Diversity in Iron Age metalworking: a unique crucible from Westwood, Coventry

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ABSTRACT: Excavation of an Iron Age settlement at Westwood in the English Midlands recovered a ceramic crucible of a hitherto unknown form, with a hollow pouring spout. XRF analysis of the crucible detected copper, tin and silver. A find of a solitary crucible in a roundhouse is typical of the period but the form of this example is extraordinary and emphasises the diversity in Iron Age metalworking practices.

Introduction

The massive increase in development-led excavation in Britain since the 1990s has produced substantial new evidence for later prehistoric metalworking, much of which has yet to be fully studied and synthesised. This paper discusses a crucible of unique form recovered from an Iron Age settlement in the English Midlands. Analysis of the crucible indicates that it had been used for metallurgical processes involving copper alloys and potentially silver. Research on the context of later prehistoric metalworking remains shows the presence of small-scale copper alloy working at an apparently ordinary domestic settlement is typical for the British Iron Age (Adams *et al* 2017; Webley *et al* in prep) whereas the possibility of silver working at such a site would be unusual.

The Westwood excavation

The Westwood site lies within the campus of the University of Warwick, in the Metropolitan Borough of Coventry (Fig 1). It was first recognised on an aerial photograph, which shows a cropmark of two adjacent curvilinear ditched enclosures (University of Warwick aerial photography collection, HAS/UK/58/902, 20 May 1958). In 2002 a new sports ground was due to be constructed in the area of the southern enclosure. An initial evaluation trench proved negative, but subsequent groundworks exposed archaeological features, and a rescue excavation was begun (NGR: SP 296 766). This

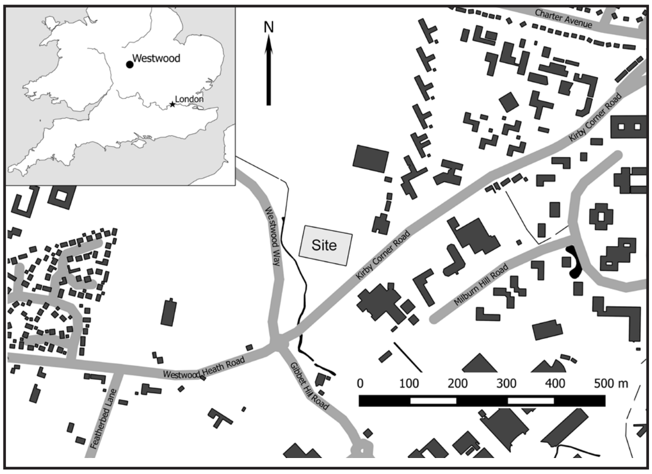

Figure 1: Location of the Westwood site.

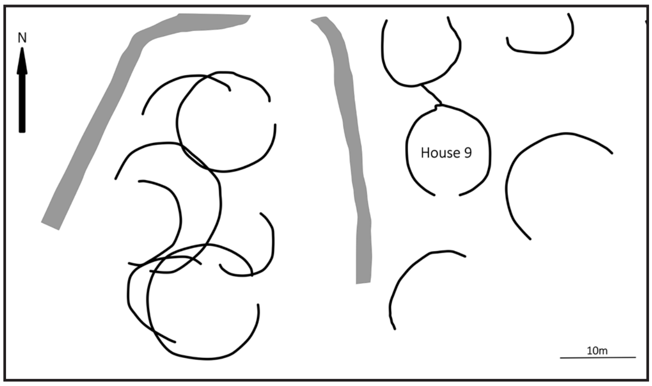

Figure 2: Schematic plan of the Westwood excavation, based on a plan held in the site archive. Roundhouse gullies shown in black, enclosure ditches in grey. Other features were not clearly depicted on the original.

was carried out by members of the University's Centre for Lifelong Learning, under the direction of Stephen Hill. In the event only limited sample excavation was carried out, as it was possible to modify the development plans to preserve the site *in situ*. The account of the site presented here is based on a brief unpublished report on the fieldwork (Hill 2002) and examination of the excavation archive and finds.

Iron Age settlement features revealed by the excavation included at least 12 roundhouses, seven of them lying within the enclosure and five to its east (Fig 2). Most were represented only by the penannular drainage gully that would have surrounded the building, these ranging from *c*9-15m in diameter. Overlaps between gullies indicate at least three phases of construction, with no more than nine houses standing at any time. Finds from the site are largely limited to pottery and animal bone. They have been labelled only with the relevant roundhouse number rather than being allocated to individual excavated contexts. No finds are ascribed to the enclosure ditches. Handmade pottery was recovered from six of the houses. Sandy fabrics predominate, and recognisable forms include slack-shouldered and barrel-shaped vessels. Most of the pottery is plain, but one vessel from House 9 is ornamented with roughly scored lines on its exterior. These characteristics firmly place the assemblage in the later Iron Age (*c*400 BC to AD 50).

The crucible was recovered from House 9, a structure of *c*11m diameter. The unpublished report mentions 'iron slag' and 'a fragment of a second crucible' from the same context, but no such objects are present among the archived finds. However, other hints of high-temperature processes from this roundhouse include a formless lump of orange oxidised-fired clay and a piece of roundwood charcoal. Bagged separately from the other finds but apparently associated with the building was a small

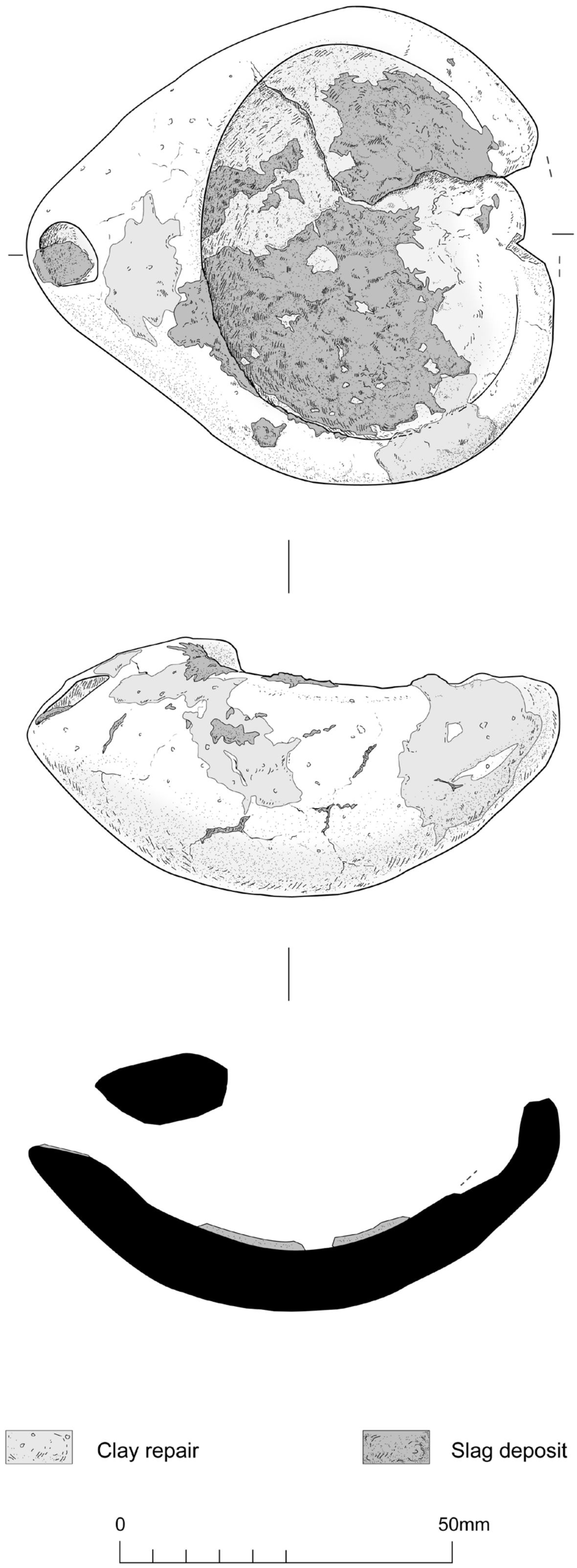

Figure 3: The crucible.

fragment of orange fired clay with one grey vitrified surface. This is potentially part of a hearth or furnace lining, though pXRF analysis failed to identify any significant metal traces.

Figure 4: The crucible. Maximum length 80mm.

The crucible

The crucible is virtually complete, though now broken into several fragments (Figs 3-4). It is pear shaped in plan, with an oval bowl and hollow spout, and has an overall length of 80mm. The crucible bowl has an internal diameter of 55 x 45mm and is 25mm deep, with a wall thickness of up to 13mm. This gives it a volume of *c*30cm^3, corresponding to approximately 250g of copper. Its usable capacity would have been much less given that the spout begins mid-way up the profile of the vessel and that the charcoal fuel was probably part of the crucible charge (see below).

The rounded shape of the base is typical of crucibles that would have sat in a small pit or an uneven bed of charcoal (more common in prehistoric crucibles), as opposed to flat-bottomed crucibles designed to sit on flat furnace platforms. An advantage of the hollow spout is that slag and charcoal floating on the top of the melt would be held back against the rim of the vessel when pouring. Other known Iron Age crucibles from southern Britain have only a simple, open, pouring lip, and an implement such as a stick would presumably have been used to prevent slag from contaminating the casting. If a crucible of this form was used for the reduction of minerals with charcoal, for example to make bronze directly with mineral cassiterite, then the spout could also have been used to introduce air using a blowpipe and facilitate the combustion of charcoal.

The crucible has a pale grey, reduced fabric, with a slightly darker grey core (Fig 4). Viewed under a hand lens (x15 magnification), the following inclusions could be observed: quartz, very common, moderately sorted, rounded, up to 0.7mm; black iron-rich inclusions (attracted by a magnet), sparse, rounded, up to 1mm. The fabric recipe is comparable to that of much of the domestic pottery from the site, except that the frequency of quartz is higher. It is distinct from the fabrics of the triangular crucibles typically found in the southern British Iron Age (see below), which are very densely packed with quartz and/or carbon (Howard 1983).

Much of the interior of the bowl and spout is covered by a brown slaggy encrustation, though green cuprous patches and droplets can clearly be seen within this in several places. Deposits of purple-red oxidation products are present around the rim. Though the crucible is nowhere heavily vitrified, the slaggy deposits in the interior combined with the absence of vitrification on exterior surfaces suggest that the crucible charge was heated from above, under a cover of charcoal, as opposed to later crucibles that are heated from the outside.

Superficial cracking is present over much of the exterior of the vessel. Three additional patches of clay have been applied around the rim and upper exterior, covering some of the cracks, presumably in an attempt to prolong

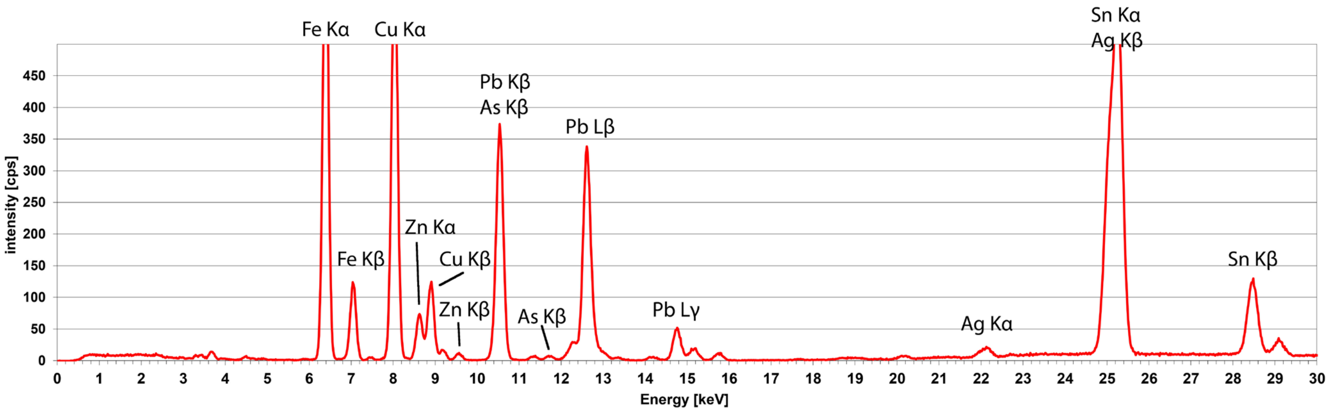

Figure 5: Representative XRF spectrum from one of the analyses of the inner surface of the crucible. The main spectral peaks relating to its use (and significantly higher than on the outer surface) are labelled.

the life of the crucible. Other than being slightly darker in colour, the fabric of these applied patches is indistinguishable from that of the rest of the vessel. In at least one place the applied clay appears to overlie the purple deposits on the rim. This shows that the crucible was used more than once and was considered worth repairing.

XRF analysis of the crucible

Several qualitative analyses of the inner and outer surfaces of the crucible were carried out using a handheld portable X-ray fluorescence spectrometer (pXRF), an Olympus InnovX Delta Premium with a Rh anode and a silicon drift detector, using the Soils method up to an accelerating voltage of 40kV (Fig 5). Unfortunately, permission was not granted for more invasive analysis. The results for the inner surfaces showed consistently higher levels of iron, which might derive from the accumulation of soil residues in the concave surface and/or the oxidation of iron impurities in the metals melted within. Of interest is the enrichment in non-ferrous metals, which is more likely to be indicative of the metals processed in the vessel. Copper and tin appeared to be particularly abundant in the residue, together with smaller but undeniable peaks for lead, zinc and silver, and a possible arsenic peak (though problems of the spectral peak overlaps between Pb and As are acknowledged).

The interpretation of surface XRF analyses from metallurgical ceramics requires caution, not least because of the variable likelihood of different metals to appear enriched in the slag or dross, depending on their vapour pressure, free energy of oxidation, and reactivity with the siliceous ceramic (Dungworth 2000; Kearns *et al* 2010). In addition, the same crucible may be used for different metals or alloys in subsequent utilisations, so that their corresponding signatures appear mixed. In particular, relatively more volatile metals such as zinc, lead and arsenic tend to leave notable traces in crucibles and moulds, even if present in the charge in very small amounts only. The moderate to low levels detected here therefore are likely to derive from the presence of these elements as impurities in other metals processed in the Westwood crucibles, rather than their use as deliberate alloying constituents. In other words, this cannot be taken as evidence of brass, and is unlikely to reflect heavily leaded alloys, both of which would be unusual in Iron Age Britain.

Thus, we are left with copper, tin and silver – metals with a considerably lower vapour pressure – as more reliable signatures consistently identified in the crucible interior. The presence of traces of silver on this crucible is unusual given that the metal does not oxidise readily and hence leaves relatively little trace unless a metal prill is trapped, which was not the case for the Westwood crucible. Based on surface analyses alone, it is not possible to confirm whether the vessel would have been used for bronze and silver on separate occasions, the melting together of silver debased with bronze, or the processing of bronze where the copper has an unusually high, though minor silver content. In relation to the last option, a specific copper ore source cannot be pinpointed, though the exploitation of silver-rich copper ores during the later Iron Age is indicated by metalworking evidence from hillforts in Powys and Shropshire over 100km away (Musson and Northover 1989; Musson *et al* 1992). This copper could also account for the peaks for lead and zinc since these are present in the Llanymynech copper-lead-zinc ore.

Part of a small hollow unworked sheep bone (the mid-shaft and proximal metaphysis of a tibia; identification by Richard Thomas) found in the same context as the crucible was also subjected to pXRF analysis. This showed raised levels of copper and tin on both ends of the bone. The excavators had proposed this find was used with the crucible as a handle but the short length of the bone and the lack of any heat damage argue against this. It may simply be that the bone took up the metal traces as a result of burial in close association with the crucible, or through post-excavation contamination (for example when the bone was inserted into the crucible spout to see whether it fitted).

Parallels for the crucible

Crucibles for non-ferrous metalworking are fairly common finds from pre-Roman Iron Age sites across Britain. Three broad types can be distinguished, though this is inevitably a simplification of a more complex reality. The best-known type is characterised by rims that are triangular in plan and with rounded bases. Triangular crucibles were the dominant form in southern Britain, although they are rare before *c*450 BC and become less frequent finds during the early first century AD. They are also found in northern Britain including the Isle of Man (Adams *et al* 2017; Webley *et al* in prep). Triangular crucibles with a shallow bowl, Bayley's (1992) Type 1 crucibles, are more widespread while those with deeper, roughly conical profiles (Bayley's Type 2) are concentrated in southern Britain and rarely found in the north, an exception being that discovered at Dunagoil, Argyll and Bute (Harding 2004). These sub-types were once thought to be successive but now appear to be contemporary with each other. A second, less common crucible form comprises rounded, cup-shaped vessels with a lug projecting from one side. These have only been found at five sites: three in Shropshire, The Berth (Morris and Gelling 1991) and Old Oswestry (Hughes 1996), and neighbouring Powys, Llwyn Bryn-dinas (Musson *et al* 1992), and two widely separated at Danebury, Hampshire (Cunliffe and Poole 1991) and Cullykhan, Grampian (Greig 1972). Those from the Shropshire/Powys cluster all exhibit the same conical base shape whereas crucibles from the latter two sites are more roughly shaped with flatter bases and larger handles almost as deep as the crucible bowl. At Danebury they occur from the earliest phase (*c*450-300 BC: Derek Hamilton pers comm) and overlap in use with shallow triangular forms, while at Llwyn Bryn-dinas, Powys, they are dated to the 3rd-2nd century BC (Musson *et al* 1992). The third form comprises simple, shallow round-bowled crucibles, sometimes with a pinched-out pouring lip. In southern Britain, these appear in the Late Iron Age (after *c*150 BC), as at Silchester, Hampshire (Fulford and Timby 2000), Ounces Barn, Boxgrove, West Sussex (Bedwin and Place 1995) and Kelk, East Yorkshire (Chapman *et al* 2000). Examples also occur in Scotland (Heald 2005, 57). With its distinctive spout, the Westwood crucible is quite different from any of these previously identified forms. It is tempting to suggest that it represents a variant of the third, bowl-shaped type, consistent with a Late Iron Age date.

We have also not been able to find examples in the literature of crucibles of this exact type from other cultural contexts. Crucibles of broadly similar shape are the sealed 'boat-shaped' vessels recovered in medieval Novgorod (Eniosova and Rehren 2012). These, however, have a solid handle that in some cases appears to have been deliberately broken off for pouring, rather than a custom-made spout. Perhaps more relevant from a functional perspective are New Kingdom Egyptian crucibles such as those preserved at the UCL Petrie Collection (see http://petriecat.museums.ucl.ac.uk/ or *eg* Davey 1985) and illustrated in contemporary tomb depictions. Albeit larger in volume, these crucibles also bear a side hole that could have been used both to allow blowpipe nozzles in during heating, and slag-free pouring after that. Closer geographically are the early medieval crucibles from London (Bayley *et al* 1991) which have a spout created by adding a clay bar across the pinched out pouring lip, as opposed to the hollow spout formed through the wall of the Westwood crucible.

Conclusions

As analysis was limited to surface XRF, the exact nature of the metallurgical processes that the Westwood crucible was involved in remains uncertain. The copper and tin signatures are consistent with use for bronze processing, but the small silver peak is more difficult to interpret. It is possible that the crucible had been used for processing silver as well as bronze, or silver-bronze alloys. This would suggest a Late Iron Age date (after *c* 150 BC), as silver was essentially absent from Britain during the early and middle Iron Age. During the Late Iron Age silver is mainly attested through its use for coinage. The earliest 'Gallo-Belgic' gold coins of southeast England were increasingly debased with silver over time (Northover 1992), and coins made of silver or silver alloy were minted from the mid-1st century BC onwards, probably using metal imported from the Roman world (Creighton 2000; Dennis 2005; Farley 2012). Silver was also occasionally used to make personal ornaments such as torcs and brooches (Northover 1992). Evidence for silver working from excavated Late Iron Age sites has been limited to the areas of southern and eastern England in which coins were minted and used. In most cases the evidence consists of silver enrichment identified on triangular crucibles or on coin pellet trays, as at Old Sleaford (Lincolnshire), which produced a possible crucible fragment with a silver droplet adhering and a silver prill stuck in a pellet mould fragment (Robbins and Bayley 1997, 61). The Hallaton 'shrine' in Leicestershire produced droplets of silver-rich copper alloy, and silver ingots that are likely to have been deposited as offerings. One of these ingots appears to have formed within a triangular crucible and has the outline of two coins visible in its upper part (Score 2011). This provides evidence that silver coins were melted down for recasting using small crucibles.

Evidence for silver working from a rural settlement in Warwickshire, at the edge of the core areas of Late Iron Age coin production and use in southern and eastern England would be unprecedented. An alternative explanation for the silver enrichment of the Westwood crucible is that it derives from the working of bronze made from copper that had a high silver impurity content. Unfortunately, our understanding of the copper sources utilised during the Iron Age is limited (Dungworth 1996). Silver-containing copper ores are known to have been exploited in the Welsh Borders (Musson and Northover 1989; Musson *et al* 1992), though other sources may also be possible.

The main interest of the Westwood crucible lies in its unique spouted form, and the implications that this has for its method of use. It is notable that this exceptional object comes from what appears to be a perfectly ordinary domestic site. There is nothing other than the metalworking evidence to distinguish Westwood from other settlements in the local region, and the house containing the crucible was typical in form and size. As few other Iron Age non-ferrous metalworking sites are known from the West Midlands, it is unclear whether the crucible was a one-off or represents a hitherto unrecognised local practice. The nearest contemporary assemblage of refractory waste has been found 21km to the east at Coton Park, Rugby, and here the crucibles were of the normal triangular form (Chapman forthcoming). Whatever the reason for this difference, the Westwood crucible provides us with a tantalising insight into diversity and innovation in Iron Age metalworking practices.

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