The social organisation of metalworking in southern England during the Beaker period and Bronze Age: absence of evidence or evidence of absence?

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1. Introduction

This contribution considers the lack of definition of the social context of metalworking during the earliest phases of metal use in southern England, in the Beaker period and the Bronze Age. Although Beaker and Bronze Age metalwork is widespread across the British Isles, and the chronology for its adoption and use is reasonably well-understood, defining the social context of metalworking has proven to be a more difficult problem to address. Metalworking is often described as a technological process divorced from the conditions of its production (Kuipers 2012), and as Brück (2008, 29) explains, 'Despite significant recent advances in our understanding of the extraction, processing and exchange of copper … our knowledge of both the landscape context and the social context of metalworking is still limited.' This issue is also commented on by Parker Pearson (2011, 68), who acknowledges that we know relatively little about the social context of bronze metallurgy and old questions remain unanswered. Was bronze cast by itinerant smiths or by specialists tied to particular communities? This social context of metalworking during the Beaker period and Bronze Age is not a new question. Britton (1963, 258) writes,

> How did the smiths set about their work? Over what regions was production carried out? If we are to understand as much as we might of the life of prehistoric times, then surely we should look at metalwork from as many viewpoints as possible – in this case the manner and setting of its production as well as its classification.

If the underlying dynamics of social and technological innovation, change and continuity are to be more fully appreciated in the Beaker period and Bronze Age, then identifying where and how certain processes or tasks were occurring is a central concern. As Sheridan (2008, 65) notes 'the noble Amesbury Archer would have regaled the Wessex locals with marvellous travellers' tales and impressed them with his arcane knowledge of metalworking.' Indeed, the ability to work and transform materials might have been imbued with special significance and might have created a special status within society (Woodward 2008, 80). Such an interpretation relies on the idea that 'objects and technologies embody certain social and symbolic practices and ideas in a specific cultural place' (Roberts 2008a, 355). This is particularly relevant for Beaker and Bronze Age metalworking: it is important to identify where such processes were occurring, and relate this to social differentiation and material perception within the communities of these time periods.

This paper discusses the evidence for copper and bronze working during the Beaker period and Bronze Age, and reflects on the under representation of the physical evidence of metalworking in the archaeological record (*in situ* furnaces, metalworking hearths and metalworking areas), and the problems of identifying metalworking residues during excavation. This discussion is focused upon post-mining metalworking processes, such as ore roasting, smelting, casting, recycling and smithing. For reasons of geological distribution of ores sources, mining sites are geographically constrained and have received targeted research. Conversely, ore preparation, smelting, casting, recycling and smithing (discussed below) are not geographically constrained to ore sources and have the potential to represent wider aspects of Beaker and Bronze Age society. The aim is to consider why so little evidence of metalworking has been recovered from these periods, and to suggest where such metalworking might have occurred. It is acknowledged that this is a speculative discussion, based on the current level of evidence, but if this social context of metalworking is to be understood, then the question of the location of metalworking is fundamental. While the issues outlined during this discussion apply throughout the whole of the British Isles, the evidence presented is biased towards southern England, although examples from outside of this geographic area are used to highlight specific aspects when relevant.

2. Metalwork: mining, making and circulating

From the early deposition of copper axes or daggers often found in Beaker-associated graves (e.g. Fitzpatrick 2011), and also Early Bronze Age barrows and hoards (Bradley *et al* 2018), through to the metalwork hoards of the Middle and Late Bronze Age (Nebelsick 2000; Yates

and Bradley 2010), there is evidence for the circulation of copper and bronze artefacts (Needham 1988; Barber 2003). There is a well-defined typological scheme for the Beaker period and Bronze Age (Needham 1996; 2009; Needham *et al* 2006), showing the adoption first of copper daggers from *c*. 2450 cal BC in the early part of the Beaker period, then the development of tinned bronzes from *c*. 2200 cal BC, e.g. Racton (Needham 2017). There is a seemingly quick uptake of this alloy (Needham *et al* 1989), and finally the addition of lead to tin bronze in the final stages of the Bronze Age *c*. 1100 cal BC (Roberts *et al* 2015; Bray 2012).

The chronological sequencing of artefacts has been complemented by significant advances in the understanding of Beaker period and Bronze Age mining practices across Britain and Ireland. There have been significant discoveries about sources of copper in the Beaker period from 2400 cal BC at Ross Island (O'Brien 2004; 2012) and also Early Bronze Age/Middle Bronze Age mines, e.g. Cwmystwyth, Ecton Park, Alderley Edge (Timberlake 2003; 2014; Timberlake and Pragg 2005), the Great Orme (Smith *et al* 2011), and potentially southwest Britain (Budd *et al* 2000). The sources of early tin are less well-known and there are no identified tin-working sites, although it is believed (Haustein *et al* 2010) that tin was obtained from southwest England, with Middle Bronze Age artefacts recovered during later periods of tin streaming (Penhallurick 1986, 173–224). Recent archaeological analyses in Cornwall recovered large quantities of cassiterite pebbles, granules and ore from two Early Bronze Age pits (Taylor, forthcoming) and tin residues have been identified on a Beaker-period stone tool-working assemblage (Carey and Jones, forthcoming) associated with a short-lived structure and a hearth. On one level, then, the mining of metal resources is reasonably well understood.

The circulation of these metals during the Beaker period and Bronze Age is recognised by the innovative analysis of metal artefacts (Bray 2016; Bray and Pollard 2012), demonstrating an increasing reworking of copper alloys in Britain and Ireland from *c.* 2000 cal BC onwards, which builds on previous identification of recycling through lead isotope analysis (e.g. Rohl and Needham 1998). Ross Island is the dominant source of this early metal in the Beaker-using period (although sites in north Wales and subsequently northwest England may also have been important (Timberlake 2016)), with a characteristic trace impurity signature centred on tin (Sn), antimony (Sb) and arsenic (As). Over time there is evidence for increasing depletion of these trace metals (Sn, Sb and As), which is indicative of more

smelting and recasting, and this depletion increases with distance from the Ross Island mine source (Bray 2016).

It is also apparent that from the onset of the British Beaker period through to the Late Bronze Age, metalworking became more widely practised, with increasing numbers of metal artefacts in circulation. As the Bronze Age progressed, it appears that more people had access to metals, and significantly, they had an increasing knowledge of how to transform these metals, with increasing levels of craftsmanship. This craftsmanship is demonstrable not only in metal goods, but also in other materials, such as jet, amber and shale from the Early Bronze Age onwards (Roberts 2013, 536; Sheridan and Shortland 2004), with a rise not only in the number of bronze artefacts but also the diversity of forms (Roberts 2013, 539–40).

3. Metals and monuments

This increasing access to metal, and knowledge of how to transform it, ties together two ends of a spectrum of metalworking activity (i.e. obtaining ore and finished artefacts). However, the social context of who was working metals and where these activities occurred is almost completely missing. This social context needs to be considered with reference to what is currently understood about the social organisation of the Beaker period and Bronze Age in Britain. The archaeological record of the Beaker period and Early Bronze Age is dominated by large numbers of ceremonial monuments and round barrows, with settlements being a rarity or poorly preserved (Brück 2000). By contrast, the archaeological record of the Middle Bronze Age (*c.* 1500–1000 cal BC) witnesses change, with roundhouse settlements often associated with land division in the form of ditched boundaries and stone walls (Brück 2000; Yates 2007) (Table 1).

It requires emphasising that these transitions are certainly skewed through bias of survival of different monument types, with the rate and timing of transition not as abrupt as sometimes supposed, and regional variations evident (Bradley 2007, 178–224). There may in fact be considerable continuity between the Early Bronze Age and Middle Bronze Age. Practices associated with the formal abandonment of Middle Bronze Age roundhouses, for example, can in some ways be considered to be a modified continuation of ritualised traditions associated with Early Bronze Age barrows (Jones 2015). It is possible that the selective deposition of artefacts into significant features associated with roundhouses and enclosures (Brück 1999) may represent a transition or realignment of belief systems from circular ceremonial monuments to circular domestic structures (Bradley 1998, 147–64; Jones 2008).

There is also a demonstrable increase in the number of metal objects from the Middle Bronze Age (Roberts 2008b, 50), as well as changes in the types of objects made. At the time of the introduction of metals (copper and gold) in the Beaker period, metal objects are generally small, and associated with societies which in central southern Britain used larger communal monuments. Although there is development of artefact types in this early Beaker period using copper, the advent of tinned bronze at *c.* 2200 cal BC sees a greater diversification of styles, with an increase in personal ornaments such as pins, as well as daggers and axes (see Woodward and Hunter 2015). Many of these artefacts have been recovered from round barrows, which become the predominant monument form in the period between *c.* 2250 to 1500 cal BC. In the Middle Bronze Age, the types and forms of metal objects produced continues to grow, with some objects becoming larger, e.g. daggers being replaced by rapiers, and new forms of personal adornment appearing, such as spiral finger-rings (Jones *et al* 2015) and Sussex loops (Wilkin 2016).

This diversification of metal artefacts occurs at the same time that roundhouse settlements and field systems transformed the appearance of the landscape. In some regions, such as Wessex, changes also occurred in pottery styles, with clear differentiation between fine wares and coarse wares (Woodward 2008, 82), although in other areas, such as southwest England (e.g. Quinnell 2012), there is little change in the ceramic record. Finally, the Late Bronze Age is associated with the development of swords and a wider range of socketed tools. This occurs at the time when linear land divisions, ditched enclosures are being constructed and large metalwork hoards are being deposited more frequently, often in wet places (e.g. Bradley 1991; Bradley *et al* 1994; Schulting and Bradley 2013; Brown and Medlycott 2013).

Debate has occurred as to whether social change was driven through the reorganisation of belief systems or through changes to land tenure from the Middle Bronze Age (Brück 2000). Either way, the transition from the societies of the Beaker period and Early Bronze Age into those of the Middle and subsequently Late Bronze Age saw a demonstrable reorganisation of the landscape, a change in use/abandonment of older monuments, the creation of new settlements, changing metalwork styles, and an increase in bronze artefacts in circulation from being a very rare resource in the Beaker period and Early Bronze Age.

4. Problems in identifying metalworking

Traditionally it has been argued that during the Beaker period and the Early Bronze Age, metalworking was an exclusive skill in Britain associated with itinerant metalworkers, which

by the later Bronze Age had become a more widespread but uncommon craft specialism (e.g. Childe 1930), although this model has been challenged (see Bray 2016). Needham (2007, 280) describes prehistoric metalworking as a 'holistic metal value system', comprised of traditions of deposition and disposal, traditions of usage and circulation, and metalworking traditions defined 'not only [by] the types cast, but also by the technique and materials employed, the places used for activity, attendant rituals and the relationship of metalworkers to the community'. If a holistic metal value system is to be discerned for the Beaker period and Bronze Age then these social aspects of metalworking are an integral part. However, for all the significant advances in our knowledge of mining, artefact deposition, typology and recycling/reworking, very little is known about who was engaged with metalworking and where metalworking took place.

One challenge in understanding the production and working of copper and bronze in the Beaker period and Bronze Age is the organisation of the metalworking process – socially, temporally and spatially. For example, were mining sites also the places where smelting and casting took place? Were there spatially discrete areas away from mining where smelting was undertaken? Were the miners also the smelters/casters/smiths? Was smelting and casting routinely undertaken in settlement sites? How were areas containing metalworking treated and viewed? Do the locations where metalworking occurred change over time? One problem in addressing these questions is the extremely rare identification of copper ingots prior to the Late Bronze Age Ewart Park hoards (Needham 2007, 261), making it difficult to interpret the distribution and supply of metals and raising the possibility that prior to the Ewart Park phase (*c*. 1000 cal BC) metals were supplied in artefact form for reworking into new artefacts (e.g. Needham *et al* 2013).

A further difficulty with identifying areas of metalworking is the lack of metalworking tools found in secure Beaker and Bronze Age contexts. For the earlier part of the period this is likely to be due to a paucity of settlements and the selective deposition of metals in barrows in the Early Bronze Age (Needham 1988). Some metalworking toolkits or tools are found in graves, for example the Amesbury Archer cushion stone and the Early Bronze Age Upton Lovell G2a assemblage (Needham 2011, 113–17), although such kits indicate cold working rather temperature-dependent processes. Bronze Age hoards rarely contain any tools associated with the working of metals, either in bronze, clay or stone (Needham 2007, 279), although stone and clay moulds have been found on settlement sites (e.g. Brown and Medlycott 2013; Evans *et al* 2016). It is also probable that some stone tools deposited in

barrows were associated with metalworking, but in the absence of non-destructive scientific analyses there is difficulty in identifying which stone tools had been used for metalworking (Carey and Jones forthcoming; Figure 1).

There have been some attempts to tackle the organisation of metalworking in Britain, most notably Rowlands (1976), who plotted the spatial distribution of artefact types from the Middle Bronze Age in southern Britain. Whilst this successfully identified five different metalworking centres (regions) of Middle Bronze Age metalwork, the locations of the workshops could not be discerned. Over 40 years later, our understanding of the social dimensions and locations of metalworking in the Beaker and Bronze Ages of southern England has barely moved forwards. It is time to address the social dimension of metalworking in the British Beaker period and Bronze Age societies, as it has the potential to contribute to wider discussions of society and identity. But how can such questions actually be tackled? There are several lines of enquiry that offer considerable scope for creating data to address these questions. The first is reports on excavations of Middle Bronze Age and Late Bronze Age sites that have produced evidence for metalworking, particularly by synthesis of unpublished/grey literature (e.g. Skowranek 2007) which might provide key evidence for changing trends in metalworking practices. Another direction is the established field of copper/bronze artefact compositional analyses and typologies, which has offered significant insights into technological aspects of bronze production. However, it is also time to consider where such metalworking might have occurred and how it can be detected, particularly deploying developments in archaeological science.

5. The metalworking process and archaeological evidence

Previous research focused on artefact-based analyses, which whilst of undoubted value, has created a disparity in the discussion of the technology of Beaker period and Bronze Age metalworking in Britain. A discussion of artefacts with a heavy emphasis on ore geologies has occurred, whilst the location and organisation of metalworking (other than mining) within society has been a speculative discussion based on little excavated evidence. The reasons for the under-representation of smelting and/or casting sites within the Beaker period and Bronze Age could be hypothesised to be the product of prehistoric societal factors. Perhaps, as indicated by ethnographical study (e.g. Eliade 1962; Budd and Taylor 1995), metalworking such as casting only occurred in specific places, governed by strict social roles, and these locations have yet to be identified successfully. An alternative explanation could be that archaeologists have investigated many sites where evidence of copper/bronze working was

present, but it was not obvious or identifiable during excavation. It is possible that the evidence from metalworking is not necessarily visible at the macroscopic excavation level and requires analysis on the microscopic level to identify residues.

Five broad stages can be defined in the early metalworking process for copper and bronze (Table 2), with each stage having the potential to produce slightly different types of archaeological evidence. A small smelting furnace would not necessarily need to have a refractory lining and could easily occur within a feature such as a conventional hearth/fire pit with a directed air supply, with the ore smelted using crucibles, although there is scant evidence for any copper or tin smelting in Britain during this period (Roberts 2009, 468–70). Such smelting of copper and tin ores would render the process 'archaeologically almost undetectable' (Ottaway and Roberts 2009, 206), especially if little slag is produced or it is removed, potentially as part of the symbolism attached to the process. Likewise, melting/recasting could also have occurred in a small hearth using crucibles and a directed air supply (Figure 2). During archaeological excavation, whether such a feature would be recognisable as a metalworking hearth/furnace is doubtful, especially if there is no other circumstantial evidence, such as metalworking tools, crushed ore residue, slag, casting debris or furnace lining (Timberlake 2005, chapter 11). In such instances, if a feature is found containing evidence of heating and no other circumstantial evidence, is it not more reasonably interpreted as a hearth, which of course it could well be as well (see below, Tremough). Thus the identification of metalworking evidence in the Beaker period and Bronze Age is problematic, especially if features, such as pits with evidence of heating, are not associated directly with other artefacts used in the metalworking process. The current evidence for metalworking (excluding mining) within southern England (and Britain more generally) is slight, and can be broadly segregated into direct *in situ* excavated evidence and *indirect* evidence (Figure 3).

5.1 *Direct* in situ *excavated evidence*

Direct evidence for excavated metalworking structures, in the form of slag, prills, furnace structures, furnace artefacts and metalworking hearths (Timberlake 2005, 198), is extremely scarce from the British Beaker period and Bronze Age, although as postulated, this is possibly due to the non-identification of evidence, as well as a scarce archaeological resource and limited survival. The most definitive evidence for early Beaker

period smelting of copper comes from the settlement site at Ross Island, Ireland, which whilst outside the primary area being considered, is included for the evidence of its smelting structures alongside its significance of supplying most of the early copper to Britain in the Beaker period (Bray 2016). At Ross Island, 10 furnace pits were excavated from phase 2A, all firmly dated to the Beaker period. Furnace pit C.1034 is noteworthy: this had a diameter of 1.07 m E–W, 0.70 m N–S and a depth of 0.25–0.35 m, with a small furnace structure found at its base. This furnace was made from courses of small stones packed with finer sediments before a final course of three larger stones. The interior measured 0.08–0.11 m E–W and 0.17 m N–S, with a depth of *c*. 0.12 m. The site contained clear evidence of ore processing, crushing and then smelting, although no finished metal artefacts were found during the excavations. No evidence of tuyeres or crucibles was found, and there was no indication of furnace lining in the smelting structures (O'Brien 2004). This evidence suggests that Beaker-period smelting furnaces are liable to be very small scale, and not associated with a furnace lining.

Another possible small-scale copper smelting area was excavated at the Great Orme, at Pentrywn, Wales; this is again located outside the primary area being considered, but it is the only known probable copper-smelting site in Britain. Here, a small conical pit 030, 0.04m wide and 0.12m deep was excavated. It was filled with charcoal-rich silt (029), and also contained fragments of slag, copper prills, and some vitrified material. Charcoal from this feature produced a radiocarbon date of 1755–1415 cal BC (2 sigma) (Hopewell and Jones 1999), although a revised Late Bronze Age date has now been suggested by more recent radiocarbon dating (Williams 2013). Subsequent excavations revealed two further small pits, pit 111 and pit 109, both having fills containing metallurgical debris and charcoal. Both features were sub-circular in plan, with pit 109 0.1 m in diameter and pit 111 0.09m in diameter, with pit 111 having a distinctive collar at its top, possibly for insertion of a tuyere blow pipe. The fill of pit 111 was dated to the Late Bronze Age: 968–809 cal BC (2 sigma) (Smith *et al* 2011). A replica of the holes was used to smelt a small amount of copper successfully, leaving very little vitrification on the sides of the pits, similar to the excavated examples (Chapman and Chapman 2013). The evidence from Pentrwyn suggests that a Bronze Age furnace might appear on excavation to be a small posthole or stake hole, with some evidence of burning, rather than as a specific feature associated with metalworking. From the evidence so far recovered, it would appear that smelting was undertaken close to the sources of the original ore.

The earliest example of a Bronze Age metalworking location in southern England comes from roundhouse 1 at Tremough, Cornwall (Jones *et al* 2015) (Figure 4). Excavation of a Middle Bronze Age hollow-set roundhouse led to the recovery of nine bivalve moulds on the house floor, located in the area of a hearth. An assemblage of worked stone also included hammerstones and pestles which could have been used during the later stages of metalworking. Conventional sampling resulted in the recovery of droplets of copper alloy. The hearth was initially identified as being associated with metalworking because of the presence of moulds (Figure 5) (Jones *et al* 2015, 180). Had the moulds not been found, it is unlikely that the hearth would have been identified with metalworking. At Trethellen Farm, Cornwall (Nowakowski 1991), the excavation of a Middle Bronze Age roundhouse (142/3022) discovered a 'fire-pit' located on the southern side of the pre-existing house hollow, which probably post-dated the main occupation of the house. The final use of this pit was evidenced by a fill and surrounding spread of burnt material, pottery and some hard-fired clay lumps. A small quantity of copper alloy waste and detritus were found around the pit, although it was not possible to identify this feature definitively as a metalworking/smelting structure.

5.2 'Indirect' evidence

In contrast to direct *in situ* evidence of metalworking activity, redeposited materials associated with metalworking are more common during the Bronze Age. Evidence from smelting is still exceedingly rare, with evidence for casting more prevalent from the Middle Bronze Age onwards (Bayley *et al* 2008). The description, distribution and analysis of moulds for casting copper alloy artefacts has been well documented (e.g. Britton 1963; Tylecote 1986; Webley and Adams 2016. However, these moulds do not define where metalworking was occurring, indicating rather that items used for metalworking have been incorporated only rarely into hoard deposits or into the structure of some archaeological sites, possibly as foundation deposits (Needham 2007, 285). However, it is possible that such areas where moulds have been found are close to the locations where metals were worked.

Some examples of this 'indirect' evidence include Dainton, Devon, where a small pit close to the southern edge of a cairn was found to contain Late Bronze Age bronze-working debris including mould and crucible fragments with three small fragments of bronze, along with some coarse pot sherds and slabs of local tuff (Needham 1980). Similar material was found around the feature as a possible surface spread. At Norton Fitzwarren, Somerset (Ellis 1989), a large posthole adjacent to an entrance into a Late Bronze Age palisaded enclosure contained

70 mould fragments, probably representing a single mould used to cast a Ewart Park-type sword. Mould debris for casting weapons was also found at the Late Bronze Age enclosure at Springfield Lyons, Essex (Needham and Bridgford 2013, 66), where the debris had been deposited into the northern ditch terminals of the western and eastern entrances. Likewise, at the Mucking South Ring, metalwork and metalworking debris was concentrated around the inner ditch circuit (Evans *et al* 2016, 157).

Another interesting, and earlier, example of '*ex situ*' evidence are the Caerloggas tin slags, where remnants of tin slag from a smelting process were found in an enclosure barrow constructed around a rocky outcrop, along with other deposits which included a fragment from a Camerton-Snowshill dagger, flints and white quartz pebbles (Miles 1975). This find is interesting for two reasons: firstly, only a very small amount of slag is derived from smelting cassiterite, and secondly, the incorporation of a metal slag into a barrow structure where it appears to have been part of a 'structured deposit' and might have been making a symbolic connection with the transformative process of metalworking. Similarly, newly obtained Early Bronze Age radiocarbon dates from two pits excavated near Truro, each containing both processed and unprocessed cassiterite pebbles, pottery and a stone muller which was laid across the top of one of pits (Taylor, forthcoming), points to the 'structured deposition' of a highly valued resource.

Another significant deposit of material associated with metalworking comes from the infilling of Shaft X at Grimes Graves, dating to Phase II (Middle Bronze Age) and Phase I (Post Middle Bronze Age). This material is interpreted as midden deposits dumped into the shaft, presumably from the nearby settlement (Longworth *et al* 1991). In total 156 fragments of clay refractories were recovered and are interpreted as a limited episode of casting involving only a few moulds, to cast channel-bladed, basal-looped spearheads (Needham 1991a, 154). The assemblage dumped into Shaft X again does not indicate casting was occurring within the shaft, but that casting could have occurred on the nearby Middle Bronze Age settlement. The excavation on this settlement also produced 23 pieces of bronze casting debris, including a miscast spearhead fragment (Needham 1991b, 175). It is therefore probable that this Middle Bronze Age settlement close to Grimes Graves did indeed contain a bronze smith's workplace, the precise location of which has not been identified.

Excavation of a Middle to Late Bronze Age site at Mile Oak, Sussex, recovered copper lead alloy droplets and objects and a fragment of crucible with copper alloy attached. These were found at the soil/chalk interface adjacent to two mounds containing fire-cracked flint,

charcoal and baked clay fragments. Within this excavation area (K), 101 cut features were identified (Russell 2002). It is likely that the mounds represent waste from several processes associated with heating, one of which is almost certainly metalworking, although the presence of fire-cracked flints is unlikely to be directly associated with metalworking. The mounds are unlikely to represent *in situ* furnaces or hearths, but given the number of cut features within the excavation area and the clustering of the copper alloy fragments, it is likely to represent an area where metalworking was occurring in the Late Bronze Age.

The recovery of metal hoards, especially so-called 'founder's hoards', was once interpreted as possible evidence for 'itinerant smiths' (Childe 1930, 45). There has been significant movement away from such functionalist explanations for the presence of such hoards, using the landscape and social context as a key to interpreting these deposits (e.g. Bradley 1991; 2017; Barber 2003, 44–61). These finds do not identify where metalworking has occurred, as clearly defined by Needham (1988, 232), nor that they are necessarily in close proximity to past metalworking. A classic example is the Migdale hoard from Scotland (Needham 2004), which although it demonstrates a distinct metalworking tradition, does not define the location of the metalworking activity.

Further evidence for metalworking has been retrieved from Early Bronze Age burials, one example being the aforementioned metalworking toolkit from the Early Bronze Age Upton Lovell G2a assemblage (Needham 2011, 113–17). Sponge fingers have been suggested to be metalworking tools and have been recovered from a number of Beaker period burials, e.g. the Sarsen burial, Durrington Walls, although their connection to metalworking has been disputed (Woodward and Hunter 2015). A large tin bead from a composite necklace and a tin-studded woven armband, both from an Early Bronze Age cist burial at Whitehorse Hill on Dartmoor, also indicate extraction and smelting of the tin from a source in Devon/Cornwall (Jones 2016), something that has long been postulated (Budd and Gale 1997) but which requires further isotopic work to establish sources.

More circumstantial evidence of metalworking is the arrival of source material into a region of an artefact type not typical for that area, such as the Middle Bronze Age winged median axes which were imported into southern Britain from Northern France/Low Countries (Needham 2007, 282). Found in a shipwreck in Langdon Bay (Needham *et al* 2013, 23–50), they are virtually absent from the terrestrial archaeological record. This has been taken to indicate recasting of this artefact type into more socially acceptable forms in southern England, many miles from the continental ore sources. As Needham (2007, 282) highlights,

most communities in the Beaker period and Bronze Age would have lived in non-metalliferous areas, so distinct artefact styles localised to a region can be argued to represent evidence of metalworking. This demonstrates a knowledge of metalworking well away from the ultimate source of the metals, and potentially indicates that life histories and the rebirth of artefacts/objects might have important symbolic connotations.

All of this 'indirect' evidence hints that metalworking was a more widespread phenomenon throughout southern England than the current paucity of evidence indicates. However, despite all the indirect evidence indicating access to metalliferous resources, and the casting/recycling of metals, it only demonstrates that metalworking was occurring; it does not identify the locations where metalworking was occurring or who was undertaking these processes. There is still precious little evidence of furnaces, smith working areas or metalworking hearths. This indirect evidence, which is more abundant than the direct *in situ* evidence, supports the notion that the identification of features associated with metalworking during the excavation of a site is problematic at the macro-level and requires additional information to be retrieved at the micro-level. This indirect evidence also indicates that metals, and their production, were extremely important to Beaker and Bronze Age societies and that metallurgy is also likely to have been a 'magical' process with controls over where, when and who undertook it. This aspect is indicated by the inclusion of the materials used in the production of metal artefacts, such as moulds or casting debris, in 'structured deposits' within sites, such as Dainton, or more exceptionally sealed within a roundhouse as at Tremough and Trethellen. Similarly, materials produced during smelting are incorporated into the Caerloggas I barrow (slag), and the Whitehorse burial (tin bead), showing a connection between tin and ceremonial monuments, the latter perhaps suggesting a direct association between production and use of metals and the transformation (burial) of people.

6. Finding the furnace (or hearth)

To summarise, there is very little direct *in situ* evidence of metalworking in southern England during the Beaker period and Bronze Age, although there is more indirect evidence, especially in the Middle to Late Bronze Age. Mining and recycling/reworking of artefacts is well understood, but the locations of metalworking activities/processes remain elusive, potentially due to the 'sparse evidence' left behind from these activities (Roberts 2013, 540). As discussed above, there is likely to be an issue with the visibility of the archaeological evidence of metalworking during excavation. It is proposed that the changes visible in the archaeological record between the Beaker period/Early Bronze Age, and Middle to Late

Bronze Age could influence the locations where such metalworking might have occurred. It is also important to consider how we might unearth this evidence.

6.1 Beaker period and Early Bronze Age

During the Beaker period there is widespread evidence for a continuing association with earlier ceremonial monuments in Wessex, recognisable by the Beaker burials at the Sanctuary (Cunnington 1931)**;** the West Kennet Avenue at Avebury (Smith 1965); and Stonehenge (Parker Pearson *et al* 2015, 30), to give some of the many examples. It is demonstrable that henges were built during, or are associated with, the Late Neolithic period and in central southern Britain, Chalcolithic/Early Bronze Age communities continued to use them (e.g. Stonehenge – Parker Pearson *et al* 2015). It has been argued that some enclosures were associated with ritual and social practices, such as large-scale feasting. Given the direct association between Beakers and the use of henges in southern Britain, and the appearance of copper artefacts during this period, is it possible that early metalworking practices were, for at least a period of time, associated with such monuments?

It has been suggested that the creation of the ditch at Durrington Walls was, given the lack of flint axe fragments and impressions in chalk blocks, at least partly undertaken with copper axes, increasing the potential linkage between such enclosures and metals in the 25th century cal BC (Parker Pearson 2011, 59), although this remains a contentious interpretation. The carvings of 110 bronze axes and four bronze daggers on stones 3, 4 and 5 on the east side of the sarsen circle at Stonehenge also indicate a connection between such monuments and metals, with the Stonehenge examples stylistically dated to the latter part of the Early Bronze Age *c.*1750–1500 cal BC (Parker Pearson *et al* 2015, 123), and this may represent a long-lived association. In Ireland there is also a direct association between older ceremonial monuments and metalworking; on the land surface next to the Neolithic passage tomb at Newgrange, which has been broadly dated to around 2000 cal BC, there are Beaker period metalworking stone tools and a bronze flat axe (O'Kelly and Shell 1979).

If the metal tools themselves were literally creating at least some enclosures or being used to create features within the enclosures (e.g. stone hole settings), is it possible that metal artefacts were created or recast (reborn?) within the enclosures? The novelty and theatre of such a transforming event associated with the making, using or remaking of a symbolically important metal object might have become a significant part of the enclosure function. Such monumental complexes have been argued to embody the transformation of individuals

between the realms of the living and the dead (Parker Pearson *et al* 2015), but maybe the process of transformation associated with such enclosures was not confined solely to people, but also applied to metals (and possibly other materials)? The performance of working metals, deeply invested within a ritualised routine to ensure the successful transformation of material from one form to another, could well have been undertaken in areas viewed as containing special powers or good omens, such as henges and other enclosure monuments. Younger (2017) draws attention to the transformative effects of fire and its association with henge sites, and it is possible that these transformative effects extend to the later working of metals within henges. Whilst the linkages described above are suggestive, there is currently no direct evidence for the making or remaking of metal artefacts within henges, although such ideas could be tested through the application of targeted geochemistry (see below).

6.2 Middle Bronze Age – Late Bronze Age

From the Middle Bronze Age period (*c.* 1500 cal BC) settlement sites become more common in the archaeological record, and many of these contain structured deposition within roundhouses and enclosure ditches. Given the positive association between the Middle Bronze Age Roundhouse 1 at Tremough and bronze working, combined with the increasing number of moulds discovered in Middle and Late Bronze Age sites across the country, this line of enquiry has the potential to yield much information on the organisation of metalworking. As discussed earlier, Middle Bronze Age roundhouses can be interpreted as representing a realignment/reorganisation of belief systems from circular ceremonial monuments to circular domestic structures. At Tremough, a roundhouse contained evidence of metalworking and many other roundhouses have produced evidence for a range of other functions including weaving and domestic occupation. In many cases though, defining activities within a roundhouse is difficult, especially given that main difference in roundhouse architecture which survives in the archaeological record is size (e.g. Jones and Taylor 2013). It is, therefore, likely that some examples have been excavated where the process of metalworking had occurred but has not been identified, due to a lack of surviving *identifiable* evidence.

7. Metalworking – the social dimension

If such suppositions as presented above are at least partially correct, then identifying what this evidence looks like is going to be challenging. However, the integration of geochemical analyses within excavations of such sites (e.g. Carey *et al* 2014) could be a means of defining

residues associated with features (e.g. hearths or burnt pits), as well as soil micromorphology of floor sequences and feature fills. Whilst such techniques are relatively costly and might be considered an additional expense, especially within developer-funded excavations, they might provide part of this missing evidence which is not visible at the macroscopic level of excavation. Such approaches have the potential to identify geochemical residues within features which can be used to elucidate function.

With reference to looking for the earliest evidence of metalworking within henges, geochemistry could play a pivotal role, being used to analyse the geochemical composition of fill sequences contained within excavated features associated with heating, to investigate whether this heating was connected to metalworking. Geochemical analysis could also be used more extensively to analyse henge ditch-fill sequences, to look at wider geochemical signatures associated with a monument. Mighall *et al* (2002; 2009) demonstrated the ability of Bronze Age airborne geochemical signatures associated with copper and lead mining to be detectable in blanket peat away from the mining sources, and a similar method can be proposed here to look at slight pollution signatures associated with metalworking but on a site/enclosure-wide basis. This approach is currently being utilised on samples from the ditch-fill sequences of Marden Henge and also the recently discovered hengiform site at Damerham, Dorset, on the edge of Cranborne Chase.

Likewise with the excavation of Middle Bronze Age houses, samples can be collected from fill sequences contained within excavated features associated with heating within roundhouses, such as hearths, to investigate whether metals were indeed being worked within such features. In addition, when intact floor surfaces are revealed, samples can be collected on a regular grid plan. Again, geochemical analyses can be utilised to look for pollution signatures associated with metalworking in roundhouses. Such an approach of context-specific geochemical sampling has recently been employed at Holwell, Devon and West Northwood, Cornwall, and proved successful at Tremough, significantly strengthening the interpretation of metalworking within this roundhouse (Jones *et al* 2015).

It is necessary to at least speculate where the locations of metalworking were during the Beaker period and Bronze Age if we are to further debates regarding the significance of metals to society in this period, and the status of the individuals involved with the creation/transformation of such materials. By developing new ideas as to where metalworking was occurring, and by testing these hypotheses using archaeological science, it is possible that patterns of metalworking may become apparent. Potentially, are certain

enclosures, roundhouses, or particular areas associated with metalworking whilst others are not? Is metalworking in these periods more common than previously thought? Does metalworking occur within ritual arenas or within domestic spheres? How was the process of artefact creation perceived by societies at the time? If roundhouses or enclosures are found to be associated with metalworking, is variation evident in their spatial or architectural morphology? Or is the current sparsity in the archaeological record a true reflection of the organisation of metalworking, and it is indeed very rare to find such evidence? Such questions need addressing if we are to elucidate this social dimension of metalworking. If we can start to gather data to answer at least some of these questions, then the locations and individuals engaged with these processes will start to come into focus; from this ideas regarding the perception of metals and the people engaged with their working can be developed. Given the current level of evidence, developing these models is based more on speculation than engagement with actual data.

However, it is undoubtedly true that mould fragments and casting debris do become more common from the Middle Bronze Age onwards. As Knight (2014) discusses, does this indicate a movement from 'metalworking masters of mystery' in the Beaker period/Early Bronze Age, through to a more common craft activity undertaken on many settlement sites from the Middle Bronze Age onwards? Whilst it is tempting to view the limited evidence in this way, it must also be remembered that there is a shift in the archaeological record between the funerary monuments of the Beaker period/Early Bronze Age to Middle and Late Bronze Age settlements. This change in the physical nature of the archaeological record changes the depositional contexts within which debris from metalworking can be found, alongside a potential difference in where the artefacts from metalworking were selectively deposited in the past. This creates an undoubted bias in the archaeological record and one that makes it even more difficult to understand changes in the social organisation of metalworking during this period. It is imperative to identify the actual locations (the 'smithies') where the metalworking occurred, rather than looking for the locations of where artefacts and tools used in the metalworking process have been deposited, although it is possible there is overlap between the two. So do the data lead us toward specialist smiths or agricultural handymen producing metals? Is there a mixture of everyday items made in one arena (e.g. settlements), but more elaborate metal items made by specialist workers? Does the social dimension of this production change over time? At present, the data are simply insufficient to draw any conclusions with confidence, with bias from the depositional contexts potentially warping

this view even further. However, recent work, particularly in southwest England does allow us to make some tentative observations regarding aspects of the social organisation of metallurgy, as well as its changing character.

Currently the earliest evidence for metalworking in the southwest is associated with traces of tin on stone tools which have been dated to *c.* 2300–2100 cal BC, at Sennen (Jones *et al* 2012; Carey and Jones, forthcoming). These tools were associated with a very lightly built structure with an external hearth. They were not heavy duty and they are likely to have been used to crush cassiterite pebbles that had eroded out of 'tin grounds' and been collected from streams. Given the temporary nature of the associated structure it is possible that the collection and working of cassiterite was a small-scale, possibly seasonal undertaking, carried out as part of the yearly round. It is likely that tin was highly valued and, as discussed above, considered to be a magical substance, the significance of which can be seen in the Early Bronze Age through its inclusion within ritualised contexts, such as the slag found at the barrow Caerloggas I (Miles 1975), and perhaps more especially by the kilos of cassiterite pebbles, granules and ore found in structured pit deposits near Truro (Taylor, forthcoming), which have been radiocarbon dated to *c.* 2000–1800 cal BC. Such practices surely represent a conspicuous waste of a highly valued material, and it is possible that this activity represented a 'return to the earth' in order to generate future supplies of cassiterite (Eliade 1962, chapter 3). Once again these actions are unlikely to have been large-scale, and may have been undertaken by a small group away from the settled area.

By contrast, towards the end of the Early Bronze Age there may have been a significant change in the organisation of metalworking which predated the shift to roundhouse settlements. Recent radiocarbon dating of the antler pick found in the Carnon Valley streamwork places it in the period 1600–1400 cal BC (Timberlake and Hartgroves, forthcoming). This suggests that the tin grounds were being worked, possibly as a result of exhaustion of readily collectable pebbles. Such a change in tin working must necessarily have involved a shift from small-scale collection to alluvial streaming which would have required more people, and in time would made a large visual (and polluting) transformative impact on the landscape. It is possible that works on this scale would have increasingly involved the resolution of issues of tenure and agreements over access to land between families and communities. It may be no coincidence that this period also saw increasing levels of structured deposition in the form of artefacts being placed into streamworks, a practice which

intensified in the Middle Bronze Age and continued throughout the Late Bronze Age and beyond (Penhallurick 1986).

The Middle Bronze Age, as noted above, marks the period when the first workplace associated with actual metalworking has been identified. Metalworking within a settlement is not unexpected, but its containment within the roundhouse at Tremough (Jones *et al* 2015) is noteworthy. Although undertaken within the settlement, all the evidence for metalworking was contained inside the building, which might suggest that the 'smith' still wished to keep the metalworking process secret or magical and, given the range of artefacts at Tremough, 'specialist'. Likewise, the deliberate burial of the moulds around the hearth could reflect a desire to establish a particular 'identity' or 'personhood' in a manner analogous to the way past generations marked certain individuals at round barrows. The latter point is emphasised by the Late Bronze Age metalworking debris found at Dainton, which was buried in a pit on the southern edge of a cairn, a position which would often be associated with the burial of human remains (Bradley 2000, 157). Metalworking within Middle Bronze Age and later settlements may therefore have continued to be organised and undertaken by certain people, and it remained a highly ritualised activity, albeit in a transformed manner, until the arrival of iron.

8. Conclusion

The advent and adoption of metalworking within Britain is a key area of research, given its rich variety of metalliferous resources and abundant archaeological evidence of the Beaker period and Bronze Age. As discussed, the physical archaeological nature of this evidence of metalworking is liable to be slight during excavation, and is possibly indistinguishable on a macroscopic excavation level from other forms of archaeological evidence. By considering new ideas about the location of metalworking and integrating this with new techniques, it might prove possible to construct spatial and temporal models of metalworking, allowing investigation of social as well as technological aspects of early metallurgy within Britain. As archaeologists, we need to access the 'middle ground' of early metallurgy; the location of some of the mining sites is known, and the artefactual record has abundant metal artefacts. However, the identification of metalworking areas and possibly 'production centres' (smithies) provides new directions for enquiry with which to investigate the social organisation of metallurgy and also to understand further the monumental record of these time periods.

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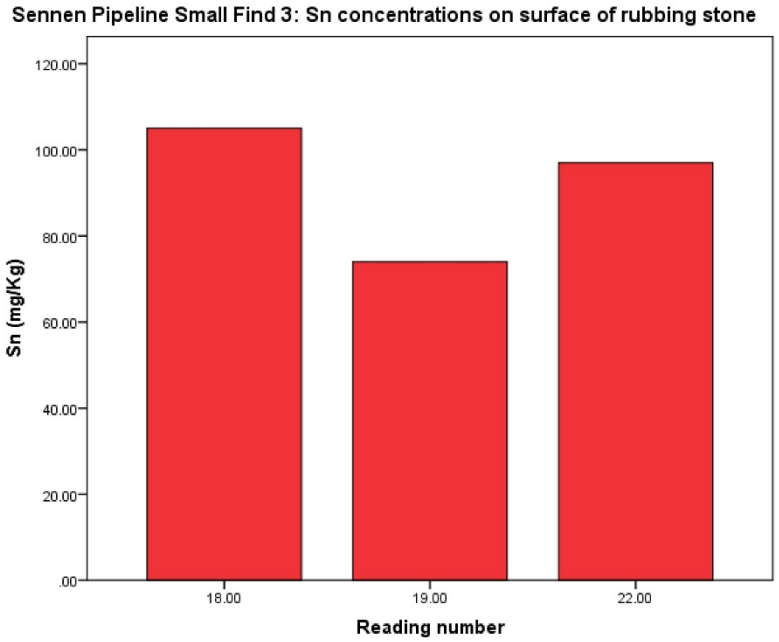
Sennen Pipline
Small find 3
Context (89)

Location of pXRF readings showing definite tin elevations



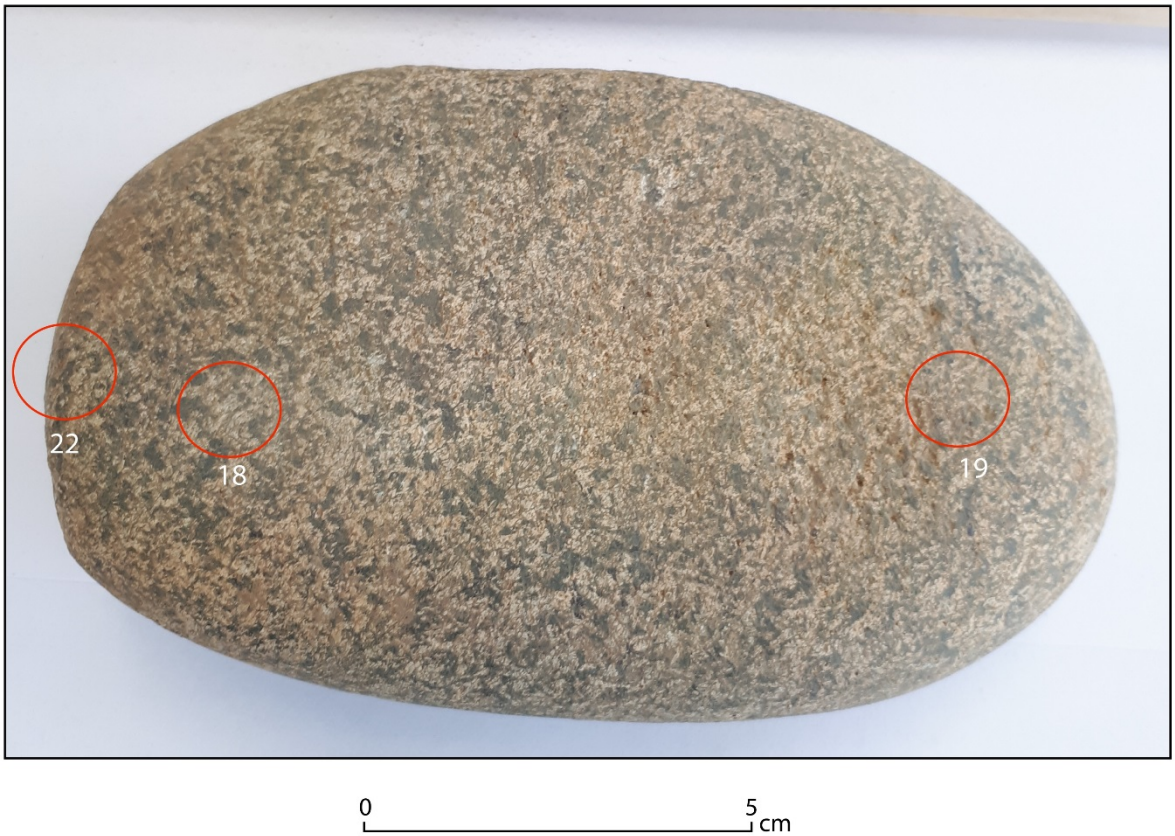


Figure 1: The analysis of a stone tool from the Beaker structure on the Sennen pipeline. With no obvious surface indications that the artefact had been used in metalworking, pXRF analysis of the surface confirmed Sn residues on the stone in high concentrations.

Figure 2: An 'experiential' casting of replica Bronze Age metal items by Neil Burridge, with a small ceramic container using charcoal and a directed air supply. Ignoring the modern tools(!), what evidence would be left by this process if the tools are removed? A heated pit/hearth structure and charcoal.

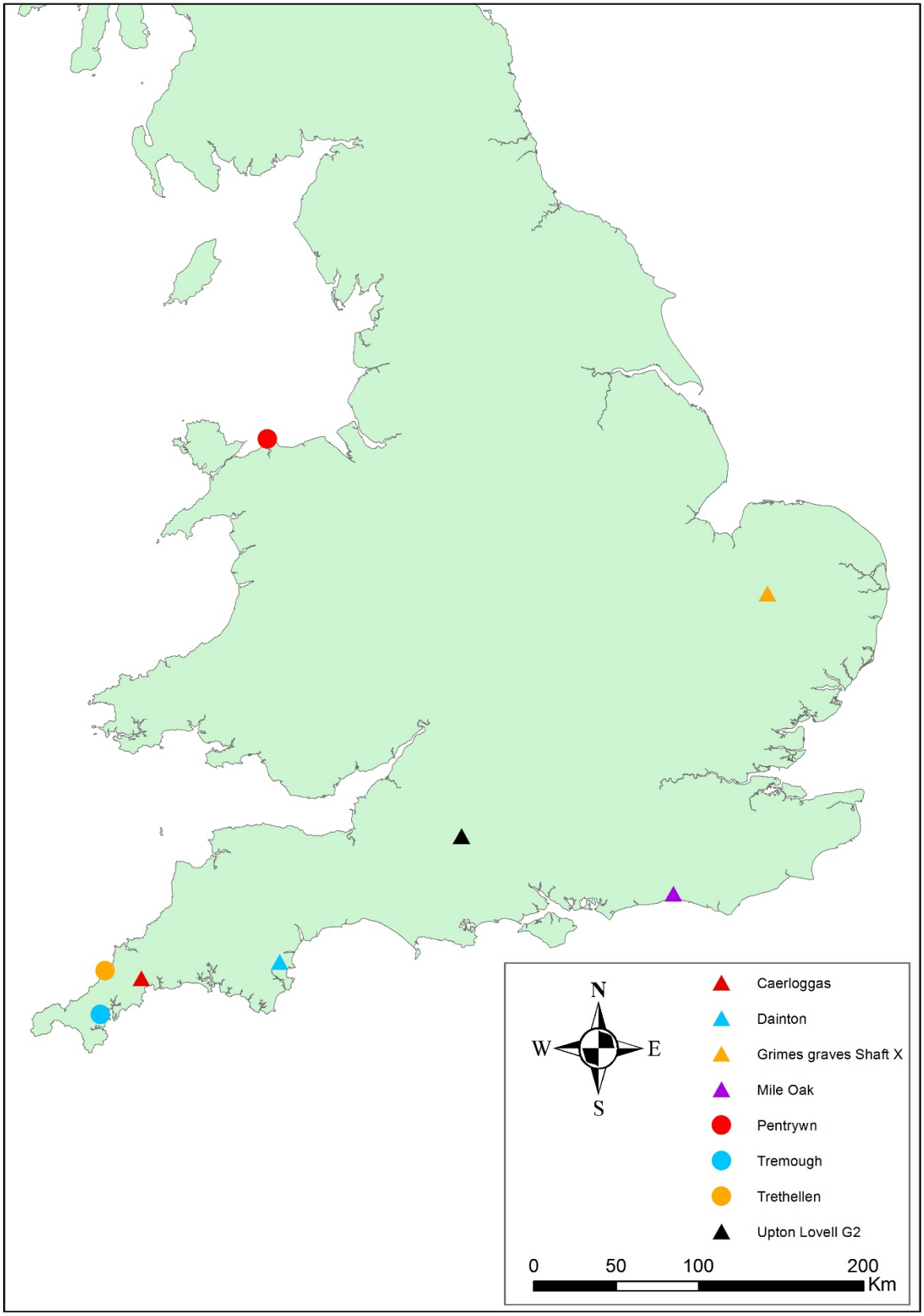


Figure 3: Key sites discussed in the text with evidence of metalworking. Sites with *direct* evidence of working marked with circles; sites with *indirect* evidence of metalworking marked with triangles.

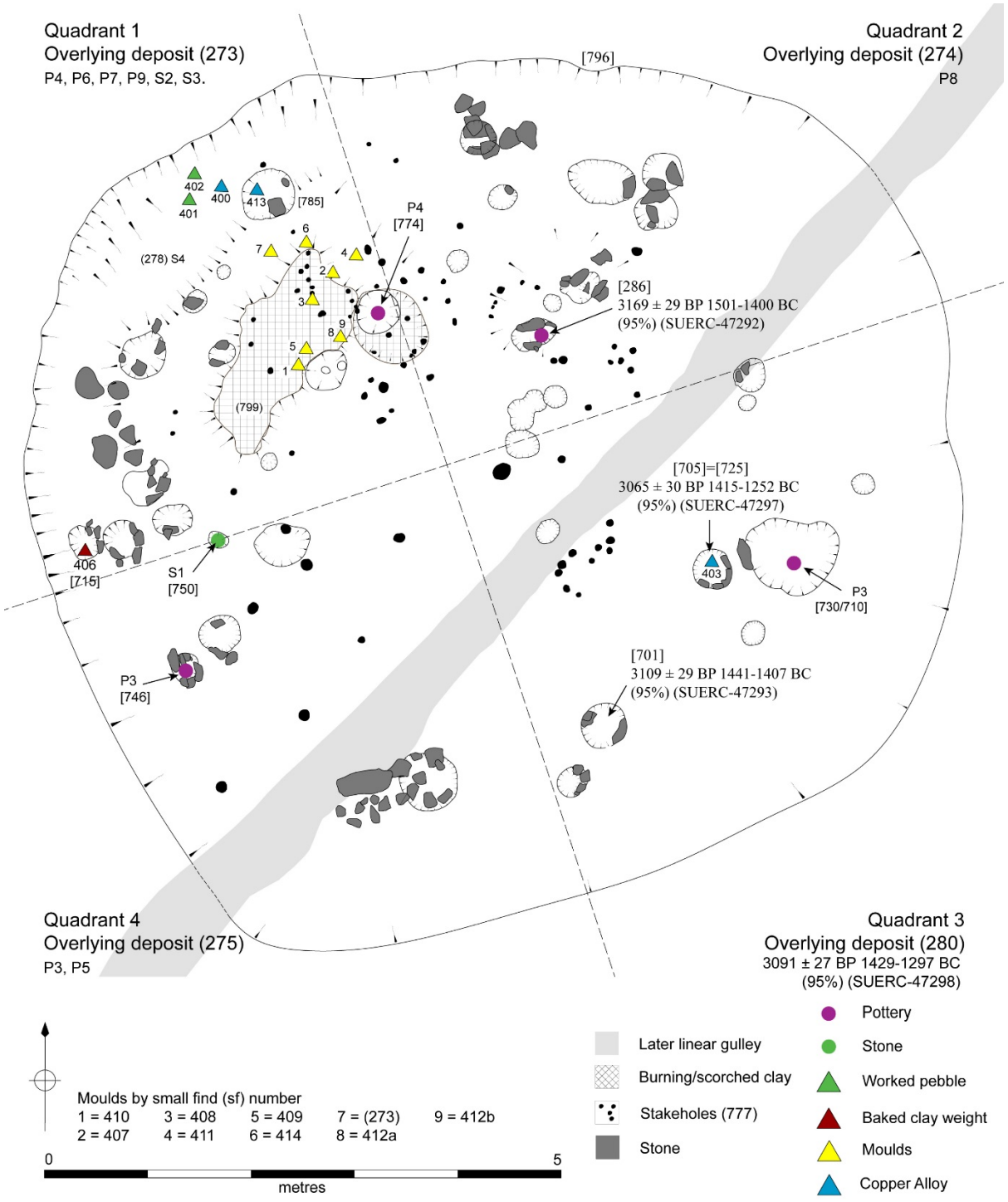


Figure 4: Final plan of the excavation of Roundhouse 1, showing the location of the finds in the house, and the metalworking hearth [774].

Figure 5: Excavation photographs of Tremough Roundhouse 1, showing: A) Pre-excavation shot of hearth [774] with pottery finds *in-situ* on top; B) Mould fragment found near hearth [774] during excavation, and C) Final excavation shot of Roundhouse 1, with the hearth highlighted by the circle.

Needham Period	Dates cal BC	Description	Principal metalwork forms/settlement evidence
Period 1	2450–2200/2150	Chalcolithic/Early Beaker period	Small copper knives, gold 'basket earrings'. First Beakers and beaker graves. Lightly built structures few and far between.
Period 2	2200/2150–1950	Beaker period	Copper alloy artefacts including Armorico British daggers. Beakers in use, and first round barrows. Lightly built structures few and far between.
Period 3	1950–1750/1700	Early Bronze Age 'Wessex I'	Some early Camerton-Snowshill daggers, copper alloy pendants, pins, etc. Faience and amber beads in circulation. Food Vessels, Collared Urns and Trevisker pottery in use. Large barrows constructed, burial predominantly inhumation, but cremation found/preferred in some areas. Little evidence for domestic structures.
Period 4	1750/1700–1550/1500	Early Bronze Age 'Wessex II'	Daggers and knife-daggers belong to this period. First copper alloy spearheads. Burials still found beneath barrows, usually cremations. Biconical, Collared Urns and Trevisker pottery found. Settlement structures rare.
Period 5	1500-1100	Middle Bronze Age	Palstaves, rapiers, spears. Deverel-Rimbury pottery Late Collared Urns and Trevisker pottery found. Decline in barrow building. Increase in deposition of metalwork hoards. Widespread evidence for roundhouse settlement and field systems. Some structural deposition of metal artefacts within roundhouses and enclosures.
Periods 6-7	1100-800	Late Bronze Age	Swords, socketed axes, spears, shields. Plain ware pottery styles. Some human remains deposited into rivers, large scale deposition of metalwork in hoards. Widespread evidence for roundhouse settlement, linear dykes, palisaded enclosures and ring-works. Some hillforts.

Table 1: Simplified chronological outline for British Bronze Age.

Metal working stage	Types of potential archaeological 'macroscopic' excavation evidence	Observations on current understanding	Archaeological identification issue
Ore preparation/ roasting	Crushed ore; fired pits	Only known current excavated examples are associated with mining sites, e.g., at Ross Island and Alderley Edge. Crushed cassiterite pebbles are also associated with an Early Bronze Age pit at Truro.	Sites containing hammerspall from mining/processing have been identified during the excavation of the mining sites. Sites of ore preparation likely to be visible during excavation due to macroscopic hammespall, spoil and heated pits containing some ore residue from crushing.
Smelting	Heath/furnace/evidence of heating, prepared ore, slag, tuyeres, crucibles, furnace lining	No definitively identified Beaker/Bronze Age copper or tin smelting sites within Britain, but analogies with Western Europe suggest they are likely to occur close to mining sites (Roberts 2009, 470). Furnaces identified at Ross Island (Ireland) and probably the Great Orme (Pentrywn). Tin slag also found at Caerloggas enclosure barrow I (Miles 1975)	Limited visibility, slag deposits could be microscopic and have very low visibility during excavation. The 'furnace' is likely to have an archaeological form similar to a hearth or burnt pit- and not definable as a metalworking structure *per se*, during excavation. Evidence from Ross Island suggests Chalcolithic furnaces could be associated with a pit.
Casting	Hearth/furnace/evidence of heating, moulds, tuyeres, metal flash from casting	Deposition of moulds have been found on multiple sites throughout Britain. Example of a Middle Bronze Age metalworking roundhouse at Tremough, associated with moulds.	Moulds are liable to be structured deposit and not left lying around the area of casting. Casting likely to use crucibles in a hearth, with the archaeological evidence of a hearth or burnt pit and not definable as a metalworking structure *per se* during excavation.
Cold working	Cold working tools, eg, anvils, cushions tones, hammers, etc	No definite evidence in the British archaeological record of locations where cold working occurred, but metalworking tools recovered from burials associated with cold working/artefact finishing (e.g. cushion stones in Beaker/Early Bronze Age burials, etc.)	Metal filings/residue. Highly unlikely to be visible during excavation.
Finished product	Deposits in burials and settlement sites; hoards	Multiple hoards and individual find spots have been found, but none in direct association with metalworking infrastructure such as hearths. Multiple examples of Beaker/Bronze Age burials containing metal artefacts.	Artefacts; thousands known in Britain and Ireland from between *c.* 2500 cal BC and 800 cal BC

Table 2: The stages of metalworking in the British Chalcolithic and Bronze Age, types of archaeological evidence and summary of current understanding (macroscopic excavation evidence is taken to mean evidence identifiable in 'the field' during archaeological excavation).