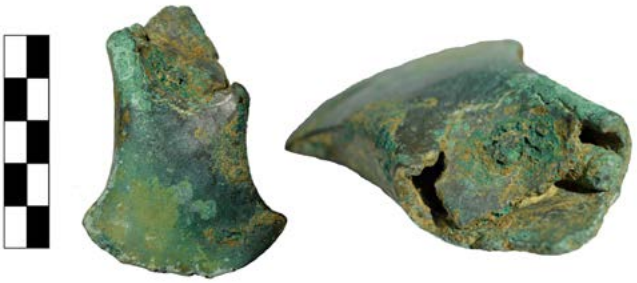


Fig 3 Blade part of a socketed axe blocked with a fragment of twisted bar and crushed by hammering from the hoard of London IV – Bromley-by-Bow (socket detail not to scale) (author's photograph; © Trustees of the British Museum London, reg-no. 1903,0623.18)

A concentration of medium and large deposits exists in south-eastern Britain, the latter being confined to regions adjacent to the estuary, namely Essex and Kent (list 9), with two outliers in Norfolk (list 9.4) and Suffolk (list 9.8). In accordance with the varying density of Late Bronze Age metalwork finds, the quantity of blocked axes from northern England is distinctly lower, and Scotland so far remains devoid of any comparable discoveries (see Fig 1). Smaller clusters, for example in the Vale of Glamorgan in South Wales,[25] can be explained as a consequence of intensive metal-detecting over recent decades.

A correlation between hoard size and the number of implements with blocked sockets cannot be established. In contrast, the amount of pieces so affected remains limited to a minority even in very large deposits. Nor is any pattern discernible with regard to axe typology, with all current types of Late Bronze Age axes being subject to this treatment. The artefacts used to block the axes, mostly bent and / or broken, are also very variable. Fragments of other axes, chisels, gouges, ferrules, knives, metal fittings, pins, razors, rings, sheet metal, spearheads and swords, as well as casting debris, bar ingots, raw metal and wire can be detected (Tables 3–7). A reliable identification is, however, difficult and often impossible when the artefacts are still in place. In some cases, for instance with the All Hallows I (list 8.1), Borstal (list 8.9), Grays Thurrock (list 9.5), London IV – Bromley-by-Bow (list 8.19) and Minster – Ebbs Fleet Farm (list 9.9) examples, the intentional arrangements had been secured by hammering the sockets (Fig 3).

Since so many blocked axes are part of larger deposits, it has been suggested that poorly documented single finds, eg Boyton (list 5.2), should be considered as remains of

[18] Roska 1942, 50 no. 202
[19] Rusu *et al* 1977, R 67b.18
[20] eg König 2004, 36, fig 5
[21] Pulszky 1884, 22–5
[22] Hansen 1996–98, 21 no. 32–8
[23] Maraszek 2006, 274 note 490
[24] www.finds.org.uk (16 May 2016)
[25] A Gwilt pers comm



Fig 4 Socketed axe blocked with gold lock-rings from North Cove (© Portable Antiquities Scheme, Record ID: SF-BDA986)

such. However, some are most likely not to have been associated with other bronzes, especially those that contained gold artefacts (Fig 4), such as Llanarmon-yn-Iâl (list 5.8) and Michaelston-super-Ely (list 5.10) in Wales. In addition, the specimen from Rossett (list 7.13) was only accompanied by a tanged knife. Considering the general abundance of Late Bronze Age gold artefacts from Ireland, it is rather unsurprising that two of the four blocked axes known from there (list 5.7 and 5.14) also fall into this group. A further find from Cornwall (list 8.18) adds to this westerly distribution. The recent discovery from North Cove in Suffolk (Fig 4, list 5.11) illustrates that a comparable treatment of gold ornaments was also known in eastern Britain. In most cases the ornaments were bent and / or broken to fit into the socket.

The combination of base and precious metals leaves claims that the fragmentation served to facilitate recycling untenable. Since the axes containing gold ornaments in their sockets do not show any signs of deliberate destruction, they were evidently used as resistant containers for valuables. In the case of Killersherdiny (list 5.7) the mouth of the axe is said to have been carefully covered by textile. On the other hand, because of their damaged state it can be considered unlikely that the ornaments were just hidden in a time of threat. Therefore, the most convincing explanation is that their destruction and concealment constituted a ritual act. It appears feasible to regard these combinations as personal offerings,[26] and we can also ask whether they became integrated into larger deposits in the course of a communally celebrated abandonment.

Single axes with blocked sockets are all intact and only sometimes show minor damages like nicked blade edges. The same is true for pure axe hoards with the exception of the specimen from Runhall (list 6.5), which was found by metal-detectorists and may once belonged to a much larger deposit with complex composition. While single axes were rendered useless with many different kinds of artefacts (Table 3), those from Group 2 only show parts of other axes and pieces of raw metal (Table 4). Despite numerous unidentified cases, all other depositional categories comprise a much larger variety of items wedged into the sockets. In accordance with the general trend towards fragmentation, the amount of forcefully destroyed and reduced axes increases with the overall size of the hoards, though some remain comparatively undamaged even in large discoveries like Burnham-on-Crouch (list 9.2), Eaton (list 9.4) and Leigh II (list 9.7).

An effective blocking was usually achieved with only one or two artefacts. Nevertheless, depending on their individual dimensions, many more items were employed at times. For example, the single-axe from Fincham (list 5.5) held the fragments of a lower axe blade, sheet-metal and casting sprues, and the specimen from the medium-sized hoard of Breage I (list 8.11) those of an upper sword blade, a hogs-back knife, another socketed implement and a torc or bracelet. Similar multifarious arrangements are known from Borstal (list 8.9), Ludham (list 8.20) and Monkton (8.23). Most frequently, axes were filled with fragments of other axes (Tables 3–7). This implies the incorporation of the Early and Middle Bronze Age tradition of axe depositions into larger hoards towards the end of this period. It is only in the case of gold artefacts, which are always inserted into the sockets, that a set of personal ornaments may be recognized.

These observations shed new light on the assessment of large deposits and the notion of fragmentation. The paradigm of interpreting broken bronzes as an indication of a hidden founder's cache goes back to Ernest Chantre[27] and was subsequently introduced into Anglophone archaeology by Sir John Evans.[28] It still figures prominently, for instance in the entries of the Portable Antiquities Scheme, and rarely is called into question, despite high rates of failed recovery casting doubt on this explanation. Many prehistoric metal artefacts are now recorded in the database of

[26] Hansen 1996–98, 19; *idem* 2016, 186

[27] Chantre 1875–76, 68

[28] Evans 1881, 456–9



Fig 5 Socketed axes blocked with pieces of rough metal (top and bottom) and the mouth fragment of another axe (centre) from the hoard of Meldreth (socket details not to scale) (author's photograph; © Trustees of the British Museum London, reg-nos 1880,1124.1, 1880,1124.10 and 1880,1124.15)

the Portable Antiquities Scheme, but research on the immediate find spots remains a desideratum. Regional case studies by David Yates and Richard Bradley revealed that metalwork deposition was carried out in places intimately connected with different kinds watery environments and not within or close to settlements.[29] Where detailed information is available, further signs of ritual activities, such as burnt mounds, can often be identified. Taken in conjunction, these elements clearly favour a cultic explanation. Tools, ornaments, weapons etc were given up at meaningful locations, and these acts of abandonment in our view both constituted social space and contributed to the creation of a ritual landscape.[30]

When considering that some widely available categories of artefact, particularly sickles, are absent from such combinations, it becomes obvious that a process of careful selection underpins the composition also of large and heterogeneous metal deposits. The blocking of axes was also subject to the same process. If these combinations were established for recycling bronze, it has to be asked why the majority of specimens remain exempt from this treatment. The same practice accounts for the related phenomenon of deliberately filling socketed axes with lead. Four cases are known to the authors: Borstal (list 8.9), Crundale (list 9.3), Ellesborough (list 7.5) and Northampton (list 8.24). The hoard from Crundale (list 9.3) illustrates very well the selective treatment of the artefacts, as only one of the fifty-seven socketed axes and one of the 16 spearheads, none of the gouges, but one of the two socketed knives were blocked by different fragments. Two further axes may originally have held lead.

The occurrence of implements with blocked sockets does not only respond to regional and structural, but also chronological patterns of hoarding. The earliest specimen known so far formed part of the large seabed find from Langdon Bay (list 10.1). Most likely the cargo of a capsized boat, the assemblage dates to the thirteenth century BC (Penard phase). All other axes from Britain and Ireland listed in the appendices are significantly later and date to the Ewart Park phase, ie the beginning of the first millennium BC. The quantity of artefacts recovered at Langdon Bay is unrivalled by any contemporary find in Britain. Only with the occurrence of large Late Bronze Age dryland hoards of miscellaneous artefacts do blocked implements again appear in the archaeological record.

Our knowledge of the phenomenon thus depends on intentional deposition of such combinations being practised, and merely by accident was a much longer tradition revealed at Langdon Bay. An earlier manifestation of this tradition also become apparent when taking into consideration Middle Bronze Age axe types as well as non-metal artefacts. Hansen has already called attention to a palstave from Colchester, Essex, with an amber bead jammed into its septum floor.[31] In the hoard from Swalecliffe (list 8.29) a peculiar red stone, probably a fragment of iron ore, was wedged between the wings of a fragmented axe. A further winged axe with a copper alloy tube pushed down into one flange had been found while diving in Poole Harbour, Dorset.[32]

Like in the Carpathian Basin, in Britain the practice of making tools un-useable by blocking or manipulating important functional parts goes back at least to the Middle Bronze Age. There thus is no reason to speculate about possible modes through which this phenomenon may have spread from eastern to western Europe. Rather, in both areas the blocking of implements evolved from a general, transcontinental trend towards fragmentation in metal assemblages and from the integration of smaller, personal dedications into large deposits. Further examples for a physical combination of artefacts are rare in Britain. The authen-

[29] Yates and Bradley 2010a; *iidem* 2010b

[30] Fontijn 2001–02; Hansen 2008

[31] Hansen 1996–98, 15; Davies 1968

[32] Knight *et al* 2015, 48 no. 216

Find spot	Axe	Bracelet	Gold artefact	Ingot/rough metal	Knife/dagger	Pin	Saw	Sheet metal	Sickle	Unidentified	Other
Bakóca									x		
Breaza								x			
Cenad										x	
Lăţunaş		x		x							
Napkor			x								
Nou Săsesc										x	
Pamuk											wire
Rozavlea III										x	
Zlatna III		x									

Table 1 Small and medium-sized hoards in the Carpathian Basin (less than 100 artefacts); italics indicate assemblages with heavily damaged and fragmented axes

ticity of the combination of a socketed axe from Tadcaster in West Yorkshire with a ring carrying a jet bead passed through its loop was doubted by Evans.[33] However, a peculiar decoration found on the side of some axes appears to imitate such an arrangement, ie a ring which runs through the loop. With the end of Bronze Age hoarding customs, blocked axes also disappear from the archaeological record, but comparable practices are once again attested in the British Late Iron Age, eg in the case of the hoards from Snettisham in Norfolk.[34]

Conclusion

Hansen intended his paper as a stimulus for future research, which he assumed would reveal further cases of deliberately blocked axes.[35] On the basis of the evidence outlined in these pages, his prediction has proven true. Given the limited geographical scope of the present study and the likelihood that many such combinations were taken apart without being recorded, the below appendices certainly represent just a glimpse of the original phenomenon. During the thirteenth and twelfth centuries BC in the Carpathian Basin and during the tenth and ninth centuries BC in southern Britain, the appearance of blocked axes is connected to a phase of intensive hoarding of heavily fragmented items in large and heterogeneous assemblages. Such finds are commonly referred to as collections of scrap, and the destruction of the artefacts is seen as a step in the recycling process. However, the careful and structured blocking of these implements is hardly in accordance with a utilitarian, technical explanation.

In south-eastern as well as in north-western Europe only a minority of socketed artefacts had been subjected to the kind of treatment describe above. In both study areas, artefacts made of precious materials were inserted into axes. These arrangements are typical for single discoveries and smaller deposits, but never appear in large hoards with more than 100 items. Furthermore, several sockets held parts of ingots, raw metal and sheet metal. Fragments of personal ornaments (bracelets and pins) were employed more often in the Carpathian Basin, while those of weapons (spearheads and swords), characteristic components of Late Bronze Age hoards in Britain, are completely missing. The types of tools also differ. Saws and sickles dominate in eastern Europe, chisels and gouges in western Europe. In the Carpathian Basin, fragments of other axes were only identified in two cases, whereas in Britain these form the main category of blocking implement.

Earlier finds of axes with comparable treatment provide evidence for long-term traditions of deliberately rendering tools unusable by physically connecting them to other artefacts. Therefore, the idea of scrap or founder's hoards must be seriously questioned. The transformation of axes described above in our opinion is best understood as the result of ritual activities and ought to be seen as meaningful fragmentation, a practice widely attested in prehistory.[36]

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[33] Evans 1881, 118, 158; Schmidt and Burgess 1981, 222 no. 1354

[34] Joy 2016

[35] Hansen 1996–98, 18

[36] Chapman 2000; Brittain and Harris 2010; Hansen 2016

Find spot	Axe	Bracelet	Gold artefact	Ingot/rough metal	Knife/dagger	Pin	Saw	Sheet metal	Sickle	Unidentified	Other
Aiud (a)										x	
Aiud (b)											lead
Bogdan Vodă (a)		x									
Bogdan Vodă (b)										x	
Brâglez						x					
Cugir (a)								x			
Cugir (b)				x							
Debeli vrh											amber beads, tubes
Dipşa (a)				x		x		x			
Dipşa (b)				x							
Dipşa (c)											tin
Dolina				x							
Guşteriţa II (a)							x		x		
Guşteriţa II (b)				x							
Klenje		x			x						
Şpălnaca II							x		x		
Uioara de Sus (a)				x							
Uioara de Sus (b)		x									
Uioara de Sus (c)				x							
Uioara de Sus (d)				x		x					
Uioara de Sus (e)	x								x		
Uioara de Sus (f)				x							

Table 2 Large hoards in the Carpathian Basin (more than 100 artefacts); italics indicate assemblages with heavily damaged and fragmented axes

Appendices

* = axes blocked with gold artefacts
** = axes filled with lead or tin
BM = British Museum London registration number in the online database of the collection <www.britishmuseum.org{\SLASH}research{\SLASH}collection_online{\SLASH}search.aspx>
PAS = Portable Antiquities Scheme individual database number <https:{\SLASH}{\SLASH}finds.org.uk{\SLASH}database>

Axes with blocked sockets in the Carpathian Basin

List 1: Small hoards (less than 20 artefacts)

1.1 Breaza, judeţ Mureş, Romania
Illustration: Rezi 2011, 326, pl 2.6
References: unpublished

1.2 Lăţunaş, judeţ Timiş, Romania
Illustration: Petrescu-Dîmboviţa 1978, pl 120B
References: Petrescu-Dîmboviţa 1978, 122 no. 146; Hansen 1994, 584 RO199

List 2: Medium-sized hoards (20–100 artefacts)

2.1 Bakóca, Baranya megye, Hungary
Illustration: Mozsolics 1985, 87, pl 87.2
References: Mozsolics 1985, 88–90; Hansen 1994, 532 HU43

2.2 Cenad, judeţ Timiş, Romania
Illustration: Petrescu-Dîmboviţa 1978, pl 216B.1
References: Petrescu-Dîmboviţa 1978, 137 no. 194

2.3 Napkor-Piripucpuszta, Szabolcs-Szatmár-Bereg megye, Hungary*
Illustration: Kemenczei 1965–66, 15, fig 1 (axe not specified)
References: Kemenczei 1965–66; Mozsolics 1985, 158; Hansen 1994, 547 HU477

2.4 Nou Săsesc, judeţ Sibiu, Romania
Illustration: Müller 1858, pl II.9
References: Müller 1858, 343, find list no. 45

2.5 Pamuk, Somogy megye, Hungary
Illustration: Mozsolics 1985, 342, pl 104.17
References: Mozsolics 1985, 168–9; Hansen 1994, 549 HU537

2.6 Rozavlea III, judeţ Maramureş, Romania
Illustration: Kacsó and Mitrea 1976, 538, fig 1.15
References: Kacsó and Mitrea 1976; Hansen 1994, 588–9 RO312

2.7 Zlatna III, judeţ Alba, Romania
Illustration: Petrescu-Dîmboviţa 1978, pl 211A.6
References: Petrescu-Dîmboviţa 1978,135–6 no. 188; Hansen 1994, 594 RO454

List 3: Large hoards (more than 100 artefacts)

3.1 Aiud, judeţ Aiud, Romania** (2 axes)
Illustration: unpublished (Museum Aiud reg-nos 7855 and 7957**)
References: Hansen 1994, 576 RO4

3.2 Bogdan Vodă, judeţ Maramureş, Romania (2 axes)
Illustration: a) Motzoi-Chicideanu and Iuga 1995, 160, fig 2.11; b) Motzoi-Chicideanu and Iuga 1995, 160, fig 2.21
References: Hansen 1994, 578 RO45; Motzoi-Chicideanu and Iuga 1995

Find spot	Axe	Chisel	Gold artefact	Gouge	Ingot/rough metal	Knife/dagger	Sheet metal	Spear	Sword	Unidentified	Other
Booltiaghdine		x									razor
Boyton									x		
Burnham Thorpe								x			
Crevilly Valley		x		x							
Fincham	x						x				casting sprue
Helsby				x							
Killersherdiny			x								
Llanarmon-yn-Iâl			x								
Llancarfan 3	x										
Michaelston-super-Ely			x								
North Cove			x								
South Kyme III				x							
Sutton									x		
Co Wicklow			x								

Table 3 Single axes in Britain and Ireland

3.3 Brâglez, judeţ Sălaj, Romania
Illustration: Bejinariu 2007, 120, pl XIII.62
References: Bejinariu 2007

3.4 Cugir, judeţ Alba, Romania (2 axes)
Illustration: a) Petrescu-Dîmboviţa 1977, pl 134.15; b) Petrescu-Dîmboviţa 1977, pl 134.18
References: Ciugudean and Aldea 2005

3.5 Debeli vrh, občina Črnomelj, Slovenia
Illustration: Čerče and Šinkovec 1995, 293, pl 60.5, and 299, pl 65–66
References: Hansen 1994, 563 JU563; Čerče and Šinkovec 1995, 159–70 no. 8

3.6 Dipşa, judeţ Bistriţa-Năsăud, Romania** (3 axes)
Illustration: a) Ciugudean *et al* 2006, 86, pl XVIII.2**; b) Ciugudean *et al* 2006, 93, pl XV.2; c) Ciugudean *et al* 2006, 92, pl XIV.2
References: Hansen 1994, 581 RO581; Ciugudean *et al* 2006

3.7 Dolina, Brod-Posavina županija, Croatia
Illustration: Hansen 1996–98, 15, fig 5.4
References: Hansen 1994, 563 JU64

3.8 Guşteriţa II, judeţ Sibiu, Romania (2 axes)
Illustration: a) Petrescu-Dîmboviţa 1978, pl 105.38; b) Holste 1951, pl 24.20
References: Holste 1951, 14; Petrescu-Dîmboviţa 1978, 120–22 no. 141; Hansen 1994, 583 RO170

3.9 Klenje, Mačva, Serbia
Illustration: Hansen 1996–98, 16, fig 6.2
References: Hansen 1994, 565 JU126

3.10 Şpălnaca II, judeţ Alba, Romania
Illustration: this paper Fig 2.1 (Museum Aiud reg-no. 266)
References: Petrescu-Dîmboviţa 1978, 127–31 no. 177; Hansen 1994, 590–591 RO369

3.11 Uioara de Sus, judeţ Alba, Romania (6 axes)
Illustration: unpublished (Museum Cluj-Napoca reg-nos III 4928, III 4936, III 4962, III 5058, III 5183 and III 5238)
References: Petrescu-Dîmboviţa 1978, 132–5 no. 184; Hansen 1994, 593 RO425

List 4: Other contexts

4.1 Banat (find context unclear)
Illustration: unpublished (Museum Timişoara reg-no. 6141)
References: unpublished

4.2 Dridu, judeţ Ialomiţa, Romania (settlement find)
Illustration: Renţa 2008, 101, fig 67.8
References: Renţa 2008, 101

4.3 Moravia or Upper Hungary (find context unclear)
Illustration: Říhovský 1992, pl 52.762
References: Říhovský 1992, 209 no. 762

Axes with blocked sockets in Britain and Ireland

List 5: Single axes

5.1 Booltiaghdine, Co Clare, Ireland
Illustration: Eogan 1983, 237, pl 21D
References: Jockenhövel 1980, 76 no. 215; Eogan 1983, 65 no. 54; Eogan 2000, 217 H 9

5.2 Boyton, Suffolk, England
Illustration: Burgess 1979, 270, fig 15B
References: Burgess 1979; Huth 1997, 275 GB 20

5.3 Burnham Thorpe, Norfolk, England
Illustration: unpublished
References: Huth 1997, 243 GB 211; Maraszek 2006, 449 NR / 7

5.4 Crevilly Valley, Co Antrim, Ireland
Illustration: Eogan 1983, 234, pl 18D
References: Eogan 1983, 52 no. 37; Eogan 2000, 218 H 15

5.5 Fincham, Norfolk, England
Illustration: Maraszek 2006, 273, fig 136
References: Maraszek 2006, 462 ENG / NR51

5.6 Helsby, Cheshire, England
Illustration: Davey and Forster 1975, no. 121 / 122
References: Davey and Forster 1975, no. 121 / 122

5.7 Killersherdiny, Co Cavan, Ireland*
Illustration: unpublished (present whereabouts unknown)
References: Eogan 1983, 63–4 no. 53; Eogan 2000, 219 H 26

5.8 Llanarmon-yn-Iâl, Clwyd, Wales*
Illustration: Green 1983, 385, fig 13
References: Green 1983

Find spot	Axe	Chisel	Gold artefact	Gouge	Ingot/rough metal	Knife/dagger	Sheet metal	Spear	Sword	Unidentified	Other
Basildon (a)					x						
Basildon (b)					x						
Bottisham	x										
Chichester										x	
Colwinston (a)	x										
Colwinston (b)	x										
Colwinston (c)	x										
Runhall	x										
Stow cum Quy										x	
Tilshead – Figheldean Down (a)	x										
Tilshead (b)					x						
Tilshead (c)	x						x				

Table 4 Pure axe hoards in Britain

5.9 Llancarfan 3, Vale of Glamorgan, Wales*
Illustration: PAS: NMGW-14B441
References: PAS: NMGW-14B441

5.10 Michaelston-super-Ely, Vale of Glamorgan, Wales*
Illustration: Aldhouse-Green and Northover 1996, 224, fig 1
References: Aldhouse-Green and Northover 1996

5.11 North Cove, Suffolk, England*
Illustration: PAS: SF-BDA986; BM: 2014,8028.1–6
References: PAS: SF-BDA986; BM: 2014,8028.1–6

5.12 South Kyme III, Lincolnshire, England
Illustration: Davey 1973, 110, fig 36.349–50
References: Davey 1973, 97; Huth 1997, 242 GB 199; Maraszek 2006, 446 ENG / LI8 (South Kyme II)

5.13 Sutton, Herefordshire, England
Illustration: PAS: HESH-A81AA5
References: PAS: HESH-A81AA5

5.14 Co Wicklow, Ireland*
Illustration: Eogan 1983, 311, pl 95C
References: Eogan 1983, 174 no. 156; Eogan 2000, 219 H 40

List 6: Pure axe hoards

6.1 Basildon, Essex, England (2 axes)
Illustration: a) Brown 1986, 142, fig 2.1; b) Brown 1986, 142, fig 2.2
References: Brown 1986; Huth 1997, 234 GB 64; Maraszek 2006, 400–1 ENG / ES3

6.2 Bottisham, Cambridgeshire, England
Illustration: Maraszek 2006, 593, pl 4.7
References: Huth 1997, 231 GB 19; Maraszek 2006, 387–8 ENG / CA3

6.3 Chichester, West Sussex, England
Illustration: Maraszek 2006, 593, pl 4.4
References: Huth 1997, 249 GB 299; Maraszek 2006, 480 ENG / WS3

6.4 Colwinston, Vale of Glamorgan, Wales (3 axes)
Illustration: PAS: NMGW-CD2C58
References: PAS: NMGW-CD2C58

6.5 Runhall, South Norfolk, England
Illustration: PAS: NMS-7517F1
References: PAS: NMS-7517F1

6.6 Stow cum Quy, Cambridgeshire, England
Illustration: Maraszek 2006, 272, fig 135B, and 619, pl 30.2
References: Huth 1997, 232 GB 37; Maraszek 2006, 394 ENG / CA21

6.7 Tilshead – PlaceCo[eng]Figheldean DownWiltshire, Wiltshire, England (3 axes)
Illustration: a) Coombs 1979, 254, fig 14.1.3; BM: 1971,0702.1; b) Coombs 1979, 255, fig 14.2.9; c) Coombs 1979, 258, fig 14.3.11; BM: 1971,0702.11
References: Coombs 1979; Huth 1997, 275 GB 23; O'Connor 2007, 75 no. 12

List 7: Small hoards (less than 20 artefacts)

7.1 Azerley, North Yorkshire, England (2 axes)
Illustration: PAS: YORYM-15AAD
References: PAS: YORYM-15AAD

7.2 Barking I, Greater London, England
Illustration: Maraszek 2006, 620, pl 31.4
References: Huth 1997, 236 GB 106; Maraszek 2006, 417 ENG / GO1

7.3 Barling, Essex, England (3 axes)
Illustration: a) Crowe 2003, 3, fig 2.1; b) Crowe 2003, 3, fig 2.2; c) Crowe 2003, 3, fig 2.8
References: Crowe 2003, 1–7; Maraszek 2006, 416 ENG / ES 57

7.4 East Bergholt, Suffolk, England
Illustration: PAS: SF-48BA44
References: PAS: SF-48BA44

7.5 Ellesborough, Buckinghamshire, England**
Illustration: Farley 1979b, 147, fig 7.4
References: Farley 1979b; Maraszek 2006, 387 ENG / BU2; Davis 2015, 138 no. 917

7.6 Havering, Greater London, England
Illustration: unpublished (artefacts lost)
References: Huth 1997, 237 GB 116; Maraszek 2006, 420 ENG / GO11

7.7 Kingston-upon-Thames – Kingston Hill, Greater London, England
Illustration: Field and Needham 1986, 142, fig 6.49 / 63
References: Field and Needham 1986, 141–8; Huth 1997, 237 GB 120; Maraszek 2006, 421 ENG / GO15

Find spot	Axe	Chisel	Gold artefact	Gouge	Ingot/rough metal	Knife/dagger	Sheet metal	Spear	Sword	Unidentified	Other
Azerley (a)	x										
Azerley (b)	x										
Barking I					x						
Barling (a)										x	
Barling (b)										x	
Barling (c)										x	
East Bergholt										x	
Ellesborough											lead
Havering					x						
Kingston					x						
Leigh I (a)	x										
Leigh I (b)					x						
Leigh I (c)					x			x			
North West Norfolk											casting sprue
Rampside				x							
Reigate										x	
Roosecote (a)								x			rapier
Roosecote (b)		x									
Rossett			x								
Shoebury II									x		
Snettisham IV	x										
Tal y Garn 2								x			ferrules
Tuxford					x						

Table 5 Small hoards in Britain (less than 20 artefacts); italics indicate assemblages with heavily damaged and fragmented axes

7.8 Leigh I, Essex, England (3 axes)
Illustration: a) Davies 1979, 160, fig 8.6.2; b) Davies 1979, 160, fig 8.6.3; c) Davies 1979, 160, fig 8.6.4
References: Davies 1979, 159–61; Huth 1997, 235 GB 85; Maraszek 2006, 407 ENG / ES24; Turner 2010, vol 2, 54–5 cat-no. 04; Davis 2015, 172 no. 1235

7.9 North West Norfolk, Norfolk, England
Illustration: PAS: NMS-37F7D3
References: PAS: NMS-37F7D3

7.10 Rampside, Cumbria, England
Illustration: PAS: LANCUM-428850
References: PAS: LANCUM-428850

7.11 Reigate – Priory Park, Surrey, England (finds from 1989)
Illustration: Maraszek 2006, 79, fig 36, and 272, fig 135A
References: Maraszek 2006, 477 ENG / SR11; Davis 2015, 199 no. 1437

7.12 Roosecote (Rampside II), Cumbria, England (2 axes)
Illustration: PAS: LANCUM-4118A0
References: PAS: LANCUM-4118A0

7.13 Rossett – Trevalyn Farm, Clwyd, Wales*
Illustration: Gwilt and Kucharski 2002, 19, fig 5; Gwilt *et al* 2005, 30, fig 2.2–6
References: Gwilt and Kucharski 2002; Gwilt *et al* 2005

7.14 Shoebury II, Essex, England
Illustration: Turner 2010, 271, fig 53.07 / 02
References: O'Connor 1980, 382 no. 151; Huth 1997, 235 GB 95; Maraszek 2006, 411 ENG / ES 35 (Shoebury III); Turner 2010, vol 2, 93–5 cat-no. 07; Davis 2015, 70 no. 243

7.15 Snettisham IV, Norfolk, England
Illustration: Coombs 1974, 32, fig 1.4
References: Coombs 1974; O'Connor 1980, 389 no. 161; Colquhoun and Burgess 1988, 122 no. 753; Huth 1997, 245 GB 242; Maraszek 2006, 458–9 ENG / NR38

7.16 Tal y Garn 2, Vale of Glamorgan, Wales
Illustration: PAS: NMGW-7EA628
References: PAS: NMGW-7EA628

7.17 Tuxford, Nottinghamshire, England
Illustration: PAS: PAS-1EB110
References: PAS: PAS-1EB110

List 8: Medium-sized hoards (20–100 artefacts)

8.1 All Hallows I – Little Coombe Farm, Kent, England (2 axes)
Illustration: a) Turner 2010, 284, fig 66.12 / 08; BM: 1894,0803.16; b) Turner 2010, 285, fig 67.12 / 11; BM: 1894,0803.19
References: Wickham 1877; Huth 1997, 241 GB 182 (St Mary Hoo); Maraszek 2006, 439–40 ENG / KE19 (St Mary Hoo); Turner 2010, vol 2, 114–20 cat-no. 12; Davis 2015, 70 no. 246

8.2 Aveley, Essex, England
Illustration: unpublished
References: Colquhoun and Burgess 1988, 126; Huth 1997, 234 GB 63; Maraszek 2006, 399–400 ENG / ES2; Turner 2010, vol 2, 1–3 cat-no. 1

8.3 Aylesbury, Buckinghamshire, England
Illustration: Farley 1979a, 142, fig 6.3.10
References: Farley 1979a; Huth 1997, 230 GB14; Maraszek 2006, 386–7 ENG / BU1

8.4 Berwick-upon-Tweed, Northumberland, England
Illustration: Needham *et al* 2007, fig 35.4; PAS: NCL-9F9F92
References: Needham *et al* 2005–06; Needham *et al* 2007; PAS: NCL-9F9F92

Find spot	Axe	Chisel	Gold artefact	Gouge	Ingot / rough metal	Knife/dagger	Sheet metal	Spear	Sword	Unidentified	Other
All Hallows I (a)							x				
All Hallows I (b)	x										
Aveley										x	
Aylesbury					x						
Berwick				x							
Bexleyheath					x						
Blackwater (a)	x						x				
Blackwater (b)	x										
Blackwater (c)				x							
Blackwater (d)	x										
Bognor Regis (a)										x	
Bognor Regis (b)										x	
Bognor Regis (c)										x	
Bognor Regis (d)										x	
Bognor Regis (e)										x	
Bognor Regis (f)										x	
Boreham II	x										
Borstal (a)	x			x				x	x		
Borstal (b)		x				x			x	x	button
Borstal (c)	x				x					x	
Borstal (d)											lead
Borstal (e)											lead
Brantham										x	
Breage I						x			x	x	torc or bracelet
Cherry Burton	x										
Cornard (a)				x							
Cornard (b)					x						
Cowbridge (a)	x										
Cowbridge (b)								x	x		
Cowbridge (c)										x	
Egham						x	x				
Grantham										x	
Hatfield Broad Oak										x	
Lelant			x								
London IV (a)	x										
London IV (b)											twisted ring fragment
Ludham (a)	x							x			
Ludham (b)										x	
Ludham (c)										x	
Ludham (d)	x				x				x		
Marazion											casting jet
Meldreth (a)					x						
Meldreth (b)	x										
Meldreth (c)					x						
Monkton (a)						x		x			bracelet, ring, wire
Monkton (b)								x			
Monkton (c)	x										pin
Monkton (d)										x	
Monkton (e)	x						x		x		
Monkton (f)	x										
Monkton (g)							x				metal fitting
Monkton (h)							x				
Northampton (a)							x				lead
Northampton (b)											lead
Petworth	x										
St Nicholas	x										
Southchurch I (a)	x				x						
Southchurch I (b)					x						
Stockbury										x	
Swalecliffe										x	
Uttlesford (a)										x	
Uttlesford (b)										x	
Uttlesford (c)	x										
Wakering (a)										x	
Wakering (b)										x	
Wakering (c)										x	
Wakering (d)										x	
Wakering (e)										x	
Wakering (f)										x	

Table 6 Medium-sized hoards in Britain (20–100 artefacts); italics indicate assemblages with heavily damaged and fragmented axes

Find spot	Axe	Chisel	Gold artefact	Gouge	Ingot/rough metal	Knife	Sheet metal	Spear	Sword	Unidentified	Other
Boughton (a)										x	
Boughton (b)	x										
Burnham (a)										x	
Burnham (b)										x	
Burnham (c)	x										
Burnham (d)										x	
Burnham (e)										x	
Crundale (a)	x										
Crundale (b)											lead
Crundale (c)											lead
Eaton (a)										x	
Eaton (b)											razor
Eaton (c)											razor
Eaton (d)										x	
Eaton (e)	x										
Eaton (f)				x						x	
Grays Thurrock (a)	x										
Grays Thurrock (b)	x										
Hoo St Werburgh											razor
Leigh II (a)	x				x						
Leigh II (b)					x						
Leigh II (c)					x						
Leigh II (d)					x						
Levington										x	
Levington										x	
Minster	x										

Table 7 Large hoards in Britain (more than 100 artefacts); italics indicate assemblages with heavily damaged and fragmented axes

8.5 Bexleyheath, Greater London, England
Illustration: Turner 2010, 297, fig 79.15 / 37
References: Tester 1957; Britton 1960, GB.53; Colquhoun and Burgess 1988, 73 no. 311; Huth 1997, 236 GB 108; Maraszek 2006, 417–8 ENG / GO3; Turner 2010, vol 2, 126–39 cat-no. 15; Davis 2015, 144 no. 975

8.6 Blackwater, Essex, England (4 axes)
Illustration: PAS: ESS-F8865B
References: PAS: ESS-F8865B

8.7 Bognor Regis, West Sussex, England (6 axes)
Illustration: a) Maraszek 2006, 604, pl 15.9; b) Maraszek 2006, 604, pl 15.10; c) Maraszek 2006, 605, pl 16.6; d) Maraszek 2006, 605, pl 16.10; e) Maraszek 2006, 605, pl 16.11; f) Maraszek 2006, 606, pl 17.5
References: Huth 1997, 248 GB 297; Maraszek 2006, 478 ENG / WS1

8.8 Boreham II, Essex, England
Illustration: Buckley *et al* 1986, 252, fig 4.7
References: Buckley *et al* 1986, 248–56; Huth 1997, 234 GB 67; Maraszek, 2006, 401–2 ENG / ES6

8.9 Borstal, Kent, England** (5 axes)
Illustration: a) Turner 2010, 304, fig 86.16 / 04; b) Turner 2010, 304, fig 86.16 / 05; c) Turner 2010, 304, fig 86.16 / 06; d) Turner 2010, 305, fig 87.16 / 11**; e) Turner 2010, 305, fig 87.16 / 14**
References: Huth 1997, 240 GB 165; Maraszek 2006, 435 ENG / KE5; Turner 2010, vol 2, 139–49 cat-no. 16; Davis 2015, 69 no. 238

8.10 Brantham, Suffolk, England
Illustration: unpublished
References: Colquhoun and Burgess 1988, 127; Huth 1997, 247 GB 267 (East Bergholt); Maraszek 2006, 468 ENG / SU8 (East Bergholt II)

8.11 Breage I, Cornwall, England
Illustration: Treasure Annual Report 2004, 234, fig 20.1
References: Worrell 2004a; Knight *et al* 2015, 29 no. 5

8.12 Cherry Burton, East Riding of Yorkshire, England
Illustration: PAS: YORYM-958D05
References: PAS: YORYM-958D05

8.13 Cornard, Suffolk, England (2 axes)
Illustration: Treasure Annual Report 2005–06, 297, fig 66.2
References: Worrell *et al* 2005–06; PAS: SF-C5C244

8.14 Cowbridge, Vale of Glamorgan, Wales (3 axes)
Illustration: unpublished
References: Davis 2015, 127 no. 804

8.15 Egham – Petters Sports Field, Surrey, England
Illustration: Needham 1990, 37, fig 6.44
References: Needham 1990; Huth 1997, 248 GB 292; Maraszek 2006, 477 ENG / SR6; Gerloff 2010, 88–9 no. 22; Davis 2015, 138 no. 916

8.16 Grantham, Lincolnshire, England
Illustration: Maraszek 2006, 654–5, pl 65 and 66 (axe not specified)
References: Maraszek 2006, 583–8

8.17 Hatfield Broad Oak, Essex, England
Illustration: Davies 1979, 155, fig 8.4.24
References: Davies 1979, 149–59; Huth 1997, 235 GB 82; Maraszek 2006, 406–7 ENG / ES21; Gerloff 2010, 259–60 no. 116; Davis 2015, 138 no. 912

8.18 Lelant, Cornwall, England*
Illustration: unpublished (artefacts lost)
References: Pearce 1983, 413–4 no. 82; Colquhoun and Burgess 1988, 128; Maraszek 2006, 395–6 ENG / CO1

8.19 London IV – Bromley-by-Bow, Greater London, England (2 axes)
Illustration: a) Maraszek 2006, 615, pl 26.9; b) Maraszek 2006, 614, pl 25.13
References: Colquhoun and Burgess 1988, 75 no. 324; Huth 1997, 238 GB 128; Maraszek 2006, 422 ENG / GO19; Davis 2015, 69 no. 237

8.20 Ludham, Norfolk, England (4 axes)
Illustration: unpublished
References: Rogerson *et al* 2008; Davis 2015, 138–9 no. 921; PAS: NMS-EE8264

8.21 Marazion – St Michael's Mound, Cornwall, England
Illustration: PAS: CORN-A8B9A0
References: Knight *et al* 2015, 34 no. 43; PAS: CORN-A8B9A0

8.22 Meldreth, Cambridgeshire, England (3 axes)
Illustration: a) Hawkes and Smith 1955, GB.13.15; BM: 1880,1124.1; b) Hawkes and Smith 1955, GB.13.31; BM: 1880,1124.10; c) Hawkes and Smith 1955, GB.13.33; BM: 1880,1124.15
References: Hawkes and Smith 1955, GB.13; Colquhoun and Burgess 1988, 81–2 no. 404; Huth 1997, 232 GB 34; Maraszek 2006, 392–3 ENG / CA18; Gerloff 2010, 174–5 no. 129; Davis 2015, 121 no. 754

8.23 Monkton – Monkton Court Farm, Kent, England (8 axes)
Illustration: a) Perkins 1991, 254, fig 3.2.15; b) Perkins 1991, 254, fig 3.2.16; c) Perkins 1991, 254, fig 3.2.17; d) Perkins 1991, 254, fig 3.2.18; e) Perkins 1991, 254, fig 3.2.21; f) Perkins 1991, 255, fig 3.3.22; g) Perkins 1991, 255, fig 3.3.23; h) Perkins 1991, 255, fig 3.3.26
References: Perkins 1991

8.24 Northampton, Northamptonshire, England** (2 axes)
Illustration: a) Treasure Annual Report 2004, 240, fig 29.3; b) Treasure Annual Report 2004, 240, fig 29.3
References: Worrell 2004b; Davis 2015, 70 no. 242; PAS: NARC-77BD13

8.25 Petworth, West Sussex, England
Illustration: PAS: SUSS-71C472
References: PAS: SUSS-71C472

8.26 St Nicholas, Vale of Glamorgan, Wales
Illustration: unpublished
References: A Gwilt pers comm (National Museum of Wales Cardiff)

8.27 Southchurch I, Essex, England (2 axes)
Illustration: a) Davies 1979, 167, fig 8.9.2; b) Davies 1979, 167, fig 8.9.6
References: Davies 1979, 166–71; O'Connor 1980, 382–3 no. 152; Colquhoun and Burgess 1988, 127; Huth 1997, 236 GB 97; Maraszek 2006, 411 ENG / ES36; Turner 2010, vol 2, 97–107 cat-no. 09; Davis 2015, 152 no. 1071

8.28 Stockbury, West Sussex, England
Illustration: PAS: KENT-916575
References: PAS: KENT-916575

8.29 Swalecliffe, Kent, England
Illustration: Turner 2010, 351, fig 133.23 / 09
References: Colquhoun and Burgess 1988, 126; Huth 1997, 241 GB 183; Maraszek 2006, 441–2 ENG / KE22; Turner 2010, vol 2, 211–18 cat-no. 23 (Whitstable); Davis 2015, 172 no. 1234

8.30 Uttlesford, Essex, England (3 axes)
Illustration: PAS: BM-961CF1 + ESS-C60114
References: PAS: BM-961CF1 + ESS-C60114

8.31 Wakering, Essex, England
Illustration: Crowe 2003, 6, fig 3.14–15, and 9, fig 4.16–22
References: Crowe 2003, 7–15; Maraszek 2006, 415–6 ENG / ES55

List 9: Large hoards (more than 100 artefacts)

9.1 Boughton Malherbe, Kent, England (2 axes)
Illustration: a) Adams 2017, 46, fig 4.176; b) Adams 2017, 46, fig 4.177
References: Davis 2015, 69 no. 236; Adams 2017; PAS: KENT-15A293

9.2 Burnham-on-Crouch, Essex, England (5 axes)
Illustration: a) PAS: ESS-35C4C4; b) PAS: ESS-B76C15; c) PAS: ESS-B77B12; d) PAS: ESS-B800F7; e) PAS: ESS-BE9E44
References: McLean and White 2011; PAS: ESS-8822A3

9.3 Crundale, Kent, England (3 axes)
Illustration: unpublished
References: Worrell 2003; PAS: KENT-7C3863

9.4 Eaton, Norfolk, England (6 axes)
Illustration: unpublished
References: West 2005–06; Davis 2015, 129 no. 806 (Eaton 2)

9.5 Grays Thurrock, Essex, England (2 axes)
Illustration: a) Turner 2010, 224, fig 6.02 / 37; b) Turner 2010, 225, fig 7.02 / 47
References: Butcher 1922; O'Connor 1980, 380–1 no. 148; Colquhoun and Burgess 1988, 77–8 no. 352.353; Huth 1997, 234 GB 78; Maraszek 2006, 404 ENG / ES 15 and ENG / ES16 (Grays I and II); Turner 2010, vol 2, 3–52 cat-no. 02; Davis 2015, 70 no. 244

9.6 Hoo St Werburgh, Kent, England
Illustration: unpublished
References: Jockenhövel 1980, 66–7 no. 188.188A; Colquhoun and Burgess 1988, 77 no. 351; Huth 1997, 241 GB 173; Maraszek 2006, 436 ENG / KE11

9.7 Leigh II, Essex, England (4 axes)
Illustration: a) Turner 2010, 250, fig 32.05 / 06; b) Turner 2010, 250, fig 32.05 / 09; c) Turner 2010, 250, fig 32.05 / 11; d) Turner 2010, 250, fig 32.05 / 12
References: O'Connor 1980, 381–2 no. 150; Colquhoun and Burgess 1988, 77 no. 350; Huth 1997, 235 GB 86; Maraszek 2006, 408–9 ENG / ES25; Turner 2010, vol 2, 55–88 cat-no. 05

9.8 Levington, Suffolk, England (2 axes)
Illustration: unpublished
References: Colquhoun and Burgess 1988, 82 no. 405.406; Huth 1997, 247 GB 278; Maraszek 2006, 470–1 ENG / SU19; Davis 2015, 65 no. 202

9.9 Minster – Ebbs Fleet Farm, Kent, England
Illustration: Turner 2010, 327, fig 109.20 / 37
References: Payne 1893; Colquhoun and Burgess 1988, 75 no. 332–335; Huth 1997, 241 GB 175; Maraszek 2006, 437–8 ENG / KE13; Turner 2010, vol 2, 170–99 cat-no. 20; Davis 2015, 133 no. 860

List 10: Other contexts

10.1 Langdon Bay, Kent, England (seabed find)
Illustration: Needham *et al* 2013, 70, fig 3.11.119
References: O'Connor 1980, 355–6 no. 108; Needham *et al* 2013; Davis 2015, 47 no. 7

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The Baltinglass hillfort cluster in the context of the Irish hillfort phenomenon: an initial view

James O'Driscoll

This paper explores the hillfort phenomenon in Ireland in relation to an important cluster of these monuments in the Baltinglass area of Co Wicklow. A brief review of this monument type confirms that many Irish hillforts were constructed in the Late Bronze Age. The construction of a hillfort probably reflected a need to communicate authority and ownership of the surrounding landscape, although it is clear that hillforts had a variety of different functions. This is evident in the morphology and landscape setting of these monuments, as well as in the survey and excavation record. The size, complexity and clustering of the Baltinglass hillforts sets them apart in an Irish context and indicates that the area was a place of exceptional importance in prehistory.

Hillforts and their interpretations – some current views from Britain and Ireland reconsidered

The term 'hillfort' is perhaps a misnomer, attributed to a category of monuments that can vary considerably in morphology, landscape setting, chronology and function. First introduced by Hawkes in 1931, the term is now used loosely to describe a wide variety of hilltop sites that are surrounded and enclosed by banks, walls, palisades, fences and ditches, with little regard to function or place in prehistoric or later society.[1] The term suggests a distinct and pervasive need for defence. This has been perpetuated by researchers such as Hogg, who defines a hillfort as 'an enclosure, apparently *fortified*, and so placed as to gain some *defensive* advantage from its position'.[2] Similarly, Avery describes these sites as '*fortified* so as to be *defensible against human attack* … [and which] exploits the natural terrain so as to give the *defenders* an advantage of height over those approaching the site'.[3] In a later publication he suggested that 'all hillforts are connected by the fact that each was in one way or another used for *defence* of the community which built it'.[4] Similarly, Barry Raftery, one of the seminal researchers in Ireland, considered hillforts as 'hilltop enclosure[s] of considerable size and strength, which deliberately exploit the natural properties of the situation for *defensive* purposes'.[5] Recently, Grogan has defined Irish hillforts as 'large hilltop sites that take advantage of the natural *defensive* properties of the topography'.[6] Today, the use of the term 'hillfort' is viewed as an oversimplification, but in the absence of a useful alternative, it continues to be widely used by archaeologists.[7]

The militaristic connotations have been challenged in recent years.[8] A post-processual backlash has downplayed the defensive role of hillforts, without providing a definition that adequately encompasses new interpretations.[9] Harding concluded that the term 'hillfort' is problematic and sees it as one of convenience.[10] He instead suggests that the act of 'enclosure' is the key element, both physically and conceptually demarcating an area to which access is restricted or controlled. This is achieved by the construction of a rampart and ditch, stockade or fence and by the incorporation of topographical and natural features such as cliff edges. The scale of the enclosing works may range from a relatively modest barrier to massive earthworks. These enclosing elements may be located around hilltop contours, or on cliff edges, ridges or promontories, spurs, hill slopes, in river bends, or across variable terrain. The enclosed area may range from under one hectare to 20ha and more, with the *territorial* or *terrain oppida* of the late pre-Roman Iron Age approximately 300ha in size.[11] This broad definition can have regional interpretations, such as in Ireland, where coastal and inland promontory forts (viewed as a sub-set of the 'hillfort' class in Britain) are a distinct monument type attributed their own cultural and chronological horizons. This is primarily due to the dating of the coastal examples. Nine examples have been dated to the Early Medieval period, although a single Late Bronze Age date was recovered from Dunbeg in Co Kerry, possibly indicating an early attempt at delimiting the promontory.

There are approximately 100 hillforts in Ireland (Fig 1). The Irish definition distinctly refers to monuments on or near hilltops, cliff edges and spurs and generally does not include enclosures outside this remit. This contrasts with the situation in Britain, where hillforts are not restricted topographically to hills.[12] Irish hillforts are often identified by their size. One definition places them over 1ha in internal area, with smaller examples classified as 'hilltop enclosures'.[13] Irish hilltop enclosures are defined as strongly defended enclosures at the summit of hills which enclose an area of under 1ha. Grogan[14] has listed over 200 examples of this site type, although a large number can be more accurately classed as Early Medieval ringforts. There are approximately 70 sites which can be termed 'hilltop enclosures' and only one of these has been excavated: Clenagh, Co Clare.

[1] Brown 2009, 7
[2] Hogg 1975, 15
[3] Avery 1976, 2
[4] *idem* 1993, 1
[5] Raftery 1994, 38
[6] Grogan 2005b, 111
[7] Harding 2004
[8] Brown 2009, 7; Harding 2012, 1
[9] cf Armit 2007
[10] Harding 2012, 1–5
[11] *ibid*
[12] *ibid*, 4
[13] Grogan 2005b, 111
[14] *ibid*, 116–17

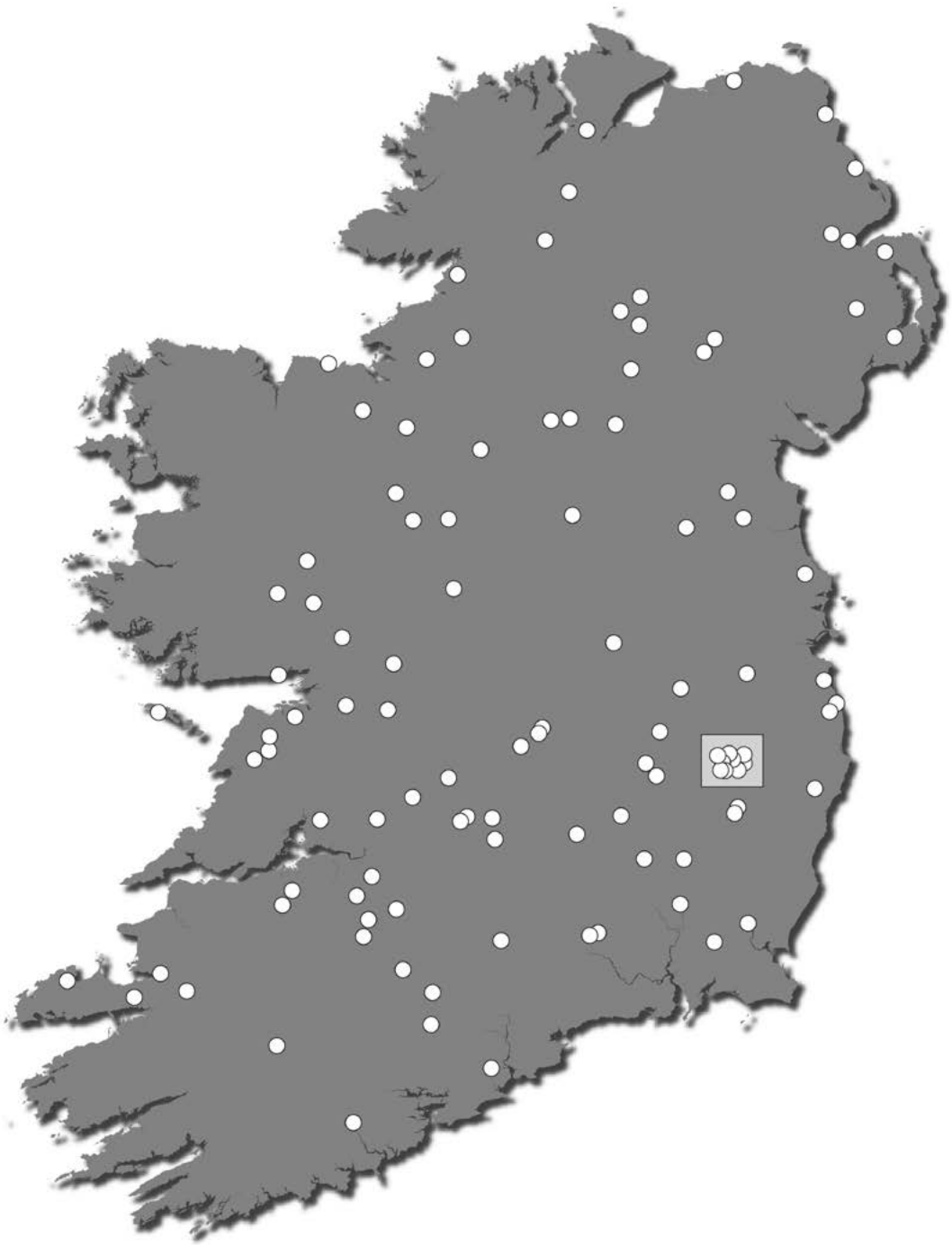


Fig 1 Distribution of Irish hillforts

Here, Grogan[15] did not recover any construction dates or artefacts that could date the occupation of the monument. These small hilltop sites are distinct from the British 'hilltop enclosure', which is usually larger than 15ha and dates to the Early Iron Age.[16]

A separate problem in Ireland is the large number of ringfort enclosures of Early Medieval date, many of which are sited on low hills or otherwise elevated ground. There are some 25,000 extant examples of this type of monument, with possibly many more destroyed. Recent developer-led excavations have highlighted the continued use of these monuments throughout the Early Medieval period and do not indicate earlier origins.[17] The dating and function of ringforts is therefore not as 'contentious' as Harding suggests.[18] More importantly, the archaeological evidence strongly suggests that ringforts are unlikely to be chronologically or culturally associated with hillforts, though there are examples where they occur at the same locations.

[15] Grogan 2005a, 247–53

[16] Cunliffe 2013, 300

[17] Clarke 2002; McConway 2002; Clarke and Carlin 2008; Kinsella 2008

[18] Harding 2012, 172

The term 'hillfort' tends to be more loosely applied in Britain than in Ireland. More than half of the total number of hillforts in Britain enclose an area under 1.2ha.[19] Halliday and Ralston note that the majority of the 1305 hillforts in Scotland are 'tiny enclosures'.[20] For Britain, Cunliffe proposes that that these small enclosures may legitimately be considered as a separate phenomenon.[21] The difference between hillforts and smaller enclosures cannot be seen as 'an issue of semantics'[22] with Brown highlighting many of the fundamental chronological distinctions.[23] To help distinguish between these site types, Sharples suggests that dominance over the landscape, as well as the monumentality of the monument should be considered.[24] However, Brown remains cautious of this approach, suggesting that substantial variations in these aspects can exist.[25]

The subjectivity surrounding the definition and terminology of hillforts also reflects the fact these monuments defy rigid classification. Coupled with this, the process of enclosure can have multiple connotations and purposes at different times and places.[26] This means that a 'hillfort' built in the Late Bronze Age might be constructed for a very different reason than one built in the Later Iron Age, yet the two might be morphologically comparable and have a similar landscape setting. In an Irish context, it is interesting that, despite the limitations of a classification system introduced by Raftery, the distinction between different hillfort types has some chronological basis. [27]

Irish hillforts

The study of hillforts in Ireland began with Thomas Westropp's surveys in the early twentieth century.[28] It was not until the 1970s that Barry Raftery conducted the first major synthesis on this subject, where he proposed the modern classification of hillfort types still in use today. Since this review, the number of identified hillforts in Ireland has almost doubled, with several important excavation and landscape studies having been undertaken.[29] Despite this, hillfort studies in Ireland have not advanced significantly, due in part to a lack of dating information and to problems of classification. In total, sixteen hillfort sites have been excavated in Ireland, with only five having more extensive investigations of their interiors. This has resulted in a poor understanding of the function and economy of these monuments and a tentative chronology. This contrasts with British hillfort studies, where numerous monuments have been subject to detailed excavations and multi-disciplinary studies. The lack of site information has pushed Irish researchers to rely heavily on data from British and continental studies, which has its limitations, given the often insular character of Irish hillforts.

An integrated study of Irish hillforts and their social context currently being undertaken by University College Cork, seeks to address many of these issues. The compilation of relevant material, including databases of hillfort, hilltop enclosures and contemporary weapons, together with geophysical survey and excavation of selected hillforts and GIS (Geographic Information Systems) analysis, is providing important data regarding the dating, topographical setting, form and function of these monuments.

Classification and morphology

Raftery proposed the first classification of Irish hillforts, dividing 40 known examples into three groups.[30] Class 1 hillforts comprised univallate sites such as Claragh hillfort, Co Cork. Class 2 sites were defined as widely-spaced, multivallate defences on (a) hill tops, including Toor More, Co Kilkenny, and (b) cliff tops such as Dún Aonghasa, Co Galway. The large majority of Irish multivallate hillforts have their enclosing elements widely spaced, at least 10m and up to 150m apart. In Britain, this form of hillfort is termed 'multiple enclosure'. Recent excavation in Ireland has confirmed that multiple enclosing elements were often contemporary, in contrast to the evidence in Britain, where the various enclosing elements represent different attempts at enclosure at different times. Class 3 included inland promontory forts such as Knockdhu, Co Antrim, and Caherconree, Co Kerry (Fig 2). Since Raftery's publication, the number of identified hillforts in Ireland has risen to approximately 100 examples, with an estimated 70 additional sites termed 'hilltop enclosures'.

Almost 55 per cent of Irish hillforts are univallate, 40 per cent multivallate, with the remainder consisting of inland promontory forts. There is no archaeological distinction between Class 1 and 2 hillforts other than the number of enclosing elements. Both classes are sited in similar topographical positions and height above sea level. Class 1 hillforts are sited on average at 167m OD and Class 2 at 178m OD. Only three hillforts are positioned above 410m OD. Cunliffe has suggested that warm, dry conditions *c* 1250–1000 BC, would have been conducive to the development of agricultural regimes, allowing settlement to extend into upland areas up to 400m OD.[31]

Grogan has concluded that elevation was not an overriding factor in location and suggests that extensive views over specific parts of the local landscape were more important.[32] It is certainly the case that most Irish hillforts have commanding views. Sixty-nine per cent of Class 1 hillforts have panoramic views (360°), with a further 20 per cent having extensive (approximately 270°) visibility of the surrounding landscape. Class 2 hillforts generally have more extensive viewsheds, approximately 80 per cent having panoramic views and 15 per cent have extensive visibility.

More notable differences become apparent when analysing the area enclosed, with Class 2 sites enclosing twice that (7.82ha on average) of Class 1 examples (3.64ha on average).

[19] *ibid*, 9
[20] Halliday and Ralston 2009, 467
[21] Cunliffe 1991, 312
[22] Harding 2004, 50
[23] Brown 2009, 12
[24] Sharples 2010, 61
[25] Brown 2009, 12
[26] *ibid*, 7; Harding 2004, 298; Halliday and Ralston 2009, 467
[27] Raftery 1972
[28] Westropp 1902; 1916–17
[29] Mallory 1995; Grogan 2005a; 2005b; Cotter 2012a; 2012b
[30] Raftery 1972, 39
[31] Cunliffe 2013, 253
[32] Grogan 2005b, 121



Fig 2 Caherconree inland promontory fort, Co Kerry

Approximately half of all univallate sites are under 2ha, in comparison to 16 per cent of multivallate sites. Half of the multivallate sites are over 5ha, in contrast to approximately 20 per cent of univallate sites. About 20 per cent of multivallate sites are over 10ha in size, compared to approximately 5 per cent of univallate examples. Grogan has proposed a revised classification of Irish hillforts that amalgamates Raftery's Class 1 and 2 and divides the combined monuments by size, Class 1 becoming hillforts under 5ha and Class 2 being represented by sites over 5ha.[33] The merits of this approach are unclear and it is obviously problematic at the lower end of the scale in relation to the status of hilltop enclosures.

There is no clear distributional separation between the separate classes. Class 1, 2 and 3 hillforts occur widely throughout Ireland. Gaps may occur in hillfort distribution where sites in agriculturally rich areas have been destroyed. A recently discovered hillfort, Rahally, Co Galway, is an excellent example. Situated at the summit of a low-rise hill, the large multivallate hillfort has been completely levelled and was discovered prior to the construction of the N6 Galway to East Ballinsloe road scheme. Hillforts mostly occur in isolation; however, there are a number of examples of pairs, such as the Friarstown group in Co Limerick, and Rathgall and the adjacent Knockeen hillforts in Co Wicklow. An exceptional group of up to nine hillforts is located in the western edge of the Wicklow Mountains, surrounding the town of Baltinglass.

Further classification of class 2(a) sites is possible. Over 55 per cent of this class could be categorized as having widely spaced enclosing elements, the separation between these always being over 55m, an excellent example being Ballylin hillfort, Co Limerick (Fig 3). About 30 per cent have more closely spaced enclosing features, separated by no more than 30m (on average 20m), such as Glanbane hillfort, Co Kerry (Fig 4). There are three sites that fit both categories: Hughstown, Co Kildare; Rathgall, Co Wicklow and Haughey's Fort, Co Armagh. The remainder of hillfort sites comprise closely spaced multivallation with no intervening gap between enclosing elements. Raftery has suggested that sites with little or no space between enclosing elements provided defence in depth, where those that are widely spaced offered space to regroup and fall back on inner ramparts.[34] Wailes suggests that the outer enclosures of a hillfort may have been a 'token' element of ritual or symbolic significance, while most would regard multivallation as a statement of power and status.[35]

[33] Grogan 2005b, 112

[34] Raftery 1994, 57–8

[35] Wailes 1982

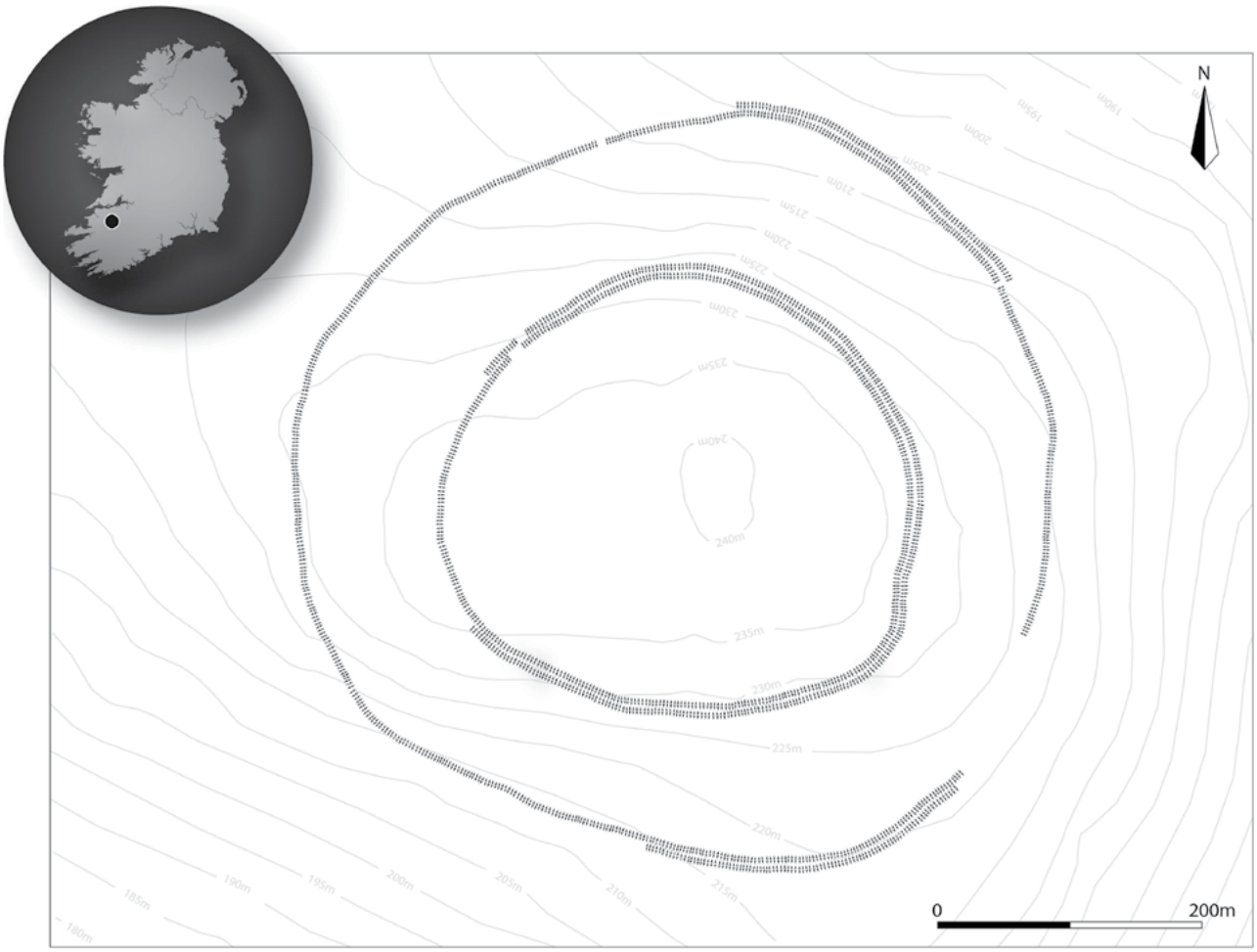


Fig 3 Ballylin hillfort, Co Limerick

Approximately 25 per cent of Irish hillforts have recorded cairns or mounds, with three examples containing megalithic tombs. The incorporation of earlier burial monuments may be a symbolic attempt to both venerate the past and legitimate power and control of the landscape. The perceived importance of these monuments is implied by the number of examples that survive. This is attested at Freestone Hill, where the hillfort builders carefully avoided an earlier cairn before Iron Age occupants destroyed it.[36] The enclosing elements of hillforts may also represent a definition of sacred space giving rise to a need to defend that space.[37]

Twenty six hillforts have surface evidence for settlement activity. Only seven of these sites have more than ten visible structures within their interiors. A small number of those have been excavated, making it difficult to prove that these hut sites are contemporary with the construction and occupation of the hillfort in question. Brown notes that the very presence of a hillfort on a prominent topographical feature would have been enough of a status enhancement not to warrant elaborate internal features and could explain the seeming 'absence of life' at some sites.[38] In some instances, the limited evidence for settlement might also be explained by seasonal, rather than permanent occupation and / or activity. The inaccessibility of certain hillforts did not preclude them from extensive settlement. For example, 600m to the east of Turlough hillfort, Co Galway, an extensive upland settlement comprising over 150 hut structures is positioned on the opposing summit of Oughtmama Mountain and is easily accessible from the hillfort. A smaller group of seven hut structures is visible at Caherconree, Co Kerry, an inaccessible inland promontory fort positioned on a western-facing spur of Gortaleen Mountain at 659m OD. Conversely, easily accessible hillforts such as Rahally, Co Galway, or Glanbane, Co Kerry, reveal limited settlement activity. This is despite over 50 per cent of the interior of Rahally being excavated and blanket geophysical survey of Glanbane hillfort.[39]

Chronology

In Britain, the term 'hillfort' has long been synonymous with the Iron Age, despite clear evidence for the construction of these sites during the Late Bronze Age.[40] Hillforts in Britain were built and occupied over a 2000 year period

[36] Raftery 1969, 7
[37] Finney 2006, 88–9
[38] Brown 2009, 195
[39] Mullins 2008; O'Driscoll 2012a
[40] Mytum 2013, 5

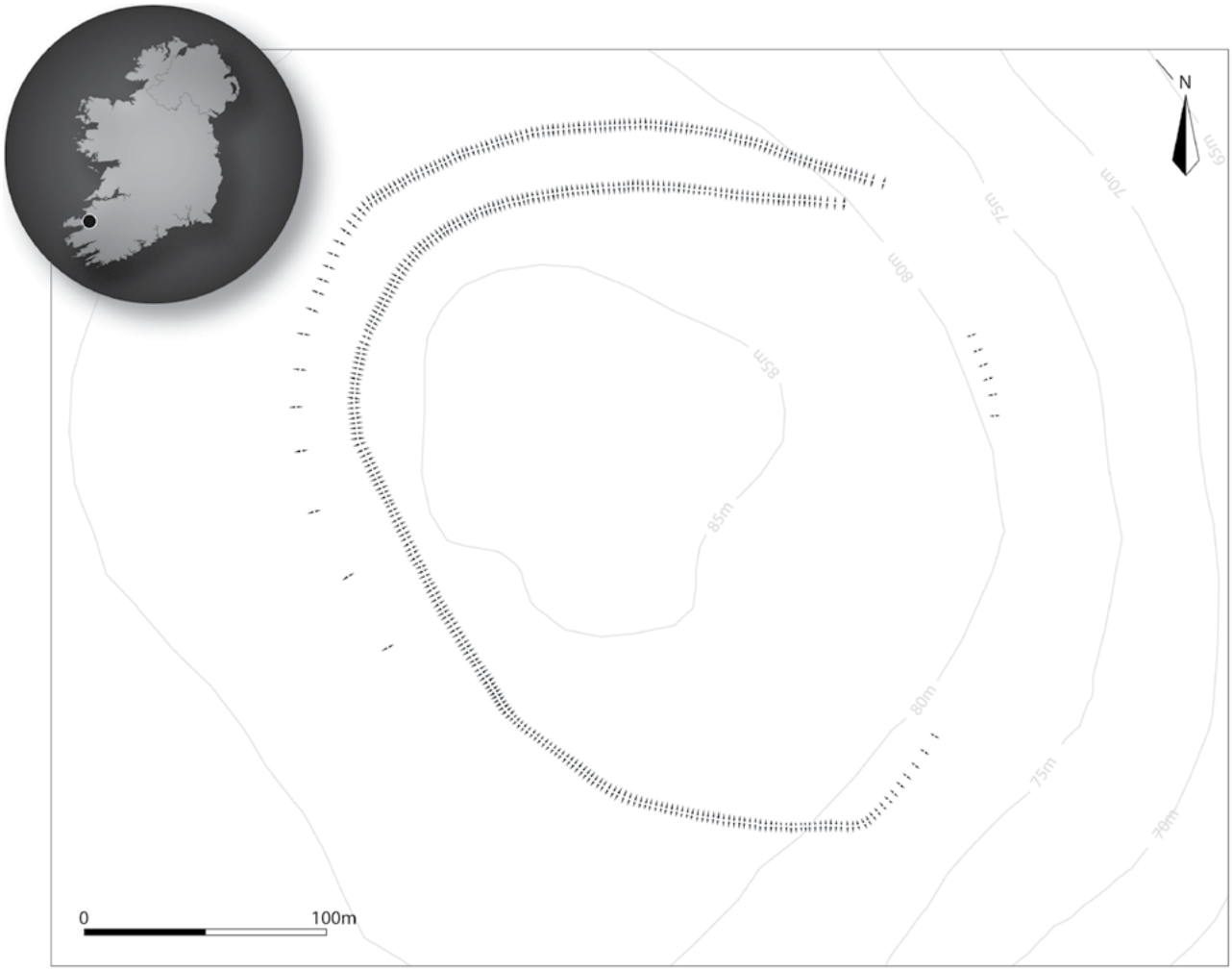


Fig 4 Glanbane hillfort, Co Kerry

between 1000 BC and 1000 AD, with a major construction horizon around the sixth and fifth centuries BC.[41] Due to a lack of excavation, early hillfort researchers in Ireland assumed that the date of these monuments coincided with a major phase of hillfort construction in Britain.[42] Current evidence, however, suggests that the majority of hillforts in Ireland date to the Late Bronze Age, *c* 1200–800 BC.

One could consider the large provincial royal enclosures of Tara, Co Meath; Dún Ailinne, Co Kildare; Rathcrogan, Co Roscommon and Navan Fort, Co Armagh, as hillforts. Three of these have been dated to the Iron Age. Dún Ailinne produced Iron Age material and an Iron Age radiocarbon date was returned from material recovered below the bank.[43] Roche has confirmed a later Iron Age date for the Ráith na Rí enclosure at Tara, with a similar enclosure built at Navan Fort around the first century BC.[44] The morphological layout of these enclosures is also somewhat distinct. Tara, Dún Ailinne and Navan Fort have substantial internal ditches, a deliberate feature that Warner has interpreted as a defence against the chaotic otherworld emanating from inside the enclosure.[45] The distinct morphological differences and the chronological gap between these enclosures and 'true' Irish hillforts may suggest that these cannot be considered as hillforts proper. 'Hillforts' with substantial internal ditches, such as Kedra, Co Tipperary, may therefore be more appropriately categorized with the Iron Age royal sites.

In Britain and on the Continent, the idea of enclosing hilltop sites is a recurring feature from the Neolithic period onwards. This is also the case in Ireland, where a small number of Neolithic enclosures including Donegore Hill, Co Antrim;[46] Lyles Hill, Co Antrim;[47] Magheraboy, Co Sligo,[48] and Tullahedy, Co Tipperary,[49] have been identified. Although these are not classified as 'hillforts', the commanding position of these sites is reminiscent of later hillforts, even though the gaps in the enclosing elements at Donegore and Magheraboy are more comparable to the British causewayed enclosures of the Early Neolithic. The Neolithic enclosures at Lyles Hill have only been partially invest-

[41] Harding 2012, 151; Cunliffe 2013, 304
[42] cf Raftery 1969; 1972
[43] Johnson and Wailes 2007; Wailes 1990, 20
[44] Mallory 2000; Roche 1999
[45] Warner 2000
[46] Mallory *et al* 2011
[47] Evans 1953; Simpson and Gibson 1989
[48] Danaher 2007
[49] Cleary and Kelleher 2011

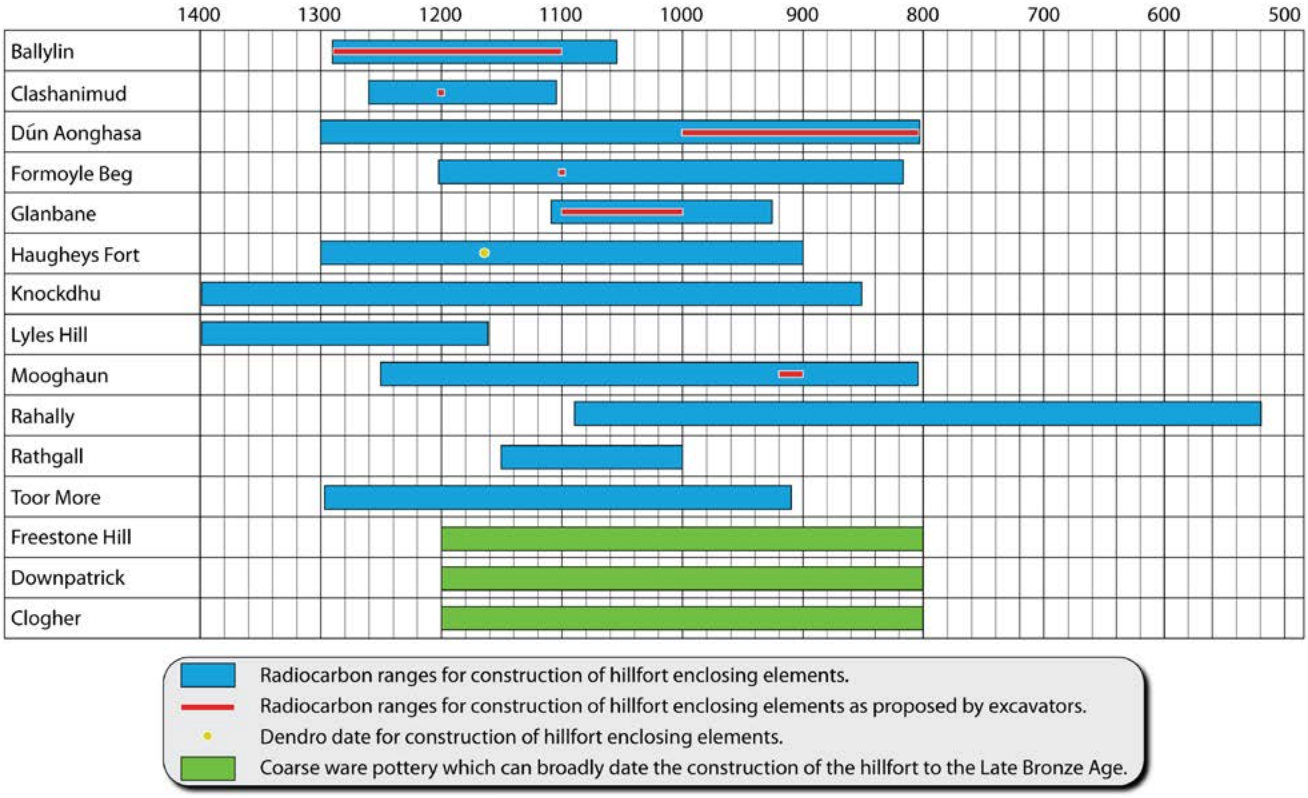


Fig 5 Dating evidence from Irish hillforts

igated and the excavators point out that the enclosures may be large hut structures as opposed to larger enclosing elements. At Tullahedy, the palisade enclosed the north-west and western section of the site and was protected on the south-eastern approach by a former glacial lake. The palisade would have enclosed an area less than 100m in diameter. Both sites are much smaller than typical Irish hillforts. Hill suggests that we need to see hillforts in terms of the specific manifestation of a long tradition of marking special places by enclosure.[50]

Earlier activity on hillfort sites is not uncommon. Excavation at Mooghaun, Co Clare;[51] Haughey's Fort, Co Armagh,[52] and Dún Aonghasa, Co Galway,[53] have provided limited evidence for activity as early as the Late Neolithic. This does not reflect continuous settlement, but rather a shared preference for commanding hilltop sites. For example, at Lyles Hill, Co Antrim, the site of a Neolithic palisaded enclosure was later used for a larger Late Bronze Age hillfort.[54] The presence of cairns within hillforts may also indicate earlier activity.

In central Europe, 'true' hillforts appear around 1300–1150 BC.[55] The increased mobility of people and commodities, partly driven by the prestige-goods economy of the Bronze Age[56] may have encouraged the spread of this monument form. Cunliffe argues that a significant increase in the volume of bronze in circulation after the beginning of the Late Bronze Age may be explained by the metal-rich Atlantic zone being increasingly drawn into the bronze-consuming world of the Urnfield and Nordic cultures.[57] As a result, the Atlantic communities developed new networks of communication and trade-routes to supply this demand and, in turn, absorbed aspects of Urnfield material culture. This fits neatly with the increasing amount of evidence in Ireland for a major hillfort construction horizon around the mid twelfth century BC.

A growing number of hillfort sites in Ireland can be securely dated to the Late Bronze Age (Fig 5; Table 1). These include the multivallate hillfort at Mooghaun hillfort, Co Clare. Grogan suggests that a series of broadly similar radiocarbon dates obtained from the three enclosing elements of the hillfort (ranging from 1255 to 813 BC) imply that they were likely constructed as a unit during the Late Bronze Age.[58]

Radiocarbon samples from the three ditches at Haughey's Fort, Co Armagh, have produced broadly contemporary results ranging from 1300 to 900 BC.[59] A dendro-date from a piece of waterlogged wood at the base of the inner ditch has more precisely dated the construction

[50] Hill 1995
[51] Grogan 2005a
[52] Mallory 1995
[53] Cotter 2012a; 2012b
[54] Gibson and Simpson 1987; Simpson and Gibson 1989; Cooney 2002, 71; Cleary and Kelleher 2011, 410–16
[55] Cunliffe 1997, 41–4; Ralston 2006, 17
[56] Henderson 2007, 57; Yates 2007; Earle 2002; Brück and Fontijn 2013, 202
[57] Cunliffe 1997, 148; see also O'Brien, this volume
[58] Grogan 2005a, 128
[59] Mallory 1995, 75

to 1166 BC.[60] Intensive activity within the interior is also dated to the Late Bronze Age.[61]

Radiocarbon dates from the basal fills of the three ditches of Rahally hillfort, Co Galway, suggest that the monument was constructed during the Late Bronze Age.[62] Interestingly, although a large portion of the hillfort was excavated, there was a distinct lack of artefacts and / or contemporary settlement evidence.

The famous cliff-top fort of Dún Aonghasa, on the Aran Island of Inishmore, Co Galway, is also dated to the Late Bronze Age, although the radiocarbon evidence is less secure. Two main construction phases were identified. The first relates to the construction of three of the enclosing elements and dates to the Late Bronze Age. The second remains undated, but seems to have comprised the construction of a fourth enclosing element and *chevaux de friese*.[63]

The important excavations conducted by Barry Raftery at Rathgall hillfort, Co Wicklow, are still awaiting publication, and only a limited number of published dates are available. The inner enclosure is likely to be an Early Medieval ringfort.[64] Excavation of the two closely spaced middle enclosing elements was inconclusive but suggested that the intervening ditch had been substantially backfilled by the Late Iron Age.[65] A recent listing of 55 radiocarbon dates from Rathgall includes 47 of Late Bronze Age date.[66] Although these lack contextual detail prior to their full publication, a number of these can be used to date the enclosing elements to the Late Bronze Age. Similarly, settlement activity within the interior is well attested and dates to the Late Bronze Age.[67] High-status occupation is implied by the extensive evidence for specialized craftworking and burials.

Recent excavations have been conducted at the substantial inland promontory fort on Knockdhu, Co Antrim. The site was dated to the Middle / Late Bronze Age by radiocarbon dating and flint tool technology.[68] This remains the only inland promontory (Class 3) hillfort excavated in Ireland. Five structures were also excavated within the interior. The majority of these date to the Late Bronze Age and were probably broadly contemporary with the construction of the enclosing works.[69] An early phase of one example dates to the Late Neolithic / Early Bronze Age and indicates that the promontory was periodically occupied prior to the construction of the enclosing elements.

The univallate hillfort at Freestone Hill was originally dated to the Iron Age due to the recovery of Roman artefacts.[70] Although the assemblage is clearly representative of a strong Iron Age presence, coarse ware discovered underneath the hillfort bank, in the ditch fill and within occupation areas implies that the original construction and occupation of the hillfort dates to the Late Bronze Age.[71] Cleary suggests that this pottery type can now be seen as indicative of the Irish Late Bronze Age.[72] Raftery later conceded that Freestone Hill was probably Late Bronze Age.[73] Ó Floinn suggests that the ceramic assemblage, as well as other artefacts such as four blue glass beads, date the hillfort to Late Bronze Age.[74] A single radiocarbon date (810–550 BC) from an occupation layer confirms Late Bronze Age / Early Iron Age occupation.[75]

Excavation of the univallate hillfort at Downpatrick (Cathedral Hill), Co Down, produced coarse ware from the ditch fill and underneath the hillfort bank.[76] Proudfoot suggests that these sherds are similar to the Late Bronze Age pottery from crannogs at Ballinderry 2, Knocknalappa and Lough Gara.[77] Raftery describes the Downpatrick and Freestone Hill pottery assemblages as 'superficially comparable' and subsequently dated the hillfort to the Late Bronze Age.[78] Three Late Bronze Age gold hoards from the interior of the hillfort also attest to Late Bronze Age activity. Intensive occupation of the hilltop in the Early and High Medieval periods saw the refurbishment of the enclosing elements.[79] Later trial excavations have led Hamlin and Lynn to suggest that the hillfort is Early Medieval.[80] However, this disregards clear evidence for the re-use of the enclosure in later periods and does not clearly explain the presence of Late Bronze Age pottery directly underneath the bank and in the ditch fill.

Coarse ware may also date the univallate hillfort at Clogher, Co Tyrone, to the Late Bronze Age.[81] Radiocarbon dates confirm occupation of the hilltop during this period, although there is considerable evidence for later activity.[82] A recent publication by Warner suggests that the hillfort is Iron Age, despite the author conceding that dating evidence for the earthwork itself is poor.[83] This is in contrast to earlier summary reports that suggest a Late Bronze Age date.[84] Coarse ware may be associated with the construction of the hillfort and large pits containing this pottery discovered at the centre of the monument are possibly Late Bronze Age.[85]

A univallate hillfort was excavated at Knockacarrigeen Hill, Co Galway.[86] Dates from a small stone-built enclosure inside the hillfort (2121–1913 to 2173–1828 BC and 2600–2484 to 2860–2460 BC) indicate that the hilltop was occupied during the Neolithic and / or Early Bronze Age. Although there were no dates obtained from the excavated hillfort bank or associated old ground surface at Knockacarrigeen,

[60] Baillie and Brown 1991; 1998
[61] Mallory 1995, 75, 78; Mallory and Warner 1988
[62] Mullins 2008, 26
[63] cf Cotter 2012a, 55, fig 3.7; Warner 2012
[64] Waddell 1998, 270
[65] cf Raftery 1988, 79
[66] Chapple 2013
[67] Raftery 1976, 341, 350
[68] McNeary 2012
[69] Macdonald 2008
[70] Bateson 1973, 45; Raftery 1969
[71] Raftery 1969, 91
[72] Cleary 1993; 2012, 23
[73] Raftery 1976, 58–9
[74] Henderson 1988, 442; Ó Floinn 2000
[75] Raftery 1995; Waddell 1998, 270
[76] Proudfoot 1954; 1955
[77] *idem* 1954
[78] Raftery 1969, 93–4; *idem* 1976, 351
[79] Proudfoot 1954, 100
[80] Hamlin and Lynn 1988, 61–4
[81] Waddell 1998, 270
[82] *ibid*, 270, 277
[83] Warner 2009, 510
[84] *idem* 1971 *et seq*
[85] Warner 1972; 1974
[86] Carey 2002, 61

Carey notes that the construction of the bank is 'remarkably similar' to the drystone banks at the Late Bronze Age hillfort at Mooghaun.[87]

A bivallate hillfort at Knockanacuig, Co Kerry, was excavated prior to development of the site.[88] Excavation revealed an external ditch comprising two phases of activity, the initial construction and a second re-cut. A radiocarbon result from the basal layer of the primary ditch cut returned a date of 90 BC–79 AD. An internal pit features returned a date of 398–544 AD. The site has not been published and without further contextual information, this single radiocarbon date cannot be regarded as evidence for the construction of the hillfort in the Iron Age.

University College Cork is currently undertaking a dating programme that aims to re-evaluate the chronology of Irish hillforts. At the time of publication, this project has dated five hillforts to the Late Bronze Age; Clashanimud, Co Cork; Ballylin, Co Limerick; Glanbane, Co Kerry; Formoyle Beg, Co Clare, and Toor More, Co Kilkenny. The radiocarbon dating of wooden palisades, as well as basal ditch deposits, places the construction and / or early use of all five sites in the twelfth / eleventh century BC (Table 2). This further emphasizes an intensive construction horizon at the beginning of the Late Bronze Age.

Hillforts in the landscape

The function of Irish hillforts is often interpreted in relation to research in Britain, incorporating evidence from monuments built and used in the British Iron Age. This is despite a growing corpus of evidence for Late Bronze Age hillfort construction in Britain, and a lack of evidence for Iron Age examples in Ireland. This chronological issue is significant, considering the important changes that occur during the onset of the Iron Age and the differences between Ireland and Britain during this period.[89] It is important, therefore, to consider the Irish evidence as a distinct cultural group and place it in the context of the Late Bronze Age, before developing a broader discussion and synthesis. This is not to dismiss the very evident connections between Ireland and Britain, and indeed Ireland and Atlantic Europe at this time. Rather, by taking the Irish evidence in isolation, we can escape the constraints of the hillfort 'grand narrative' and associated spatial and temporal problems, and suggest an interpretative scheme embedded within evidence.[90]

Enclosure is a conscious act, involving the expenditure of resources that could have been employed elsewhere.[91] Neustupný considers the practical, social and symbolic significance of enclosure, concluding that prehistoric peoples would not have necessarily been able to distinguish these as separate aspects of hillfort use.[92] Although there is a general consensus that hillforts had a number of diverse functions that changed throughout time and region, recent debate has focused on two competing views.[93] One side argues that some of these monuments functioned as practical, defensive enclosures.[94] The other criticizes this position, highlighting the inherent weaknesses in hillfort design and interpreting these monuments as symbols of social isolation.[95] More recent studies stress the importance of monumental display in hillfort architecture and their role in the proclamation of power and status.[96]

The defensive perspective is based on the assumption that violence was a recurring threat during the Iron Age.[97] This was a view first advanced by Wheeler after his excavations at Maiden Castle, where thousands of sling stones were discovered.[98] Wheeler saw this as evidence for warfare based on the mass use of the sling, explaining the evolution of the site from univallate to multivallate as a means of mitigating this threat.[99] Avery subsequently proposed an evolution from simple defences incorporating dumped material reverted by timber, to larger dump defences with no timber revetment to avert the threat of fire.[100] Wheeler's interpretation fits neatly with the development of Maiden Castle, where the number of sling stones recovered increases exponentially during the developed phase of the hillfort.[101] Armit and Wheeler see the make-up of the enclosing elements at Maiden Castle as further evidence for its defensive nature.[102] Up to four closely spaced banks and ditches comprise the hillfort. The large enclosing elements were constructed at a steep angle, set at 40° or higher. Armit argues that this slope would have provided sufficient defence to allow the hillfort to be protected by a 'substantially unmanned' force.[103] Furthermore, Armit proposes that multivallation was intended to keep defenders out of range of effective sling fire and to prevent any possibility of rush attack.[104] Finney's critical review of the sling calls into question the use of multivallation as a form of defence, as it does not explain the continued building of ditches and banks at many hillforts.[105] In practical terms, Finney suggests that a large inner bank and ditch with a smaller outer enclosure placed 70m apart, is all that is necessary for protection against assault by sling.[106] Armit has suggested that multivallation provides a 'ranging certainty' which would enable well practiced defending slingers to 'pick off attackers with deadly accuracy'.[107] However, the addition of such earthworks and the amount of labour required seems unnecessary for such practical use, considering that other, less labour-intensive markers such

[87] *ibid*, 70
[88] Dunne and Bartlett 2009, 227 (no lab code or uncalibrated date provided)
[89] Hodson 1964; Bradley 1980; Rowlands 1980; Barrett 2012
[90] Lock 2011, 361
[91] Mytum 2013, 6
[92] Neustupný 2006
[93] Armit 2007; James 2007; Brown 2009; Lock 2011; Harding 2012, 27
[94] cf Armit 2007
[95] cf Lock 2011
[96] Sharples 1991; Driver 2013
[97] Mytum 2013, 310
[98] Wheeler 1943
[99] *ibid*, 49
[100] Avery 1986; 1993
[101] Armit 2007
[102] *ibid*, 27; Wheeler 1943, 41
[103] Armit 2007, 27–8
[104] *ibid*
[105] Finney 2006
[106] *ibid*, 80
[107] Armit 2007, 27

as wood or bushes could have been employed.

Cunliffe's excavations at the developed hillfort of Danebury revealed similar evidence for use of sling stones, recovering one large deposit of 10,300 stones near the eastern gate.[108] This is comparable to a large deposit of more than 22,000 sling stones found near the inner entrance at Maiden Castle. Cunliffe sees the large enclosing elements of Danebury as 'primarily defensive in character'.[109] The remains of an estimated 100 individuals at Danebury, a number of which show signs of severe injury by weapons such as spears and swords, prompted Cunliffe to associate this with the 'ever-present social horrors of endemic warfare'.[110] Cunliffe exercises caution in relating all of these examples with warfare, highlighting the potential for ritual, particularly where human remains were found in backfilled pits.[111]

Harding sees the paucity of weaponry in the Early–Middle Iron Age of southern Britain as one of the main problems associated with the 'military' interpretation.[112] However, James argues that this could be seen as a misrepresentation of the evidence, considering the changes in deliberate depositional practices during this period, rather than a decline in production of these artefacts.[113] The 'war cemeteries' of Maiden Castle,[114] Sutton Walls,[115] South Cadbury[116] and Breedon-on-the-Hill[117] in England, as well as Dinorben[118] in Wales have been used to further emphasize the defensive nature of hillforts. Skeletal remains of nine women and children were recently discovered in the ditch fill at Fin Cop in Derbyshire, England.[119] These remains were mixed with faced stone from the internal bank, implying that these individuals were killed and thrown into the ditch as the aggressors were slighting the defences of the hillfort. Ralston, however, notes the rarity of burials recovered in hillfort ditches and suggests that these need to be regarded as something 'distinctly out of the ordinary'.[120] The size of the enclosing elements at Danebury and other developed hillforts in Britain, as well as the 'defensive ingenuity' of entrance features, has led Cunliffe to view hillforts as works 'designed to proclaim the strength of the occupants and to withstand attack', a view shared by Heath.[121] Armit sees hillfort architecture as a deterrent, and as such, the fact that there is little unequivocal archaeological evidence for hillforts coming under attack in not surprising, since the purpose of deterrence is to avoid it being put to the test.[122]

Conversely, Hamilton and Manley argue that Early Iron Age hillforts acted as 'landscape coordinators' within intensive distributions of non-hillfort settlements.[123] Hillfort ramparts 'have the appearance of being delimitators rather than substantial barriers'.[124] Entrances are simple breaks directing people and animals across through the enclosures and it is 'difficult to imagine security issues being a design intent'.[125] Lock continued this theme by viewing hillforts as 'structures that mediated a peaceful and harmonious life within small scale agricultural communities' and argues against what he describes as 'the grand narrative of Iron Age warfare'.[126] He argues that the defences of many hillforts are out of proportion to any possible threat posed[127] and suggests that 'community building' offers a better explanation than a purely defensive rational.[128] Lock suggests that we should not under-estimate the importance of participation in communal work and the sociality it engenders and maintains.[129] He further suggests that this acts to structure the sociality of people whose interests are in creating a harmonious existence.[130] Sharples considers that the construction of these sites could have been an annual event which would attract an influx of people from the surrounding communities.[131] Such an assembly would have added an important social function to hillfort construction, bringing together disparate groups and solidifying social ties through marriage arrangements and other relations.

Sharples advances this theory, proposing that hillforts were the focus of community building *and* that hillfort ramparts acted as the mechanism for competitive display.[132] The idea of monumental display has gained popularity in hillfort studies, not least because it can explain quite disparate forms of archaeological information. In a recent study of the hillforts in north Ceredigion, Wales, Driver argues that monumental display was the driving force of hillfort construction.[133] This study proposes that hillforts in this region were built using a complex suite of monumental devices to heighten the appearance of the defences from particular approaches.[134] Although this limits the enclosing elements in strategic terms, it allowed the most important and more visible approaches to effectively communicate greater strategic strength than the hillfort actually possessed.[135] This also prioritized labour output by focusing on more important sections of the enclosure. Sharples suggests that if the construction process of a hillfort is related to the gift of labour and resources, then construction of even larger and more complicated enclosure boundaries is effectively the conspicuous consumption of resources.[136] The 'strength' of these hillforts, therefore, may have been in the perceived

[108] Cunliffe 2011
[109] *ibid*, 67
[110] *ibid*, 77
[111] *ibid*, 149–56
[112] Harding 2012, 20
[113] James 2007
[114] Wheeler 1943
[115] Kenyon 1953; Redfern 2011
[116] Alcock 1972
[117] Hencken 1938; Craig *et al* 2005; Redfern 2011
[118] Osgood 2006
[119] Waddington 2011
[120] Ralston 2006, 117
[121] Cunliffe 2005, 539; Heath 2009, 121
[122] Armit 2007; Harding 2012, 198
[123] Hamilton and Manley 2001, 13
[124] *ibid*
[125] *ibid*
[126] Lock 2011, 355
[127] See also Finney 2006, 81; Sharples 2007; 2010; Driver 2007; 2013
[128] Lock 2011, 359
[129] *ibid*
[130] *ibid*
[131] Sharples 1991, 83
[132] Sharples 2007; 2010, 123
[133] Driver 2007; 2013
[134] *idem* 2013, 135
[135] *ibid*
[136] Sharples 2007, 180

threat of strength embodied in the monumentality of the main façade ramparts. As Driver suggests, hillforts may have been a vital component of a chieftain's 'psychological armoury', acting as more permanent displays of power, less transitory than feasting, raiding or material deposition.[137]

The concept of 'competitive display' can also be seen as a type of conflict. Sharples envisages ritualized display and threatening behaviour as warfare, although he views such behaviour as a deterrent, or a symbolization of the nature of conflict, rather than its actual practice.[138] This concept would fit well with the competitive Wessex societies of the Early and Middle Iron Age and Late Bronze Age societies in Atlantic Europe.[139] Bowden and McOmish suggest that hillforts positioned on sloping ground or in areas overlooked by higher ground were non-defensive.[140] They regard the positioning of such sites as a deliberate device to make activities within the interior visible to spectators outside the enclosure, while also excluding them from participation. Driver has recently proposed that such sites may have facilitated the communication of strength through visibility, where the interior revealed a populous, well organized community.[141] The positioning of sites on sloping ground may also increase the visibility of the monument from certain positions. As such, this interpretation can be seen as another facet of competitive display. It can also be explained from a defensive standpoint, as Driver notes that a hillfort with a role to command and / or control a population and / or territory would need to be highly visible.[142]

Monumental display may explain the large defences of some hillforts, the size and composition of the enclosing elements acting as a physical imposition of power.[143] For example, Sharples sees the enclosing elements of Maiden Castle as symbols of competitive display.[144] The size of the enclosing elements at Rathgall, Co Wicklow, suggests a need for the ramparts to be visible and contrast in the local landscape. Here, the rather unimpressive location of the hillfort is substantially augmented by large banks. The placing of additional earthworks flanking the main entrance to Carn Tigherna hillfort, Co Cork, could also be interpreted as an attempt to monumentalize the approach to the monument.

In Ireland, the few examples of excessive architecture contrast with the unimpressive nature of many hillfort ramparts. This is also a feature of Late Bronze Age hillforts in Britain.[145] During that period, the topographical and strategic setting of these monuments was important and monumentality was emphasized by the creation of an enclosing element and the clearance of the hilltop of vegetation. Hillforts helped to monumentalize topographic landmarks and heightened the appearance of artificiality, putting the hilltop at odds with the natural environment.[146] Knockdhu and Lurigethan in Co Antrim are excellent examples of this. The preoccupation with the display of power is also attested through the production, display and consumption of prestige goods. Monumentalization of the landscape through hillfort construction fed into this competitive social system. In many cases in Ireland, the strategic setting of hillforts may have been acquired from a need to be seen from and control strategic routes, with the hillfort declaring the community's authority over this location.

This corresponds with Cunliffe's argument that a hillfort functioned as a 'central place', acting as a focal point in a redistribution network.[147] This was prompted by the 2,400 excavated grain storage pits within Danebury hillfort.[148] More than a dozen clay or wattle-and-daub lined pits of varying size were excavated in the interior of Downpatrick hillfort, Co Down.[149] At Haughey's Fort, Co Armagh, large pits containing quantities of carbonized grain, among other artefacts such as fragments of quern stones, coarse ware and metalwork were recorded.[150] These were interpreted as grain storage pits by the excavator.[151] Geophysical survey at Toor More hillfort, Co Kilkenny, has identified a concentration of pit-like features within the interior of the inner enclosing element.[152]

Environmental studies have highlighted the intensive clearance and exploitation of land immediately surrounding Irish hillforts. At Mooghaun, woodland had been almost completely removed and replaced by pasture and some cereals during the Late Bronze Age.[153] A clearance event in the period 1400–1100 BC was of such severity that pollen representation of trees and tall shrubs fell from between 83 and 94 per cent to 18 per cent.[154] Cattle were the dominant species (followed by pig and sheep / goat) and this suggests that animal husbandry was the principal form of agriculture.[155] This may explain the absence of storage pits at Mooghaun, as well as the limited extent of excavation.

Weir's extensive analysis of the paleo-environment surrounding Haughey's Fort has revealed a major clearance episode around 1400–1000 BC.[156] Cereals comprise 6 per cent of the open landscape. This is amongst the highest known from prehistoric Ireland and indicates that arable agriculture was an important component of the economy.[157] Animal bone indicates a mixed economy based on rearing cattle and to a lesser extent pig.[158] This is confirmed by lipid analysis of pottery from the site, which has found positive traces of cattle meat.[159] The major clearance phase ended by *c* 1000 BC, a time broadly contemporary with the abandonment of

[137] Driver 2013, 136
[138] Sharples 1991, 88
[139] Hill 1995, 55
[140] Bowden and McOmish 1989, 13
[141] Driver 2013, 135
[142] *ibid*, 109
[143] *ibid*
[144] Sharples 2010, 123
[145] Hamilton and Manley 2001
[146] *ibid*, 29; Driver 2013, 91
[147] Cunliffe 1995, 93
[148] *idem* 2011, 99, 113–16
[149] Proudfoot 1954, 98
[150] Mallory and Warner 1988; Mallory 1995, 78
[151] *ibid*, 79
[152] O'Driscoll 2012b
[153] Molloy 2005, 284
[154] O'Connell *et al* 2001; Molloy 2005, 285–6
[155] McCormick and Murray 2005, 304
[156] Weir 1987a; 1987b; 1993; 1994
[157] *idem* 1994, 175; Plunkett 2006, 65
[158] McCormick 1991, 31
[159] Mallory 1995, 82

Haughey's Fort.[160] Plunkett suggests that the environmental data indicate that Haughey's Fort and Mooghaun hillfort were supported by 'thriving economies'.[161]

At Rahally, Co Galway, the environs of the hillfort were cleared of deciduous woodland during the Late Bronze Age, with fewer trees and a rise in clearance indicators implying an increase in pastoral farming contemporary with the construction of the hillfort.[162] A reliance on cattle rearing is evident in the recovered faunal remains,[163] which like Mooghaun, may explain the lack of pit features within Rahally.

At Lyles Hill, Co Antrim, pollen evidence suggests that the landscape was already being exploited immediately prior to the construction of the hillfort, when barley was being cultivated.[164] This was succeeded by hazel scrub and grassland, again indicating a preference for animal husbandry. Snail remains in the ditch fill at Freestone Hill, Co Kilkenny, are characteristic of dry fauna and infer that the sides of the hilltop were covered with patches of hazel scrub and open grassland.[165] Pollen analysis undertaken near a potential hillfort on Croghan Hill, Co Offaly, shows substantial Late Bronze Age activity in that area. Plunkett has noted extensive woodland clearance comparable with other hillfort sites, with the absence of arable weeds indicating that pastoral farming dominated.[166] Plunkett cites Ballylin hillfort, Co Limerick, as another example where an agricultural expansion occurs near a hillfort in the Late Bronze Age.[167] This is a more tenuous link. The pollen core was taken from a bog 7km from the hillfort. Analysis suggests that an intense phase of clearance began *c* 1200 BC and 'flourished' from the eleventh century BC, the pattern and duration of activity being reminiscent of that recorded at Mooghaun.[168] Recent excavation at the site has revealed that Ballylin hillfort is Late Bronze Age. A pollen core 3.5km from Lurigethan hillfort, Co Antrim, indicates an intensification of activity during the Late Bronze Age, attested by a major woodland clearance.[169] The very low levels of tree pollen suggest that the local area was probably almost entirely clear at this time.[170]

The environmental evidence, therefore, strongly indicates that the immediate environs of Irish hillforts were being exploited for agricultural purposes. In certain instances, where more extensive excavation of the interior has been undertaken, features associated with the storage of agricultural produce have been identified. This is important, as Yates suggests that wealth in the Late Bronze Age resulted from the successful management of available resources, particularly agricultural produce, with intensive farming possibly leading to rapid economic growth.[171] Cunliffe also considers control of agrarian surplus as connected to the maintenance and expansion of elites, used for feasting purposes or to acquire high status goods outside the local territory.[172] The archaeological evidence suggests that Irish hillforts fit into a model of a competitive Late Bronze Age society. The monuments were highly visible displays of power, with their landscape position dominating trade routes, controlling the distribution of goods and the movement of peoples. It may be suggested that the locational aspect of the monument was acquired from a need to control territory and routeways through visibility. A large number of Irish hillforts are located at strategic positions in the landscape, at the interface between upland and lowland landscapes and overlooking one or more natural corridors.[173] The need to control these routeways and to be seen from them may have been a significant factor in choosing a location to construct these monuments. Similarly, early hillforts in Britain are positioned to control physical access to varied landscapes and resources.[174] Murrieta-Flores observed that natural corridors in the Sierra Morena region in Spain seem to have been heavily used during prehistory,[175] with similar evidence identified in northern Portugal by Fonte *et al.*[176] This does not exclude the communal aspect of hillfort building as presented by Lock or the potential defensive role of these monuments promoted by Armit.[177] Rather, it may be seen to amalgamate the two. A community may have built a hillfort primarily to convey their authority over a routeway. Sharples admits that control over exchange networks and the inter-community alliances that provided mechanisms for this trade would be a principle cause of conflict and competition.[178] The destruction of this monument would have been a striking visual way of undermining this authority. The archaeological evidence for the burning of hillfort defences is evident in a number of excavated and surveyed examples (eg Rathcoran, Rathnagree, Sruhaun, Hughstown, Clashanimud, Toor More). Although hillforts may not have been built to function as defensive enclosures, they may still have been heavily linked with warfare practices in prehistory.

[160] Mallory 1995, 79
[161] Plunkett 2006, 65
[162] Mullins 2008
[163] *ibid*
[164] Simpson and Gibson 1989, 215
[165] Raftery 1969, 99
[166] Plunkett 2009, 274
[167] *eadem* 2006, 65–6
[168] *ibid*, 66
[169] Weir 1993, 21
[170] *ibid*, 23
[171] Yates 2007, 2–4
[172] Cunliffe 1995, 90; *idem* 2013, 252–8
[173] Condit 1998, 22; Waddell 1998, 269; Grogan 2005b
[174] Hamilton and Manley 2001, 31
[175] Murrieta-Flores 2012, 114
[176] Fonte *et al* 2011
[177] Armit 2007; Lock 2011
[178] Sharples 1991, 84

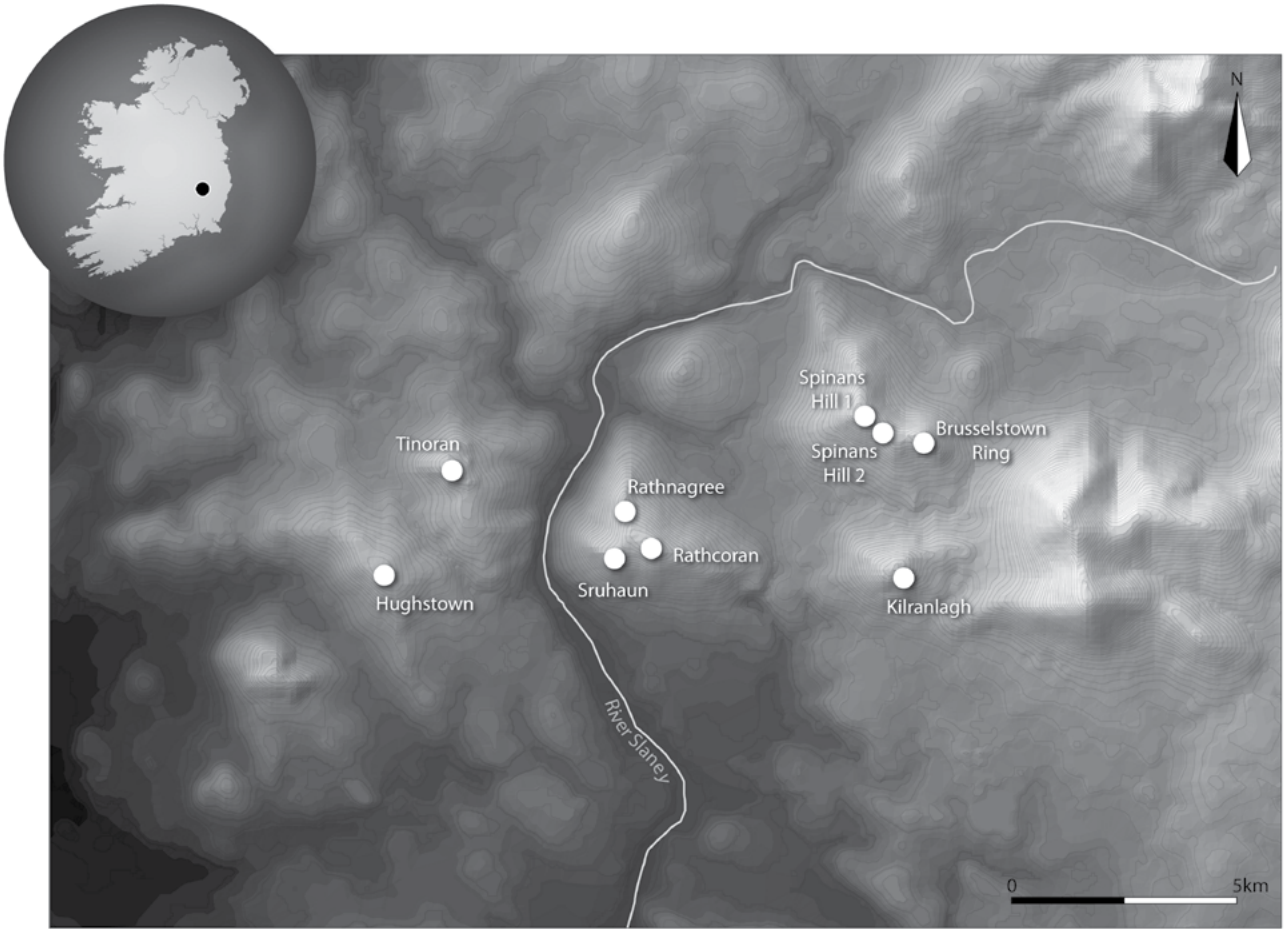


Fig 6 The Baltinglass hillfort cluster

The Baltinglass hillfort cluster

The Baltinglass cluster comprises a remarkable group of nine hillforts occurring within a 10km by 4km area near the south-western edge of the Wicklow Mountains in eastern Ireland (Fig 6). The hillforts are unique in an Irish context and stand out in terms of density, complexity and scale. The cluster consists of three individual hillforts, Tinoran, Co Wicklow; Hughstown, Co Kildare, and Kilranlagh, Co Wicklow, in addition to two hillfort complexes on Tuckmill Hill and Spinans Hill. Tuckmill Hill comprises three hillforts, including Rathcoran, Rathnagree and a newly discovered univallate example in Sruhaun townland. The Spinans Hill complex includes Brusselstown Ring and Spinans Hill 1, both of which are surrounded by the exceptional contour fort of Spinans Hill 2, arguably the largest hillfort in Britain and Ireland. Condit has described this impressive group of hillforts as 'Ireland's hillfort capital'.[179]

Despite a number of commentaries by Corlett and Weaver, Corlett, Condit, and Grogan, there has been no systematic study of the west Wicklow hillfort cluster.[180] The current project addresses this lack of research, and will contextualize the results of this landscape study to assess its significance on a regional, national and international level. The Baltinglass landscape and the concentration of such large and elaborate hillforts raise a number of questions. Why were these hillforts constructed in such close proximity? Are they contemporary? Why were they so large and elaborate? Were they built by a single community or by a number of social groups? Why were they built in this area and why are there no comparable hillfort clusters in Ireland? Broader questions of social and settlement hierarchy may also be informed by this study.

Spinans Hill hillfort complex

The Spinans Hill hillfort complex is the easternmost group of hillforts in the Baltinglass cluster (Fig 7). It comprises three hillforts: Brusselstown Ring, Spinans Hill 1 and Spinans Hill 2 contour fort. All three lie on a north-east / south-west running hill with two summits. The northern summit rises to a maximum height of 406m OD and is surrounded by Spinans Hill 1. The southern summit at 386m OD is surrounded by Brusselstown Ring with Spinans Hill 2 enclosing the entire hill.

Brusselstown Ring (Record of Monuments and Places: WI027-018) is a large bivallate hillfort with widely spaced enclosing elements occupying a total area of 32.43ha (Figs 8

[179] Condit 1992

[180] Corlett and Weaver 2002; Corlett 2004; Condit 1992; 1998; Grogan 2005a; 2005b

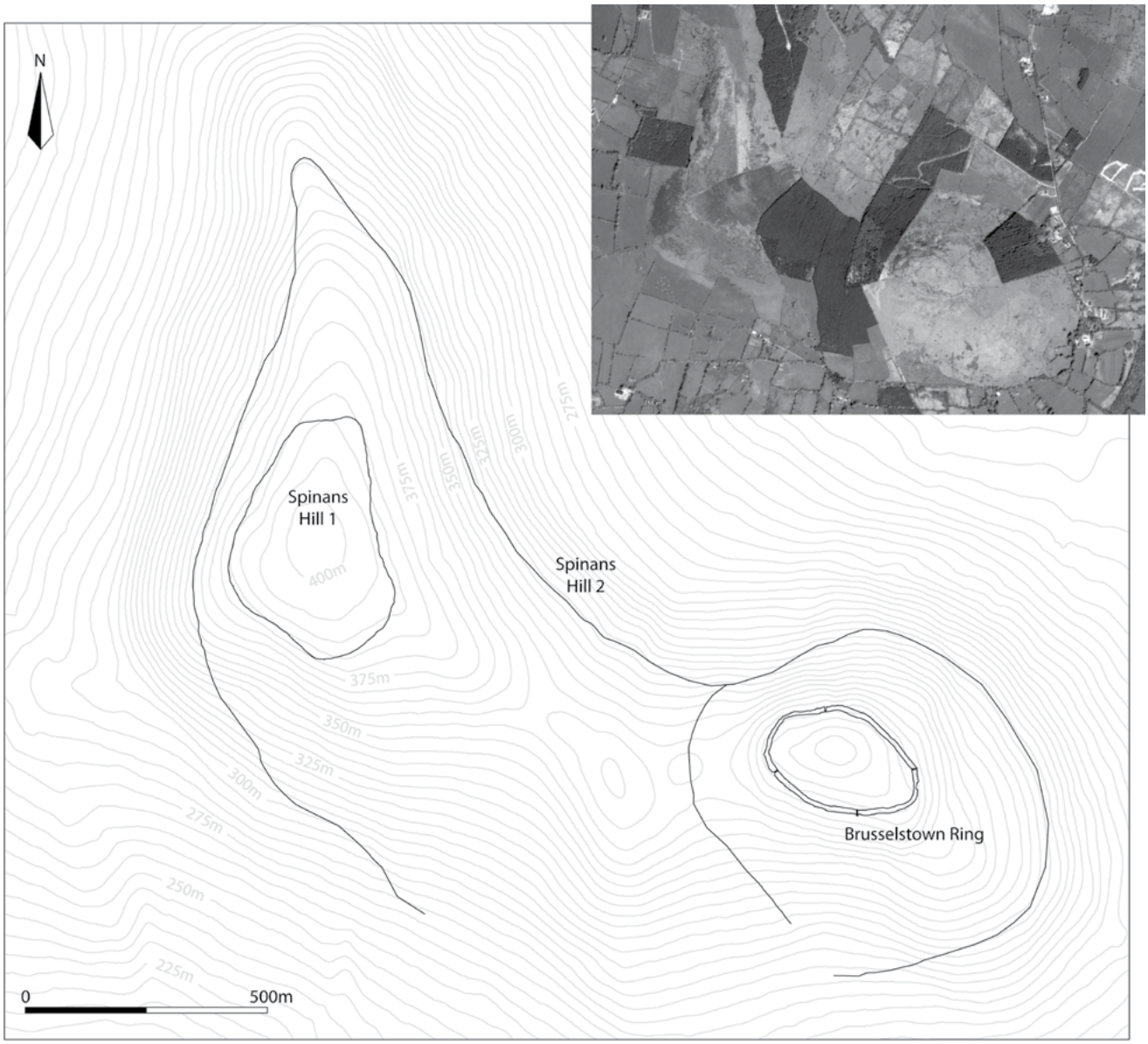


Fig 7 Spinans Hill hillfort complex (satellite image from Google Earth, Digital Globe 2014)

and 9). The inner enclosure closely follows the 370m contour, deviating by less than five metres along its 824m perimeter. A stone rubble bank of varying width (max 11.7, min 5.3m) surrounds a natural oval terrace that occupies an area of 4.63ha. A modern wall was built on the inner face. The bank comprises large stones of andesite and andesitic tuff. Loose stone and boulders are scattered on the immediate lower slopes, suggesting that the original stone bank was more extensive. In 1947, Price identified some internal wall facing on the north-west side and recent survey has revealed further internal and external facing and four entrance features.[181] These comprise simple breaks in the bank, 1.5–2.5m in width at the north, south, east and west. The outer rampart is positioned 124–305m from the inner rampart. In contrast to the inner example, the outer bank does not follow the contours of the hill, varying between 366–298m OD. It comprises a less substantial rubble stone bank, the eastern and south-eastern section of which is incorporated into modern field systems. The outer enclosing element is best preserved to the north, where the rubble stone bank averages 10.2m in width and is more comparable to the inner enclosing element.

There are numerous rock outcrops in the interior of Brusselstown Ring. The largest of these is located at the centre of the monument, where it forms a substantial plateau overlooking most of the interior. There are two recorded structures within the inner enclosing element and twenty four immediately outside the rampart to the south. These features are visible as circular platforms marked by a setting of roughly laid stones or boulders on average 7–8m in diameter. The largest of these is 18.6m by 20.8m. A previously recorded nucleated settlement is located immediately to the north-west of the outer enclosing element. This comprises

[181] Price in Corlett and Weaver 2002, 466

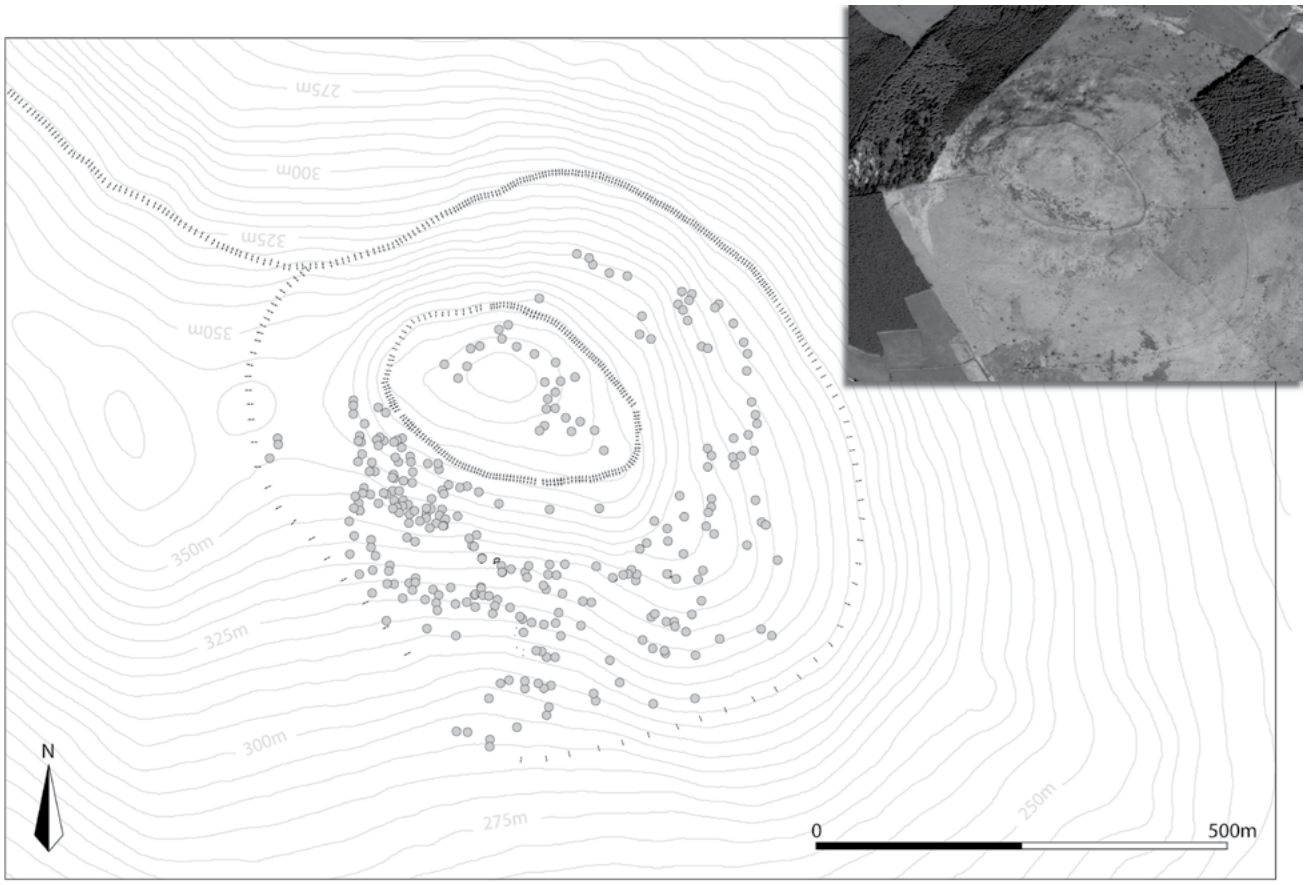


Fig 8 Brusselstown Ring (satellite image from Google Earth, Digital Globe 2014)

enclosures, hut sites and field walls covering an area of 320m by 145m.[182] The majority of this settlement has been forested. GPS survey of the hillfort has revealed approximately 250 possible hut sites within and immediately surrounding the inner enclosing elements. These are visible as circular terraces cut into the hillslope, defined by circular settings of stone, on average 8m in diameter.

On the northern summit of Spinans Hill, Spinans Hill 1 (WI027-078002) is defined as an irregularly shaped area enclosed by a peat-covered earthen bank occupying 11.11ha (Fig 10). The bank is best preserved at the north and east and is largely levelled over the remainder of its perimeter.[183] It was identified through aerial photography by Condit.[184] Price had previously noted an element of the hillfort, but did not identify it as such.[185] The interior of this hillfort is overgrown with heather, making identification of low relief ground features difficult. No habitation evidence has been identified within the interior. Condit has recorded six cairns at its centre.[186] A large central cairn (WI021-080004) positioned at the summit of the hillfort is surrounded by five smaller examples (WI021-080003, WI021-080006, WI021-080007, WI021-080008, and WI021-080009), with a sixth example identified by the author. This group of cairns has been interpreted by Condit as a possible passage tomb cemetery.[187] Structural features at the centre of the smaller cairns indicate that these may well be megalithic tombs. Price identified ruined cists in several robbed-out smaller cairns.[188] Sample excavation at the site has revealed that it may be Early Neolithic in date, though further work is needed to obtain secure dating material to confirm this.[189]

Spinans Hill 2 (WI027-078001) is an extensive earthwork over an area of 131ha that surrounds Brusselstown Ring and Spinans Hill 1 (see Fig 7). Over the course of its perimeter, the enclosure varies from 295 to 368m OD, being on average 330m OD. It is most complete at the north and north-west, where it comprises a double bank with an intervening ditch, 15m in total width. Some sections of the banks are stone-faced. The south-eastern section of the contour fort integrates a large portion of the outer enclosing element of Brusselstown Ring. Condit has noted that there are 'a number of breaches' to the north which he believes are original entrance features.[190] Bersu noted a possible roadway to the hillfort at the south-west corner of Brusselstown Ring.[191] To the south of the interior there is a cairn (WI027-078004) currently under forestry. Fifty metres to the north-east, a 17m

[182] Condit 1992, 16–20
[183] Grogan and Kilfeather 1997, 40–1
[184] Condit 1992
[185] Price in Corlett and Weaver 2002, 538–9
[186] Condit 1992, 19–20
[187] *ibid*, 20; *idem* 1998, 20
[188] Price in Corlett and Weaver 2002, 467
[189] cf O'Brien and O'Driscoll 2017, 249
[190] Condit 1992, 19
[191] Corlett and Weaver 2002, 504



Fig 9 Brusselstown Ring, viewed from Spinans Hill 1

diameter circular enclosure (WI027-078004), located on level ground between two natural mounds, has been interpreted as a possible ritual monument.[192]

Tuckmill Hill hillfort complex

Three hillforts are positioned on the northern, south-eastern and western summits of Tuckmill Hill, located at the centre of the Baltinglass cluster (Fig 11). Tuckmill Hill overlooks the modern town of Baltinglass at the base of the hill to the south. The northern summit is 318m OD and is surrounded by Rathnagree hillfort. The south-eastern summit rises to a height of 378m OD and is enclosed by Rathcoran hillfort. The author has discovered a previously unrecorded hillfort in Sruhaun townland, on the western summit at a height of 315m OD.

Rathcoran (WI027-026001) is the largest of the three hillforts (Fig 12). The name probably refers to a large prehistoric cairn at its centre (rath of the cairn). This pear-shaped bivallate monument occupies a total area of 10.06ha and surrounds an internal area of 7.03ha. The shape is dictated by the topography of the hill to which the enclosing elements largely follows. The inner rampart is situated between 363–353m OD and the outer example 361–347m OD. Waddell and Condit have both interpreted Rathcoran as an unfinished hillfort, due to the incomplete nature of the enclosing elements and intervening quarry features.[193] The enclosing elements are most complete at the north and north-west, where the inner example is 16m in width and comprises a mixture of earth and stone. Geophysical survey has identified strong magnetic anomalies at the crest of the bank in this area, indicative of a possible burnt palisade feature. The internal enclosure has an average internal height of 1.7m and average external height of 2.6m. The outer enclosing element has an average internal height of 1.3m and an average external height of 2.1m. Here, the banks are separated by approximately 28m (max 35m). There is no evidence of an adjacent ditch. To the east, the gap between the enclosing elements narrows to an average of 12m. Although the banks are slighter, the steeply sloping ground enhances the perception of the bank from the exterior. The inner enclosing element is on average 0.8m in height internally but almost 3m in height externally. Similarly, the outer enclosure is 0.4m in average height internally and 2.1m high externally. To the south, a 185m section of the enclosing elements is characterized by closely-set multivallation and very slight banks. Quarry pits and associated spoil are visible in many sections

[192] Condit 1992, 20

[193] Waddell 1998, 356; Condit 1998

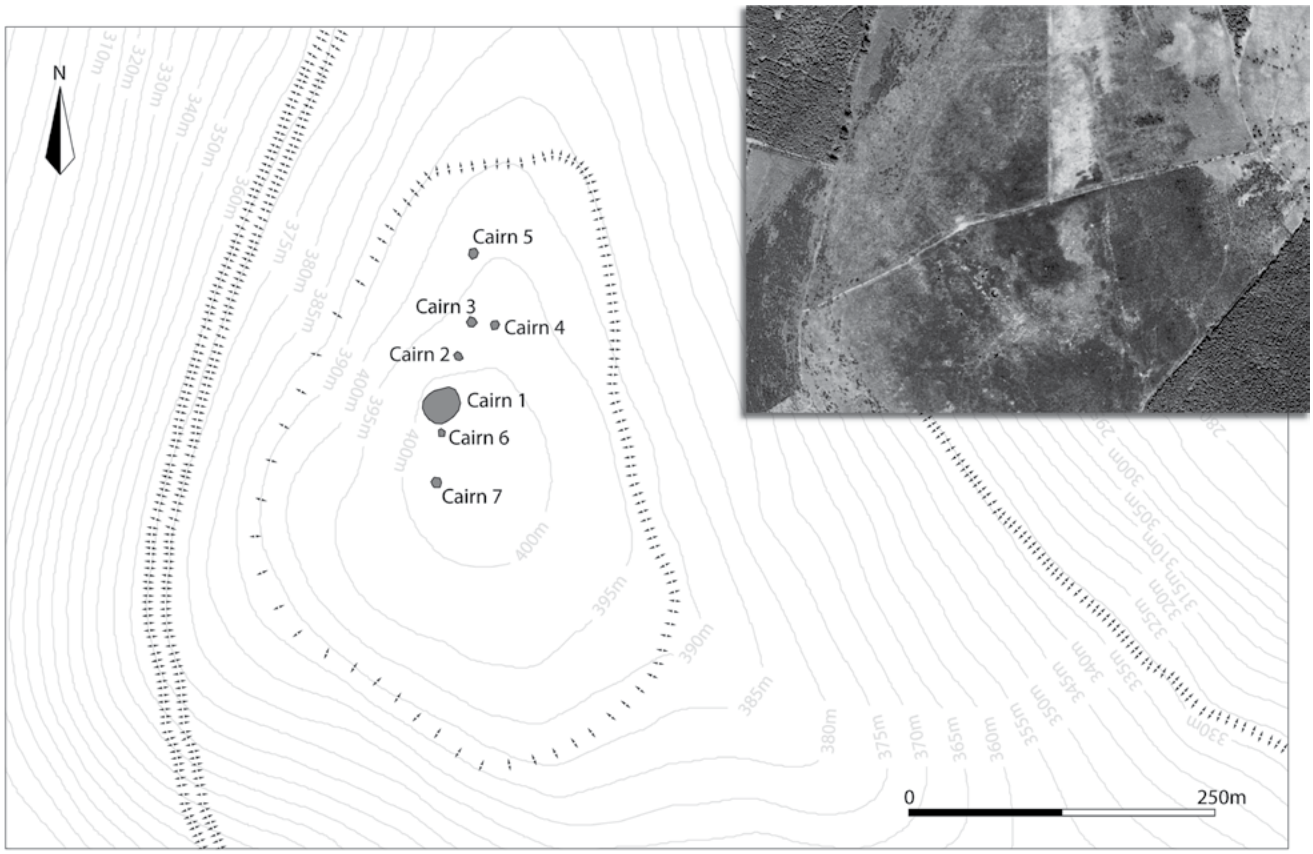


Fig 10 Spinans Hill 1 (satellite image from Google Earth, Digital Globe 2014)

between the enclosing elements. Presumably, the material from these pits was used for constructing the banks. There is no indication of an entrance, although Waddell suggests an original break in the banks to be located in the eastern section.[194]

The interior of the hillfort rises towards a rock out-crop at the south-east corner of the site and is characterized by significant heather growth and loose stone. The summit of the hillfort is crowned by a substantial passage tomb (WI027-026003) excavated in the 1930s by Walshe.[195] A significant amount of the stone that originally covered the monument now forms a protective wall around the tomb and is often mistaken for the hillfort. A second cairn (WI027-076) abuts the exterior of the outer enclosing element to the south. There are three recorded hut structures (WI027-026002, WI027-026004, WI027-026007) within the hillfort. Recent LiDAR and GPS survey undertaken by the author has identified over 50 possible hut structures within the interior of the hillfort, comprising terraces cut into the slope of the hill and defined by a circular setting of stones.

Geophysical survey of the monument has revealed that the northern section of the inner enclosing elements had a large palisade on the crest of the bank. These are apparent as a strong magnetic signature, indicating that they were deliberately destroyed through burning *in situ*. This is the most substantial section of the enclosing elements and it is the only area which is visible to all of the hillforts in the Baltinglass cluster. From this it can be inferred that, if this is an unfinished monument, the construction process began on the most visible section of the monument, or, if the hillfort is completed, the most visible portion of the enclosing elements are the most monumental.

Rathnagree (WI027-027010) is a trivallate hillfort positioned on a northern spur of Tuckmill Hill, 400m north-north-west of Rathcoran (Fig 13). The name translates as 'rath of the king'. It occupies a total area of 5.78ha and an internal area of 0.69ha. In contrast to Rathcoran, the enclosing elements do not follow the contours of the hill. The ramparts disregard topographical variation to form three circular enclosures. The inner and middle features are separated by approximately 37m. The middle and outer examples are 35m apart. The enclosing elements do not have a uniform composition. The middle enclosure is the most impressive of the three. It comprises a well preserved inner bank, outer ditch and counterscarp bank best preserved to the south. The bank and counterscarp are composed mainly of earth. The height of the bank ranges between 0.5 and 2.4m and is on average 7m wide. The ditch ranges from 2.9 to 1.3m in depth and is on average 7m wide. The counterscarp ranges from 0.4 to 0.9m in height and is on average 3m wide. There is no evidence for stone revetment. A large number of small breaks are present throughout the perimeter, although these are most likely modern. The inner rampart comprises a low-rise rubble stone bank with no corresponding ditch. The bank is on average 0.2m in height and 6m wide. There are two en-

[194] Waddell 1998, 356

[195] Walshe 1941

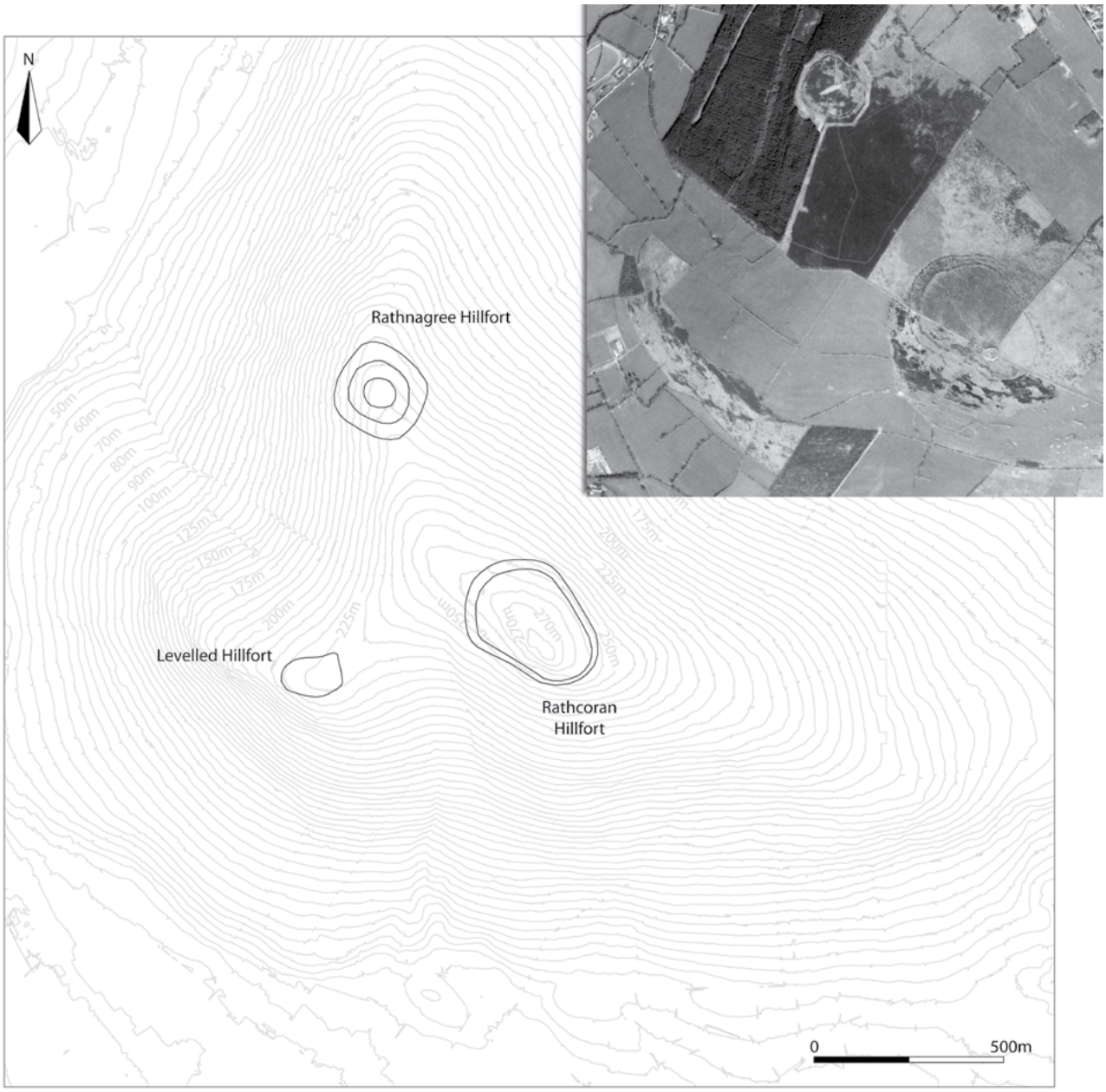


Fig 11 Tuckmill Hill hillfort complex (satellite image from Google Earth, Digital Globe 2014)

trances to the north-north-east and north which may be original. There are no features to suggest habitation; however, there is extensive vegetation cover inside the enclosure. The outer enclosing element is similar in composition where visible. It is denuded and remains in forestry or actively farmed areas. It is most apparent to the south where it is 0.1m high and 5m wide.

Geophysical survey at Rathnagree suggests that the low-rise rubble stone banks comprising the inner and outer enclosing elements were the footings of substantial timber palisades. Similar to Rathcoran hillfort, the palisades are apparent as strong magnetic anomalies, indicating that they were deliberately burnt down. In this case, the entire circuit of both the inner and outer enclosing elements was destroyed, suggesting that this burning was deliberate. Unlike Rathcoran, there is no indication of internal settlement. Sample excavation of all three of the enclosing elements has revealed Middle Bronze Age dates of *c* 1400–1200 BC.[196]

An unrecorded univallate hillfort was recently identified by the author on the south-western spur of Tuckmill Hill in the townland of Sruhaun (Fig 14). Positioned on a level terrace with steep slopes to the south and east, the enclosure comprises a single low-rise bank occupying a total area of 1.43ha. Geophysical survey indicates that this bank was the footing for a substantial palisade which was later destroyed by fire (Fig 15). This has recently been confirmed by excavation and these palisades have been dated to the beginning of the Late Bronze Age. Geophysical survey has also identified a single entrance comprising a simple 4m wide gap

[196] Walshe 1941, 269–70

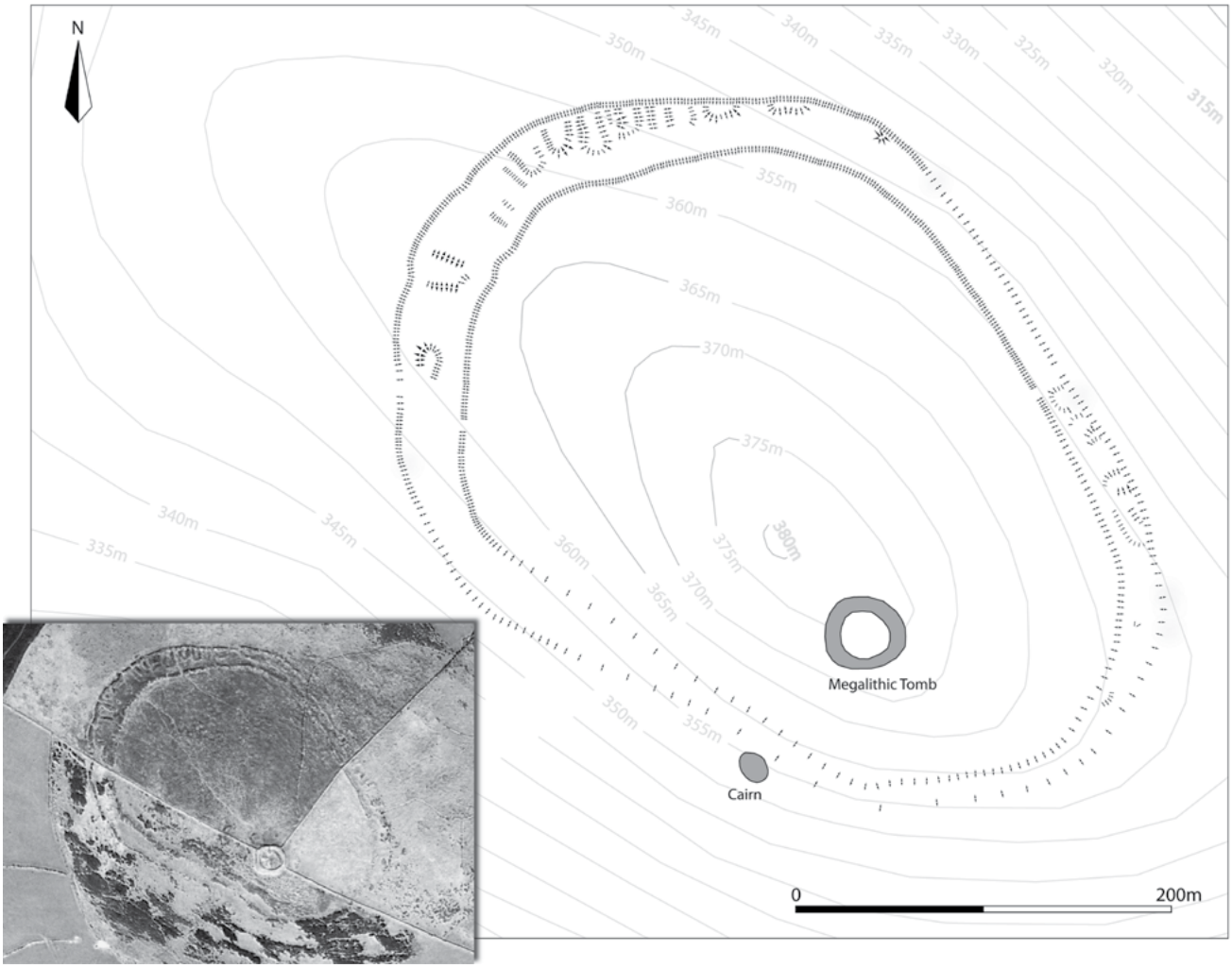


Fig 12 Rathcoran hillfort (satellite image from Google Earth, Digital Globe 2014)

to the north-west. There is no indication of internal activity. Sample excavation of the Sruhaun enclosure produced a Middle Bronze Age date contemporary with those obtained from Rathnagree.[197]

GIS viewshed analysis undertaken by the author using high resolution LiDAR reveals that there are extensive, panoramic views from Rathcoran and more limited views from Rathnagree. Ninety-nine per cent of the views from Rathnagree are visible from Rathcoran. Similarly 99 per cent of the views from the levelled hillfort in the townland of Sruhaun are also visible from Rathcoran. Importantly, the distinctive views that comprise the 1 per cent of unique visible areas from both Rathnagree and Sruhaun hillfort are found in areas surrounding the base of Tuckmill Hill. Least-cost-path analysis indicates that the northern spur of Tuckmill Hill restricts the views of this area from Rathcoran. This is supplemented by Rathnagree hillfort. Similarly, a large portion of the eastern tract of land at the base and slopes of Tuckmill is concealed to both Rathcoran and Rathnagree but is visible from Sruhaun. Least-cost-path analysis has also identified four access routes to the summit of Tuckmill Hill. All of these routes travel through one of the three forts, implying that these monuments may have been placed principally to protect the most naturally accessible paths to the hill summit. This does not necessarily mean that Rathcoran is contemporary with Sruhaun or Rathnagree. Rather, the latter may have been placed in strategic locations in reference to Rathcoran.

Hughstown

Hughstown is recorded as a bivallate hillfort (KD038-025001) with a small enclosure at its highest point at 295m OD (Fig 16). Located on the summit of Hughstown hill, it sits on the border between Kildare and Wicklow, falling just inside the former. It is the westernmost hillfort of the Baltinglass cluster. The hillfort is heavily truncated by modern agricultural activity and is currently used for cattle grazing. Irish Army Air Corp and Cambridge University aerial photographs reveal the two enclosing elements as parch-marks, separated by 23–48m. Condit has described the banks as consisting of inner banks with external ditches which appear to be rock cut.[198] The north-east of the outer enclosure

[197] O'Brien and O'Driscoll 2017, 279

[198] *ibid*

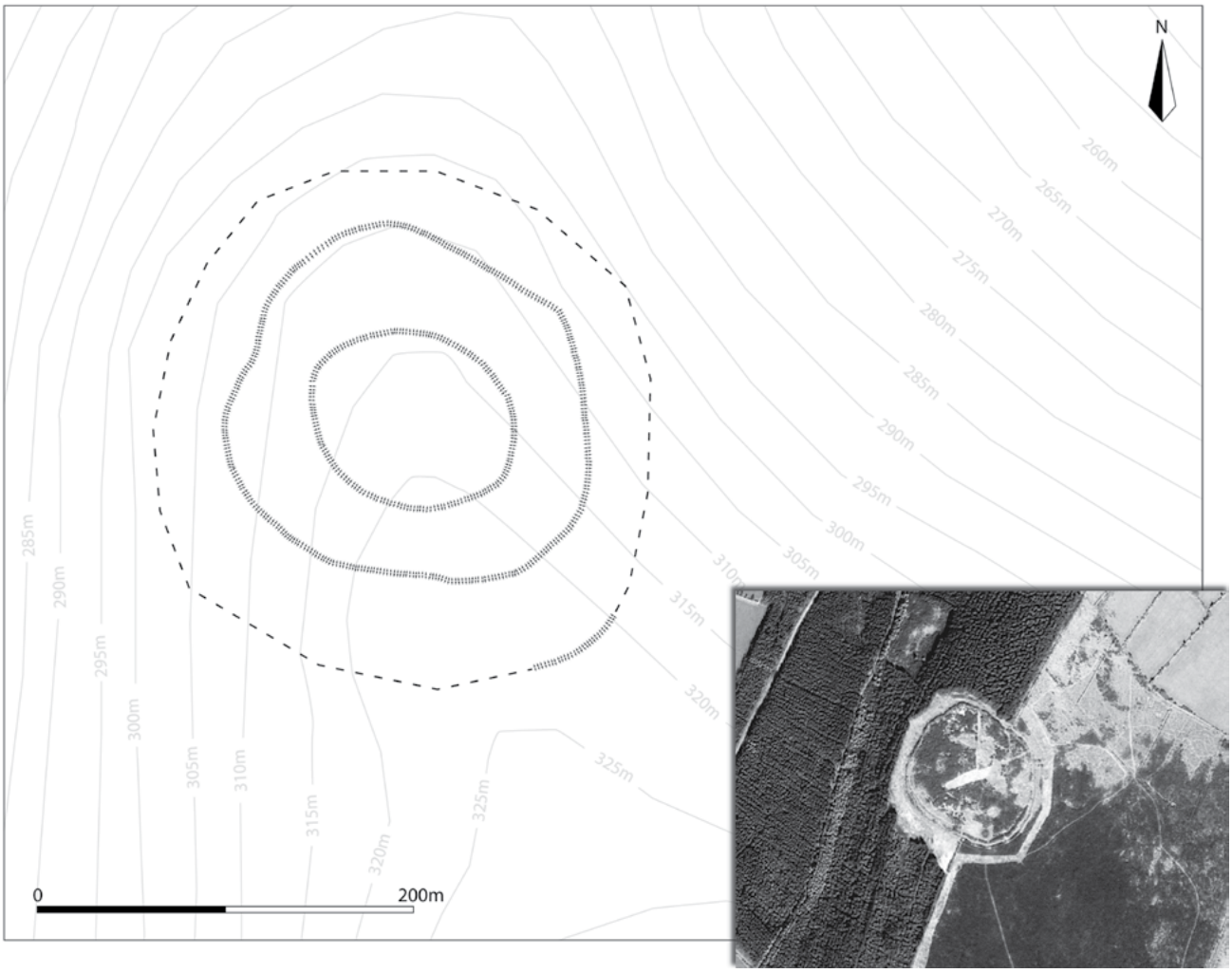


Fig 13 Rathnagree hillfort (satellite image from Google Earth, Digital Globe 2014)

may be partially preserved as a curving field bank. This is a distinctive boundary comprising large boulders, in contrast to the earth and stone composition of the modern boundaries in the immediate area. There is no corresponding ditch feature. The inner enclosing element ranges from 288 to 274m OD and the outer example between 292 and 285m OD, both generally following the contours of the hill.

Geophysical survey has revealed a more complex monument, comprising a large outer bank and ditch feature 375m in diameter and a series of four closely-set palisaded enclosures, 260–300m in diameter (Fig 17). The respective positioning of these features suggests they were largely contemporary. The strong results from a gradiometer survey imply that the palisades were destroyed by fire. The entire perimeter of these palisades was destroyed, implying this was a deliberate act of destruction undertaken in a single event. The small enclosure at the centre of the hillfort comprises a large boulder bank with no corresponding ditch feature and is similar in construction to the possible extant section of the outer bank. Condit recorded a 2m wide entrance gap to the north, which may be original.[199] A large circular setting of stones 17m in diameter is visible near the centre of the enclosure. A number of geophysical features which may represent hut structures are visible within the hillfort. Similarly, Condit notes that there are 'circular arrangements' of boulders within the interior, indicating that more than one example was visible in the past.[200] There is a recorded mound (KD038-025002) within this enclosure, although this cannot now be exactly recognized. This monument may instead be located 180m to the north of the hillfort, where a 1.5m high mound of earth, 12m in diameter, is present. Sample excavation of all three of the enclosing elements reveal that the monument was constructed during the Early Neolithic, *c* 3650–3350 BC.[201]

Tinoran

Tinoran (WI026-004) is the second-largest hillfort in Ireland, occupying a total area of 55.74ha (Fig 18). It comprises three widely spaced enclosing elements and a central enclosure placed at its summit 312m OD. Tinoran can be translated as 'house of Odhrán'. Most of the hillfort area was forested in

[199] Condit 1998, 16

[200] *ibid*

[201] O'Brien and O'Driscoll 2017, 316–17

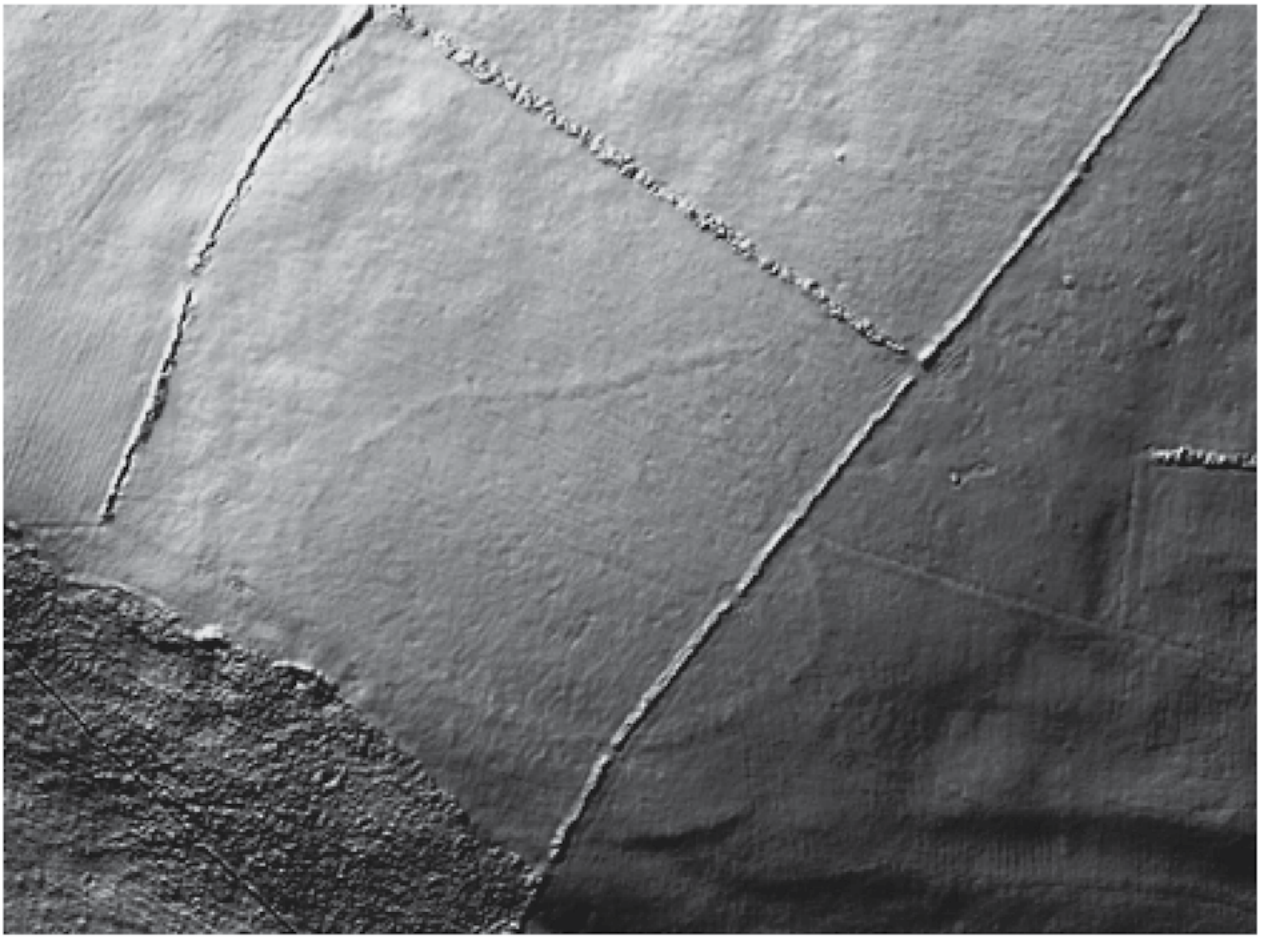


Fig 14 LiDAR images of levelled hillfort in townland of Sruhaun on Tuckmill Hill

the modern era. The inner enclosure comprises an earth and stone bank 2.2m in average width and 0.9–1.2m in height. The exterior face is stone revetted. There is a ditch immediately outside this bank, 1.6m wide and 0.8m deep, that is best preserved to the south-south-west. These features enclose an area of 0.062ha. The second enclosing element is oval in shape and surrounds an area of 4.67ha. It strictly follows the 300m contour varying from 304 to 296m OD. This bank has been incorporated into modern field systems. Immediately inside the southern section of the bank is a hut structure (WI026-004001). This consists of a D-shaped platform, 14m by 12m, cut into the hillslope and defined on the north and east slope by a boulder wall, 1.2–1.3m in width, and a steep scarp 0.8m in height to the south. The third enclosing element is located 65–127m outside of the second enclosure. It is somewhat oval in shape and follows the 280m contour, ranging from 276 to 284m OD over the course of its 1.37km perimeter. The southern half of this enclosure has been incorporated into a field wall which is largely responsible for its survival. It occupies an area of 14.46ha. The partial remains of a fourth enclosing element have been identified through aerial photography.[202] The southern half of this enclosure survives as a low-rise bank feature on agricultural land rather than forestry. When projected, the enclosure occupies an area of 55.74ha. The bank of this enormous enclosure ranges from 221 to 244m OD. A large ring-barrow (WI026-005) abuts the outer enclosure to the east. This comprises a low domed interior, 16–22m in width and 0.4m in height, surrounded by a ditch, 7–9m in width, and outer bank, 11–18m in width and 0.3m in average height. The barrow is approximately 55m in diameter. LiDAR has identified a possible fifth enclosure, approximately 50m from the outside former example. This is best preserved at the south where it survives as a low-rise bank 11.6m in maximum width. When projected, this bank may enclose an area of 84.03ha. Two of the enclosing elements were excavated and revealed Late Bronze Age dates.[203]

Kilranlagh

A possible hillfort was recently discovered by the author on the summit of Kilranlagh, a prominent hill in the Baltinglass area (Fig 19). It is covered in scrub and heather and is partially forested. Recent survey has identified a curving rubble stone bank on the western side of the hill, 140m in length and extending into newly planted forest. The bank is approximately 14m in width and has exterior facing comprising

[202] Condit 1998, 15

[203] O'Brien and O'Driscoll 2017, 288, 297–8

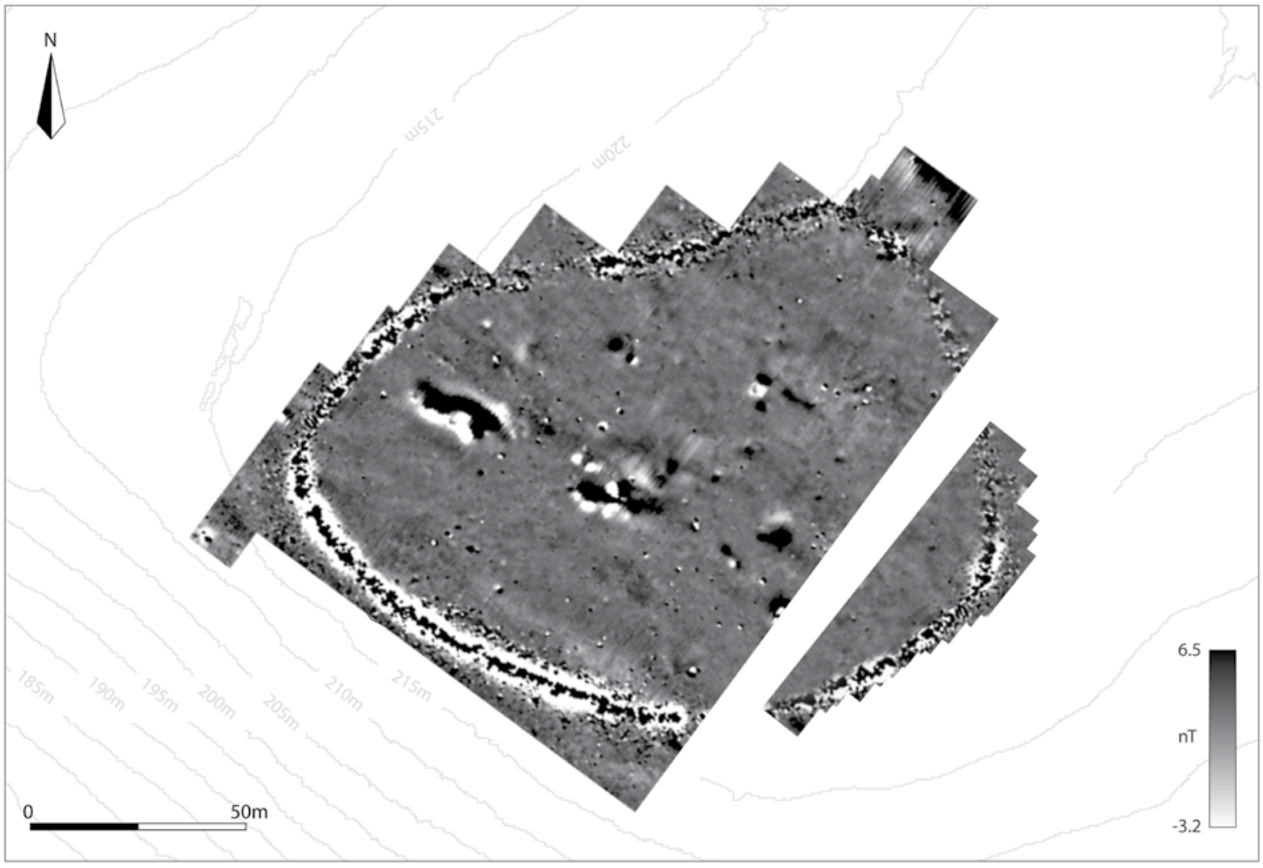


Fig 15 Gradiometry survey results of levelled hillfort in townland of Sruhaun on Tuckmill Hill

large slabs. A change in vegetation on the immediate outside may indicate an outer ditch feature. This corresponds with a curving section of bank on the eastern side of the hilltop, depicted in first-edition Ordnance Survey maps. These may be the remains of a hillfort bank that, when projected, would have enclosed an area 5.33ha. Three large cairns are visible on the hilltop, and on the eastern foot of the hill there is a barrow and stone circle consisting of 11 stones. Though undated, the stone circle is important, as it may indicate Late Bronze Age ritual activity in the immediate environs of the hillfort.

Interpreting the Baltinglass hillfort cluster

Mitchell and Ryan have proposed two scenarios explaining the function of this particular hillfort complex.[204] The first suggests that the tribal centre of a particular community was moved from hilltop to hilltop over a period of time. The second interprets the hillforts as defensive structures built by opposing polities, the monuments acting as 'rival works inspired by competitive emulation'. We now know, however, that not all of the forts are contemporary, with at least two dating to the Early Neolithic (Spinans Hill 1 and Hughstown), two dating to the Middle Bronze Age (Rathnagree and Sruhaun) and one dating to the Late Bronze Age (Tinoran). Clearly there may have been overlap in terms of construction and use between some of the sites, and those sites may have been built by a single community, the monuments reflecting a hierarchy of settlement within a stratified society. This would fit neatly with theories of competitive display within the power- and prestige-centred societies of the Late Bronze Age. This is further manifest in the excessive architecture of these forts and the conspicuous consumption of labour involved in their construction.

Grogan has estimated that the largest section of the inner bank at Rathcoran, Co Wicklow, comprises 24m³ of material, making it one of the largest hillfort banks in Ireland.[205] In total, the enclosing elements of Tinoran hillfort, Co Wicklow, are 7.596km in length, comprising the longest cumulative length of hillfort banks in Ireland. Spinans Hill 2, Co Wicklow, enclosing an area of 131ha, represents the largest hillfort in Ireland. The elaborate enclosing elements at Hughstown, Co Kildare, comprise a large ditch feature 375m in diameter, surrounding a complex series of closely spaced, concentric timber palisades comprising 3.27km worth of vertically set timber posts. Wood was the main raw material used in prehistoric Ireland and its extensive use on a single hillfort must have been seen as a dramatic display of power and authority.[206] At Rathnagree, Co Wicklow, geophysical survey and excavation have re-

[204] Mitchell and Ryan 1997, 241

[205] Grogan 2005a, 237

[206] Mitchell and Ryan 1997, 232–3

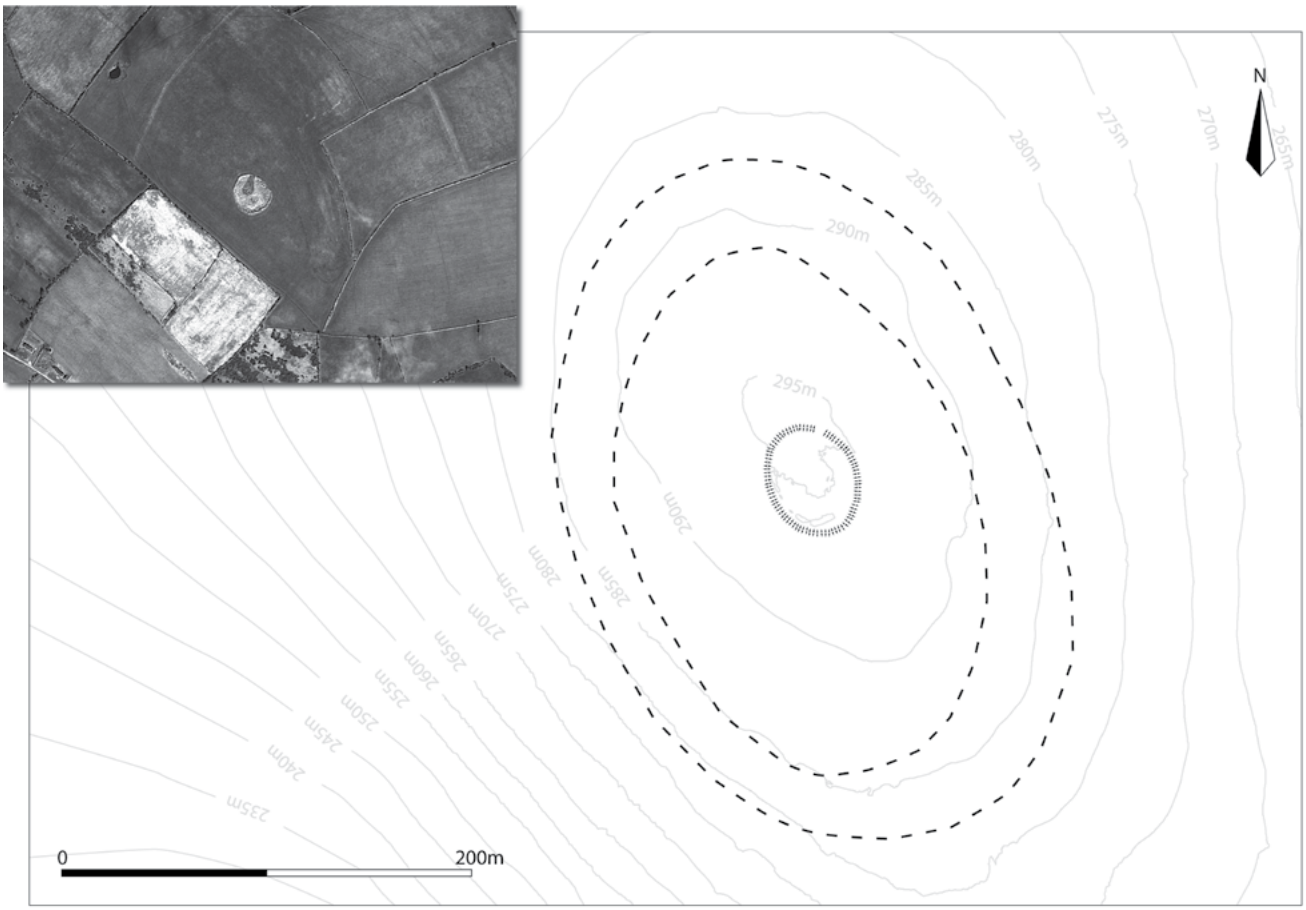


Fig 16 Hughstown hillfort (satellite image from Google Earth, Digital Globe 2014)

vealed that the inner and outer enclosing elements were footings for large palisades, comprising a cumulative length of 1.17km. Geophysical survey has also identified the probable use of timber in the enclosing elements at Rathcoran and the levelled hillfort in the townland of Sruhaun, both on Tuckmill Hill, Co Wicklow. Regardless of their relative dating, the forts in Baltinglass comprise some of the largest forts in the country, and their construction would have required extensive labour and resources.

The complexity of the Baltinglass examples sets them apart from other hillforts or hilltop forts in Ireland. Multivallate hillforts in the Baltinglass cluster average 28.1ha in size, compared with the average 7.82ha for all multivallate examples. Univallate hillforts in the Baltinglass cluster (not including Spinans Hill 2) are on average 5.96ha in size, comparing better with the Irish average of 3.64ha. The size of the Baltinglass monuments is presently unmatched in Ireland, as is the dense clustering of these large monuments within a relatively small area.

Mitchell and Ryan have commented on the size of the Spinans Hill 2, stating that it is a 'truly remarkable investment in labour and organization' and that 'it was not just a response to local needs', rather, 'there must have been a centre of regional importance there'.[207] Raftery has suggested that the hillfort could have been used to delimit an area of tribal assembly or may be comparable to the Dorsey 'enclosure', Co Armagh.[208] Condit, however, stresses that the Dorsey and the Dun of Drumsna, Co Roscommon, probably functioned as defensive dykes protecting multiple fording points in rivers.[209] While these enclosures compare with Spinans hill 2 in terms of size, Condit points out that the latter encloses a hilltop and is not a gateway in the fashion of the Dorsey and the Dun of Drumsna.[210] Raftery questions the defensive function of the contour fort, suggesting that it could never have functioned as a single defended settlement.[211] Whatever its function, it is clear that the construction of such a large monument represents a concentrated effort by a significant number of people.[212] Certainly, the large number of hut sites, if contemporary with the hillfort complex, suggests an extensive, nucleated population large enough to build such monuments. The extensive size of the hillfort could certainly be regarded as the conspicuous consumption of labour and might be regarded as another facet of competitive display.

Competitive display is further emphasized by the results of GIS viewshed analysis of the wider Baltinglass area. Viewsheds of areas visible from each hillfort were created

[207] *ibid*, 241
[208] Raftery 1994, 63
[209] Condit 1998; Condit and Buckley 1998
[210] Condit 1998, 23
[211] Raftery 1994, 63
[212] *ibid*

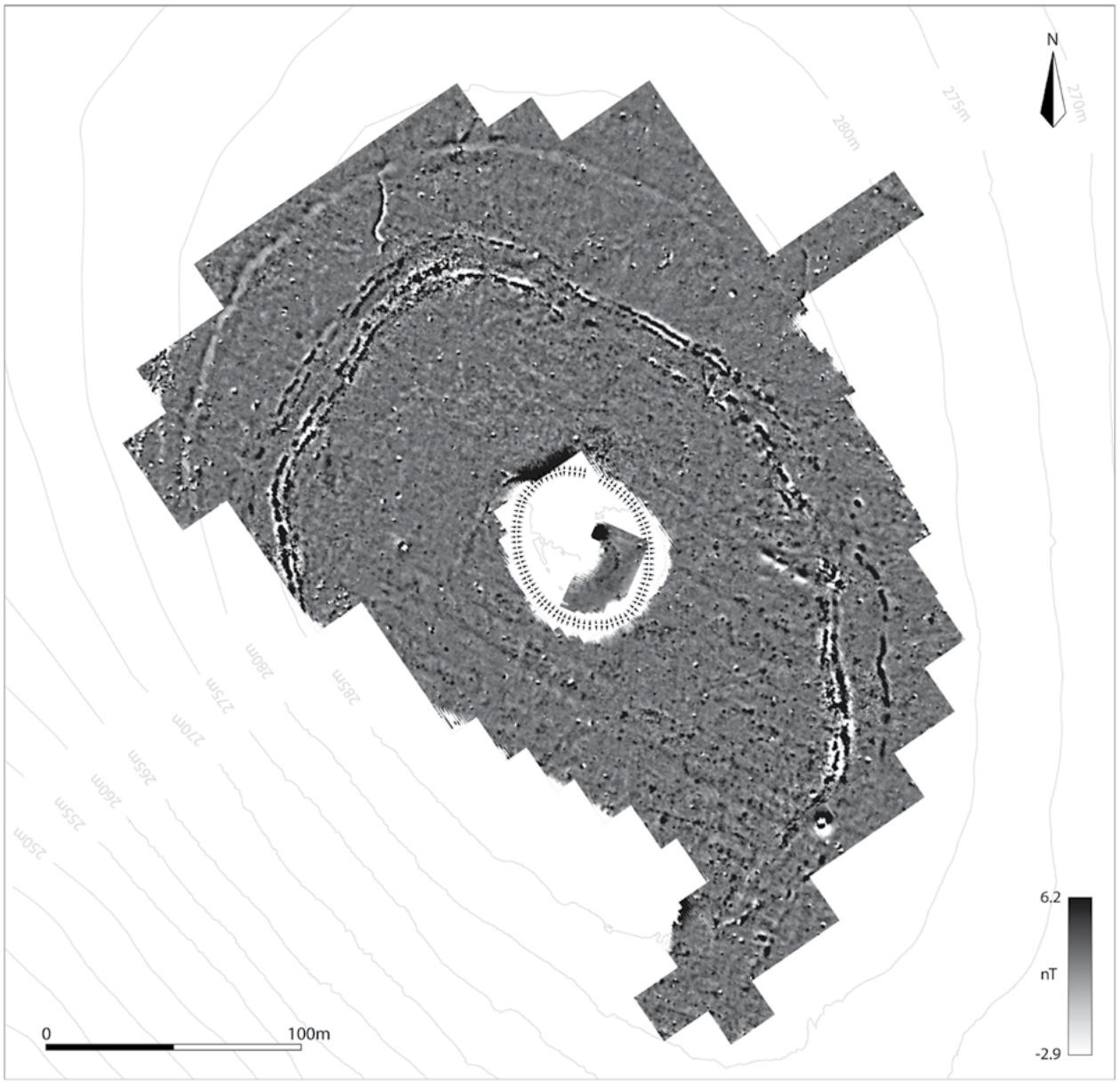


Fig 17 Hughstown hillfort gradiometry survey results

and intersected, revealing a limited cumulative visibility of the immediate landscape. All of the hillforts in the Baltinglass area, with the exception of Sruhaun hillfort on Tuckmill Hill, are intervisible. This model does not consider potential palisade features identified through geophysical survey, which would further increase the visibility of the hillfort defences and help them to contrast in the landscape. While we now know that these monuments are not 'rival works of competition emulation', we might consider that later construction of an important Bronze Age power centre (such as Rathnagree or Tinoran) may have been a deliberate attempt to reference past monuments of power (such as Hughstown or Spinans Hill 1). In this regard, intervisibility would be seen as a key influence on site location. This analysis prompted survey of Kilranlagh Hill, Co Wicklow, and the subsequent identification of the possible remains of a hillfort on its summit. A further two hilltops are intervisible with the hillforts and await detailed survey. The viewshed analysis also suggests that Keedeen Mountain was one of the most prominent features in this area. GIS analysis of Tuckmill Hill LiDAR indicates that these three monuments may have been placed to overlook all access routes to the summit. This may also be argued for the three hillfort comprising the Spinans Hill complex.

The geophysical surveys at Hughstown, Tinoran, Rathnagree, Sruhaun and Rathnagree, indicate that timber palisades were important components of the defences and that these were destroyed by fire, a method of both purification and destruction abundantly found in the Neolithic and Bronze Age throughout Europe. In the case of Rathcoran, the destruction of the palisade may have taken place prior to its completion, indicating that this was probably not a

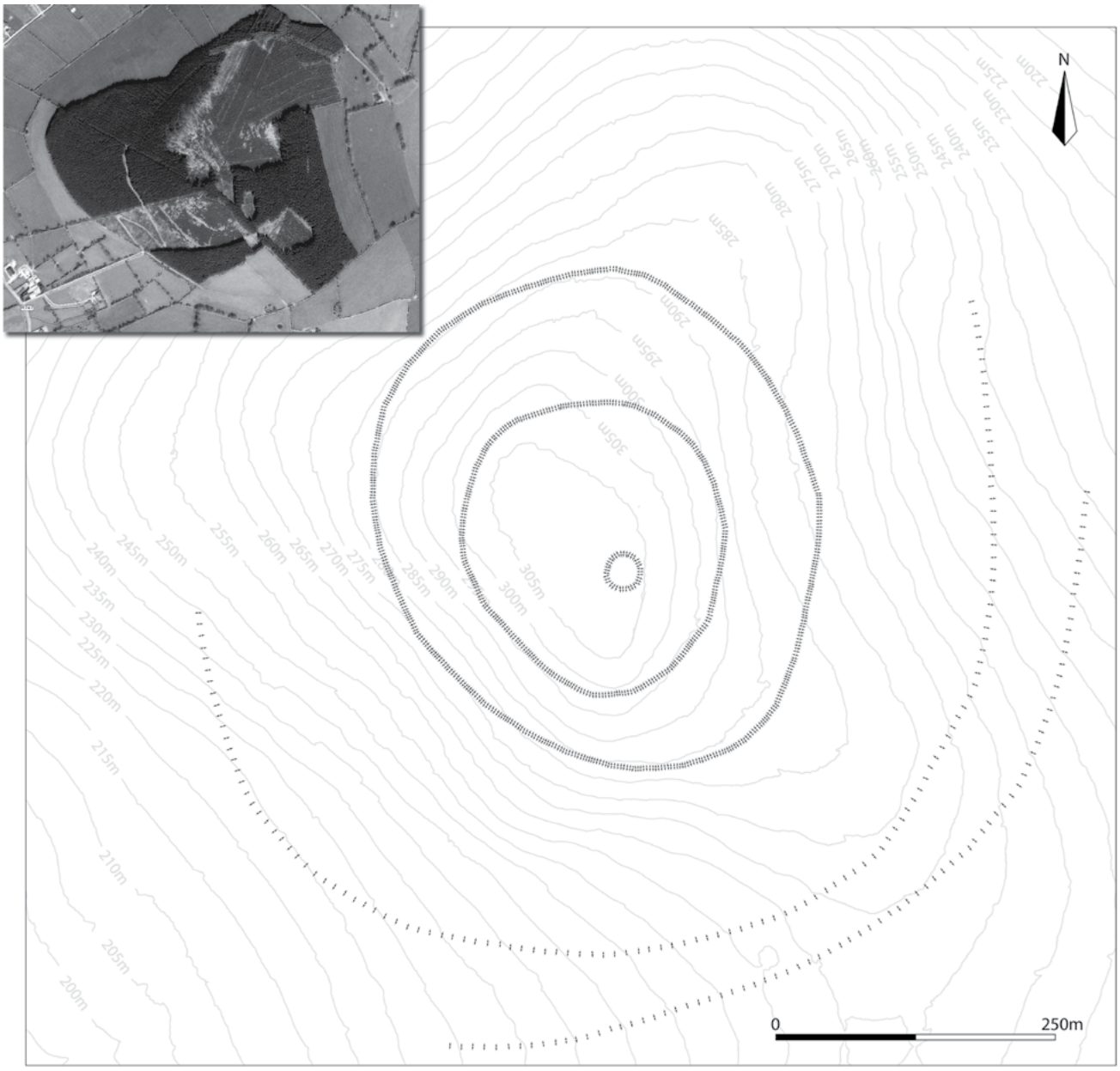


Fig 18 Tinoran hillfort (satellite image from Google Earth, Digital Globe 2014)

ritual act. Rather, the destruction of this monument, and possibly the destruction of the other hillforts in the Baltinglass cluster, may have been deliberate acts of aggression by competing groups. When discussing the creation of vitrified forts, Ralston[213] suggests that the resultant 'intense glow' from the deliberate burning of the hillfort defences was not a natural sight, but a spectacular display of calculated destruction that was a clear intimation of the power of those commanding the process, although in this example, the firing of the defences may have been undertaken by the hillfort builders themselves. In a similar way, the firing of hillfort palisades by competing communities may have acted as a striking display of dominance over the subordinate group. Irrespective of if this was an act of aggression or ritual, this destruction was clearly a deliberate, premeditated act, as the entire circuit of the palisades at Hughstown, Rathnagree and Sruhaun was completely destroyed. Considerable resources would have been needed to start and maintain these fires, particularly at Hughstown, where the four palisades with a combined length of 3.27km were completely destroyed. Evidence for the burning of palisades at other Irish hillforts has been identified at Clashanimud, Co Cork, and Toor More, Co Kilkenny.

[213] Ralston 2006, 163

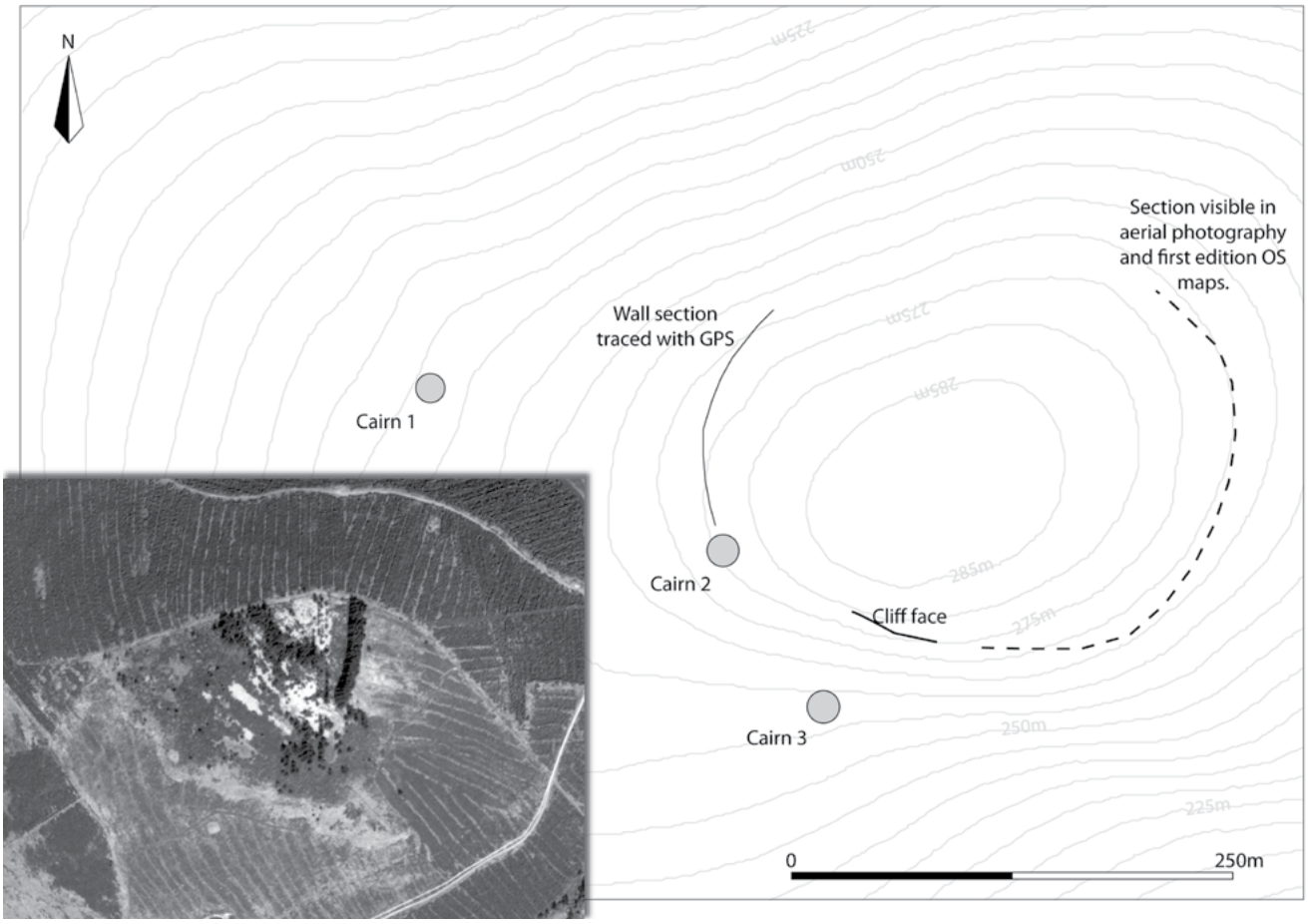


Fig 19 Kilranlagh hillfort (satellite image from Google Earth, Digital Globe 2014)

Conclusion

The effort involved in constructing large hilltop forts clearly indicates the mobilization of a sizable community who controlled considerable resources. The multiple lines of enclosure could be viewed as a mark of status and a proclamation of the power possessed by the creators, particularly in regard to the Bronze Age hillforts, and may also have acted in a functional, possibly defensive manner. The deforestation of the environs would have further enhanced each of the monuments and would have made them a visually striking feature in the landscape, at odds with its natural surroundings. Often positioned overlooking natural routeways, the control of goods and people would have been of great concern, and the ability to attract both may be manifest in the monuments position and its monumentality.

Current evidence strongly suggests that Irish hillforts were constructed in the Late Bronze Age. In Ireland, hillforts generally occur in isolation, with few examples occurring in pairs. Similarly, there are no examples of groups of early Neolithic monuments in Ireland, though there are some comparisons to be made with southern Britain. This is one of the unique aspects of the Baltinglass cluster. Surrounding the town of Baltinglass, Co Wicklow, a group of nine forts are positioned on adjacent hilltops. The clustering of hilltop forts may be indicative of a contested landscape or else a remarkable concentration of wealth and hierarchical power. This is further emphasized by the size and elaboration of these forts. The Baltinglass cluster comprises some of the largest hillforts and Early Neolithic enclosures in Ireland and includes the enormous Spinans Hill 2, the largest recorded hillfort in Britain and Ireland. The size of other hillforts in this cluster, such as Tinoran and Brusselstown Ring, which are the second and third-largest hillforts in Ireland, highlight a cluster of monuments that are monumental in scale. The elaboration and incorporation of different types of enclosing elements also emphasizes the knowledge of the builders and the resources under their control. The monuments themselves represent the conspicuous consumption of labour on a scale greater than anywhere else known in Ireland in prehistory. They represent a huge and concentrated effort by a significant populous. This on-going study concurs with previous assessments that the Baltinglass area must have been a place of exceptional importance in prehistory.[214] The defensive positioning of the hillforts on Tuckmill Hill indicates that protection against aggressors may have been a primary concern, while the intervisibility of the hillforts suggests that competitive display and reference to older monuments of power were also important. The individual forts may have been symbols of power and status erected by different communities at different times, though

[214] Condit 1992; 1998; Raftery 1994, 62–3

we must also acknowledge that some may have been occupied concurrently. We must therefore question if these were competing communities located in close proximity to one another and if destruction by another group could be seen as an act of supremacy. Community building as described by Lock[215] could have been important in such social conditions, strengthening the sense of individual community and increasing the divide between neighbouring groups. This may have resulted in the conspicuous consumption of resources with large, elaborate forts being built as acts of competitive display.

Future research will help to better contextualize the significance of this area on a national level, assessing its sociopolitical, economic and ideological importance in both contemporary and later society. Geophysical survey on the Spinans Hill complex will be particularly important. It will help to build a more comprehensive picture of the importance of this complex in the overall context of the Baltinglass cluster. Targeted excavation of a number of these hillforts, to attain dating evidence related to their construction and destruction, will be another important facet of this research. This will help to place these hillforts in a chronological framework and will inform the interpretation in a cultural landscape setting.

Acknowledgements

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[215] Lock 2011, 359

Table 1 Radiocarbon dates from Irish hillforts (based on Chapple 2013, with additions); calibrated dates expressed at two sigma (95.4%) levels of confidence; calibration conducted using CALIB software, versions 5 to 7, as available at the time (after Stuiver and Reimer 1993)

Site	Lab code	^{14}C result BP	cal BC date (2 σ)	Context	Source
Mooghaun, Co Clare	GrN-20490	2895±50	1259–931	Charcoal from directly under base of rampart (outer stone bank; area F)	Grogan and Condit 1994, 7
	UB-4274	2720±26	912–814	Bone (bos) from occupation in rampart; phase 2/3?; F200. Hill-fort, middle rampart; area C	Grogan 2005a, 128
	UB-4275	2738±29	970–816	Bone (bos) from below final bank F249; phase 3; F257. middle rampart; area C	Grogan 2005a, 128
	UB-4276	2716±31	916–809	Bone (bos) from within rampart; phase 1?. inner rampart; area A11	Grogan 2005a, 128
	UB-4277	2534±28	795–546	Bone (bos) from within final bank F249; phase 2/3?. area C; middle rampart	Grogan 2005a, 128
	UB-4278	2760±27	976–832	Bone (bos) from occupation; phase 2; F257. area C	Grogan 2005a, 128
	UB-4279	2762±32	996–832	Bone (bos) from house D; phase 3; F108. area C	Grogan 2005a, 128
	UB-4280	2783±35	1010–838	Bone (bos) from hearth; phase 3; F251. area C	Grogan 2005a, 128
	UB-4281	2719±30	917–811	Bone (bos) from occupation; phase 2/3; F202. area C	Grogan 2005a, 128
	UB-4315	2600±28	816–673	Bone from material in rampart. Hill-fort, middle rampart; area H	Grogan 2005a, 128
	UB-4318	2849±35	1122–918	Bone (bos) from occupation under rampart; phase 1; F338. middle rampart; area C	Grogan 2005a, 128
Haughey's Fort, Co Armagh	GrN-15480	2855±40	1188–910	Wood, small branches from base of inner ditch	Mallory 1995, 75
	GrN-15481	2865±25	1123–938	Charcoal. hearth F2. associated with coarse pottery, burnt bone	Mallory 1995, 75
	GrN-15482	2920±25	1250–1019	Charcoal. Pit F3. associated with coarse pottery, bunt bone, burnt stones	Mallory 1995, 75
	GrN-15483	2850±20	1112–929	Charcoal. Pit F4. associated with coarse pottery, carbonized barley, burnt bone	Mallory 1995, 75
	GrN-15484	2850±35	1122–919	Charcoal. Hearth F5. associated with coarse pottery, burnt bone	Mallory 1995, 75
	UB-3049	2833±55	1191–841	Charcoal. Pit F4. associated with coarse pottery, carbonized barley, burnt bone	Mallory 1995, 75
	UB-3050	2923±50	1294–978	Wood, small branches from base of inner ditch	Mallory 1995, 75
	UB-3880	2872±47	1210–918	Charcoal from fill large shallow pit (Ft 275) around cup & ring stone in interior of site	Mallory 1995, 75
	UB-3881	2962±47	1370–1026	Charcoal from pit (Ft 295) in interior of site	Mallory 1995, 75
	UB-3386	2877±60	1260–906	Charcoal. Pit Ft-267, post-pit of double post-ring? Associated with gold stud from pit	Mallory 1995, 75
	UB-3387	2889±27	1193–980	Charcoal	Mallory 1995, 75
	UB-3388	2852±55	1212–856	Charcoal	Mallory 1995, 75
	UB-3605	2923±16	1211–1047	Charcoal from palisade slot Feature 370 (in palisade packing), associated with coarse pottery	Mallory 1995, 75

Table 1 *continued ...*

Site	Lab code	^{14}C result BP	cal BC date (2 σ)	Context	Source
Haughey's Fort, Co Armagh	UB-3606	2915±16	1207–1026	Wood, small branches from Levels 20/21. Trench 5, from base of inner ditch – primary silt, layer H, associated with coarse pottery, animal bones	Mallory 1995, 75
	UB-3607	2666±16	838–800	Wood, small branches from Level 14, Trench 5, from 0.30m above where UB-3608 was taken, just above main occupation debris (G), Layer F, peaty; dates end of main occupation	Mallory 1995, 75
	UB-3608	2845±16	1053–927	Wood, small branches from Level 17. Trench 5, main occupation debris, Layer G, from small pieces of hazel growing either on the bank or in the ditch when the ditch had filled to a height of 1m; associated with coarse pottery, wooden artefacts, animal bone; dates main occupation.	Mallory 1995, 75
	UB-3878	2824±37	1114–898	Charcoal from post-hole on inner line of stockade (Ft 112) – interior, internal 'stockade'	Mallory 1995, 75
	UB-3879	2920±43	1267–981	Charcoal from post-hole on inner line of stockade (Ft 86) – interior, internal 'stockade'	Mallory 1995, 75
Freestone Hill, Co Kilkenny	GrN-21255	2565±35	810–550	Charcoal from occupation layer	Raftery, 1995
Rahally, Co Galway	UB-7244	2756±32	994–827	Alder from charcoal deposit in basal fill of innermost ditch of hillfort	Mullins 2008, 26, 164
	UB-22636	2509±30	787–538	Charcoal from basal fill of hillfort ditch	Mullins 2008, 26, 164
	UB-22637	2826±30	1108–902	Charcoal from basal fill of hillfort ditch	Mullins 2008, 26, 165
Dún Aonghasa, Co Galway	GrN-20226	2840±25	1120–910	Animal bone from occupation layer overlying the paced floor (F56)	Cotter 2012b, 214, 215
	GrN-20227	2870±35	1190–920	Animal bone from occupation material beneath the paved floor of Hut 1, top of subfloor sequence; under Wall 1.2 terrace (Area B2, F203)	Cotter 2012b, 214, 215
	GrN-20228	2990±30	1370–1120	Animal bone from fill of small bedrock hollow; top of subfloor sequence; under Wall 1.2 terrace (Area B2, F221, Structure 1)	Cotter 2012b, 214, 215
	GrN-20229	2955±25	1270–1050	Animal bone from a spread of occupation material overlying the bedrock hollow, top of subfloor sequence; under Wall 1.2 terrace (Area B2, F216, Structure 1)	Cotter 2012b, 214, 215
	GrN-20230	3070±60	1460–1120	Animal bone from spread of material on the bedrock E of the midden dump, hollow F235, middle of F235 sequence; before Wall 1.2 (Area B2, F209)	Cotter 2012b, 214, 215
	GrN-20231	3165±30	1500–1390	Animal bone from lover level of midden dump (Area B2, F220). Hollow F235. Bottom of F235 sequence; before Wall 1.2	Cotter 2012b, 214, 215
	GrN-20232	2645±35	900–770	Animal bone, on bedrock under Structure 3 (Area B2, F43)	Cotter 2012b, 214, 215
	GrN-20233	2760±35	1000–820	Animal bone from occupation material (Area A, F71/77, over F255)	Cotter 2012b, 214, 215
	GrN-20234	2470±35	770–410	Animal bone from occupation material under floor of Structure 2 (Area B1, F51)	Cotter 2012b, 214, 215
	GrN-20235	2765±35	1000–830	Animal bone from occupation on the bedrock at the northern end of the cutting, late hearth; before Wall 1.2 (Area A, F255)	Cotter 2012b, 214, 215
	GrN-20238	2435±45	760–400	Animal bone from occupation material underlying the paved floor of Structure 2 (Area B1, F258)	Cotter 2012b, 214, 215
	GrA-902	2475±35	770–410	Human bone from infant burial (Area B. F98)	Cotter 2012b, 214, 215
	AA-10270	2585±60	900–510	Animal bone from occupation layer which continues in under the foundations of the external face of Wall 1 at the eastern end of Cutting 2 (F101)	Cotter 2012b, 214, 215
	AA-10273	2785±60	1120–810	Animal bone from occupation material overlying paving east of Area 7 (Area b2, F42), occupation material over path to Structure 2	Cotter 2012b, 214, 215
	AA-10274	2295±60	520–190	Burnt animal bone on the bedrock (F39), abutting linear stone feature which may be an internal division	Cotter 2012b, 214, 215
	AA-10276	2625±60	920–540	Animal bone from gravelly clay underlying the threshold stone at the entrance to the alcove/chamber in Wall 1, outside entrance to chamber (Area C, F92)	Cotter 2012b, 214, 215
	UB-3645	2374±36	730–380	animal bone from base of fill of trough (Area B2. F19)	Cotter 2012b, 214, 215
Rathgall, Co Wicklow	D-132	2960±110	1432–904	Charcoal from upper levels of basket-lined storage pit outside circular house, Square 18	Dresser 1980, 1028
	D-133	2810±110	1294–795	Charcoal from pit at SW corner of Hearth 2, Square 32	Dresser 1980, 1028
	D-134	2810±105	1288–796	Charcoal from Hearth 1, Square 25. sample from initial late Bronze Age occupation (Phase 2)	Raftery 2004, 87
	D-135	2490±120	895–365	Charcoal (wood & cereal grain) from upper levels of ditch/gully surrounding circular house	Dresser 1980, 1028
	SI-1476	2470±80	781–406	Charcoal from Hearth 2 in burnt layer	Waddell 1998, 277–8
	SI-1477	2475±80	783–408	Charcoal from Hearth 7	Waddell 1998, 278
	SI-1478	2560±105	895–407	Charcoal from Hearth 10	Waddell 1998, 278
	SI-1483	2215±80	403–54	Charcoal from black fill of Ditch 1	Chapple 2013, no. 6179
	SI-1484	2450±75	770–402	Charcoal from black fill in lower part of Ditch 1	Chapple 2013, no. 6180
	SI-1485	2930±75	1375–928	Basal fill of hillfort ditch, dating to period just after hill-fort construction	Chapple 2013, no. 6181
	UB-2343	3440±120	2114–1455	Charcoal from grey layer under ramparts; contained fragments of clay moulds and coarse pottery	Anon 1987–88, 79

Table 1 *continued …*

Site	Lab code	^{14}C result BP	cal BC date (2 σ)	Context	Source
	UB-2344	3780±140	2580–1776	Charcoal from grey layer under ramparts; contained fragments of clay moulds and coarse pottery	Anon 1987–88, 79
	UB-2348	2915±75	1371–916	Charcoal from upper fill of hillfort ditch	Anon 1987–88, 79
	GrN-27097	2950±45	1307–1016	Date on charcoal from dark occupation, spread from Hearth 3	Chapple 2013, no. 6155
	GrN-27098	2945±40	1292–1019	Charcoal from thick black occupation level in Ditch 1, 50cm west of wall, 25cm deep	Chapple 2013, no. 6156
	GrN-27099	2475±25	765–417	Charcoal from blackish organic material, 30–40cm below rim of Ditch 1; same context as GrA-23351	Chapple 2013, no. 6157
	GrN-27101	2950±30	1286–1050	Charcoal from black lining of Pit 119; associated with penannular copper ring with gold foil cover 6070	Chapple 2013, no. 6158
	GrN-27102	2880±30	1192–938	Charcoal from black outer level in Pit 118 (large storage pit)	Chapple 2013, no. 6159
	GrN-27104	2965±45	1372–1043	Charcoal from Basket Work 2 in Pit 118	Chapple 2013, no. 6160
	GrN-27105	2910±40	1260–997	Charcoal from thick black layer under cashel wall, associated with pottery and mould fragments	Chapple 2013, no. 6161
	GrN-27106	2910±25	1208–1013	Charcoal from upper zone of black occupation layer	Chapple 2013, no. 6162
	GrN-27107	2870±35	1190–926	Charcoal 'in brown material'	Chapple 2013, no. 6163
	GrN-27108	2890±30	1207–977	Charcoal from suspected wooden feature	Chapple 2013, no. 6164
	GrN-27109	2910±35	1257–1003	Charcoal from 'heavy black charcoal-filled layer'	Chapple 2013, no. 6165
	GrN-27110	3000±30	1374–1129	Charcoal from 'heavy black charcoal-filled layer'	Chapple 2013, no. 6166
	GrN-27111	2880±35	1194–934	Charcoal from 'light, mottled ashy brown, S of black'	Chapple 2013, no. 6167
Rathgall, Co Wicklow	GrN-27112	2990±40	1385–1060	Charcoal from V-shaped trench (Ditch 2) in burial enclosure	Chapple 2013, no. 6168
	GrN-27113	2970±30	1310–1057	Charcoal from 'black material on top of bank' (bank associated with Ditch 1)	Chapple 2013, no. 6169
	GrN-27114	2940±30	1263–1046	Charcoal from 'black heavily burnt horseshoe shaped area' in burial enclosure	Chapple 2013, no. 6170
	GrN-27115	2910±30	1250–1008	Charcoal from 'black material in section-strip'	Chapple 2013, no. 6171
	GrN-27116	3100±40	1446–1266	Charcoal from black fill of Pit 166	Chapple 2013, no. 6172
	GrN-27117	2930±30	1259–1024	Charcoal from 'black occupation layer'	Chapple 2013, no. 6173
	GrN-27118	3175±35	1514–1396	Charcoal from black fill of Pit 4 – associated with cremation	Chapple 2013, no. 6174
	GrA-22304	2805±35	1049–846	Burnt human bone; cremation in pot (coarseware) in pit	Chapple 2013, no. 6246
	GrA-23341	2915±45	1264–978	Charcoal from grey fill, under stones (Ditch 1)	Chapple 2013, no. 6290
	GrA-23344	2985±45	1380–1056	Piece of basketry from basketry lining, Phase 1 (Pit 118)	Chapple 2013, no. 6291
	GrA-23345	2920±45	1268–980	Charcoal from innermost brown filling (Pit 118)	Chapple 2013, no. 6292
	GrA-23346	2940±50	1366–1002	Charcoal from darkish material immediately east of bank	Chapple 2013, no. 6293
	GrA-23347	2965±45	1372–1043	Charcoal from bedding trench of sub-rectangular structure	Chapple 2013, no. 6294
	GrA-23349	2930±45	1292–1004	Charcoal from black fill (Pit 166), same as GrN-27116	Chapple 2013, no. 6295
	GrA-23350	2900±45	1259–939	Charcoal from black organic material, 55cm below yellow natural (Ditch 1)	Chapple 2013, no. 6289
	GrA-23351	2975±45	1375–1051	Charcoal from blackish organic material, 30–40cm below rim of Ditch 1, same context as GrA-27099	Chapple 2013, no. 6288
	GrA-23353	2955±45	1313–1016	Charcoal from black fill (Pit 4)	Chapple 2013, no. 6296
	GrA-23355	2585±45	832–545	Charcoal	Chapple 2013, no. 6297
	UBA-10284	2277±39	402–208	Plant macrofossils	Macdonald 2016, 49
	UBA-10286	2386±38	740–389	Unidentified charred and charred twigs	Macdonald 2016, 49
	UBA-10289	2949 ± 39	1295–1027	Unidentified charcoal fragments charred twigs	Macdonald 2016, 49
	UBA-10335	2209±28	373–200	Woody stem fragment	Macdonald 2016, 49
	UBA-10337	3086 ± 27	1426–1293	Charred and uncharred plant terial	Macdonald 2016, 49
	UBA-10914	3834±22	2454–2201	Charred hazelnut shell	Macdonald 2016, 49
	UBA-10915	3851±32	2459–2206	Charred hazelnut shell	Macdonald 2016, 49
	UBA-10916	2960±47	1370–1020	Unidentified charcoal twigs	Macdonald 2016, 49
	UBA-10917	4012±21	2573–2476	Unidentified charcoal twigs	Macdonald 2016, 49
	UBA-10920	3053±29	1409–1221	Unidentified charcoal twigs	Macdonald 2016, 49
	UBA-10921	2145±20	350–107	Unidentified charcoal twigs	Macdonald 2016, 49
Knockdhu, Co Antrim	UBA-10947	2619±21	818–782	Unidentified charcoal twigs	Macdonald 2016, 49
	UBA-10948	2792±22	1008–858	Unidentified charcoal twigs	Macdonald 2016, 49
	UBA-10950	2557±28	802–555	Unidentified charcoal twigs	Macdonald 2016, 49
	UBA-10952	3297±21	1626–1516	Unidentified charcoal twigs	Macdonald 2016, 49
	UBA-10954	3850±27	2459–2206	Charred hazelnut shell	Macdonald 2016, 49
	UBA-10955	2635±27	836–784	Unidentified charcoal twigs	Macdonald 2016, 49
	UBA-10957	2746±26	972–825	Unidentified charcoal twigs	Macdonald 2016, 49
	UBA-10958	2663±27	895–795	Unidentified charcoal twigs	Macdonald 2016, 49
	UBA-10959	3377±27	1743–1613	Unidentified charcoal twigs	Macdonald 2016, 49

Table 1 *continued ...*

Site	Lab code	^{14}C result BP	cal BC date (2 σ)	Context	Source
Knockdhu, Co Antrim	UBA-10960	2855±27	1118–930	Unidentified charcoal twigs	Macdonald 2016, 49
	UBA-10961	3136±3	1494–1318	Unidentified charcoal twigs	Macdonald 2016, 49
	UBA-10962	3357±27	1737–1535	Unidentified charcoal twigs	Macdonald 2016, 49
	UBA-10963	2927±27	1257–1026	Unidentified charcoal twigs	Macdonald 2016, 49
	UBA-10964	2609±28	1257–1026	Unidentified charcoal twigs	Macdonald 2016, 49
	UBA-10965	2735±30	969–814	Unidentified charcoal twigs	Macdonald 2016, 49
	UBA-10968	2964±26	1297–1058	Unidentified charcoal twigs	Macdonald 2016, 49
	UBA-10969	3183±24	1499–1416	Unidentified charcoal twigs	Macdonald 2016, 49
Clogher, Co Tyrone	UB-837	3045±75	1451–1055	Charcoal predating the 'inauguration mound', from old soil sealed by debris derived from construction of mound	Pearson 1979, 276
	UB-839	2630±45	904–604	Charcoal (probably from a post-hole) on habitation platform associated with flat-based coarse ware	Pearson 1979, 276
	UB-840	2420±100	798–236	Charcoal part of post, perhaps contaminated by occupation	Pearson 1979, 276
	UB-2175	2640±45	903–675	Charcoal spread on artificial platform (field?) cut by plough marks	Pearson 1979, 277
	UB-2246	2210±115	721 cal BC–51 cal AD	Charcoal from bank of ring barrow	Chapple 2013, no. 6145
Freestone Hill, Co Kilkenny	GrN-21255	2565±35	807–550	Charcoal from occupation layer	Waddell 2000, 277
Knockacarrigeen Hill, Co Galway	UB-3968	3621±55	2189–1781	Charcoal from pit with occasional burnt stone (Area A)	Carey 2002, 61
	UB-3969	4021±48	2851–2458	Charcoal from layer of grey gravels (Area A)	Carey 2002, 61–2

Table 2 Radiocarbon dates from Irish hillforts, calibrated dates expressed at two sigma (95.4%) levels of confidence, calibration conducted using OxCal 4.2 software (after Bronk Ramsey 2013)

Site	Lab code	^{14}C result BP	cal BC date (2 σ)	Context	Site sample no.
Clashanimud, Co Cork	GrN-29042	2920±50	1263–976	Charcoal at base of ditch, inner enclosure	CD2004-01
	GrN-29043	3075±20	1409–1280	Charcoal from palisade post, bank of inner enclosure	CD2004-02
	GrN-29044	3000±20	1371–1130	Charcoal from palisade post, bank of inner enclosure	CD2004-03
	GrN-29045	2965±20	1260–1116	Charcoal layer within bank of inner enclosure	CD2004-04
	GrN-29046	3050±20	1396–1231	Charcoal from palisade post, bank of inner enclosure	CD2004-05
	GrA-42677	2985±35	1378–1089	Charcoal at base of ditch, outer enclosure	CD2008-01
	GrA-42678	3160±40	1511–1303	Pre-bank charcoal, outer enclosure	CD2008-02
	GrA-42679	3105±35	1442–1273	Charcoal from palisade post, entrance to inner enclosure	CD2008-05
	GrA-42682	2910±35	1214–1006	Charcoal from palisade post, entrance to inner enclosure	CD2008-04
	GrA-42683	2940±35	1258–1027	Charcoal from palisade post, bank of inner enclosure	CD2008-03
	GrA-42684	2915±35	1216–1008	Charcoal from palisade post, bank of inner enclosure	CD2008-06
	GrA-67392	2745±35	976–815	Charcoal at base of ditch, inner enclosure	CD2016-01
Ballylin, Co Limerick	GrA-54510	2975±30	1368–1059	Charcoal from gate posthole, inner enclosure	BL2010-01
	GrA-54599	2930±50	1279–980	Charcoal beneath bank slip, inner enclosure	BL2010-02
	GrA-54616	2915±45	1258–979	Charcoal from entrance passage, inner enclosure	BL2010-04
Glanbane, Co Kerry	GrA-54508	2850±30	1111–927	Charcoal at base of ditch, inner enclosure	GB2012-02
	GrA-54509	2860±30	1118–929	Charcoal at base of ditch, inner enclosure	GB2012-03
Formoyle Beg, Co Clare	GrA-54956	2840±30	1108–917	Charcoal from inside bank of inner enclosure	FM2012-01
	GrA-54957	2890±30	1195–978	Charcoal at base of ditch, inner enclosure	FM2012-02
	GrA-54958	3125±35	1494–1289	Pre-bank charcoal, inner enclosure	FM2012-03
	GrA-54961	2880±30	1192–939	Charcoal from stake fence, outer enclosure bank	FM2012-05
	GrA-54963	2900±30	1207–1004	Charcoal from stake fence, outer enclosure bank	FM2012-06
	GrA-54964	2880±30	1192–939	Charcoal from stake fence, outer enclosure bank	FM2012-07
	GrA-54965	2920±35	1218–1011	Pre-bank charcoal, outer enclosure	FM2012-08
Toor More, Co Kilkenny	GrA-58572	2970±30	1281–1058	Charcoal from palisade trench, inner enclosure	TM2013-01
	GrA-58574	2945±30	1258–1049	Waterlogged wood at base of ditch, inner enclosure	TM2013-04
	GrA-58575	2935±35	1257–1019	Waterlogged wood at base of ditch, inner enclosure	TM2013-03
	GrA-58576	2920±35	1218–1011	Charcoal from palisade trench, outer enclosure	TM2013-06
	GrA-58577	3000±30	1377–1126	Charcoal from burnt spread, outer enclosure	TM2013-07
	GrA-58614	2845±35	1114–917	Charcoal at base of ditch, inner enclosure	TM2013-02
	GrA-59103	2975±35	1369–1056	Burnt bone from palisade trench, inner enclosure	TM2013-05

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The re-use of prehistoric burnt mounds in Ireland: the importance of social memory, identity and place

Alan Hawkes

This paper explores the long-term re-use of burnt mounds, practices of trough re-cutting and abandonment, and the implications of these actions for the construction of memory, myth and identity in prehistoric communities in Ireland. The archaeological evidence suggests that the sustained re-use and modification of certain sites was carried out in order to create conscious links with the past, where evidence of pyrolithic activity influenced subsequent activities at the same locations. Burnt mounds must have been redolent with 'memories' of past social occasions involving feasting, and as such would have been important for the construction and reproduction of social memory.

Introduction

As outlined by Gibson,[1] it is not difficult to understand how 'monumental' sites in the landscape continued to be relevant in the lives of later inhabitants. In fact, most studies of memory and landscape have tended to emphasis the continued significance of large ritual monuments of place over time. Smaller or less 'visible' features were also bound up in such practices over long periods, including the subject of this paper, prehistoric burnt mounds.

Burnt mounds have become one of the best known and most frequently excavated prehistoric site types in Ireland. By 2010 an estimated 1200 sites have been excavated, with some 900 of these as a direct consequence of road and pipeline development, making this the most common archaeological site discovered during such projects. The excavated deposits are mainly composed of accumulations of charcoal and heat-affected / cracked stones representing the waste-firing material associated with a pyrolithic technology. This involved a process of heat transfer that centred around the immersion of hot stone in troughs of water, often but not exclusively lined with wood or stone (Fig 1).

After numerous firings these stones were eventually shattered by the sudden cooling process, and gradually accumulated near the boiling pit to form a low mound or spread that contained large amounts of charcoal. These are generally recognized as crescent-shaped mounds of burnt stone, or are exposed in plough-soil and in modern developments as levelled spreads of burnt stone mixed with high levels of charcoal-enriched soil. While the use of water-boiling technology was particularly common, examples employing a dry heat are also known in the archaeological record.[2] During the Bronze Age, the use of this particular technology became widely adopted in northern Europe, particularly in Ireland. While the peak of burnt mound activity takes place in the Bronze Age, it is by no means confined to this period, as examples exist from the Early Neolithic period through to the Early Iron Age. There are no convincing examples dating to the medieval period, with the evidence instead suggesting that burnt mounds were later mythologized in Irish folklore.[3]

The rapid adoption of pyrolithic technology in Bronze Age Ireland does not seem to have been based on a search for a more efficient cooking technique, but rather in the social context of its use. For instance, the considerable social investment required for pyrolithic water-boiling provides a backdrop for social activity where 'networks of personal relationships are created and maintained and social bonds are constructed and expressed'.[4] Ó Néill observed that the boiling process could take anything from three to four hours to as many as seven or eight, depending on the anticipated result.[5] This is a substantial amount of time for an activity that seems to have been undertaken on a sporadic basis. If cooking was indeed the primary function of burnt mounds, it should not be viewed as a mundane undertaking, but rather one that actively contributed to the constitution of social relations. In this sense, burnt mounds were far more than just places where water was heated or food was cooked. They may have represented significant areas in which people engaged in different forms of social reproduction.

Therefore, the technology was not just a technical process, but a social one that was as much about the making and reproduction of social relations, individual and group identities, as about the production of heated water. As such, burnt mounds may have been important to the maintenance of social memories. Rather than becoming static and quickly forgotten landmarks, their significance was sometimes retained, remembered and redefined by later groups wishing to stake claims to particular places in the landscape. As outlined by Dewer and McBride in relation to settlement patterns, 'the distribution of archaeological materials across a landscape is almost always a product of many years and even generations of use'.[6] This can be extended to include burnt mound deposits, which may not necessarily reflect an articulation of a typical seasonal round with permanent landscape features, but rather many years of the establishment and abandonment of residential occupations on a landscape, some of whose features altered over time in response to previous use. As such, it is important to acknowledge that

[1] Gibson 2013, 99
[2] Hawkes 2015, 62–5
[3] *idem* 2012
[4] Jiménez and Montón-Subías 2011, 1
[5] Ó Néill 2009, 197
[6] Dewer and McBride 1992, 229



Fig 1 Hearth and water trough with parcels of meat boiling within (photo courtesy of Ferrycarrig Heritage Park, Co Wexford)

the evidence of earlier pyrolithic activity must have influenced in some way that which followed it. Burnt mounds may have been layered with meaning through multiple episodes of earlier activity, each of which leaving its own distinctive physical imprint.

This paper explores these issues by presenting a summation of the archaeological evidence for the re-use of burnt mounds in Ireland. The reasoning behind these episodes of re-use is examined along with evidence of deliberate deposition related to periods of permanent abandonment. From the foregoing review, it is possible to see the re-use of certain sites as a powerful material reminder of identify, important for the construction and reproduction of social memory, investing groups with a sense of past. To this end, certain aspects of commemoration may have been important at some burnt mounds, with the deposition of objects seen to either maintain social memories, ritual traditions or to underline ancestral connections to reinforce their physical and social place in the landscape.

The archaeological record: burnt mound 're-use'

To discuss aspects of site re-use, it is necessary to consider terminology and how this represents the archaeological record. For instance, what do we mean by the term 're-use' when it is obvious that many burnt mounds in Ireland had long histories of use. Re-use at burnt mounds is best illustrated by those sites where multi-context radiocarbon sampling is applied, establishing a detailed site chronology. Unfortunately, the number of sites dated in such a manner is relatively low, with sampling methods not always capturing the entire history of a site.

It should also be acknowledged, however, that some pyrolithic sites were short-lived and did not form mounds. These are composed of smaller deposits of fired stone and charcoal with an accompanying pit(s) used for either water-boiling, steaming or dry-roasting. It is reasonable to suggest that these smaller pyrolithic sites may not have been used for larger communal gatherings, but may instead relate to smaller familial or hunting party meals organized on an *ad hoc* basis.[7] Therefore, at some of the larger burnt mounds, it is conceivable that the archaeological remains represent places that people regularly returned to over a long period of time, and were intentionally constructed and 'maintained' as monuments, invoking memories and providing constant reminders of the past.[8]

In contrast with shorter-lived sites, the use of larger, more complex burnt mounds reflects an extended occupation of landscape. Such sites could have been temporarily or seasonally abandoned and only occasionally taken permanently out of commission. With a well-defined physical presence in the landscape, particularly where they cluster in small groups, this might have been connected to tenure where particular owners / families marked rights to good land with the mounding of burnt stone from cooking episodes. The formation of mounds from this practice would have brought them into the realm of social memory by making it a place associated with feasting and myth of particular families or communities of those areas.

While the radiocarbon evidence may indicate that a particular pyrolithic site was 'returned' to after an interval of disuse, it is difficult to differentiate burnt mound re-use after shorter periods of inactivity such as a week, month, year, decade or century. All we can say is that some sites were used for 'prolonged periods' while others were 're-used' after phases of abandonment. While the former may reflect aspects of continuity where a burnt mound could have been used seasonally, the latter signifies periods of 're-occupation' after short or long episodes of inactivity.

While it can be difficult to distinguish between sites used for prolonged periods and those which were 're-used' due to incomplete site chronologies, in some cases this can be clearly demonstrated. Where evidence exists for multiple phases of use on a site, it is seen principally in the form of (a) burnt mound stratification, (b) pits that have been replaced, re-cut or re-lined, and (c) burnt mound clusters that exhibit prolonged inhabitation of specific areas.

The following section briefly explores how each of these episodes of re-use manifest in the archaeological record, while the latter section examines different scenarios of re-use, giving detailed site examples from across Ireland. This is followed by a discussion on deliberate deposition or aspects of commemoration at burnt mounds which are interpreted as signifying the permanent abandonment of a site.

(a) Burnt mound stratification

A burnt mound is probably the most obvious means of establishing the overall use-history of a pyrolithic site. A mound of burnt stone may have multiple 'lifecycles', but these are not always recognizable, particularly if later disturbance has destroyed the necessary evidence. Attempts have been made to record burnt mounds using the single context recording system to build up a detailed stratigraphic picture of different phases of use; for example, at Inchaquire, Co Kildare and Doughiska, Co Galway.[9] While variations in the mound material are common, these cannot be readily linked to dumps of material. Factors such as the arbitrary nature of the waste deposition, the weathering and leaching of exposed material and natural silt build-up around the stones mean that individual tip lines are often difficult to identify during excavation.[10] As such, mound material is often regarded as a single, uniform deposit. As mentioned previously, this has led to uncertainty in the way in which single radiocarbon dates from mounds should be interpreted.[11] These provide snapshots in time of mound activity and do not capture the continuum of site use.

Another problem specific to burnt mounds relates to voids forming within the mound due to the coarse stony nature of the burnt mound deposits. Such spaces allow the filtration of organic materials, charcoal and seeds down in a process known as pedoturbation.[12] This should also be borne

[7] Murray 1995, 125–51; Dietler 1990, 352–406

[8] Bradley 1993

[9] Richardson 2009; McKinstry 2010

[10] Richardson 2009, 17

[11] Ó Néill 2009

[12] Hedges and Gowlett 1986; Schiffer 1987

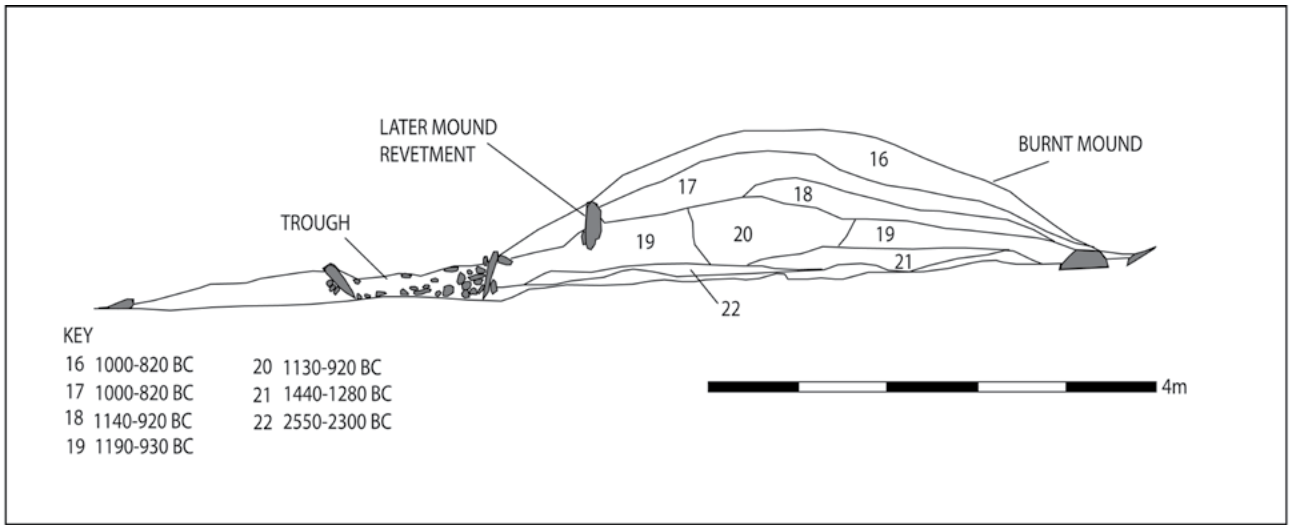


Fig 2 Burnt mound at Cahircalla Beg, Co Clare, showing different phases of use through mound stratification (after Bermingham *et al* 2012)

in mind when interpreting radiocarbon dates from specific areas of a site.[13] Awareness of these limitations when interpreting the archaeological record is, however, vital in comprehending the complexity of burnt mound sites and the multiple meanings that can be assigned to different contexts and deposits.

However, several new directions for research have been identified in recent years. The homogeneity of the burnt mound deposit at a site in the Norfolk Fens of East Anglia was such that divisions between individual burning and dumping episodes were not possible. Soil micromorphology demonstrated episodic build-up of burnt material, indicative of repeated visits rather than sustained occupation.[14] The succession of cut features and the breaks observed in the mound formation demonstrated that the site was probably revisited a number of times, more likely through seasonal activity and renewal rather than sporadic use over an extended period.[15] This excavation strategy, along with the adoption of soil micromorphology, has yet to be undertaken in an Irish context, but it is one which could be useful where distinct dump layers are indistinguishable. Such analysis could be accompanied by a programme of fine-resolution radiocarbon dating of charcoal fuel residues to investigate the timescale over which a burnt mound accumulated.

Opportunities for total excavations and detailed sampling provided by some developer-funded excavations in Ireland have allowed detailed histories and biographies of some burnt mounds to be established. This, along with their wider landscape context, permits a more in-depth understanding of how these sites developed over time. Some of these contextual approaches are supported by detailed radiocarbon dating, which helps distinguish between the different spatial and temporal deposits. For example, a particular well-preserved mound at Cahircalla Beg, Co Clare, exhibited seven separate depositions of fired debris.[16] Radiocarbon dating established that the mound began to form during the Chalcolithic and continued in use until the Late Bronze Age (Figs 2 and 3). The charcoal derived from short-lived tree species and therefore the radiocarbon determinations are reasonably accurate of the different periods of deposition in the make-up of the mound. At Caherweelder 5, Co Galway, a series of separate, but similar deposits consisting of heat-shattered stone and charcoal were identified, suggesting repeated and prolonged use of the site. The radiocarbon dates from the site support this, as they range from the Early to Middle Bronze Age.[17] At Glen, Clare Island, Co Mayo, a burnt mound composed of a complex series of burnt material represents at least four distinct phases of accumulation.[18] At Ahanaglogh, Co Waterford, twenty-seven separate deposits were recorded in the excavated portion of the mound.[19]

The Cahircalla Beg mound is significant in that it had a relatively unusual stratigraphic sequence of deposits which provides an absolute chronology for the site. The excavations of burnt mounds at Bearnafunshin, Co Clare; Caltragh, Co Sligo; Kilmessan, Co Meath; Bracetown 1, Co Meath, and Brackbaun, Co Limerick, reveal different use phases separated by flooding events from adjacent rivers.[20] Excavation also demonstrated that these sites were returned to and reused after different episodes of flooding. Another example comes from the River Tolka, Co Meath, where a number of sites excavated along the M3 motorway susceptible to flooding could not have been in constant use. These sites were probably used on a seasonal basis.

Later features cut into burnt mounds also indicate episodes of re-use. For example, a number of deliberately laid

[13] Anthony 2003
[14] Crowson 2004, 34
[15] *ibid*, 37
[16] Hull 2006; Bermingham *et al* 2012, 31–5
[17] Delaney and Tierney 2011, 128
[18] Gosling *et al* 2007, 78
[19] Johnson *et al* 2008, 72
[20] Grogan *et al* 2007, 181; Halpin 2005; Tobin 2010; Clarke 2008; McQuade *et al* 2009, 117

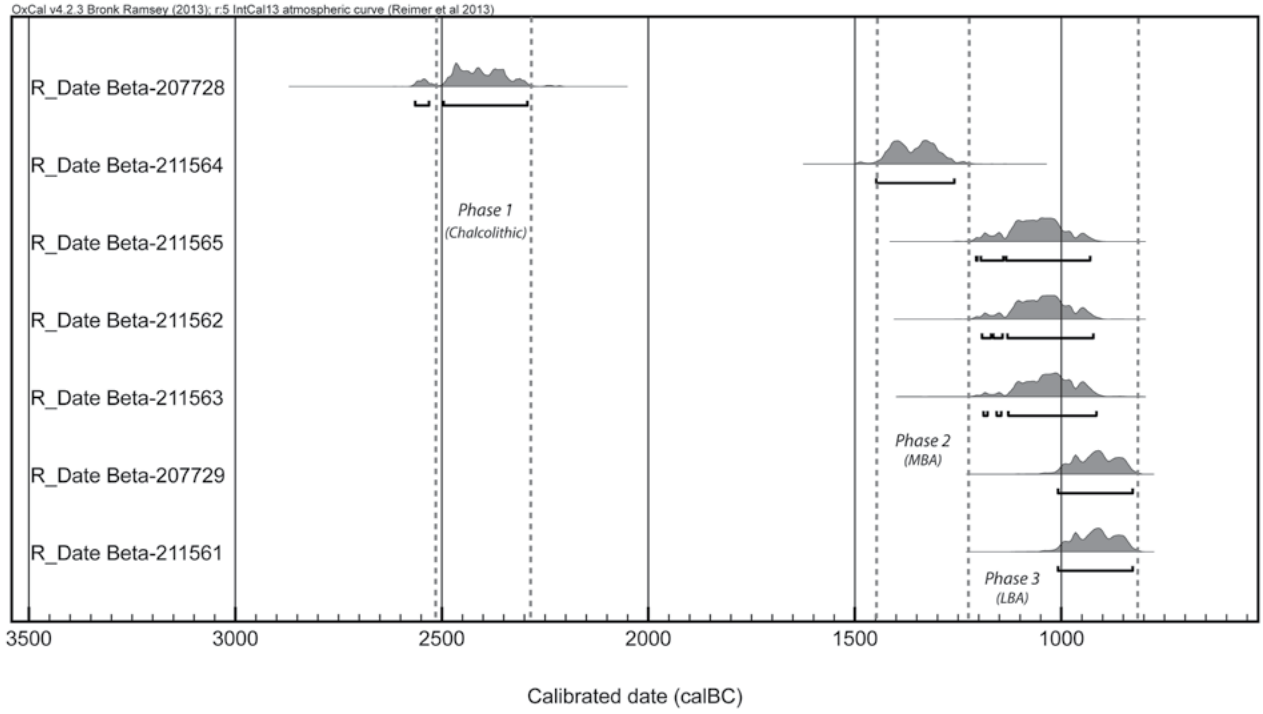


Fig 3 Calibration chart indicating different use phases at Cahircalla Beg, Co Clare

timbers found on top of mound deposits have been interpreted as possible 'platforms' for activities carried out at those sites. In some cases it is more likely that these represent the remains of truncated troughs where only the base of the feature survives. This is further supported by the identification of supporting stakes placed at the corners of 'platforms' at Killulla, Co Clare; Killescragh, Co Galway; Sonnagh, Co Mayo and Ballyclogh North, Co Wicklow. These are common in Late Bronze Age troughs and were used to support timber side walls.

It is apparent that these features are latter additions to the site, associated with a period of re-use, as they are placed on earlier burnt mound deposits. For instance, at Sonnagh, Co Mayo, the platform was stratigraphically later than the adjacent trough, as it rests on a 0.3m-thick layer of mound material.[21] At Mullamast, Co Kildare, radiocarbon dating has shown that the 'platform' was 250 years later than the dates returned from the burnt mound material and timber trough.[22] A similar situation was confirmed by radiocarbon dating at Islands, Co Kilkenny (see below).[23]

(b) Trough re-cutting and re-lining

The re-use or continued use of pyrolithic locations is also evident at sites where earlier troughs were re-cut and re-lined, or where a new trough replaces an earlier example. Troughs of different types and sizes are also superimposed on one another. As with the changes from timber to stone, this development could be emphasized by destroying the older trough before pyrolithic water-boiling re-commenced at the site. The pattern is most obvious in those cases where successive troughs show no resemblance to one another such as at Killeens, Co Cork; Gortaroe, Co Mayo, and Lisdornan, Co Meath (Fig 4).[24] While some re-cuttings may have been a way of adhering to tradition and maintaining links to the past, choosing to break with traditional practice may also have involved an explicit position on the relationship between the present and the past.[25] The builders of these troughs had the potential to remember them in divergent ways, drawing upon those aspects which seemed most salient at that point in time. This was not 'faulty memory' as observed by Holfmann but 'a process in which the past was actively used to negotiate the present. In other words, memory work was part of the narrative of people's lives'.[26]

In other cases, where conditions are conducive to preservation, the same timber-lined trough had a long history of use, and was returned to in later periods and modified. This was the case at Cahiracon, Co Clare; Moneycross Upper, Co Wexford; Killoran, Co Tipperary, and Perssepark, Co Galway, sites where a number of re-linings had taken place.[27] There is also evidence of more radical transformations when later troughs take on a more durable form than their predecessors. An interesting example is where timber-built troughs were replaced in stone. Stone-lined troughs with internal stake-holes may be multi-phased with the

[21] Gillespie and Kerrigan 2010, 67
[22] Clark 2010a
[23] Hardy and Green 2009
[24] O'Kelly 1954; Gillespie 2001; Russell 2001
[25] Bradley 1993
[26] Holfmann 2013, 49
[27] Grogan *et al* 2007, 92. 185. 189; Stevens 2010; Cross May *et al* 2005, 245; Grogan *et al* 2007, 230

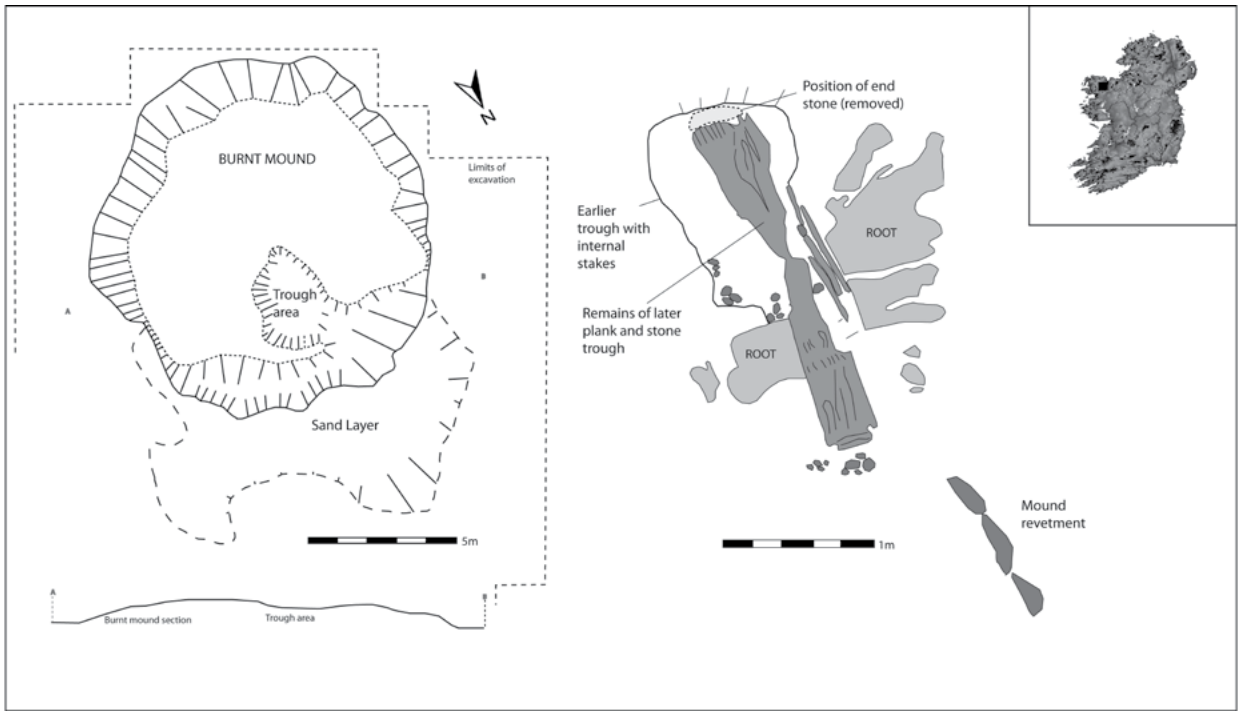


Fig 4 Burnt mound and separate trough phases at Gortaroe 1 (Area 3), Co Mayo (adapted from Gillespie 2001)

latter evidence reflecting an earlier timber trough. This may be evidence of an essential continuity, but there are cases in which radiocarbon evidence suggests an interval of disuse between the decay of the timber uprights and the creation of later stone settings.

Where conditions are not conducive to the preservation of organic remains, the re-use of previous troughs may be evident from the re-cutting of pits. A certain degree of caution, however, should be applied in such cases, as several explanations are possible. These may be no more than an over-cut of the original trough pit when the trough was constructed, or if the trough was unlined at the base, the ground level may have reduced when the trough was emptied prior to re-use.[28] That said, at a number of sites, such as Lissava, Co Tipperary; Gransha, Co Derry, and Athronan, Co Meath, the evidence seems to indicate that the site was temporarily abandoned before a new trough was constructed in a possible deliberate attempt to redefine the earlier example.[29] In some cases, the dimension of an earlier trough was adhered to, while in other examples the original pit was widened or shortened, depending on user requirements.

In other examples, the original trough cut is avoided, but extended just far enough to take in the cut of the older pit, resulting in the identification of sequential troughs. There may have been some order to an arrangement that was carefully contrived so that a newly built trough cut across earlier examples. These practices may suggest a concern with social continuity and cohesion, and with creating temporal and spatial links between troughs. Such links, as discussed by Robinson in relation to Bronze Age structures, could have acted as 'solid metaphors or "memory traps" that created lineages of inhabitation activated through material traces and memories of previous generations'.[30] Whether or not site sequence can be correctly determined, it seems to have been important that troughs built in different (but not necessarily successive) phases should make reference to the positions of the older troughs. Such evidence is obviously tenuous, as the latter may have been used concurrently or re-location may have been a result of rising water-levels. These relationships may also be completely coincidental. That being said, the associations are repeated so often that they might be significant and worth exploration. It is possible that the position of older troughs was known even when their visible mounds may have vanished.

Later use-phases where earlier troughs have been redefined and re-used are recorded on many burnt mound sites in Ireland. Unfortunately, without multi-context sampling for radiocarbon dating, it is difficult to establish an exact chronology for these periods of re-use. While it has been successfully demonstrated at some sites where structural timbers survive and are scientifically dated, it mostly can only be established that troughs were re-used at some later date.

The question remains as to how the exact location of these troughs was known after long periods of abandonment. There is no archaeological evidence to suggest that troughs were marked above ground in any way, though in some instances slabs of stone-lined examples may have been visible. Single stake-holes cutting the base of some unlined troughs may have also served this purpose; however, this is unproven. As mentioned earlier, the archaeological evidence does not support the impression that burnt stone was randomly deposited. More than merely being an

[28] Cleary and Hawkes 2013, 11

[29] McQuade *et al* 2009, 112; Chapple 2008, 22–59; McGowen and Fallon 2010

[30] Robinson 2013, 153

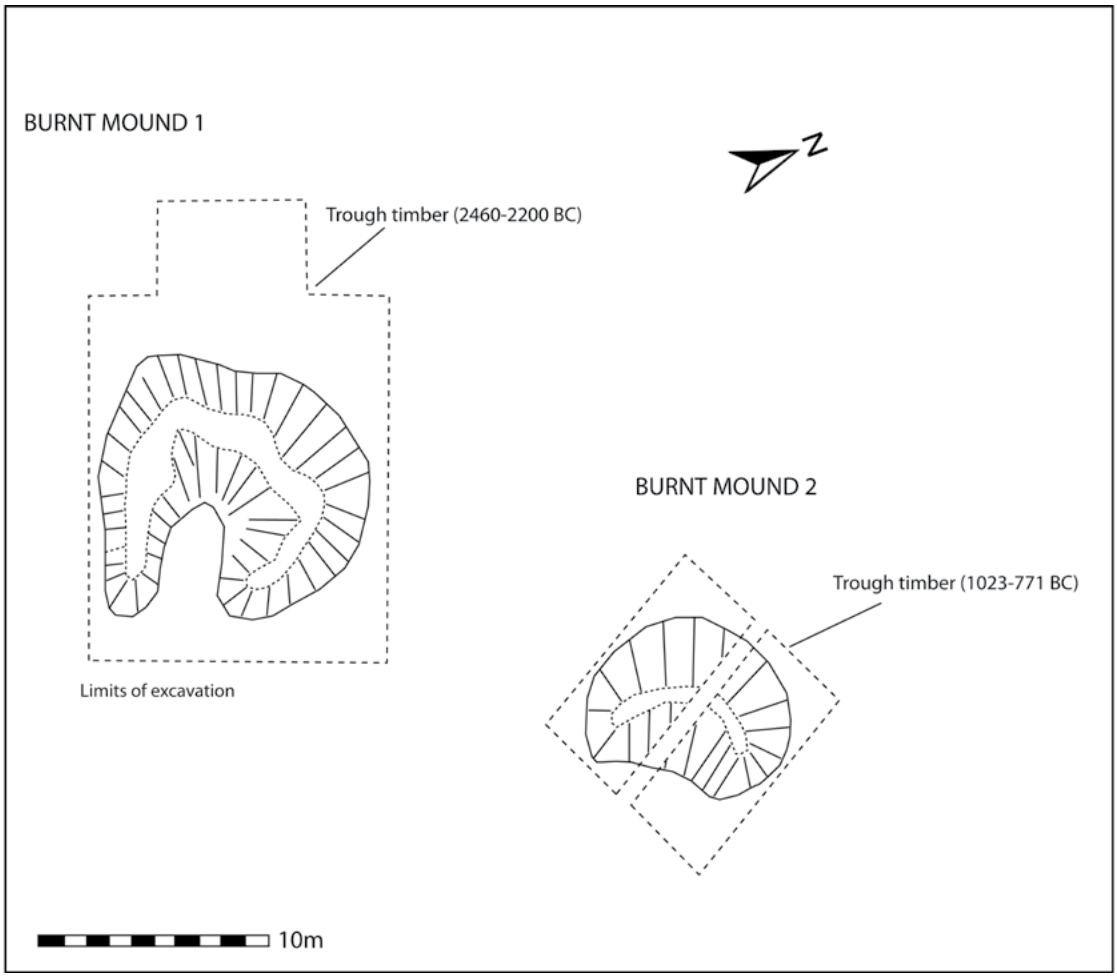


Fig 5 Two adjacent burnt mounds built 1,400 years apart at Ballyclogh, Co Cork (adapted from Lehane 1988)

effect of disposal, it may be that deposits were deliberately built up in crescentic formation to mark the location of a trough during periods of inactivity. As troughs are mostly located between the 'arms' of the mound, this may explain how earlier troughs were re-located and recut after periods of abandonment. This may support the theory that the re-cutting of earlier trough pits was not coincidence in most cases.

As with some ritual monuments, the re-use and modification of burnt mound troughs was carried out in order to create a conscious link with the past. By repairing and renewing activity at a burnt mound site, the users 'expressed their continued commitment to the ideas that lay behind it, or at least to their own interpretation of them'.[31] In this way, ritual plays an important role in shaping cultural identity, allowing fundamental beliefs to pass through the generations, mediated through monuments that were central to the symbolic construction of community and identity. Building directly over a pre-existing trough structure also incorporates that structure into a new phase of site use, perhaps acknowledging the earlier structure as a form of foundation deposit.[32]

Where excavated burnt mounds exhibit multiple pit features, these are not all contemporary to each other. This is reflected by the stratigraphy and / or dating evidence. As Cleary has noted in relation to the spatial organization of Bronze Age settlement, it is interesting to observe exactly where older and newer house structures are situated in relation to each other.[33] Some structures are superimposed, either completely or partially, while others appear to deliberately avoid the location of older sites. Similar observations have been noted in relation to burnt mounds where troughs or pits replace older examples. In other cases they are situated in relative close proximity but do not overlap, suggesting the possibility of deliberately organized social space (see below). Similarly, as O'Brien has noted in relation to wedge tombs,[34] the clustering of mounds in a small area may reflect lineage ties and kin relationships within a specific territory. Each cluster of mounds may represent a locality group with one specific site for each sub-division of territory, or alternatively a lineage relationship where adjacent burnt mounds are linked to different family branches. However, it is more likely that the clustering of burnt mounds is related to replacement over time, especially in areas that were prone to waterlogging at particular times of the year. That said, these may not have been accidental associations or merely evidence for 'continuity', but rather prehistoric communities

[31] Bradley 1993, 57
[32] Cleary 2007, 145
[33] *ibid*, 142
[34] O'Brien 1999, 333



Fig 6 Pre-excavation view of extant horseshoe-shaped burnt mound at Caherweelder 5, Co Galway (photo courtesy of Eachtra Archaeological Projects)

following established tradition by continued use of earlier mounds of burnt stone in parts of the landscape with specific connotations.

(c) Burnt mound clusters

Burnt mound clusters are another indicator of site re-use or more likely 'prolonged' use of an area for pyrolithic processes. They often occur in significant clusters with groups of up to six or more recorded, often within a few metres of each other.[35] While such clustering possibly indicates the focus of individual communities within a wider landscape of social organization, little is known of their chronological sequence. Recent road archaeology projects have provided interesting results with regard to the temporal sequence of such groupings. This suggests that all these pyrolithic sites were not in contemporaneous use, and that the appearance of these mounds on the landscape was a slow process over a prolonged period of time. One striking feature is the way burnt mounds seem to be prolific in certain locations. This may be illustrated at Curraheen 5, Co Cork, where a burnt mound of Chalcolithic date occurred in the same field as two Late Bronze Age examples. This was also the case at Borris, Co Tipperary, and Coonagh West, Co Limerick, where significant periods of inactivity separate closely spaced burnt mounds. These sites support the findings of two excavated burnt mounds at Ballyclogh near Fermoy, Co Cork, in the 1980s (Fig 5), which yielded a date range of 2460–2200 BC (GrN-11803: 3850±30 BP) for the timber of one trough, while that from an adjacent mound is dated 1023–771 BC (UB-2626: 2705±70 BP).[36] Even allowing for a significant 'old wood effect', this suggests an interval of possibly 1,400 years between the use of two pyrolithic sites at the same location. In this way, a single burnt mound may provide the focus for a whole series of mounds in later periods. Often these sites are only slightly different from one another, yet once established they also underwent a complex sequence of refurbishment and modification.

The implied shift in focus of activity along a particular stretch of river / stream is also intriguing. Such marginal shifts in location are unlikely to be a result of settlement relocation due to their close proximity. Perhaps local environmental factors such as changes in natural drainage, or changes in land use connected to farming hold the key to understanding these apparent shifts in burnt mound location. The function of each site may also have differed in some way as to make an area of ground nearby more suited for the particular activity at hand.[37] The location of some burnt mounds on seasonally flooded margins has prompted others to suggest that pyrolithic sites were used seasonally.[38] Excavation in recent years has certainly attested to this being the case where silt deposits within the burnt mound matrix indicate flooding events.[39] In addition, troughs cut at different elevations within a site could be indicative of use at

[35] Power 1990; Waddell 2000; Grogan 2005

[36] Lehane 1988. All radiocarbon dates in this paper are given as calibrated dates, expressed at two sigma (95.4%) levels of confidence using Oxcal 4.2 software (after Bronk Ramsey 2013)

[37] Anthony 2003

[38] O'Kelly 1954; Feehan 1991; Grogan 2005

[39] Schweitzer 2008; Murphy 2008; Tobin 2009; 2010

alternate times depending on the level of the water table. An example here is the site of Ballyadam, Co Cork, where several troughs were cut at different elevations close to a seasonal pond.[40] It is, however, difficult to know how site hydrology has changed (if at all) over the millennia. Certain sites, for instance, show evidence of being systematically moved upslope, possibly as a result of rising water. This seems to have been the case at Gortaroe, Co Mayo, where a new phase of pyrolithic activity began at a higher elevation as lake levels rose.[41] Seasonal use of burnt mounds would help partly to explain the frequent clustering of several sites in one locality.

While this is how re-use is represented in the archaeological record, it is now pertinent to explore different scenarios of re-use based on a number of well-dated burnt mound locations.

Scenarios of re-use

It is evident that some sites were returned to after periods of inactivity; however, without multi-context sampling for radiocarbon dating, it is difficult to establish a chronology for the overall sequence. While this has been successfully demonstrated at *some* sites where structural timbers are scientifically dated, for many it is only possible to establish a relative sequence of burnt mound trough use. That said, at least four scenarios of re-use can be identified from the current archaeological record. These include (1) continuous use of burnt mound locations over long periods, (2) episodes of re-use after short intervals, (3) re-use after longer intervals and (4) where there is evidence of a subsequent change of use.

(1) Prolonged use

Prolonged use of burnt mounds is evident from those sites where large mounds of burnt stone are found and where they have been particularly well dated. The general sequence of events observable at these sites is the digging of a pit or pits which functioned as troughs, followed by the build-up of heat shattered stones and the residues of fires (Fig 6). The one feature all larger extant mounds have in common, apart from their proximity to one another, is that in general only one trough is present. On this basis it appears that some sites were not complex and may have been used for one purpose only. This one-trough-per-mound scenario appears to be the case in areas where tight clusters of sites have been excavated such as at Rathmore, Co Wicklow; Killeens, Co Cork; Errew, Co Leitrim; Ballyclogh, Co Cork, and Caheraphuca, Co Clare.[42] It has also been witnessed at Cahircalla Beg, Co Clare, and Caherweelder, Co Galway, where substantial mounds are associated with a single trough located centrally between the arms of the mound.[43] While limited excavation may account for this phenomenon at some excavated sites, more extensive investigations suggest this may have been a true occurrence.

Excavations at Dunlo, Co Galway, revealed a substantial burnt mound overlying a large oval trough that was wattle-lined. The mound was composed of several layers of dumped material and measured 21.5m by 18.6m, with an overall thickness of 0.8m, suggestive of prolonged pyrolithic water-boiling at the site. Occasional lenses of peat and clay were visible in the sections over and above the mound layers, which suggested that there were periods when the site or areas of the site were not in use, allowing natural peat to form.[44] Radiocarbon dates for charcoal samples date the main mound to 1259–1000 BC (UBA-13396: 2911±38 BP), while the basal fill of the trough is dated 1112–901 BC (UBA-13397: 2826±33 BP). This indicates that the use of the site extended from the Middle Bronze Age to the Late Bronze Age. Following the intensive use of this burnt mound, it is likely that the adjacent site came into use. Charcoal from that mound is dated 507–386 BC (UBA-13399: 2354±23 BP), placing the site in the Early Iron Age.

The Dunlo site can be compared to Killeens, Co Cork, where three large burnt mounds were associated with single troughs suggestive of continuous and prolonged use of the area for pyrolithic water-boiling.[45] At one particular mound, the remains of a rectangular, plank-lined trough replaced an earlier trough composed of a hollowed-out log with an adjacent formal hearth (Fig 7). A timber sample from the hollowed-out log is dated 1611–1453 BC (GrN-15885: 3250±25 BP), placing this phase of activity in the Middle Bronze Age.[46] After a period of time this large trough was replaced by a smaller rectangular pit placed at right angles to the first. This was lined with planks supported with corner stakes, a common lining method during the Middle / Late Bronze Age in Ireland.[47] The secondary trough was associated with a new formal hearth, defined by an arc of small boulders opening to the shorter side of the pit. Interestingly, the timber remains of the earlier trough were not fully removed before the new trough was built.

Other pyrolithic sites are much more complex and exhibit evidence of prolonged use involving numerous troughs and pits. For example, at Magheraboy, Co Sligo, three troughs associated with one phase of site use were positioned close together in a north-east / south-west direction. A narrow band of subsoil separated each of the troughs, suggesting that the presence of a trough was known when a new one was dug.[48] Several troughs are recorded at Fermoy 5, Co Cork, where their superimposition suggests the continuous use of the site over a long period.[49] Similar, sequences of troughs are recorded at Leahy's, Co Limerick; Cuffsborough, Co Laois; Kilbeg 6, Co Westmeath; Rathcash, Co Kilkenny, and Greenhills, Co Tipperary.[50] It is possible, however, that some of these troughs and ancillary features were not in use at the

[40] Cleary and Hawkes 2013

[41] Gillespie 2001

[42] McLoughlin 2001; O'Kelly 1954; Péterváry 2007; Lehane 1988; Coughlan 2009

[43] Bermingham *et al* 2012; Delaney and Tierney 2011

[44] O'Driscoll 2010

[45] O'Kelly 1954

[46] Brindley *et al* 1989-90

[47] Hawkes 2014a

[48] *ibid*, 29

[49] Hanley and Hurley 2013

[50] Taylor and Jones 2003; Murphy 2008; Lyne 2009; Coughlan and Bailey 2011a; Kiely 2011

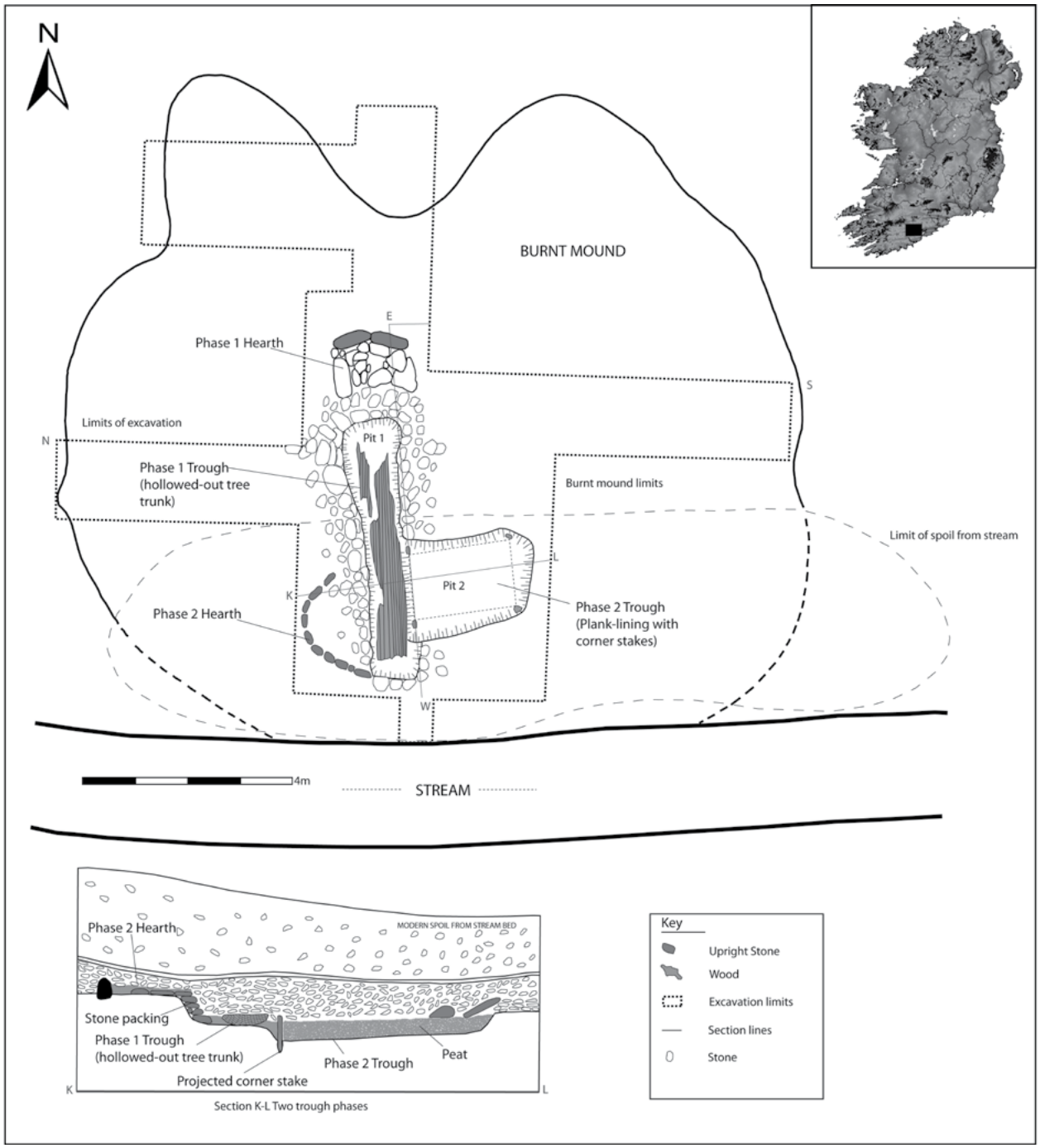


Fig 7 Burnt mound and separate trough phases at Killeens 2, Co Cork (adapted from O'Kelly 1954)

same time, and may have developed during periods of episodic use.

At Ballyglass West, Co Galway, the excavation of a large burnt mound revealed a number of archaeological features, with the mound itself containing up to 16 different deposits of fired debris associated with water-boiling. Eight potential troughs were identified below the burnt mound, one of which appeared to be stone-lined, and others had internal and external stake holes.[51] Dates were obtained from hazel charcoal fragments from four deposits. These include Early / Middle Bronze Age dates of 1687–1532 BC (UB-11271: 3336±22 BP) from a pit or trench cut into the upper layers of the burnt mound and 1740–1618 BC (UB-11272: 3377±23 BP) for an ashy deposit within the mound. A Middle Bronze Age date of 1411–1270 BC (UB-11270: 3070±23 BP) was derived from a similar ashy deposit in the sides of a stone-lined trough, while a Late Bronze Age date of 1125–978 BC (UB-11273: 2873±21 BP) was retrieved from a hazel sample from another trough.

The site can be compared with Seeoge 2, Co Westmeath, a substantial burnt mound overlying a range of associated features close to the edge of a natural pond. These include at least two and possibly up to four troughs, a probable well

[51] Delaney and Tierney 2011, 134

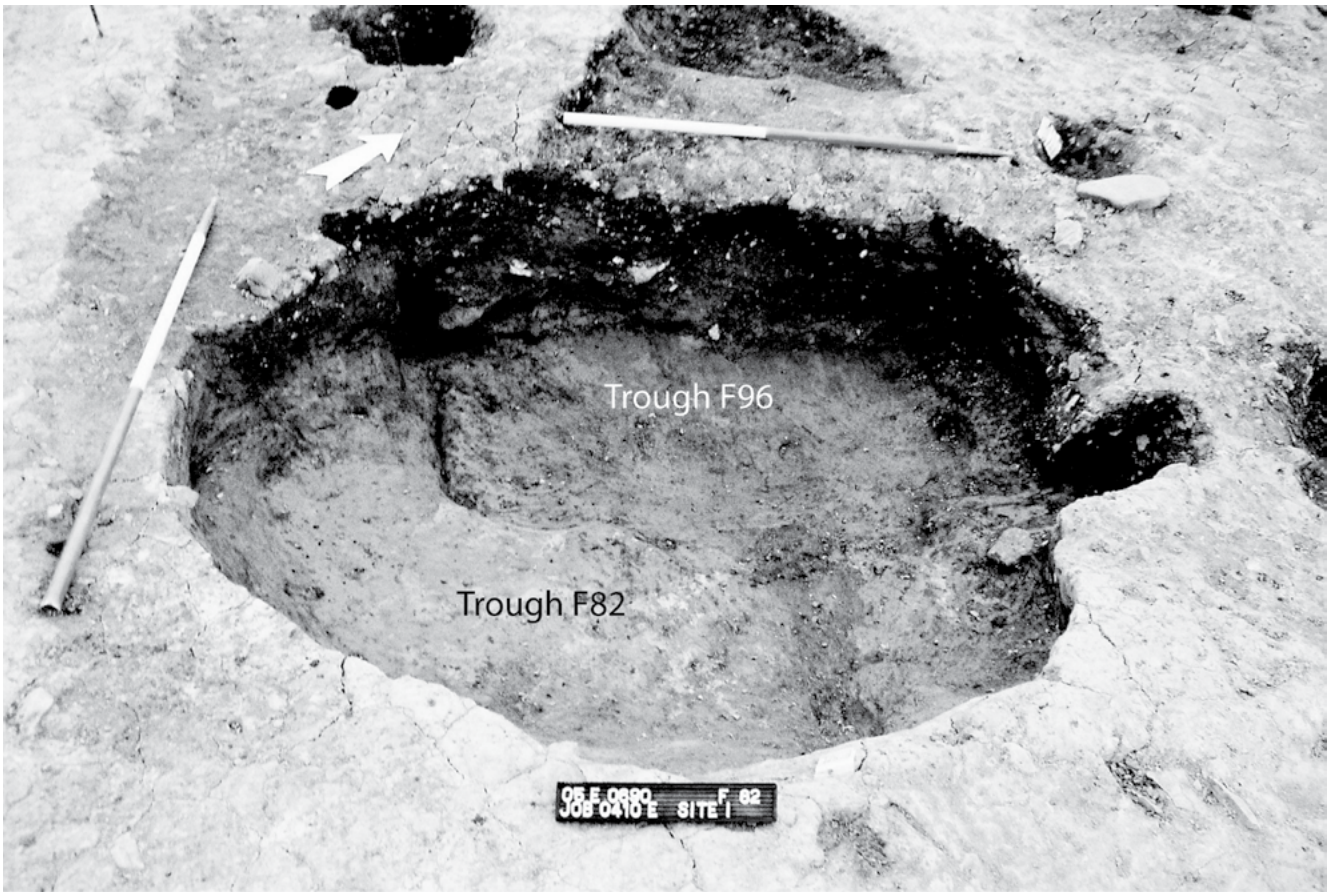


Fig 8 Two trough phases at Athronan 1, Co Meath (photo courtesy of CRDS Ltd)

or pit, various other pits of unknown function and a substantial rectangular structure.[52] Given its size, this mound may represent repeated use of the troughs over a long period, perhaps several generations. The two definite troughs were located at different elevations in the site and were used at alternate times, depending on the level of the water table. With regard to the dating of the site, a sample of Pomoideae charcoal from a posthole is dated 901–816 BC (UBA-9161: 2712±19 BP), while a sample of blackthorn charcoal from the fill of a trough is dated 764–416 BC (UBA-8581: 2473±26 BP). There is no overlap in these date ranges, neither is the difference between them very great. Seeoge 2 can therefore be seen as a Late Bronze Age / Early Iron Age site, perhaps with a lifespan of up to a few centuries.

(2) Re-use after short interval

At a number of burnt mounds, the excavation record indicates that the site was temporarily abandoned before a new trough was constructed. This may have been a deliberate attempt to redefine the earlier example.[53] As mentioned previously, in some cases the dimensions of earlier troughs were maintained, while in other examples the original pit was enlarged or reduced in size, depending on user requirements.

For instance, troughs at Athronan 1, Co Meath, consisted of two consecutive pit cuts on the same location, the second largely erasing the first (Fig 8).[54] The first pit consisted of a large sub-rectangular cut (F96) 1.5m in length and 0.84m in width with a flat base. While the base of the cut was 0.6m below the original ground surface, only 0.15m of the cut's original vertical extent survived, being almost entirely removed by a second, broader pit (F82) in the same location. Only one shallow fill was identified within the original cut, a sample of hazel charcoal from which yielded a radiocarbon date of 1930–1750 BC (WK-24271: 3518±30 BP).[55] Similarly, at Lissava, Co Tipperary, a number of use phases were identified in the trough. The primary trough was re-cut and enlarged during a second Middle Bronze Age phase of activity. Both of these features were, in turn, cut again by an additional trough during another separate phase. This second phase of activity suggests that the site was temporarily abandoned and that the construction of a new trough was an attempt to redefine the earlier troughs.[56]

At Lisdornan 3, Co Meath, a large burnt mound was revealed in advance of the N11 Northern Motorway.[57] This measured 19.4m in length, 14.6m in width and 0.22m in depth and overlay a number of pits, including two troughs.

[52] Lyne 2009

[53] McQuade *et al* 2009, 112; Chapple 2008, 22–59; McGowen and Fallon 2010

[54] McGowen 2010

[55] *ibid*

[56] McQuade *et al* 2009, 114

[57] Russell 2001

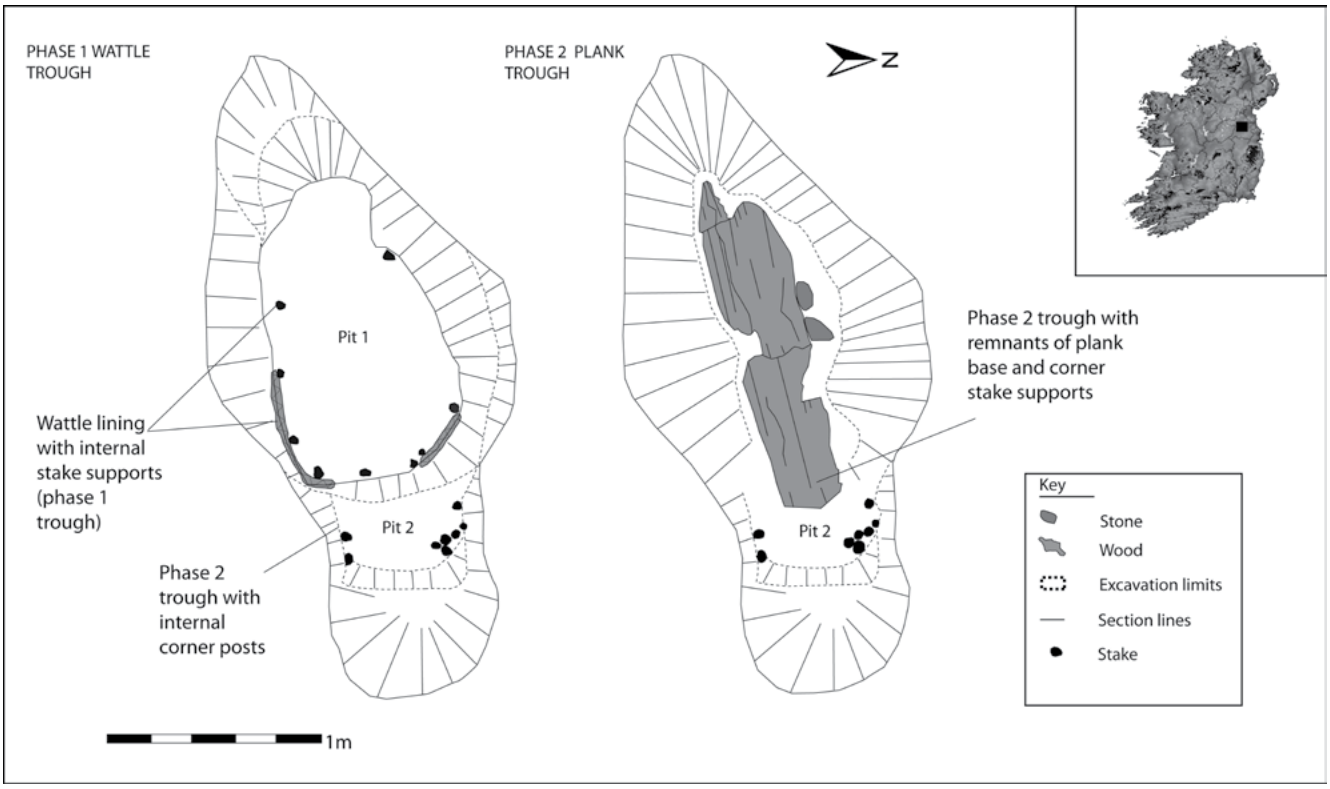


Fig 9 Two trough phases at Lisdornan 3, Co Mayo (adapted from Russell 2001)

The first consisted of a wattle-lined pit, which was subsequently replaced by a sub-rectangular, plank-lined trough (Fig 9). The former consisted of an oval pit measuring 1.85m in length, 1.3m in width and extended to a depth of 0.28m. The sides of the trough had originally been lined with a wattle lining, but this only survived along the northern and eastern edge of the trough. The surviving portions were made from up to eight strands of hazel rods supported by nine surviving vertical wooden stakes. One of these uprights is radiocarbon dated 2014–1561 (Beta-159690: 3460±80 BP), and can be compared with similar troughs excavated over recent years, all dating to the Chalcolithic / Early Bronze Age.[58]

Similarly, at Gortaroe I, Area 3, Co Mayo, a trough composed of a roughly hewn plank and end stones directly overlay an earlier plank-built trough, the basal timbers of which were still *in situ* and held in place by a series of stakes (see Fig 3).[59] The site was composed of a burnt mound measuring 11.75m by 10.5m, with an average thickness of 0.75m. It consisted of burnt sandstone in a matrix of charcoal and peaty clay which also contained animal bone fragments and a hammer-stone. The mound had a hollow close to its centre, which overlay the trough area, an upright slab, a roughly hewn oak plank abutting this stone and three smaller upright stones perpendicular to the upright slab. The upright stone and the oak plank appeared to be contemporary, as they were both set on or into the peat and abutted each other. An earlier wooden trough survived as three poorly preserved horizontal timbers and the worked ends of four stakes. The wood remains were alder (three pieces), hazel (two fragments) and willow (two fragments). The horizontal timbers are likely to have been basal timbers from a rectangular trough. The side timbers are likely to have been removed or displaced in antiquity, possibly when the timber from the later trough was inserted.

The mound at Kilbegly, Co Roscommon, was irregular in shape with maximum dimensions of 8.2m by 6.3m, with a maximum thickness of 0.4m. A well preserved, oval shaped, wattle-lined trough was also identified on the site, positioned near the centre of the burnt mound.[60] This consisted of a sub-oval cut measuring 1.62m in length, 1.12m in width, and had a depth of 0.4m–0.2m. This was lined by hazel wattle, caulked with woodland mosses. Samples taken from the wattle lining are radiocarbon dated 2134–1944 (UBA-12826: 3653±26 BP), 2129–1941 BC (UBA-12827: 3645±23 BP), 2032–1902 BC (UBA-12828: 3615±24) and 2020–1886 (UBA-12829: 3587±23 BP). A result of 3487±42 BP for a moss sample suggests a possible re-use, as the four dates from the trough wood indicate this may be some 200 years older. The possibility that the moss material was added several years after the construction of the trough should be considered.

(3) Re-use after long interval

Radiocarbon evidence does indicate considerable periods of inactivity at some burnt mounds. For example, at Moneycross Upper Co Wexford, the first phase trough is dated to the Late Bronze Age. This trough was returned to in the Early Iron Age, extended and re-lined with tim-

[58] Hawkes 2014b
[59] Gillespie 2001, 75
[60] Jackman 2010

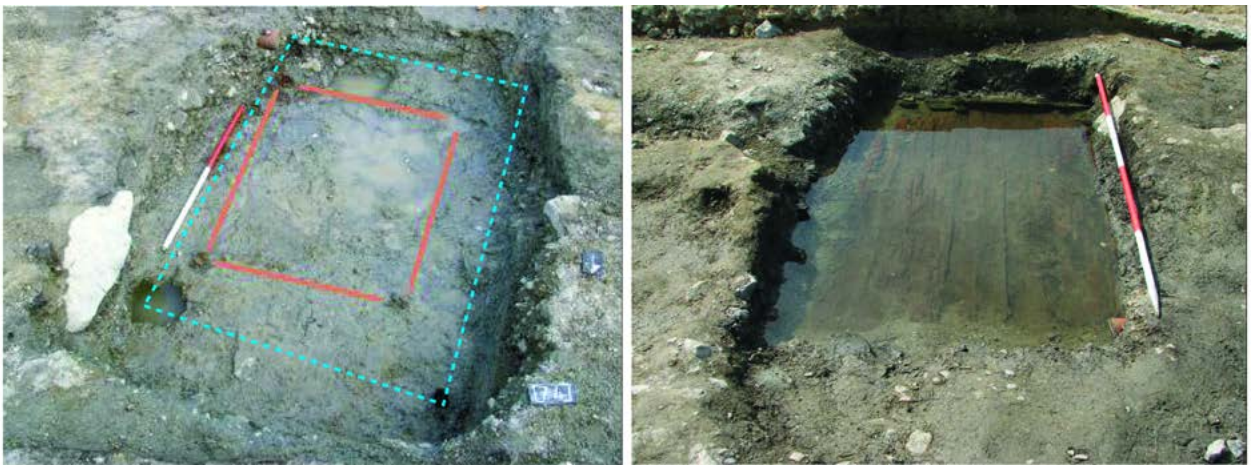


Fig 10 Two trough phases at Moneycross Upper, Co Wexford; first phase dating to the late Bronze Age highlighted in orange, Iron Age phase in blue (left), surviving planks dating to Iron Age (right) (photos courtesy of Transport Infrastructure Ireland)

ber planks (Fig 10).[61] The first phase of the trough was evidenced by four corner stakes of holly wood, which outlined a small rectangular trough measuring 1.25m by 0.85m. Four samples of these timber stakes were sent for radiocarbon analysis, producing calibrated age ranges of 1193–920 BC (UBA-8264: 2869±41 BP), 1188–918 BC (UBA-8265: 2861±36 BP), 1114–1097 BC (UBA-8266: 2831±36 BP) and 1006–835 BC (UBA-8267: 2869±41 BP). This places the stake-hole structure of the trough firmly in the Middle to Late Bronze Age, centring on the period 1100—1000 BC. Contemporary with the construction of the trough was an irregular-shaped raised clay platform. This was built to provide a dry 'working' area surrounding the trough. A small hearth was located in the southwest of the site, *c* 3m to the northwest of the trough.

After the abandonment of this first pit, the trough was extended towards the north and west. Prior to the lining of the base and sides with split planks, the base was covered with a compact clay deposit to provide a level base, thus sealing the stakes of the first phase underneath. At the north-eastern corner, two small upright stakes held the eastern side plank in place. Three samples of these ash timber planks were sent for radiocarbon analysis, producing dates of 748–388 BC (UBA-8261: 2389±42 BP), 748–391 BC (UBA-8262: 2396±41 BP), and 750–396 BC (UBA-8263: 2409±41 BP). This places the plank structure of the trough firmly in the Late Bronze Age / Early Iron Age, centring on an approximate age range between 750–400 BC, some 300–500 years later than the stake-built structure in the same trough. The trough was subsequently filled with burnt mound material, containing alder and ash charcoal and fire-cracked stone.

The Moneycross Upper findings are significant in the continued use of burnt mounds into the Early Iron Age. At Cahiracon, Co Clare, an alder plank-lined trough dated to the Late Bronze Age was re-cut and re-lined with oak planks during the Early Iron Age.[62] A similar trough, also in the townland of Cahiracon was returned to in that period and reduced in size with the dumping of a stone deposit.[63]

Reference can also be made to two burnt mounds in close proximity at Islands, Co Kilkenny, located in a marshy area close to a natural spring.[64] The larger mound (Site A) measured 24m in length, 14.5m in width and 0.06m–0.6m in depth. The main trough located under this burnt mound was a sub-rectangular pit lined with twelve alder planks. A sample of timber (alder) from the base of the trough has an Early Bronze Age date of 2120–1880 BC (Poz-24994: 3605±35 BP), indicating the primary phase of activity of the site. Within the upper layers of the mound there was a pit with gradually sloping sides and a rounded base which measured 1.44m in length and 0.58m in depth. This was lined with seven timbers, one of which has a Late Bronze Age date of 1130–910 BC (Poz-24995: 2850±35 BP), indicating a second phase of activity some 750 years after the first use of this site. Charcoal (hazel / alder) from the basal fill of a pit beneath a second burnt mound (Site B) produced a date of 3345±35 BP (1740–1520 BC), indicating an approximate 260-year interval between the use of both burnt mounds.

At Fauleens, Co Mayo, two layers of burnt mound material represent separate phases of activity associated with two wood-lined troughs.[65] Trough B was used in the Early Bronze Age, with a hazel post dating 2022–1785 BC (GrN-30832: 3505±30 BP), while Trough A was constructed in the Late Bronze Age, with a hazel post dated 774–521 BC (GrN-30831: 2500±30 BP). The excavators suggest that the re-use of the site long after its initial 'occupation' indicates that it was ideally located to exploit the primary resources required for pyrolithic activity and so remained an attractive location for such processes in the Bronze Age.[66]

A Middle Bronze Age burnt mound at Sranagalloon 3, Co Clare, contained two troughs and a pit sealed by a mound of heat-shattered stone.[67] The large trough contained a number of timbers that may represent a dismantled or disturbed wooden lining. The western upper edge was lined with five

[61] Stevens 2010
[62] Grogan *et al* 2007, 186
[63] *ibid*, 189
[64] Hardy and Green 2009
[65] Gillespie and Kerrigan 2010, 112
[66] *ibid*
[67] Nunan 2010

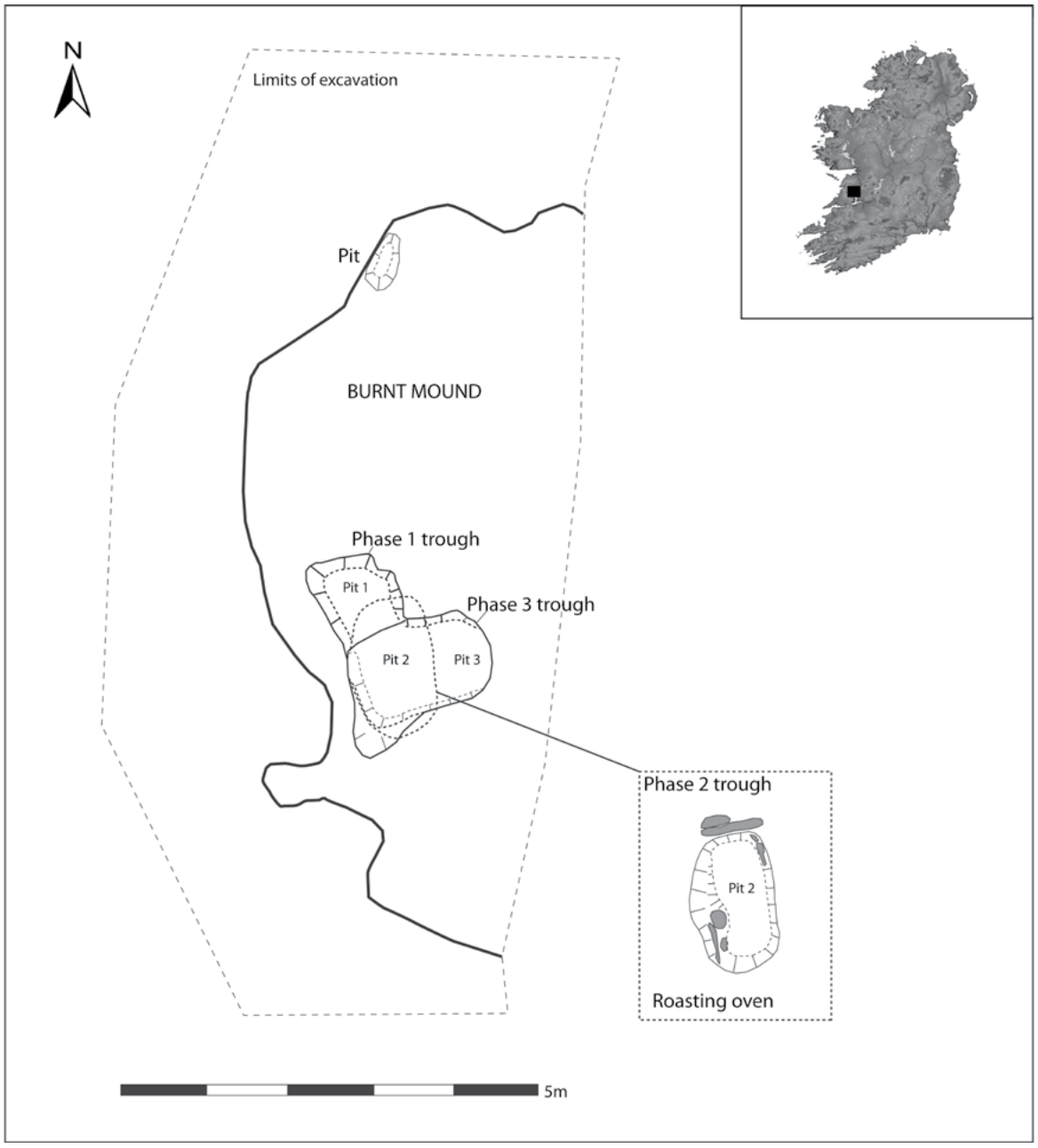


Fig 11 Partially excavated burnt mound at Cahiracon, Co Clare, with three trough phases (adapted from Grogan *et al* 2007)

stake holes connected to either fixing pegs for a lining or perhaps a windbreak. An AMS date from a middle fill of the trough indicates use between 1494–1399 BC (UBA-12729: 3144±27 BP). The second trough was much smaller and produced a contemporary date range of 1494–1324 BC (UBA-12728: 3157±22 BP). The abandonment of the site is indicated by a layer of peat over the burnt mound.[68]

Following this peat growth, pyrolithic activity was carried out again at the site. This is indicated by a burnt mound of compact, heat-fractured limestone and a shallow trough and a pit cut into the aforementioned peat. This survived as a shallow cut lined with eighteen individual timbers laid sided by side. This trough was sealed by a mound of heat-shattered limestone. Charcoal from the mound is dated 706–400 BC (UBA-13022: 2403±22 BP), placing the reuse of the site at the end of the Bronze Age period.

As mentioned previously, little is known of the chronological sequencing of many burnt mound clusters; however, recent research suggests that many were not in contemporaneous use. For example, at Borris, Co Tipperary, burnt mound (Site A) was located on the northern side of the site, situated 30m to the north of Site B.[69] It was located on the north-western area of the site and consisted of a Middle Bronze Age burnt mound and single, large, ovoid, irregular trough. Radiocarbon dating of timbers from a trough below the burnt mound returned a date of 1880–1660 BC (Poz-24993: 3440±35 BP). Site B contained thirteen potential archaeological features, seven of these proved to be archaeological, and included two troughs and five pits. Although

[68] Nunan 2010

[69] Conboy and Green 2009a

no mound or burnt spread was revealed, the evidence represented a denuded burnt mound site type. A Chalcolithic date of 2486–2299 BC (UBA-10197: 3923±29 BP) from one trough feature suggests a possible hiatus of activity between sites of *c* 420 years.

At Coonagh West 6, Co Limerick, two burnt mounds were located flanking the River Shannon. One of the mounds overlay a well-preserved wood-and-stone-lined trough, dated to the Chalcolithic period 2458–2203 BC (UBA-13268: 3840±26 BP). The second mound immediately to the south overlay a shallow pit and a linear cut feature. Alder charcoal from the latter is dated 1605—1433 BC (UBA-13266: 3231±24 BP).[70] This indicates an interval of *c* 800 years between the two sites, suggesting it was a preferred location for pyrolithic processes.

At Errew, Co Leitrim, the remains of four pyrolithic sites were identified some 30m east of the River Errew.[71] Clay platforms were constructed at each site, into which a trough was placed. The construction method of the troughs varied in these sites. A stone-lined trough at the first clay platform was associated with a small deposit of fired debris dated 2200–1960 BC (WK-23159). A second clay platform had a roundwood-lined trough caulked with moss. Charcoal from the associated burnt stone deposit is dated 1000–830 BC (WK-23160). A third clay platform was located further to the south, associated with a wattle-lined trough, possible hearth and burnt mound material. The fourth site lay 8m to the south and was composed of a similar clay platform with a thin deposit of heat-shattered stone, a sample of which is dated to 790–500 BC (WK-23161). No trough can be associated with this site.

The above examples question whether burnt mound clusters formed through a process of accretion or replacement over time. Here we must distinguish between successively 'built' and successively 'used' burnt mounds, as adjacent sites may have been in simultaneous use. In some cases, the dumping of mound material in close proximity represents contemporary water-boiling activities; however, in other instances it represents an abandonment in favour of an adjacent site. The latter is well attested in the archaeological record, at sites such as Johnstown, Co Carlow; Ballyline, Co Clare; Doughiska, Co Galway, and Ballyquirk, Co Kilkenny.[72] While the close proximity of burnt mounds may relate to practical considerations such as flooding, lengthy periods of abandonment between sites may be a statement of social affiliation, expressing kin relationships, sodalities and other membership groups. The location of some of these sites in close proximity to earlier examples may be coincidental; however, in others it could relate to some form of ancestral association. For example, lengthy periods of abandonment were noted between sites at Ballyclogh, Co Cork; Islands, Co Kilkenny; Errew, Co Leitrim; Rathcash, Co Kilkenny; Boherard, Co Laois; Richill, Co Limerick, and Sonnagh, Co Mayo.[73] Each site used for prolonged periods probably enshrined different memories of social occasions and historical events, which can sometimes be represented by deliberate depositions of artefacts and human remains. This may be seen at a number of mound clusters, including Killeens, Co Cork; Coolroe, Co Mayo; Clowanstown, Co Meath, and Sonnagh, Co Mayo, (see below). When constructed within or near older sites, burnt mounds made reference to the past through manipulation of a structured and meaningful action. By the appropriation of genealogical history and ancestral space, a sense of permanence and continuity was established.[74] This may have led to the formal abandonment of one site and the beginning of another.

(4) Change of use

The variations in size and layout of burnt mounds may partly be explained by post-depositional disturbance and alteration in more recent times. Such variations may also reflect an adaptation of pyrolithic processes to changing functional demands, seasonal adaptations, local traditions or even the idiosyncratic tendencies of their users. We can no longer view these sites as simply representing water-boiling activities, exhibited archaeologically by a trough and a mound of burnt stone. Additional features identified in recent years suggest the technology was used in different ways, with the water-boiling process being just one of these.[75] The technology may also have been used for dry roasting, steaming for cooking and for sweat-bathing. Furthermore, where scenarios of site re-use occur, these may not be related to water-boiling. In some cases there is evidence of more radical transformations where a site has its origins in the pyrolithic water-boiling tradition but it is later modified for another purpose. Whether these changes reflect fluctuating water levels at a site is unknown, but does indicate an adaption of the pyrolithic process in later periods of the Bronze Age.

This is almost certainly the sequence at Cahiracon, Co Clare, where an earlier water-boiling trough was replaced by a stone-lined roasting oven.[76] The site consisted of a D-shaped burnt mound and a number of inter-cutting troughs representing at least four different use phases. The first phase consisted of an L-shaped trough which was later re-cut and shortened during a second period of use (Fig 11). The trough was lined with stone flags during this phase, with evidence of a large amount of burning from exposure to heat. After this episode of use, the trough was backfilled and abandoned. During a third phase, another large trough was cut through the eastern portion of the original trough pit. After another period of abandonment a final phase of activity was recorded on the mound, involving some burning events not associated with the earlier trough features. A charcoal sample from this final mound activity is dated to the Middle Bronze Age 1520–1120 BC (Beta-179176: 3090±80 BP).

[70] Bermingham *et al* 2013, 72

[71] Péterváry 2007, 286-7

[72] Breen and Clarke 2009; McNamara 2009; McKinstry 2010; Jennings and Coughlan 2011

[73] Lehane 1988; Hardy and Green 2009; Péterváry 2007; Coughlan and Bailey 2011a; Danaher 2008; O'Connell and Ní Thóibín 2009; Gillespie and Kerrigan 2010

[74] Murray 1995

[75] Hawkes 2015, 62–5

[76] Grogan *et al* 2007, 190-1

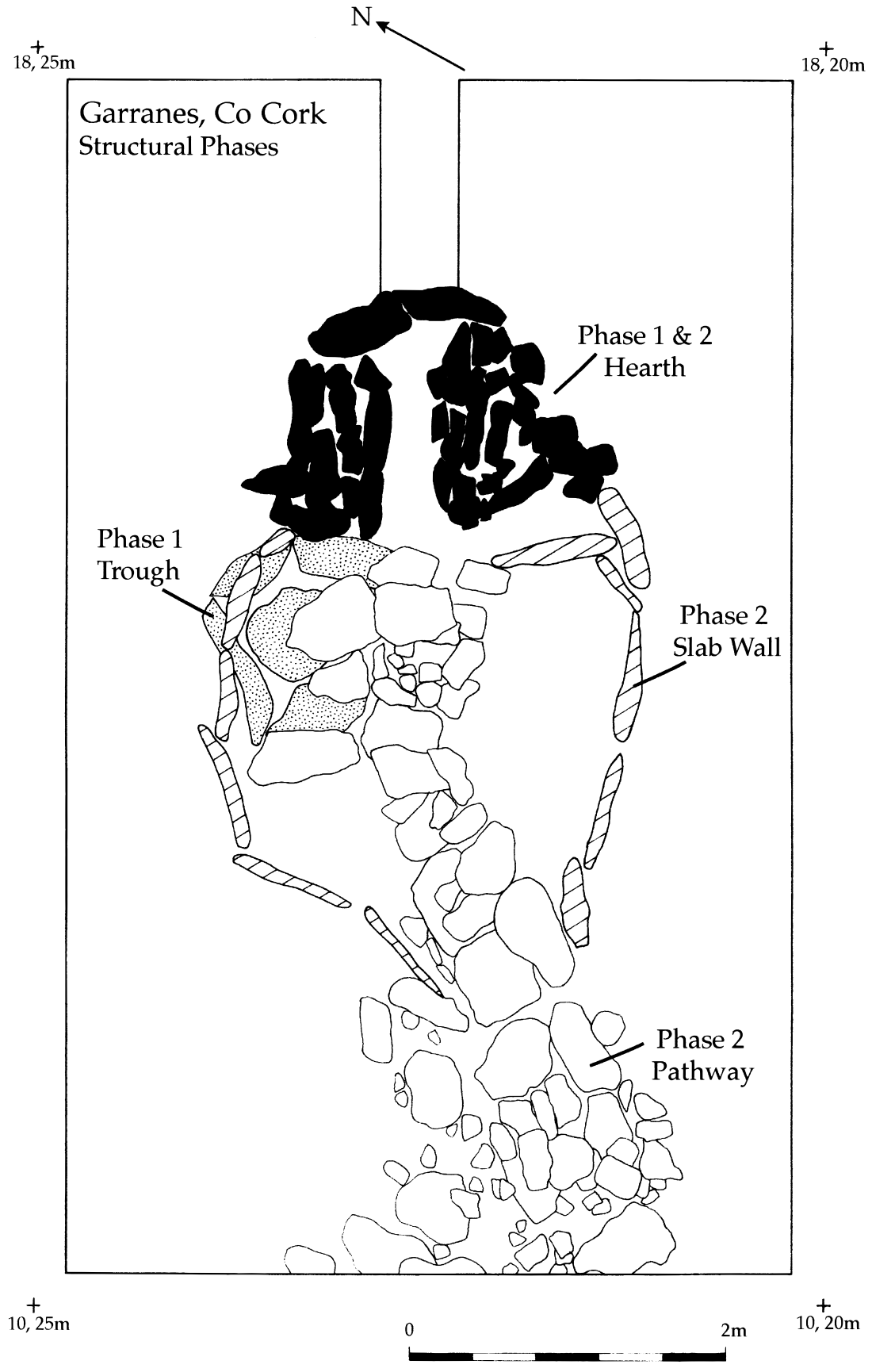


Fig 12 Plan of excavated features at Garranes, Co Cork; the two phases in this site are illustrated, including the early water-boiling operation and its replacement by a dry-roasting operation (illustration courtesy of Billy O'Brien)



Fig 13 View of Garranes burnt mound during excavation (photo courtesy of Billy O'Brien)

A site at Garranes, in the Beara Peninsula, Co Cork, provided evidence for two separate phases of activity that began with a typical burnt mound using the hot-stone / water-boiling technique (Figs 12 and 13). This consisted of a polygonal-shaped stone-lined trough with an overflow drain and adjacent stone-built hearth. The pyrolithic process resulted in the deposition of fuel ash and broken stones in the trough vicinity. The limited occurrence of this fired debris suggests that the site was used over a short period, approximately around 1493–1311 BC (GrN-29051: 3125±35 BP).[77] This was replaced when the trough was deliberately backfilled, and a slab pathway and a possible roofed stone-footed structure were constructed over the site for use as a cooking house for dry roasting, re-using the stone-built hearth of the earlier phase.[78] A radiocarbon result of 910–801 BC (GrN-29048: 2695±35 BP) from gorse charcoal taken from the final use of the stone hearth broadly dates this second phase of activity in this site.[79] The absence of a water trough or burnt stone residues in the interior suggests that this involved a different process from the Phase 1 burnt mound. Instead of water-boiling, the hut may have been used for the dry roasting of food and can be compared with other stone-built huts with roasting ovens such as those at Drombeg, Co Cork; Site D, Barrees, Co Cork, and Coarhamore, Co Kerry.[80] The site at Garranes provided clear evidence for a change in cooking methods during the later Bronze Age, and can be compared with other sites where there is evidence for a change from water-boiling to dry roasting in later periods.

Ballinaspig More 7, Co Cork, is characterized by a stratigraphic sequence where there were three principal phases of activity on the site. These involved the construction of three troughs and associated deposits, all superimposed one over the other. The first phase was represented by a sub-oval trough and a series of associated stake holes. The trough had been dug into an impermeable clay layer, and so naturally held water without the need for a lining. The burnt mound material generated during the use of this pyrolithic stone-boiling structure formed a sealing layer above the surviving cut features. A sample of birch charcoal from the burnt mound material is radiocarbon-dated 2860–2490 BC (Beta-178218: 4080±40 BP). Trough 2 was dug into the burnt mound from this earlier phase and the underlying impermeable clay subsoil. A third trough to the south of Trough 2 in a similar alignment was cut through the same subsoils. This trough appeared to be contemporary with a northeast–southwest aligned ditch that functioned as a drain taking water into the trough. A distinctive feature of this trough, however, was that its base was oxidized to a bright pink colour, indicating exposure to intense heat. One possibility is that the trough functioned both as a hearth and trough, and was a possible steam bath.[81]

An interesting feature of these two phases of the site is that after Trough 2 went out of use and was backfilled, Trough 3 was created and the site reused as a sauna / bathing place. Although it is difficult to estimate the intervening time period, a fill from Trough 3 is dated 1430–1130BC (Beta-178219: 3040±50 BP), while the primary fill of Trough 2,

[77] O'Brien 2012, 127
[78] *ibid*
[79] *ibid*, 125
[80] Fahy 1960; O'Brien 2009, 203; Hayden 1995
[81] Hanley and Hurley 2013, 116

representing its last use, is dated 1500–1380BC (Beta-78217: 3160±40 BP). The median dates for both of these features suggest an intervening period of some 150 years. While these dates support the stratigraphic sequence, the 'old wood' effect should also be taken into consideration.

The main focus of activity at Inchaquire, Co Kildare, centred on the Early Bronze Age burnt mound with three associated troughs and a well feature.[82] This first phase of activity also involved a storage pit that contained a flint assemblage interpreted as a processing toolkit, including projectile implements (both finished and in stages of production). Two later phases of activity dated to the Middle Bronze Age. The first (Phase 2) was characterized by the presence of a stone-lined cist placed in the western corner of a large 'court'-like area. This was succeeded by Phase 3, which included the re-cutting and reuse of the cist as a trough. Both phases of burnt mound activity are associated with a relatively large animal bone assemblage that includes some of the earliest evidence of the presence of horses within the Irish Bronze Age.

The cist was quickly succeeded by a second phase of burnt mound activity, with the possible burial structure itself recut and reused as a trough. The excavator suggests that this re-cutting was probably responsible for the removal of any grave goods and human remains in the cist. Numerous fragments of animal bone were recovered from the deposits within this trough, along with a few small fragments of cremated bone that could not be identified as human or animal bone.[83]

A similar site was excavated at Shankill, Co Dublin, where it is suggested that a wedge tomb had been built on top of an earlier burnt mound.[84] Such an interpretation implies that the location was ritualized as an important burial shortly after the earlier pyrolithic site was abandoned. The site began as a water-boiling area which had been constructed on a slight hollow on a prominent slope with underlying natural springs. At this stage the site was well laid out, with a trough, a cobbled area, a fence line and a hut site. A fence line (possible windbreak) and cobbled surface lay immediately north of the trough, with the hut site positioned just to the north of the cobbled area.

Some time after the pyrolithic site was constructed, large portions of burnt stone debris from the trough were pushed aside and a foundation pit was dug into the slope. This provided a level base for the construction of a short 'megalithic gallery', which was double-walled and widened at its eastern end, an atypical setting for Irish wedge tombs. It measured 2.35m in length (east-west), 1.5m in width at its western end, and 3.4m in width at the east. No capstones were discovered on excavation; however, large amounts of stone were interpreted as the remains of a cairn.

Though interpreted by the excavator as a wedge tomb, the Shankill structure can be compared with a number of other large, stone-built hearths found at burnt mounds across Ireland. They can be described as a U-shaped setting of stones, sometimes several courses high, which are always open to the shorter end of the trough, to facilitate the deposition of hot stones. Examples include those excavated at Killalough, Co Cork; Garranes, Co Cork, and Ballydowney, Co Kerry.[85] Radiocarbon dates from 18 sites where stone hearths have been recorded all date to the Middle to Late Bronze Age (1608–500 BC), and are associated with either rectangular stone-lined / wood-lined troughs or hollowed-out logs used for water-boiling. As the limit of excavation at Shankill was almost immediately adjacent to the open end of the U-shaped setting, it is likely that this is a stone-built hearth associated with a trough that lies immediately outside the area of excavation. Therefore, the structure relates to a separate phase of burnt mound activity and not that of a burial monument of Early Bronze Age date.

These episodes of re-use reflect fundamental changes from a pyrolithic water-boiling technology to a dry-heat process using hot stones. Sometimes re-use was subtle or gradual, but at other times it was more sudden, implying that quite dramatic shifts had occurred. For example, the production of steam led to new applications of pyrolithic technology during the later part of the Middle Bronze Age. Evidence for this is limited, but a number of distinguishing characteristics may be tentatively identified. These include the presence of large circular pits, *c* 5m in diameter, which were internally cut by stake holes indicating the presence of a tented structure. Examples include Rathpatrick, Co Kilkenny; Ballykeoghan, Co Kilkenny, and Burrow, and Glennanummer, Co Offaly. These sites have been interpreted as the remains of sweatlodges where water was poured on hot stones to create steam inside small tented structures.[86] Other sites defined by large elongated troughs, formal hearths and substantial trough coverings or buildings may have played another role, such as roofed cooking huts, with an extra-large trough allowing the processing of greater amounts of food.[87]

Long temporal gaps between phases may indicate later 'invented traditions', or deliberate acts of forgetting and dislocation.[88] As Bradley has suggested in relation to monument re-use, these changes could even have been accompanied by a symbolic slighting or stripping of the remains of the older construction.[89] A process of this kind may account for the possible symbolic burning of trough timbers seen at Killoran, Co Tipperary; Ballywilliam, Co Down, and Kilmainham 1, Co Meath.[90] Alternatively, these burning episodes may relate to some sort of non-funerary purification ritual or a 'closing event', deliberately decommissioning the trough when abandoned. This will be the subject of the latter half of the paper, where it will be argued that the deliberate destruction or backfilling of troughs along with the deposition of artefacts represented intentional acts of decommissioning, permanently removing some burnt mound locations from cycles of re-use.

[82] Hanbidge 2009

[83] *ibid*

[84] Ó Néill 1999

[85] Cotter 2005; O'Brien 2012; Kiely 2010

[86] Eogan and Shee-Twohig 2011; Laidlaw 2008; Coughlan and Bailey 2011b

[87] Hawkes 2015, 73

[88] Chadwick and Gibson 2013, 8

[89] Bradley 1993, 98

[90] Cross May *et al* 2005, 305; Chapple 2007, 21–33; Walsh 2009

Aspects of commemoration

The occurrence of votive offerings, as foundation or closing deposits, is a feature of the broader settlement landscape in the Bronze Age.[91] While the types of objects found in hoards and votive deposits are rarely encountered at burnt mounds, evidence of special deposits at these sites is now evident in the archaeological record. These include items of stone, metal, bone and wood, some of which are comparable to structured deposition at Bronze Age settlements. These episodes of deposition may have occurred at critical points in the lifecycle of a burnt mound. They may relate to the death of a member of society, the ending of a social relationship or the abandonment of the site or nearby settlement. These types of events may also account for the use of decommissioned artefacts, animal and human remains, symbolic of the end of one life cycle and the beginning of another.

This includes a site at Killeens, Co Cork, where a gold-covered ring was found beneath the timber lining of the pit. A tin bead and a gold-covered ring were identified under a similar plank-lined trough at Sonnagh, Co Mayo.[92] A Late Bronze Age penannular gold ring was recovered from under burnt mound deposits at Rathmore, Co Wicklow, while a complete twisted copper alloy bracelet was recovered from the basal silts of a pit associated with a burnt mound and structure at Bestwall in Dorset.[93] While most of these have been interpreted as artefacts lost during site construction, it is equally possible that they were deliberately deposited as an 'act of foundation', given the rarity of some artefacts such as the bi-conical bead at Sonnagh.

More convincing, however, is evidence of possible 'closing deposits' at these sites. For instance, at Coolroe, Co Mayo, a deposit consisting predominantly of iron, was placed in a wooden container or bucket that was found inverted in the centre of the trough after its final use.[94] At Clowanstown 1, Co Meath, the site was apparently 'decomissioned' by the insertion of a wooden cylindrical container in the centre of the mound when the site was abandoned. All four mounds at the site were subsequently sealed with burnt stone material. A more extensive spread of stone then sealed the burnt stone material and contained a number of lithic and bone finds, as well as evidence for at least seven animal skulls.[95] Further evidence of decommissioning may be inferred by the placement of two large boulders found in troughs at Chapelbride 5, Co Meath, and Newtown, Co Louth.[96]

At Charlesland, Co Wicklow, a set of Early Bronze Age timber musical pipes were found deliberately deposited in the base of a timber-lined trough (Fig 14).[97] At Claristown, Co Meath, a stone pestle and mortar were interpreted as votive deposits in a similar context.[98] Other food-processing artefacts such as saddle querns have been found deposited in troughs such as Charlesland, Co Wicklow; Ballyduff East, Co Waterford, and Inchirourke, Co Tipperary,[99] while at Kilree 1, Co Kilkenny, the saddle quern was deliberately placed on top of a pit filled with domestic waste.[100] At Sranagalloon, Co Clare, the presence of a worked yew rod with axe chop-marks sealed within a fill of re-deposited subsoil suggests that it may have been placed deliberately. The function of the yew rod is impossible to determine; however, wear marks on one end point towards a specific use such as pounding or mixing or even stunning animals.[101]

Several high status objects recovered from burnt mounds have also been interpreted as being deliberately deposited. For instance, at Dooros, Co Mayo, a gold dress fastener was supposedly discovered in a burnt mound, while at Ballymaclode, Co Waterford, two Late Bronze Age gold bracelets were found at the top of a surviving burnt mound.[102] The fact that the type B2 bracelet from the site survives as two folded-up fragments also suggests that it was in a transitional, if not the final stage, of its life as a bracelet. The folding of gold objects prior to deposition is known from Early to Late Bronze Age contexts.[103] At Ballynakelly, Co Dublin, once the heating of water and the subsequent dumping of heated stone in and around an adjacent well had ceased, a thick layer of organic-rich silt with wood inclusions began to accumulate in the feature. A Middle Bronze Age palstave and numerous bound bundles of wood were deposited in this well pit, at a time after the water heating activity had ceased.[104]

Human bone was also occasionally included in closing deposits at burnt mounds. Human remains have been recovered from 17 pyrolithic sites in Ireland, four of which have been interpreted as deliberate deposits. These include Inchagreenoge, Co Limerick; Cragbrien, Co Clare; Belan, Co Kildare, and Leshemstown, Co Meath.[105] The complete skull of an adult male was found deliberately placed in the bottom of a spring at Inchagreenoge, Co Limerick, while at Leshemstown, Co Meath, the crouched inhumation of an adult female was broadly contemporary with the dated trough.[106] The burial represented the formal deposition of an articulated individual at a time when cremation seems to be the norm in the Middle to Late Bronze Age. Furthermore, this burial was placed into a burnt mound, a site not normally associated with the deposition of human remains. The nature of the back-fill in the grave at Leshemstown suggests that little time had passed between the deposition of the mound material and the burial. The latter was sealed by a final deposition of burnt material after the grave had been back-filled. This suggests not only that the burnt mound and the burial were broadly contemporary, but that pyrolithic activity continued after the internment. A burnt mound at Feltwell Anchor in Norfolk, England, produced an inhumation of an adult female dating to the Chalcolithic. That individual

[91] Brück 1999; Cleary 2006
[92] O'Kelly 1954; Gillespie and Kerrigan 2010
[93] McLoughlin 2001; Ladle and Woodward 2003
[94] Gillespie 2010, 13
[95] Mossop 2008
[96] Gallagher 2008; Ó Drisceoil 2002
[97] Molloy 2003
[98] Murphy 2001
[99] Molloy 2003; Eogan and Shee-Twohig 2011; Conboy and Hardy 2009
[100] Lynch and Coughlan 2011
[101] Nunan 2010
[102] Cherry 1990; Pollock 2009
[103] Cahill 2009
[104] McCarthy 2010
[105] Grogan *et al* 2007, 199; Clark 2010b; McGowen and Fallon 2010
[106] Grogan *et al* 2007; McGowen and Fallon 2010

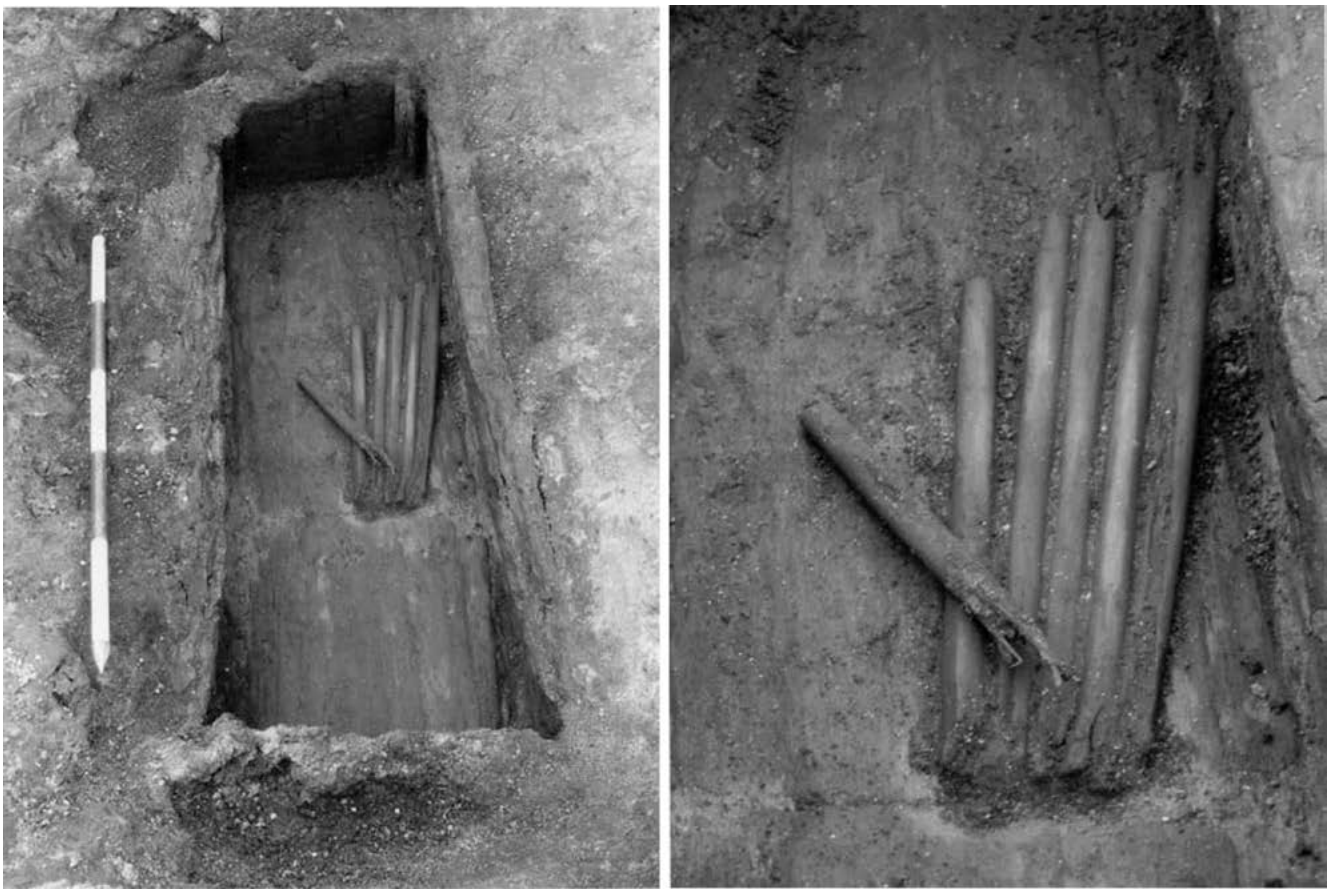


Fig 14 Yew wood pipes thought to form part of a composite musical instrument (dated to 2137–1909 BC) found in the base of a plank-lined trough at Charlesland, Co Wicklow (photo courtesy of Margaret Gowen and Co. Ltd)

was interred within a wooden coffin or mortuary structure some time after the final phase of use of the mound.[107] The insertion of inhumations through the centre of mounds at Feltwell Anchor and Leshemstown 5, Co Meath, highlights the visibility of these burnt mounds on the landscape. This can also be demonstrated in South Wales, where a standing stone is sited atop a burnt mound.[108] These examples suggest an occasional ceremonial 'closing rite' associated with the abandonment of burnt mounds.

Such 'closing deposits' can relate to a range of 'rituals', from the abandonment of an entire site to the decommissioning of a single trough or pit. The latter 'may therefore have taken on a new function as the location of a symbolic deposit linked to maintaining the everyday balance of the society'.[109] These episodes of deposition may have occurred at critical points in the lifecycle of the burnt mound. They may relate to the death of a member of the society, the destruction of a nearby building, the ending of a social relationship or the abandonment of the water-boiling area or a nearby settlement site. As outlined by Cleary in relation to Bronze Age houses, these types of events may also account for the use of broken or decommissioned artefacts, animal and human remains; all strong symbols of the end of one life cycle and the beginning of another.[110]

Burnt mounds had varied biographies, sometimes extending over many centuries, and the layers of communal and cultural memory associated with these distinct spaces over long periods of re-use must have been important in building and maintaining social and cultural identities. As such, the deposition of material culture might have been an important way of remembering or emphasizing particular connections to social places in the landscape.

The importance of place

As observed by O'Brien, much of the recent research on prehistoric landscapes in Ireland has focused on so-called 'sacred landscapes', 'elite landscapes' and 'landscapes of power', with little research on the 'unexceptional landscapes of everyday living'.[111] These are the environments in which burnt mounds typically occur, and so it is important to understand how people in the past related to the world in which they lived, and how they invested their surroundings with cultural meaning through various symbolic processes connected to their sense of time and place. Thomas has observed that 'people are knitted into a network of locales

[107] Bates and Wiltshire 2000
[108] Crane and Manning 1998
[109] Cleary 2007, 256
[110] *ibid*, 276
[111] O'Brien 2009, 324

with which, through habitual and inconspicuous familiarity they will have formed a kind of communion'.[112] These locales have the characteristic of being places where people lived their lives in what were inherently 'social landscapes' made up of different scales of relationships. Landscape may thus be viewed as '…a network of related places, which have gradually been revealed through peoples habitual activities and interactions, through the closeness and affinity that they have developed for some locations.[113] Burnt mounds are good examples of such places: environmentally differentiated space where the setting and use of pyrolithic technology contributed to a strong sense of local place and identity.

As pyrolithic sites are marked by an accumulation of burnt stone, these mounds would have been visible in certain locations where they influenced an understanding of settlement space. The revisiting of burnt mounds, and specifically the reuse and re-lining of individual troughs, shows that these locations were a permanent element in the landscape, even if the activity at each site was episodic. The repeated and prolonged use of these sites, as indicated by multiple cooking pits and / or hearths, would have invoked a sense of community around a persistent place in the landscape. The act of deposition itself may also have been significant, as fired debris could have been mounded to deliberately mark a particular location. Equally, it may have been about connections to specific parts of the landscape, and particular ways of doing things in those places. One effect of concentrating the debris within a limited area was to increase the height of the mound, with the result that they became visible symbols within the landscape. As Cummings observes in relation to shell-midden deposits, it may have been about a connection to a place, one that may well have existed in relation to other sites, but expressed in a different way.[114] It has been stated that mound morphology is probably of limited importance as they were likely formed by randomly depositing burnt stones and fuel residue around the trough area.[115] The archaeological evidence, however, does not support the impression that waste firing material was randomly deposited. The structured distribution of mound material is clearly evident in more extant examples not affected by agricultural activity. The material is usually found adjacent to the trough, deposited continuously over many years of intermittent use. Most are well defined, organized mounds rather than haphazard dumps, with an obvious intention to deposit this material at the shorter ends of the trough location rather than a short distance away (see Fig 8).

Moore and Wilson observed that the presence of kerbing at some Scottish burnt mounds 'indicates that a degree of forethought was involved in the construction and management of burnt mounds, and this implies that the shape and size of a mound was significant to the people who built them'.[116] An organized approach to the management of these mounds is also apparent from the Irish record and is an aspect of site structure that is not often discussed. A number of burnt mounds have evidence for kerbs or revetments interpreted as retaining features to minimize mound slippage. Such features are usually identified on more well preserved sites where the mound survives relatively intact.[117] The remains of twenty possible stone revetments have been uncovered in recent years; however, interpretation is hampered by disturbance caused by later agricultural activity.

It is also possible that the accumulation of waste-firing material was done for other reasons. It may be that deposits were deliberately built up and revetted in such a way as to provide shelter to a working area, helping to reduce heat loss from prevailing winds. One other effect of concentrating the debris within a limited area was to increase the height of the mound, with the result that they may have been visible within the landscape. For instance, a layer of unburnt stone was added to a small cluster of burnt mounds at Clowanstown 1, Co Meath, effectively consolidating the mounds into one large site.[118] Similarly, a setting of six unburnt boulders on top of a burnt mound at Caltragh, Co Sligo, seems to have been deliberately placed and covered by the final stages of burnt material.[119] A burnt mound at Ballyburn Lower, Co Kildare, was deposited around a large granite boulder, and the excavator suggests that the latter may have served as a focus point for activity.[120] A similar phenomenon was noted at Woodlands East, Co Kildare, where a large granite boulder was identified in the northern portion of the mound.[121]

It is important to acknowledge that the evidence of preceding pyrolithic activity must have influenced in some way similar activity of later date at the same locations. The reuse of older sites may have signalled that the area was suitable for pyrolithc water-boiling and there were sufficient raw materials and natural resources in the environs to maintain a site. This association with a particular place probably led to a concern with genealogy. It is suggested by Pollard that 'acts of deposition on or after the abandonment of a settlement and by the construction of monuments over former occupation sites were permanent embodiments of place-values'.[122] For example, the clustering of burnt mounds in an area may have been part of the process of attributing significance to particular places. Bradley contends that the use of monuments helped to create a distinctive type of consciousness, one that involves a changing perception of time and place. Monuments, he argues, 'have an enduring quality and their physical presence is a constant reminder of a human past that can serve the needs of people in the present'.[123]

Conclusion

The re-use of a particular site may have been determined by a number of factors that could have operated collect-

[112] Thomas 2001, 173
[113] *ibid*, 172
[114] Cummings 2009, 17
[115] Thelin 2007, 42
[116] Moore and Wilson 1999, 232
[117] Fahy 1960; Hull 2006
[118] Mossop 2008
[119] Halpin 2005; Danaher 2007
[120] Hackett 2009a
[121] *idem* 2009b
[122] Pollard 1999, 88
[123] Bradley 1993, 5

ively or independently. Firstly, some natural areas may have been deemed sacred by virtue of an earlier ritual association, while others may have had a commemorative importance in relation to earlier pyrolithic processes, connected with an ancestral history. Secondly, the choice of a particular location may have been influenced by certain practicalities such as the availability of resources (eg water, fuel and stone).

Social factors are also likely to be of significance, their position within a settlement territory and proximity to residential centres. In most cases, it is likely that a combination of social and environmental factors determined the siting of individual pyrolithic sites within a wider settlement landscape, and it can generally be assumed that the environmental factors that influenced the siting of burnt mounds in some way reflect the settlement pattern and economic concerns of their users. The connection to place is also important, as previously discussed, and it is likely that these depositions of burnt stone were long-lived actions that may have had genealogical association linked to previous inhabitations. By returning to the same site and re-using troughs and constructing new ones, this may have helped to legitimate the user's rights to the land and certain resources, giving the site an additional time depth.

Similarly, the formal deposition of objects may have taken place at critical stages in the lifecycle of both settlements and related burnt mounds. It is probable that the abandonment of a burnt mound was marked in some way, possibly including the deposition of human remains, to lay claim to a particular area through the bones of the ancestors or to end the association between the area of the living by placing a 'closing deposit' at the site. Other important events that may have been marked could include particular births, seasonal changes, deaths of leaders, and marriages or the creation of social relations.[124] Similar to ideas proposed for settlement sites, the deliberate deposition of the remains of ancestors in troughs and burnt mounds may have symbolically tied the living to the land their kin once inhabited, while also ensuring good fortune for the living.[125] These artefacts may not have been at the end of their 'use-life' but may have marked out specific places, events or ideas.

It is possible that other objects deposited were curated items connected with certain events, people or places,[126] and that they were repeatedly brought together to mark a specific place in the landscape. The occurrence of various stone tools, pottery and saddle querns would suggest the use of 'mundane' artefacts in a more symbolic way, as would the use of faunal remains. This may imply a concern with everyday living, particularly the importance of sustained subsistence, such as the prosperity of crops and animals. It is also likely that the artefacts entered the troughs / mounds through practices which had become 'ritualized' through frequent, routine practice, rather than as overt acts of 'ritual' which were generally undertaken at ceremonial monuments. The infilling of troughs and the deposition of domestic material culture would appear to have formed part of a widely held ideology concerned with making an appropriate offering or with marking the occupation of a place in a particular way; in short, part of a long-held tradition of inhabitation of the landscape.[127] The formal deposition of artefacts and human remains is still a rarity at excavated burnt mounds and it may have only been under special circumstances that pit digging and infilling became a part of a larger-scale or significant event, thereby becoming an overtly conscious ritual act.

As outlined by Connerton, by incorporating earlier features into new ones, the past and present were threaded together into continuous and connected networks, allowing ruptures and instabilities to be smoothed over.[128] A key factor in remembering is repetition. While earlier troughs were acknowledged, new structures adapted or retranslated the original meanings, depending on the relevance they held for those societies at the time. Through repetitive action, social groups lay claims to commemorating earlier events, and instil a sense of continuity that reinforces links between past and present, often invoking important moments and monuments. As observed by Gibson, 'new features were sunk into the mnemonic depths of the past, through sequential re-cutting, overlapping, juxtapositioning, incorporation and layering. This was the physical work of memory'.[129] Renewal however, implies change as much as continuity, and choosing to break with traditional practice may also have involved an explicit position on the relationship between the present and the past. After a certain period of time had elapsed, it might have been necessary for communities to physically negate their memories of a certain process, hence the construction of morphologically different troughs overlying earlier ones. On the present evidence it is hard to assess how rhythmical or episodic these trough renewals and depositional events were, and exactly how they punctuated the different temporalities evident at the various sites.

In contrast with the shorter-lived sites, larger, more complex burnt mounds were obviously used with the intention of extended occupation of that landscape. They could have been temporarily or seasonally abandoned and only occasionally taken permanently out of commission. With their well-defined physical presence in the landscape, particularly where sites cluster in small groups, this might have been about tenure of certain areas of good land, linked to particular owners / families who marked rights to land with the mounding of burnt stone from cooking episodes. The formation of mounds from this practice would have brought them into the realm of social memory by making it a place associated with feasting and myth of particular families or communities of those areas.

It may have been these earlier feasting events that made it a suitable focal point for further activity in later periods.[130] Continuity may also be inferred from the location of these sites in marginal areas, highlighting the continued importance of water for their operation. However, subtle changes in relation to trough linings and additional features relating to site drainage, along with pits and associated structural evidence imply a continuous evolutionary model, with new and

[124] Cleary 2006, 34
[125] *ibid*, 32
[126] Harris 2009
[127] Jones 2013, 62
[128] Connerton 1989, 45–6
[129] Gibson 2013, 119
[130] Jones 2013, 67

different pyrolithic practices emerging as a consequence of social evolution and economic development. For instance, it has been proposed that social memory is such that sites can become re-interpreted and inhabited in quite different ways.

As previously mentioned, the true lifecycle of a burnt mound, however, can be difficult to establish. Obviously, scientific dating methods provide some answers, especially where multiple contexts are dated, but it is difficult to determine whether or not sites were 'persistent places'.[131] Similar to prehistoric habitation sites, the act of settling at a locale may have involved reference to the previous use of that place. As Bradley observed, people live their lives in relation to the past and they understand their world by referencing to tradition.[132] A water-boiling area may have played a similar role, as an appropriate setting to invoke the past and tradition in the ordering of a living society.

If cooking was the primary function of Bronze Age burnt mounds, it should not be viewed as a mundane undertaking, but rather one that actively contributed to the constitution of social relations. The duration and frequency of activities associated with burnt mounds and the opportunities they provide for social interaction suggest that they contributed some familiar frames of reference to contemporary discourse. As people took part in different roles in either the production, consumption and disposal activities on the site, those roles, their contributions and their return may have been a direct reflection of their wider social relationships and, in that way, their sense of identity.

In constructing a mound from the debris of the firing, rather than disposing of the material in discrete spreads, practitioners were both drawing attention to the site, creating a sense of place, and creating a physical reference to the activities being carried out. Clusters of burnt mounds would have also transformed certain areas, adding to the visual distinctiveness of locales, creating unique places. Seen in this way, burnt mounds may have been associated with long-term engagement with particular 'wet' places of the landscape, on the margins of settlement spaces that were 'remembered' as places of familial or communal gatherings for ancient cooking.

At the end of the lifecycle of a burnt mound, those materials used in the process were used to bury and seal it. The abandonment deposits, rather than being neutral, were depositories or reliquaries of memory. The material residues of past pyrolithic users may have embodied memories of individual family members, of activities of production and consumption. Memory is thus not fixed to a specific time and space by the material world, as proposed by Robinson, but acts as a form of material metonymy that may create dynamic connections to the lived and remembered lives of past householders.[133] Re-using trough pits of previous generations would have acted as a powerful material reminder of identity, and was equally important for the construction and reproduction of social memory. In this respect Cubitt notes that social memory should not be seen as a product, but a process which draws upon the individual memories of a social group and invests people with a 'sense of past that extends beyond what they themselves personally remember.[134] At sites with long-lived inhabitation, material culture might have been essential to maintaining and recreating social memories and ritual traditions. By making such public connections with the past, the families or local lineages were perhaps underlining real or fictive ancestral connections, reinforcing their physical and social place in the landscape.

The act of selecting any space for human occupation implies the creation of a relationship with that place. The way in which that relationship was marked and remembered is a vital insight into prehistoric beliefs. Repeated visits to these earlier burnt mounds may have been initially dictated by practicalities, then perhaps group tradition, but over time communities regularly using these sites would have developed a clear sense of place.

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[133] Robinson 2013, 160

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Chronologies and connections: exploring the reuse of rock art and geological choice in Bronze Age Ireland

Rebecca Aroon Enlander

Atlantic rock art (commonly referred to as cup-and-ring art) was carved in landscape contexts at various times during prehistory, with dense concentrations of material across the Atlantic façade, including the north and south-west of Ireland. In an Irish context, rock art in the landscape seems to have been carved during the Neolithic period, with the tradition continuing into the Early Bronze Age in many regions. By the onset of the Bronze Age, panels from landscape contexts were also being reused in a variety of ways. In contrast with northern Britain, where the presence of reused rock art panels in Bronze Age cists is well documented, there is comparatively little evidence to suggest that decorated stones were purposefully quarried from in situ *rock art panels at any great scale in Ireland. There are, however, a number of Irish examples of rock art in secondary contexts, particularly in counties Antrim, Louth, Meath and Monaghan. This paper specifically addresses the rock art tradition during the transition between the Neolithic and Bronze Age periods, by exploring the differences in character and context of quintessential and 'reused' rock art. Specific examples from the Antrim Plateau and the Dundalk region, county Louth, are drawn upon. A broader discussion of examples of reuse and the mechanisms of reuse are also considered against a backdrop of wider changes in contemporary Bronze Age society.*

Introduction

The carved rock surfaces of Ireland form just one branch of a wider art tradition witnessed across Atlantic Europe: a broad geographical area which is frequently defined by an emphasis on largely coastal cultural connections. The exclusive distribution of passage-graves and associated megalithic art, as well as the rock art tradition during the Neolithic and Bronze Age periods form one such distinct tradition manifested around the Atlantic fringe of north-west Europe. Like its British counterpart, the Irish rock art tradition is of a principally non-figurative style, with isolated motifs or complete panels composed from a restricted repertoire of curvilinear forms. These decorated surfaces can broadly be divided into two classes: rock art on *in situ* rock surfaces within the landscape, and rock art on architectural surfaces or cultural stone. These categories can be subdivided further, reflecting the broad spectrum of carved contexts in Ireland.

The precise chronology of rock art in landscape contexts can be difficult to define, and it is important to remember that rock art was probably not restricted to one period of time; rather, carving practices and the life histories of individual sites extended over much longer durations than previously supposed.[1] There are, however, a number of recent excavations associated with rock-art sites that shed some light onto the use of these locations, and provide a means of interrogating chronological indications of site use. While the evidence comes from disparate parts of Britain and Ireland, there has been surprising consistency across these sites. Excavation results have demonstrated a strong association with quartz, with surplus quantities of broken and worked quartz identified, which may have been used in a range of processes beyond the physical creation of rock art motifs. The presence of a formal surface or platform around certain areas of rock art, suggesting that an audience was an integral part of the creation and use of these sites, has also been revealed.[2]

Dating evidence from Torbhlaran, Kilmartin (a large whale-back outcrop), relates to a circle of stake-holes sealed by a substantial platform structure, and a large fissure on the rock surface which contained lithic material. These contexts suggest a later Neolithic date for these probable remains of carving activity 2580–2340 cal BC (SAUERC-28692: 3970±35 BP).[3] Excavations at the Drumirril rock art complex in County Monaghan revealed a number of features, principally an enclosure and terrace-like structure, with a cluster of decorated outcrops at its centre. A number of diagnostic artefacts from the excavation included Early and Middle Neolithic pottery and a round scraper, and the evidence is consistent with the growing premise that rock art was practised from the Neolithic period onwards.[4]

Secondary contexts

The presence of pre-decorated slabs in secondary contexts dating to the Early Bronze Age period seems to mark the termination or change of emphasis of the cup-and-ring tradition. Specifically, areas of decorated outcrop were quarried and used in the construction of various monuments, including cist burials. Carved panels redeployed in this way seem to have been selected intentionally, detached from their original locality, and very deliberately displayed (or concealed) in these secondary contexts. Waddington[5] has argued that the deliberate deposition of rock art, equated with inhumations and death, represents the expropriation of old belief

[1] cf Enlander 2014

[2] Bradley and Watson 2012; Bradley *et al* 2012; Ellis and Webb 2007; Jones *et al* 2011; Nash *et al* 2011; O'Connor 2006, 178–9

[3] Jones 2012, 83; Jones *et al* 2011

[4] O'Connor 2006, 244

[5] Waddington 1998, 43–5

systems and the substantiation of new values.[6] Of course, rock art sites may have been used into the Early Bronze Age period and beyond, and the presence of ceramics and other indicators of chronology uncovered through excavation certainly points to the continued importance of certain sites.

The rock art tradition also encompassed rock art motifs on the exposed surfaces of stone monuments such as wedge tombs, standing stones, and stone alignments and stone circles. Decorated standing stones, for instance, may have been quarried from pre-decorated landscape contexts, and accordingly are argued to be associated with the same tradition that saw the reuse of rock art in the construction of cist graves by Waddington.[7]

It is, however, difficult to establish whether such decoration represents the redeployment of *in situ* rock art which was quarried from outcrops, or whether these surfaces were carved after erection of the monument. Evidence for the reuse of panels is, therefore, highly subjective and varies from region to region. The majority of rock art panels in monumental contexts within Ireland consist of cupmarks on readily accessible surfaces, making their chronology ambiguous.[8] Notable exceptions include the Ardmore standing stone, located along the eastern Inishowen shoreline, Co Donegal, which is decorated with several large cup-and-ring-style motifs, and more numerous examples in Counties Louth and Meath with clear homologies with megalithic art.

Cist and cairn burials

Secondary contexts provide explicit *post terminus* dating evidence for the rock art tradition at a local scale and include decorated slabs from Drumnakeel cist, Co Antrim, and Moylough cist, Co Westmeath, providing date ranges of 2020–1777 cal BC and 2131–1881 cal BC respectively (UB-2639: 3255±80; GrA-14775: 3610±40).[9] In contrast with northern Britain, where the presence of rock art panels in Bronze Age cists and cairn burials is well demonstrated,[10] there is limited confirmation from secondary contexts to suggest that decorated stones were purposefully quarried from *in situ* rock art panels at any great scale in Ireland. Exceptions include a cist slab from Drumnakeel, Co Antrim, which features a number of potentially truncated cupmarks (Fig 1) – truncation was not recorded in the original site report,[11] but inspection of the stone by the current author identified three potentially truncated cupmarks – and a cist slab from Carn More, Co Louth, which shows signs of quarrying.[12]

In keeping with the British trend, however, the numbers of slabs with complex compositions are over-represented when compared to those in the landscape.[13] Particularly in Counties Louth and Meath, decorated slabs and panels are often idiosyncratic in nature, and it seems probable that they were decorated specifically for their 'secondary' use. Examples include the Crumlin cist in County Louth, which features dispersed pecking and shallow cups (which appear poorly defined), and a sandstone slab from a cist-like burial at Windmill Hill, Co Tipperary, which features bands and dispersed areas of pick dressing. O'Sullivan and O'Connor[14] argue that the nature of the decoration in such contexts 'has more in common with megalithic art than with the more deeply carved forms of *in situ* rock art'.[15] In reference to examples from Ireland, these particular stones are highly individual and distinct as a group, and seem to borrow or condense motifs more commonly encountered in the megalithic and rock art traditions (with particular reference to the Meath and Louth examples).

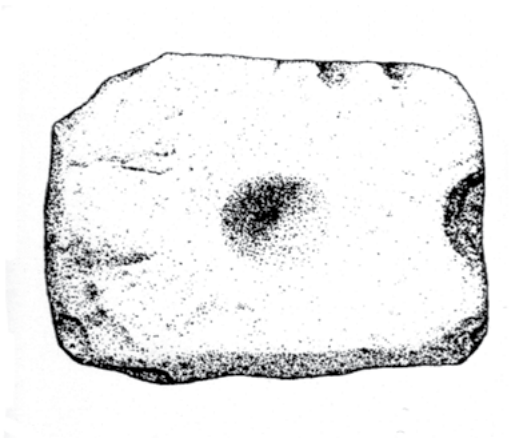


Fig 1 Cupmarked cist slab from Drumnakeel, Co Antrim (after Williams and Wilkinson 1985, fig 11)

O'Connor[16] has further argued that the insertion of cupmarked slabs and stones, as well as smaller cup-marked portable stones and cobbles, may have been deliberately created as part of the funerary process, culminating in their purposeful inclusion in funerary contexts. The 'creation' (either through selection or physical production), and often strategic placement (including central and cardinal positions, and being deposited face-down) of rock art in funerary monuments may have formed a significant act, with production in particular reflecting a specific sensory experience linked to processes of remembrance. Similarly, undecorated stones with unusual forms or features, as well as stones more traditionally associated with the domestic realm, including grindstones, such as the examples at the Carn More cist in County Louth, may have been intentionally selected for inclusion because of their particular life histories.

[6] But see Evans and Dawson 2004 for an alternative viewpoint

[7] Waddington 2007, 16

[8] cf Enlander 2013

[9] Brindley 2007, 373

[10] eg Simpson and Thawley 1972

[11] Williams and Wilkinson 1985. Due to the nature of the excavations (intermittent rescue excavations), the dimensions of the Drumnakeel cist slabs have not been recorded in the published literature. However, the cist was reported to have been set within a large pit, measuring 2m in depth and 2m in width

[12] O'Connor 2010a; 2010b

[13] Bradley 1997, 58

[14] O'Sullivan and O'Connor 2009, 18

[15] A point also argued by Shee Twohig 1972, 231

[16] O'Connor 2010b

Re-appropriating beliefs?

In a broad British-Irish setting, the identification of surfaces decorated with cupmarks, rock art and megalithic art is characteristic of certain contexts from the Late Bronze Age onwards, and particularly those associated with habitation. A portable boulder decorated with a cup, double ring and radial line was found re-deposited in the interior of Haughey's Fort, Co Armagh, from a large, charcoal filled pit. Excavations revealed direct dating evidence of *c* 1250–910 cal BC (UB-3881: 2962±47), indicating a Late Bronze Age context. The boulder was damaged in antiquity on its left side, perhaps indicating that it was intentionally quarried from a larger slab. Its deposition perhaps reflects its use as a votive offering, especially considering its central placement.[17]

Standing stones and stone arrangements in Kilmartin, Scotland, typically feature cups and / or cup-and-ring marks on their faces, the most profusely decorated being the Ballymeanoch and Nether Largie stone alignments.[18] Interestingly, the Ballymeanoch alignment has recently been dated to *c* 1370–1050 cal BC (GrA-28613: 2970±40 BP), and the more complex arrangement at Nether Largie is likely to date to a similar period (*c* 1300–1100 BC).[19] While the presence of rock art on these surfaces may represent the quarrying of *in situ* decorated panels during the later Bronze Age, Jones[20] argues that the rock art motifs were added during or after the erection of the stones, based on the position of motifs. In each case, the physical act of prising off outcrop from the valley sides and erecting it along the valley floor could be seen as altering the landscape, while the deployment and potential creation of rock art in these new contexts suggests a re-appropriation of beliefs.

Figures 2 and 3 condense the themes discussed above; in Figure 2 a broad chronological sequence has been proposed, based on dating evidence and sequential chronologies established during the excavation and analysis of a number of Irish and British sites. Figure 3 explores the nature of reuse within the rock art tradition, with the shaded area (approximately 2800–2200 / 2000 BC) representing the proposed period for the cup-and-ring tradition. It is difficult to equate such widespread examples with equivalent behaviour in disparate locations, and so it should be stressed that individual sites may have had different beginnings, and seen repeated use over a much longer period of time. Two main phases of reuse are tentatively proposed in this scheme. In the first phase (early Neolithic), cupmarks are carved onto a variety of monuments, including portal tombs and capstones, and by the later Neolithic, cupmarked and otherwise decorated panels were being quarried and erected in the landscape as standing stones, stone complexes and some tomb structures.

The second phase of reuse begins with the appearance of traditions involving the reuse of carved stones explicitly in mortuary monuments from the later Neolithic / Early Bronze Age. The shift in emphasis from landscape and more communal contexts, to locations related to individual burials, is in all probability mirrored in major changes in contemporary monumental architecture at this time.[21] The change in art 'use' may be a reflection of social change at the beginning of the Chalcolithic period in Ireland (*c* 2500 BC), suggested by O'Brien.[22] The reuse of rock art is demonstrable from the Later Bronze Age through the potential deposition of panels as votive offerings (as suggested by the evidence from Haughey's Fort), while both later contexts, from the Iron Age onwards, could represent the deliberate re-appropriation of ancient remains.[23]

Geological landscapes

In the remainder of this paper, the geologically distinct regions of the Antrim Plateau and the area surrounding Drumirril (Louth / Monaghan border region) will be used as arenas to explore the relationships between rock art in the landscape and rock art in contexts of reuse at a local level. Previous work by the author[24] explored the relationship between rock art and geology at a variety of scales, demonstrating that certain geological areas were favoured in the distribution and character of Irish rock art. It should be stressed, however, that both solid geology and the availability of stone surfaces need to be considered in tandem. Geological trends in site distribution do **not** suggest that carvers were aware of geological divisions; rather, subtle distinctions in texture, colour and even 'hardness' may have determined the selection of surfaces. A number of regionally specific trends have been identified, and these trends are worth summarizing here (Fig 4).

The main clusters of Irish rock art occur across the Argyll and Appin Groups, particularly in areas of outcropping psammites and pelites (Co Donegal), with the highest concentrations of rock art seen across Inishowen, especially along the Termon Formation. The area characterized by the Lower Palaeozoic Down-Longford series,[25] which is broadly characterized by Silurian sandstone and shale, also has a high concentration of rock art sites, including the Monaghan and Louth material. Additionally, on an Ireland-wide scale, there is a strong association with the Devonian redbed series, characterized by sandstones, mudstones and localized conglomerates (the Munster Basin – Iveragh and Dingle peninsulas).

Outside of these groups, there are very few rock art sites which employ naturally outcropping stone in Ireland, with sandstone and psammite erratic boulders and slabs most frequently selected, often clustering near areas characterized by a change in slope or terrain. A strong preference for sand-

[17] Aitchison 1998, 31–9; Corlett 2000, 77–8

[18] RCAHMS 1999

[19] Sheridan 2012; ScARF 2012, 123

[20] Jones 2007, 216–17

[21] Cooney 2000, 17

[22] O'Brien 2012, 215

[23] See Enlander 2013 for discussion

[24] Enlander 2013; 2014

[25] The Dalradian Argyll and Appin Groups of Co Donegal consist of a range of metamorphic rocks, including quartzite (metamorphosed quartz sandstone), psammites (metamorphosed sandstone) and pelite (metamorphosed mudstone and siltstone), which range considerably in colour, texture and surface form; the Lower Palaeozoic Down-Longford formation is characterized by Silurian sandstones and shales, of coarse to fine bedding

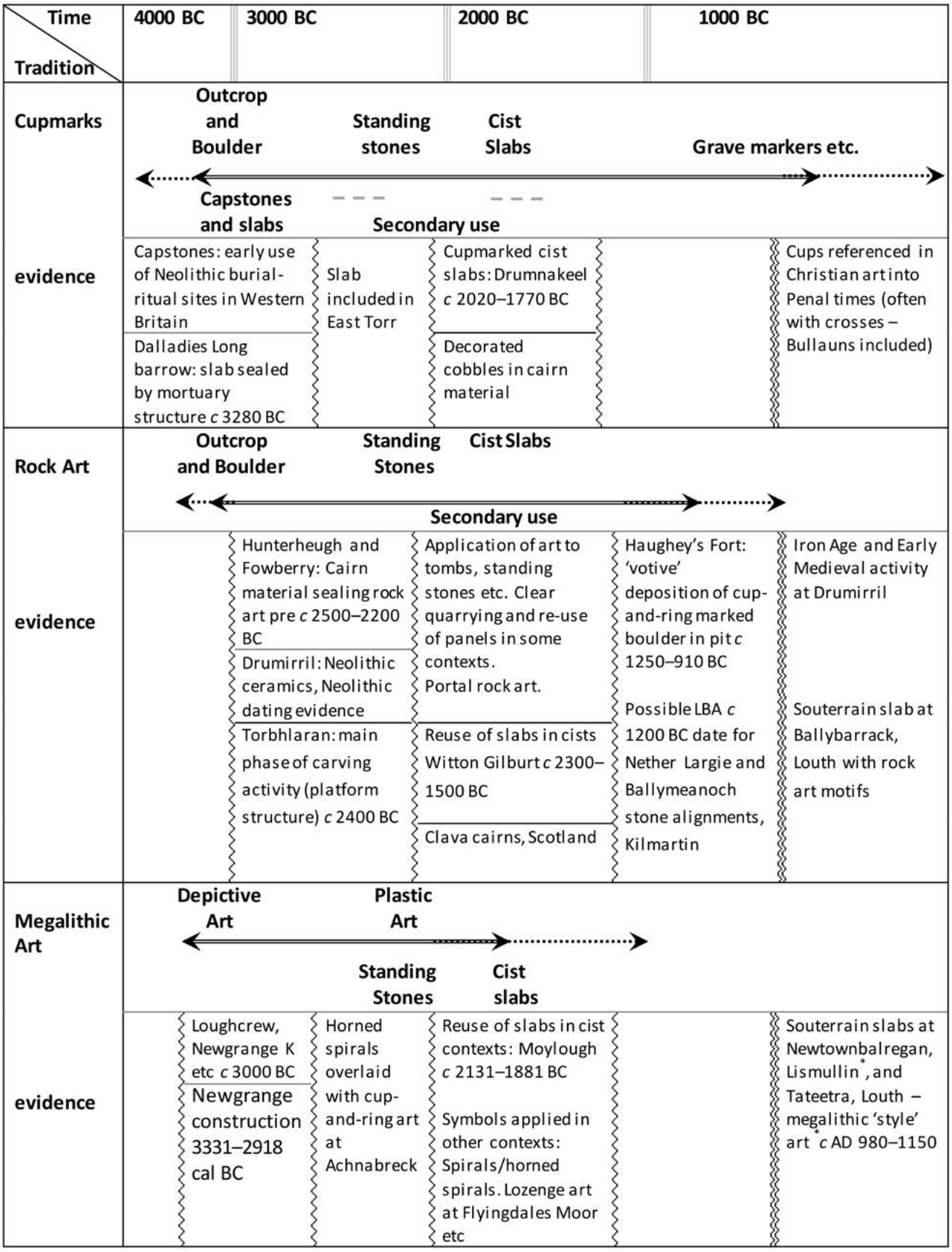


Fig 2 Proposed chronological relationship of British and Irish rock art traditions based on current dating evidence and indirect chronological indicators; the periods are approximations only and are based on evidence discussed in the text

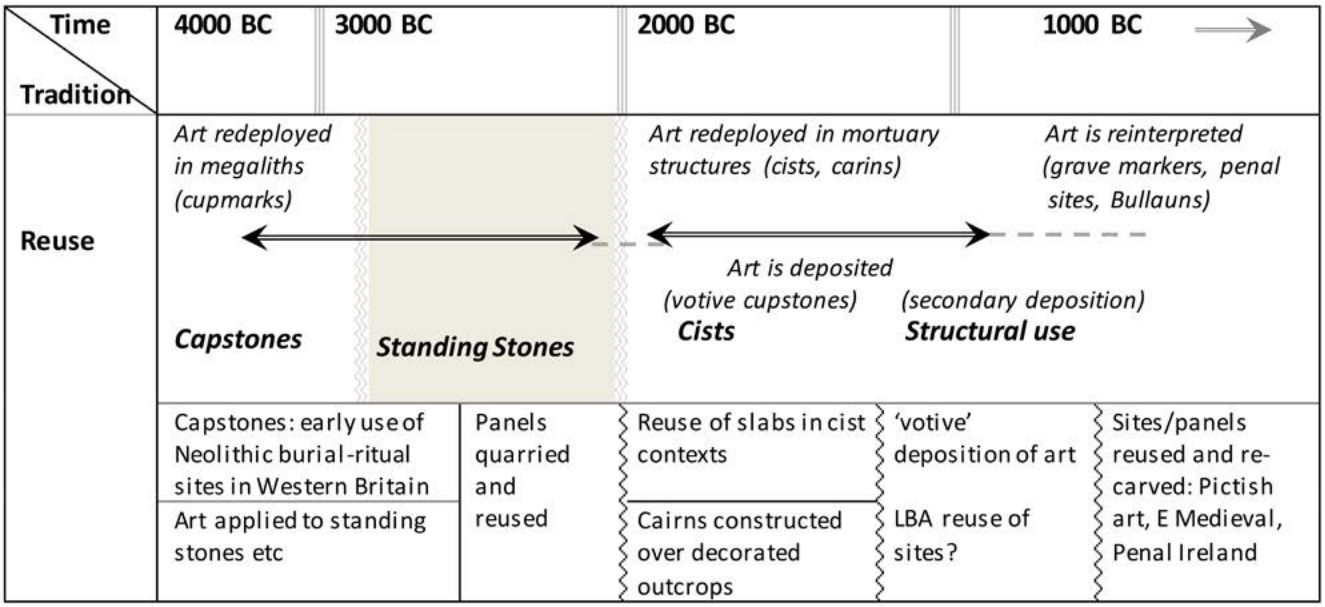


Fig 3 The nature of the reuse of rock art; the shaded section represents the proposed period for the cup-and-ring tradition. The table can broadly be divided into two periods of reuse, the first involving the appearance of cupmarks in a variety of monuments, with cupmarked and otherwise decorated panels being quarried and erected in the landscape near the end of this period (later Neolithic). The second phase begins with the appearance of traditions involving the reuse of carved stones in mortuary monuments (later Neolithic / Early Bronze Age). This shift in emphasis is mirrored in major changes in contemporary monumental architecture (cf Cooney 2000, 17) and may be a reflection of social change at the beginning of the Chalcolithic period in Ireland (*c* 2500 BC) suggested by O'Brien (2012, 215). The reuse of sites arguably extends to the present day; here the reinterpretations of sites, almost exclusively in a Christian context, are noted

stone, siltstone and mudstone formations of the Devonian redbed series reflects the significant cluster of rock-art sites across the Dingle and Iveragh peninsulas. However, the preference for large erratic sandstone boulders as opposed to outcropping rock suggests that underlying geology was not as much of a driving factor in site selection in the southwest, as both outcrops and boulders are generally available in these landscapes.

The Antrim Plateau

The Antrim Plateau is an area characterized by significant uplands, glacial valleys and basalts, collectively classed as the Antrim Lava Group. The sizable geological area is defined by extrusive igneous complexes, which reflect ancient volcanic activity. Geographically, much of the county can be characterized as belonging to the Antrim Plateau and Antrim lowlands, the latter of which frequently occur in drumlin form.[26] The published rock art recorded in the area is minimal, and the rock art itself is predominantly characterized by isolated cupmarks, many of which have clear homologies to the naturally occurring vesicles (naturally occurring cavities) in the basalt surfaces encountered. More varied designs do occur in the region, but these are carved exclusively upon non-local surfaces such as erratic schist slabs.

Marked basalts include: an upright, elongated slab which is decorated with two well-rounded cupmarks overlooking an estuary at Ballycarry; a number of cupmarked boulders and blocks at Linford, close to Knockdhu and the Linford prehistoric enclosures; several cupmarked boulders at Glenarriff, located in the vicinity of the Inver River before its descent along an extensive glacial valley to the coast; and a large block-like outcrop at Tievebulliagh,[27] decorated with well-formed cups (Fig 5).[28]

A further three schist slabs occur within the region and are located in close proximity to one another, to the northeast of the county, below Fair Head. These slabs are of similar dimensions, two exhibit dense cupmarking, while one has

[26] Cruickshank 1997, 61

[27] Tievebulliagh Hill is set above Cushendall, in open grassland, and forms part of the watershed between River to the north and Glenballyemon River to the south. Tievebulliagh's geological and archaeological importance relates to its geological history, where iron and aluminium-rich interbasaltic laterites collapsed within a volcanic vent, where they were altered due to extreme thermal temperatures and converted into porcellanite, which sits within a substantial plug composed of dolerite and porcellanite (Holland and Sanders 2009, 348). During the Neolithic this was quarried from a narrow face near the top of Tievebulliagh as a raw material, primarily for the production of polished stone axes. At a distance of *c* 300m to the southwest of these exposures, in a terrain of little surfacing rock, is a shoulder of outcropping basalt, which exhibits deep jointing lines; on its north facing vertical surface four well-formed cups were identified which range in size considerably from 6 to 12cm in diameter. The largest cup is exceptionally well executed and probably began as a natural hollow where jointing lines diverge

[28] Identified by Enlander 2013

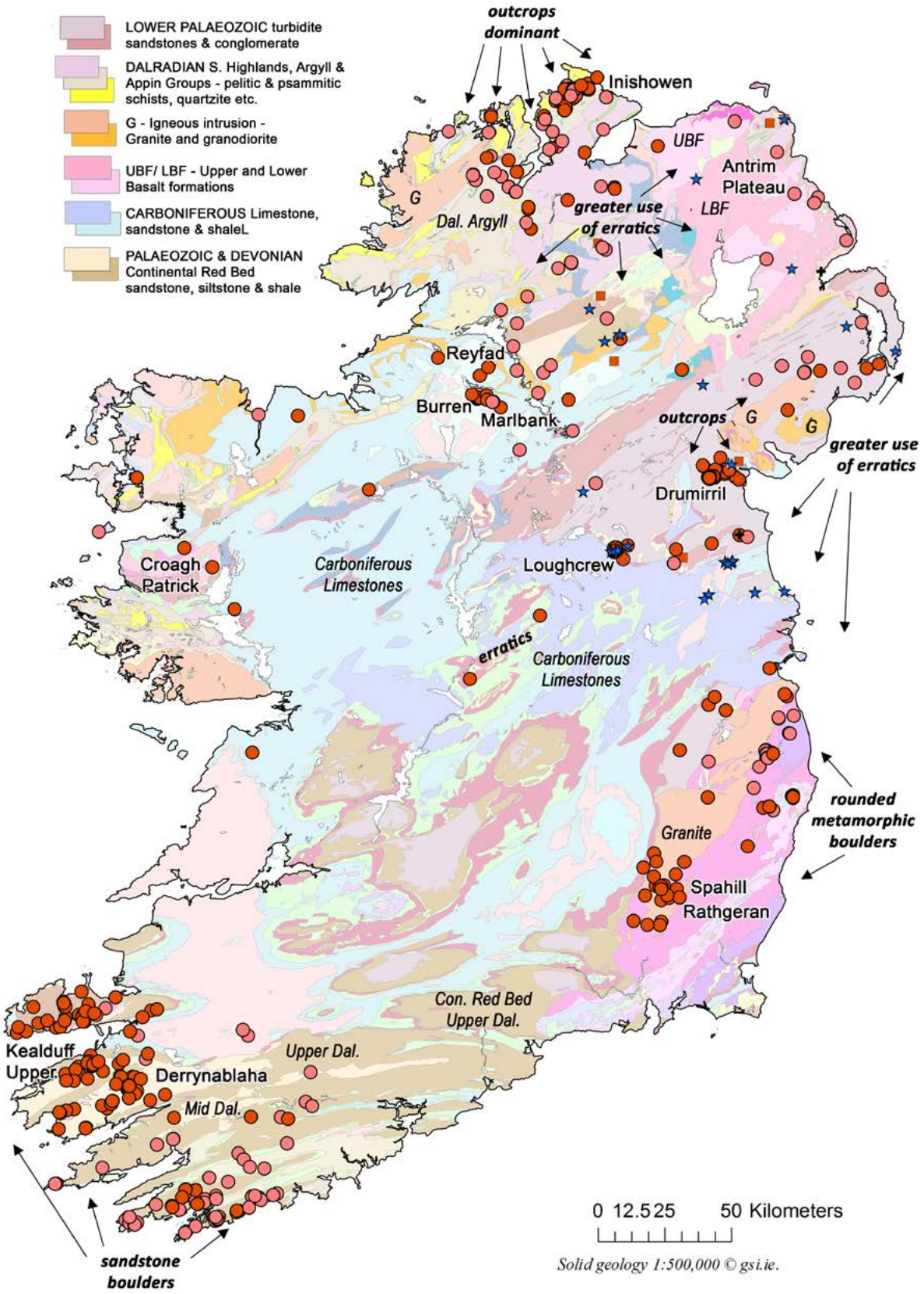


Fig 4 Distribution map demonstrating site location of all Irish rock art and passage-grave art sites in relation to the solid geology of Ireland: note the apparent avoidance of the central lowlands which are principally underlain by Carboniferous limestones. Sites discussed in text include: the Argyll Group in the Inishowen area (and Doagh Island); the Lower Palaeozoic Turbidite sandstones in Counties Down and Meath (Drumirril, Loughcrew); sandstone erratics on Carboniferous limestone in Counties Cavan and Fermanagh (Burren, Marlbank, Reyfad); and sandstone surfaces across the Continental redbed sandstone series in Counties Cork and Kerry (Kealduff Upper, Derrynablaha) (solid geology 1:500,000 © Geological Survey Ireland, images produced in ArcMap 10.1 by the author)

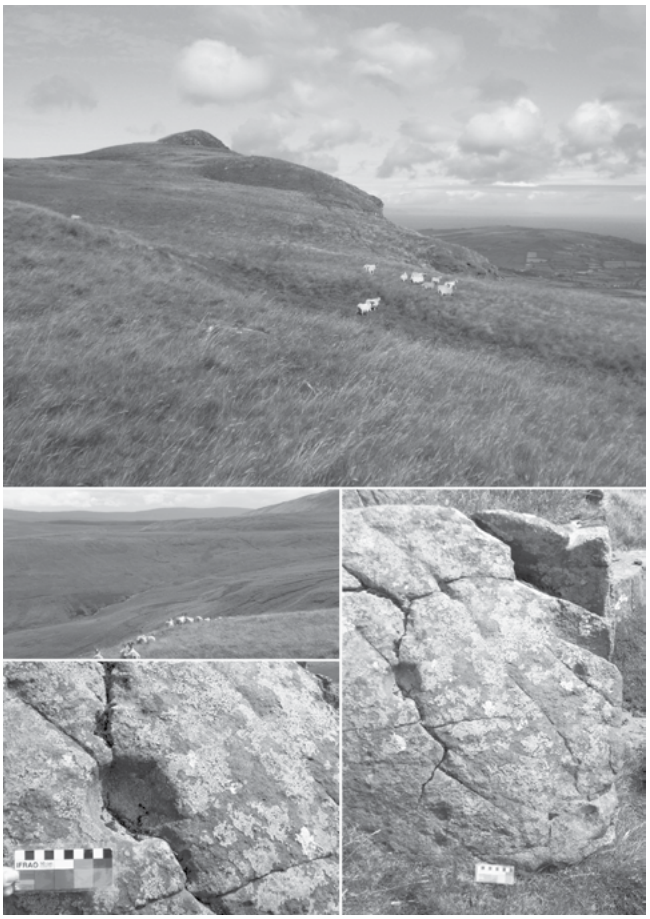


Fig 5 The Antrim Plateau: clockwise from top left: looking towards Tievebulliagh axe factory (the dome-like bulge in the mid-ground – bulge on the skyline is a round cairn), and the coast beyond; north-facing surface of basalt shoulder with four cups (scale is 10cm); and detail of the largest cup, centred on diverging jointing lines; valley floor with Issbawn Burn and waterfalls just visible, and Glenballyemon valley beyond (photographs © Rebecca Enlander)

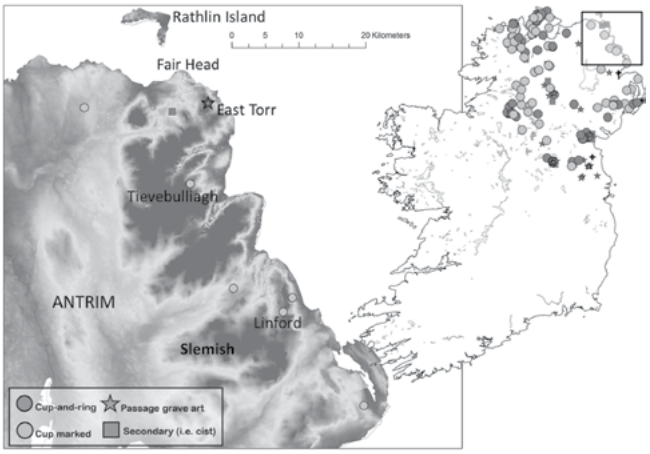


Fig 6 Distribution map of rock art along the Antrim Plateau, including the locations of the survey areas: Rathlin Island, East Torr chambered tomb, Tievebulliagh Hill (and Tievebulliagh axe factory) and Linford (images produced in ArcMap 10.1 by the author)

several truncated cups, and all have been found in secondary contexts: two cist slabs at Glenmakeeran and Drumnakeel, and a roof slab in Carnanmore (East Torr) chambered tomb. Each of these locations (landscape and reused rock art) share extensive views along wide glacial valleys, across headlands, or sweeping across the coastline (Figs 6 and 7).

Despite the small sample size, a distinction in stone treatment is apparent: basalt does not seem to have been widely utilized in the production of rock art, and many of the cups occurring on basalt show clear homologies with natural vesicles, or are clear elaborations of vesicles or hollows occurring where jointing lines converge. The character of motifs occurring at these recorded sites is consistent (simple, isolated cupmarks). The presence of naturally occurring hollows probably acted as a point of reference, with certain surfaces being formally marked through the physical elaboration of these geological forms. Alongside significant evidence for Neolithic settlement activity in the area,[29] specific points in the landscape, which routinely commanded extensive views across the terrain, were marked, perhaps reflecting a network of connected or inter-visible places.

The differing treatment between basalt and schist is stark. The reused schist slabs are much more densely decorated than *in situ* basalt surfaces in the region, and although the original source of the schist slabs is unclear, their incorporation into mortuary structures suggests intentionality.[30] In the Antrim region at least, the secondary pieces are very different in character from the rock art encountered in the landscape. Two differing acts seem to be present: the restrained marking of basalt surfaces associated with specific places in the immediate landscape (including movement towards or across the coast), and the inclusion of comparably elaborate slabs which differed in colour, texture and possibly origin from the landscape art, making their inclusion in cultural contexts all the more potent.

The east coast – Drumirril

The second emergent rock art group is that of the east coast, or central belt, which is overtly associated with the Lower Palaeozoic Down-Longford series (discussed above), the exposure of which runs from the Ards peninsula through to County Meath, and represents the largest expanse of Silurian rocks in Ireland. Glacial drift cover and drumlins also characterize the region.[31] Although broad, the region can be roughly classified as rolling lowlands bounded by coastline to the east, broken by a belt of drumlins to the west (running NE–SW), and the seaward igneous intrusions of the Mourne and Carlingford Mountains. The published rock art record for the area is extensive and encompasses the vast Drumirril complex (Fig 8).

Rock art in the Dundalk area falls within a parcel of Silurian sandstone, belonging to the Clontail Formation, and the localized exposure of bedrock at Drumirril itself is very

[29] eg Bamforth and Woodman 2004; McSparron 2008

[30] eg Evans and Dawson 2004; Jones 2001

[31] Holland and Sanders 2009, 124

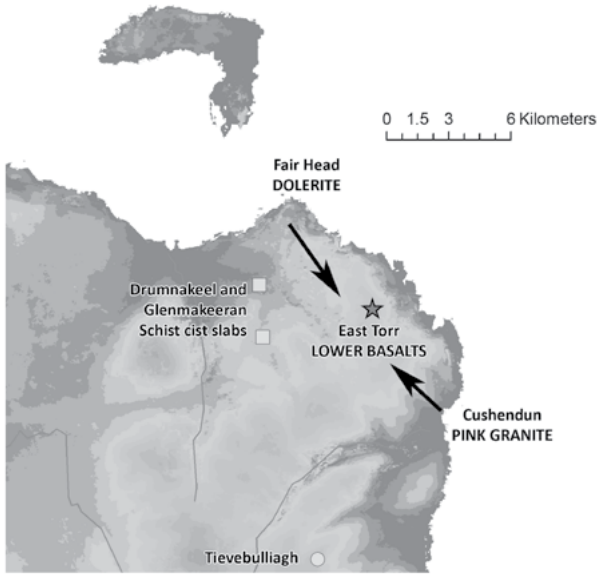


Fig 7 East Torr cairn, with the location of nearby sources of pink granite at Cushendun and dolerite at Fair Head indicated, along with cupmarked slabs at Drumnakeel and Glenmakeeran cists (images produced in ArcMap 10.1 by the author)

distinctive. Dominated by linear ridges with a northeast–southwest orientation, the surface outcrop exhibits marked dissolution hollows (often with a distinctly elongated form) and block-like units within the outcrop. The distinctive geology was in turn referenced through the carving of rock art motifs, whereby natural features characteristic of these surfaces were incorporated into the carvings. The use of natural features ranges from the central enclosure of depressions and dissolution hollows with rings, their use as orbiting cups in multi-ringed designs, and the use of linear joints to form radial grooves or tails.

Moving eastwards, rock art throughout the Dundalk area most frequently occurs on outcropping surfaces at hillocks or other topographically distinct points in the otherwise open landscape. Consistent with the motifs known from Drumirril, isolated cupmarks or panels composed principally of cupmarks are not a feature of the Louth rock art. To the east, rock art sites are more dispersed, and more frequently evidence for rock art is in the form of decorated panels in secondary contexts, including cists and souterrains.

There are three recorded decorated cist slabs from Carn More and Crumlin. The Carn More example, a cupmarked sandstone slab (local greywacke), features dispersed pecking and shallow cupmarks, while the two greywacke slabs found from Crumlin are decorated with cup-and-ring and more complex concentric motifs (more typical of passage-grave art). While the original stone sources of the reused panels are unclear, the stone type reflects that of rock art sites in the wider landscape. The presence and reuse of rock art and potentially passage-grave art suggest that these panels were being reused from decorated outcrops and passage-graves in the immediate area. The character of the Carn More slab contrasts with the typical rock art of the region, which could arguably reflect the deliberate selection of a 'simpler' design.

At a regional level, aspects such as topography and distinct geological formations, (frequently domed / ice smoothed outcrops and knolls) played a role in structuring the distribution of rock art in the Drumirril area. Motifs were frequently carved in response to the characteristic, naturally occurring hollows and jointing of the rock surface through their placement and design. Evidence for passage-grave art is further suggested by the reuse of a number of decorated slabs at Carrickrobin (a probable kerb stone decorated with passage-grave art and 'erected' as a standing stone), and further east in souterrains at Newtownbalregan and Tateetra (passage-grave art with Iron Age additions, and distinctive lozenge-design passage-grave art respectively), potentially signifying the existence of decorated passage-graves in the immediate landscape in prehistory.

The Carn More slab potentially reflects the deliberate incorporation of a comparably simple design, and passage-grave art appears to have been selected for reuse, certainly in contexts from the Iron Age onwards. Unlike the material explored from the Antrim Plateau, there is no difference in the materials selected, perhaps representing the potent attributes of the local greywacke. O'Connor has previously pointed out that rock art sites in the Monaghan / Louth border region consistently fall on turbidite sandstone (greywacke), and this stone's symbolic role in the construction of the Boyne Valley Passage tombs.[32] The passage-grave cemetery of Loughcrew and surrounding open-air rock art sites also fall within an envelope of this bedrock type.[33]

Conclusions

The incorporation of decorated slabs into Irish cists or cairn structures is rare when compared with those in Scotland and northern England. Despite this, the exploration of similarities and differences in the form and character of reused slabs in mortuary contexts suggests regional variation. Through the incorporation of rock art in alternative contexts, a change in ideology is arguably being asserted through material and imagery of the past. However, the very fact that the material differs from the rock art encountered in the wider landscape perhaps reflects a deliberate avoidance of 'locally' specific materials. In the Antrim region this avoidance is best articulated through the use of a geologically and visually dissimilar medium.

[32] O'Connor 2006, 91; also Cooney 2000

[33] Recent investigations by Shee Twohig (2012; Shee Twohig *et al* 2010) have also demonstrated a number of rock art practices within the Loughcrew landscape, including the decorated passage-graves, cup-and-ring art on erratic Silurian sandstone boulders, and rock art from secondary contexts, including a cist and several displaced and reused slabs. While it remains difficult to tease apart the sequence of events that gave rise to the Loughcrew landscape, similarities shared between the motifs employed and the close proximity of rock art, passage-grave art and 'reused' art in this location demonstrate that the traditions cannot be considered as wholly distinct

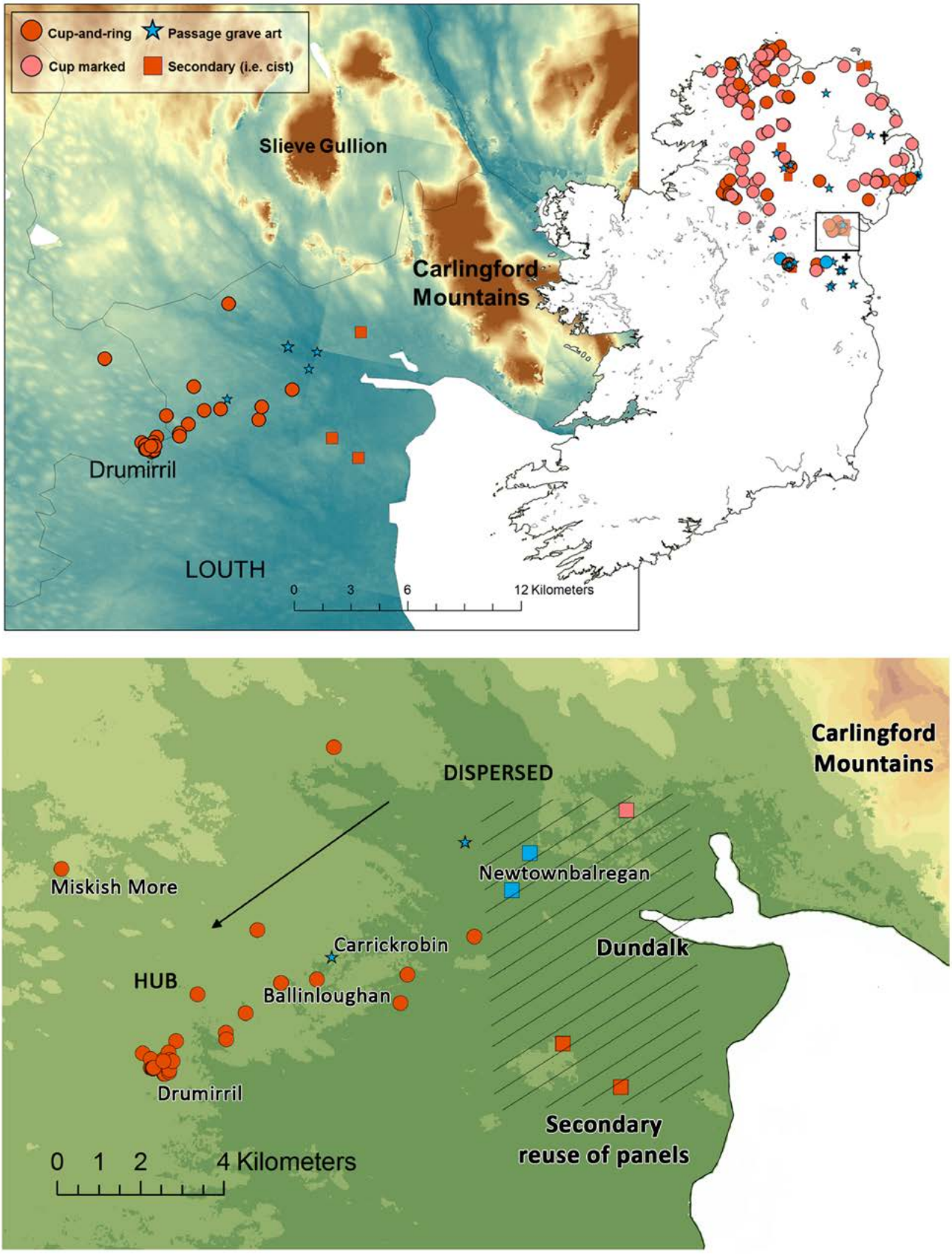


Fig 8 Top: Distribution map indicating the location of the Drumirril rock art site on the Monaghan border and the location of dispersed sites to the east which include landscape art, portable examples of passage-grave art, and reused rock art in County Louth. Bottom: the zone of reused examples of rock art (images produced in ArcMap 10.1 by the author)

The continual process of reuse results in specific sites having extended and altered life histories. The reuse of rock art sites arguably took place throughout the Neolithic period, and into the Bronze Age and beyond, and this reuse no doubt took a number of forms. Discrete occasions of reuse may have included performative acts being repeated (including carving and other 'unseen' rites) and surfaces being reinterpreted. Excavated evidence for the use of quartz and formal platforms certainly suggests that sites where visited and interacted with on subsequent occasions. Intermittent processes of reuse may result in the superimposition of motifs with stylistically different imagery, the quarrying of surfaces to reveal 'fresh' faces, and the incorporation of rock art in different contexts, including burials.

Processes of reuse may have occurred throughout the course of the Neolithic period, whereby the nature of repetition over extended periods of time results in inconsistencies in carving form, depth and meaning. Alternatively, processes of reuse may mark the deliberate transformation of sites as a result of ideological change. Specifically, the deployment of quarried panels and the potential creation of 'new' rock art in secondary contexts may suggest a reappropriation of beliefs. This shift in emphasis, from landscape and communal contexts, to locations associated with the individual, potentially mirror ideological changes reflected in monumental architecture during the Late Neolithic and Early Bronze Age periods.

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Bronze Age landscape rules of deposition around Lakes Mälaren and Hjälmaren, Sweden

Martin Rundkvist

This study deals with the landscape locations of Bronze Age deposition around Lakes Mälaren and Hjälmaren in Sweden, aiming at identifying regularities in the placement of the deposition sites, and at generalizing these observations to build a heuristic toolkit for field archaeologists working in the area.

Introduction

I write these lines near the end of a four-year book project,[1] the main results of which I presented at the Bronze Age Forum in Belfast. I have studied the landscape locations of Bronze Age deposition sites in four Swedish provinces around Lakes Mälaren and Hjälmaren. Most previous studies of deposition have focused on the finds and treated the find circumstances as their attributes. My project, conversely, has dealt with sites and treated the finds as their attributes. The aim has been to identify regularities in the placement of the deposition sites, landscape rules as it were, and to generalize these observations into a heuristic toolkit for field archaeologists working in the area. Main inspirations for the project have been work by David Fontijn, Richard Bradley and David Yates.[2] More recently, similar work has been undertaken in other parts of northern Europe by Lise Frost, Svend Hansen *et al*, Katharina Becker and Marcin Maciejewski.[3]

The south Scandinavian Bronze Age dates to *c* 1700–520 cal BC,[4] starting with the proliferation of distinctly flanged axes and ending with the adoption of iron tools. A major cultural shift about 1100 cal BC divides the period into an earlier and a later part. In the study area, Bronze Age metalwork rarely occurs in graves or at settlements. Instead it used to be found quite abundantly by workmen and farmers during drainage work and stream dredging up until about 1950. It is clearly a question of a separately conceptualized category of deposition site, strongly tied to wet environments. About 1950 land use changed, tractors replaced horses at ploughing and new finds became rare. The last time a multi-object non-grave bronze deposit surfaced in the study area was in 1986, at Sigridsholm in Lunda parish, near Arlanda airport (Figs 1 and 2).

The strategy used by pre-war archaeologists in relation to Bronze Age deposition, where we sat in our offices and waited for workmen to deliver finds, is no longer productive. I believe that there is an unrealized opportunity for contract archaeology, particularly on our well-funded highway and railway projects, to search actively for Bronze Age deposition sites. If we can identify some of the rules that govern their placement in the landscape, then we can use these to find undisturbed sites. That way we may learn what sort of evidence they contain that the ditch-diggers and ploughmen of yore disregarded – wood, plant matter, bones, lithics – and we will start to accumulate knowledge not only of what people deposited, but how they did it.

Pinpointing and reconstructing sites

In order to find the sites, I started out with the museum catalogues for the area. The most voluminous one is that of the Swedish History Museum in Stockholm, an absolutely invaluable resource.[5] Overall indeed, the project would not have been practically feasible without Sweden's many digitized archives. They have allowed me to read original museum inventory notes, study maps from the seventeenth century on, access the Sites and Monuments Register and place what I found in relation to the study area's rapid but uneven post-glacial shoreline displacement, all without even leaving my desk. In the end I came up with about 370 named hamlets or crofts that have yielded at least one relevant documented find. These properties have given 143 finds that are recorded at least to land parcel within a hamlet, forming the core material of the study. Of these 143 finds, finally, 51 have recorded find spots within a land parcel to an accuracy of a few tens of meters or better.

The material at hand consists of bronze, a little tin, a little gold, a few pre-1100 cal BC flint daggers and a considerable number of post-1100 cal BC stone battle axes. Eighty-seven per cent of the finds with hamlet-level or better provenance consist of only one object, usually a socketed axe, generally from after 1100 cal BC (Figs 3 and 4). There are only 30 hoards of more than two objects, plus six accumulated multi-episode sites, mainly in river rapids.

Looking closely at the 143 core sites in their ancient landscape settings, patterns have in fact emerged, as I hoped. Some of the more marked ones follow:

- Seventy-nine per cent of the sites are in or on the edge of Bronze Age open water. Usually lakes or sheltered sea inlets, sometimes streams.
- These are often places where the water *does something*: entry and exit points of streams on lakes and sea inlets, rapids, narrows, the south shores of islands in the sea, lakes on islands in the sea.

[1] Rundkvist 2015

[2] Fontijn 2001–02; 2008; Bradley 1998; 2005; Yates and Bradley 2010a; 2010b

[3] Frost 2008; chapters in Hansen *et al* 2012; Becker 2013; Maciejewski 2013

[4] Hornstrup *et al* 2012

[5] SHMS <http://mis.historiska.se/mis/sok/sok.asp> (11 Feb 2015)

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Fig 1 Bronze hoard found in 1986 at Sigridsholm in Lunda parish, Uppland province, near Arlanda airport, Sweden, dating from Per VI (800–530/20 cal BC). See Figure 2 for deposition circumstances; privately owned; photo ATA archives, Stockholm

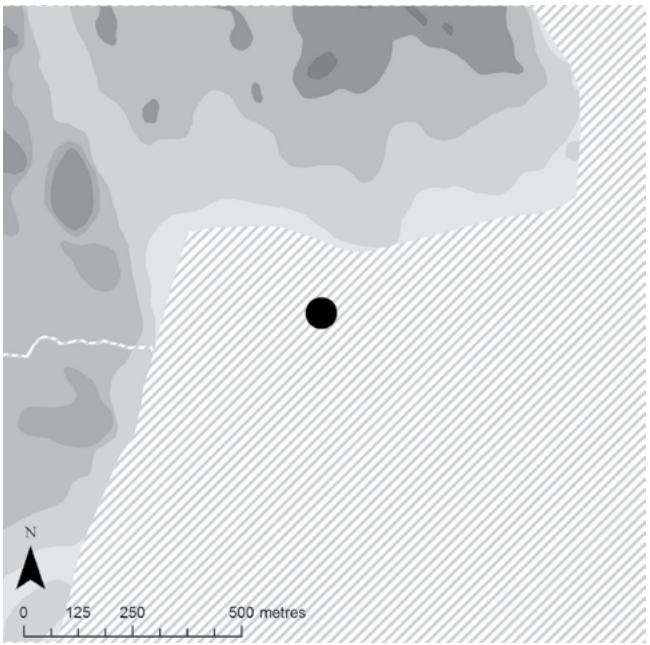


Fig 2 At the time when the hoard in Figure 1 was deposited, its find spot was in a coastal lake or a sea inlet just being closed off by shoreline displacement; map by Tove Stjärna

- And they are overwhelmingly in the settled landscape: usually about 1.8km from currently known burnt mounds (indicating settlements) and rock art (possibly indicating waterside landing sites).
- The great majority of deposition events – those in lakes, sea inlets and streams – move away from burnt mounds over the course of the Bronze Age, most dramatically in the case of the sea sites. Did deposition events become more private affairs after 1100 cal BC, at the same time as ornaments became more common in the deposits? Conversely, the deposition events in lakes and streams tend to take place closer to rock art sites over time – probably because most of the rock art was made at the same time as the later depositions, and by the same people.

I have also found some patterning in what sort of objects were considered appropriate for deposition at specific types of site:

- Before 1100 cal BC swords and daggers are never found in sea inlets where axes and spears are common. Instead, they concentrate in Bronze Age bogs, which have yielded no spears and hardly any axes.



Fig 3 Type Mälaren socketed axe found shortly before 1910 in the Ekolsundsviken inlet in Husby-Sjutoft parish, Uppland province, dating from Per IV or V (1100–800 cal BC). Length 136mm. See Figure 4 for deposition circumstances; Swedish History Museum 13991:4; photo from the Swedish History Museum's Bronze Age catalogue

- After 1100 cal BC all axes are rare on the few nondescript dry sites (which are probably unrecognized settlements). Stone battle axes are also rare in lakes but common in sea inlets. Ornaments are rare in sea inlets and common on nondescript dry sites.

Does the post-1100 cal BC opposition between stone battle axes and ornaments have to do with gender and mobility? Were men depositing sloping-butt and rhomboid stone axes in the sea on voyages abroad, while women deposited bronze ornaments at home? We really have no idea whether either gender travelled more than the other.



Fig 4 At the time when the axe in Figure 3 was cast, its find spot was just off an island in a dense archipelago in the Baltic Sea; map by Tove Stjärna

How can we use this new information?

Well-preserved Bronze Age wetland deposits are generally found far below metal-detector depth. Major exploratory excavations in wetlands are beyond the reach of university archaeology because of the cost and environmental protection rules. But large volumes of wetland basins are routinely drained and emptied for highway and railway projects. The deposition sites could in fact be accessible to contract archaeology if potential deposition sites were put onto the heritage management agenda. I believe that this would be the best way forward in a field of study that is enjoying abundant scholarly interest and methodological creativity, but which is hampered by a lack of new, high-quality data.

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List of contributors

Dr David Bell,
School of Natural and Built Environment,
Queen's University Belfast,
Belfast, BT7 1NN,
United Kingdom.
E-mail: dbell26@qub.ac.uk

Dr Linda Boutoille,
School of Natural and Built Environment,
Queen's University Belfast,
Belfast, BT7 1NN,
United Kingdom.
E-mail: l.boutoille@qub.ac.uk

Dr Dirk Brandherm,
School of Natural and Built Environment,
https://ugg2nd.de/index.php?cl=search\&searchparam=C3i\&lang=0Queen'sUniversityBelfast,
Belfast, BT7 1NN,
United Kingdom.
E-mail: d.brandherm@qub.ac.uk

Dr Peter Bray,
School of Archaeology,
University of Oxford,
1 South Parks Road,
Oxford, OX1 3TG,
United Kingdom.
E-mail: peter.bray@rlaha.ox.ac.uk

Dr Kerri Cleary,
PCAS Archaeology Ltd,
47 Manor Rd, Saxilby,
Lincoln, LN1 2HX,
United Kingdom.
E-mail: kerry.cleary@gmail.com

Dr Rachel J Crellin,
School of Archaeology and Ancient History,
University of Leicester,
University Road,
Leicester, LE1 7RH,
United Kingdom.
E-mail: rjc65@le.ac.uk

Dr Oliver Dietrich,
Deutsches Archäologisches Institut,
Orient-Abteilung,
Podbielskiallee 69–71,
14195 Berlin,
Germany.
E-mail: oliver.dietrich@dainst.de

Dr Rebecca Aroon Enlander,
1 Alexandra Avenue,
Whitehead, Co Antrim,
BT38 9SB,
United Kingdom.
E-mail: renlander@hotmail.co.uk

Dr Fernando Fernández Palacios,
Calle de Sánchez Preciado 59, 4º C,
28039 Madrid,
Spain.
E-mail: mbuchanscot@gmail.com

Prof Andrew P Fitzpatrick,
School of Archaeology and Ancient History,
University of Leicester,
University Road,
Leicester, LE1 7RH,
United Kingdom.
E-mail: af215@le.ac.uk

Prof Sabine Gerloff,
Spindelmühler Weg 8,
12205 Berlin,
Germany.
E-mail: gerloffsabine@hotmail.com

Dr Catriona Gibson,
Department of Archaeology,
University of Reading,
Whiteknights, PO Box 217,
Reading, RG6 6AH,
United Kingdom.
E-mail: c.d.gibson@reading.ac.uk

Dr Alan Hawkes,
Department of Archaeology UCC,
Connolly Building, Western Road,
Cork City,
Ireland.
E-mail: alanhawkes@gmail.com

Prof John T Koch,
University of Wales Centre for Advanced Welsh & Celtic Studies,
National Library of Wales,
Aberystwyth, SY23 3HH,
United Kingdom.
E-mail: john.koch@wales.ac.uk

Dr Katherine Leonard,
PO Box 1465,
Jasper, Alberta, T0E 1E0,
Canada.
E-mail: leonardkate@yahoo.ca

Dr Peter David Marshall,
Historic England,
Cannon Bridge House,
25 Dowgate Hill,
London, EC4R 2YA,
United Kingdom.
E-mail: peter.marshall@HistoricEngland.org.uk

Dr Tobias Mörtz,
Freie Universität Berlin,
Institut für Prähistorische Archäologie,
Fabeckstraße 23–25,
14195 Berlin,
Germany.
E-mail: tobias-moertz@gmx.de

Dr David Mullin,
Institute of Science and the Environment,
University of Worcester,
Henwick Grove,
Worcester, WR2 6AJ,
United Kingdom.
E-mail: d.mullin@worc.ac.uk

Prof William O'Brien,
Department of Archaeology UCC,
Connolly Building, Western Road,
Cork City,
Ireland.
E-mail: w.obrien@ucc.ie

Dr Brendan O'Connor,
48 Rodney Street,
Edinburgh, EH7 4DX,
United Kingdom.
E-mail: brendanjoc@aol.com

Dr James O'Driscoll,
Department of Archaeology,
University of Aberdeen,
St Mary's, Elphinstone Road
Aberdeen, AB24 3UF,
United Kingdom.
E-mail: james.odriscoll@abdn.ac.uk

Dr Ros Ó Maoldúin
The Irish Fieldschool of Prehistoric Archaeology,
School of Geography and Archaeology,
National University of Ireland Galway,
University Road,
Galway,
Ireland.
E-mail: rosomaolduin@gmail.com

Dr Alice Rogers,
Department of Archaeology,
University of Reading,
Reading, RG6 6AH,
United Kingdom.
E-mail: a.j.rogers@pgr.reading.ac.uk

Martin Rundkvist,
Department of Historical, Philosophical and Religious Studies,
University of Umeå,
901 87 Umeå,
Sweden.
E-mail: martin.rundkvist@gmail.com

Dr Katharine Sawyer,
Alegria, St Mary's,
Isles of Scilly, TR21 0NW,
United Kingdom.
E-mail: katharine@alegria.plus.com

Dr Simon Timberlake,
19 High Street, Fen Ditton,
Cambridge, CB5 8ST,
United Kingdom.
E-mail: simon.timberlake@gmail.com

Dr Robert Alan Williams
Department of Archaeology, Classics and Egyptology,
University of Liverpool,
Liverpool, L69 7WZ,
United Kingdom.
E-mail: r.a.williams@liv.ac.uk

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