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Assessment of archaeometallurgical residues from Truro Eastern District Centre, Cornwall (TX12)

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Abstract

The site produced evidence for iron smelting in a non-slag tapping, 'slagpit'-style furnace [1077] in Field 1, with minor occurrences of associated residues in other contexts. Residues from this type of iron-making also occurred in the topsoil of Field 2. This style of furnace occurs widely in the Iron Age and early medieval period and the residues are not able to resolve the ambiguity in dating at the current level of understanding of its evolution.

A single piece of iron ore was recovered from topsoil in Field 2 and this may provide some circumstantial evidence for the nature of the ore being exploited. The ore superficially resembled the gossan ore from the Richard Lander School site, to the W of Truro, which lies close to the post-medieval East Wheal Falmouth mine. Although no examples of gossans have been identified in the published literature in the Woodcock Corner area, the site does lie along the strike of the veins of the Wheal Falmouth area and a minor occurrence of suitable ore in the area is certainly possible. A small piece of malachite/azurite copper ore was also recovered from Field 5, but it is unclear if this was present through human agency or is further circumstantial evidence for supergene mineralisation on the site.

Two fragments of tin slag, probably of medieval or post-medieval date, were also recovered from topsoil (one from Field 1, one from Field 4).

Hearth ceramic lifted from Field 3 was examined, but it produced no evidence for metallurgical use.

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Methods

The materials were examined visually (with a low-powered hand lens or microscope when required) and a catalogue prepared (Table 1). As an evaluation, the materials were not subjected to any high-magnification optical inspection, not to any form of instrumental analysis. The identifications of materials in this report are therefore necessarily limited and must be regarded as provisional.

Stratigraphic information in this report is derived from the Archive Report (Taylor 2013).

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Results

Distribution of the residues

Field 1: Residues from Field 1 include coal and medieval/post-medieval tin smelting slag from the topsoil (1001), but the most important occurrence was the basal pit of a slagpit iron smelting furnace [1077]. The fills of this pit (1002, 1069, 1070 and 1067) contained over 2kg of flow slags and associated material, as well as 2kg of slagged furnace wall and approximately 5kg of less-altered furnace shaft fragments and pit lining.

Lesser quantities of material very likely to have been derived from this furnace occurred in other contexts, including iron slag from context (1071) and a further fragment of furnace wall from (1044).

A small slag fragment from deposit (1011) might be related, but is not necessarily so, and may even be non-metallurgical.

According to the Archive Report (Taylor 2013), slag was also present in fill (1012) of burnt pit [1013], but this was not present in the submitted material.

Field 2: The topsoil in Field 2 (2001) yielded three pieces of dense iron slag, formed in a slagpit furnace of the type seen in Field 1, as well as single fragment of dense goethitic iron ore.

Field 3: Material from the base of hearth (3037) was examined, but it provided no evidence for a metallurgical origin. Although described as a block lift, the material simply comprised a sample tray of fragments.

Field 4: A testpit in this field produced a single fragment of chert-like tin slag, likely to of medieval/post-medieval age.

Field 5: A single fragment of malachite/azurite copper ore was recovered from a test pit in this field, but this need not be other than of natural occurrence.

In summary, no stratified metallurgical residues were recovered outside Field 1, in which residues occurred within the basal pit of an iron smelting furnace, as well as in small quantities in other deposits; similar resides occurred unstratified in Field 2. Field 1 also produced a single piece of iron ore.

Fields 1 and 4 each produced a single piece of probably medieval to post-medieval tin smelting slag from topsoil.

Description of the residues

Residues from iron smelting: furnace [1077] produced a variety of residues associated with bloomery iron making in a slagpit furnace.

Much of the residue was structural, with deposit (1069) being a substantial part of the collapsed superstructure. Much of this material was included within what was described as being a 'block lift', but in fact comprised a package of disaggregated fragments. The superstructure was formed of a slightly gravelly ceramic, with most fragments being oxidised-fired. Some piece showed a well-vitrified curved inner face. In most instances these vitrified faces showed small embedded rusted particles – presumably part-reacted ore trapped by the silicate glaze. A significant proportion of fragments showed an unvitrified inner face – which is significant for demonstrating the existence of a shaft extending beyond the hot-zone area. One fragment with a well-vitrified and eroded face, probably from the sub-blowhole area, showed a progression into a much more shillet-rich fabric – probably indicating the blowhole was only just above the level of the top of the pit. In sufficient vitrified fragments survived to be able to reconstruct any substantial section of all.

Slagged pit wall, or floor, material was seen in the assemblage from deposit (1067), described as furnace lining, but mostly being slagged natural deposits rich in shillet. Only a small proportion appeared to be of prepared clay ceramic – and these pieces were reduced fired.

Fills (1002), (1070) and (1067) all produced flow slags typical of slagpit furnaces. These materials were mainly small prills, with only a few larger pieces showing the flow of the prills around the large fragments of wood pit-packing. These assemblages also include rather friable residues comprising partially mineralised fuel debris, with slag films and some denser incorporated slag blebs.

In detail, the significant proportion of the residue present within the slagpit as a friable material including fuel fragments and moulds, together with slag blebs, is reminiscent of several assemblages from Iron Age furnaces in Ireland (e.g. Lismore-Bushfield 1, Young 2008; Derryvorrigan 1, Young 2008) rather than of the described British occurrences.

A fragment of vitrified furnace wall, very similar to the material from the furnace, was recovered from context (1044). Dense flow slags were found in topsoil (2001) and in the West spoil of field 2.

Residues from tin smelting: two fragments of glassy (chert-like) tin smelting slags were recovered from topsoil (one from Field 1, one from Field 4). These materials are likely to be of either of medieval or post-medieval age.

Other residues: a small vitrified ball of quartzo-feldspathic rock from (1011) might have an origin with a metallurgical hearth or furnace, but this is not necessarily the case, although the degree of vitrification would require a high temperature.

Natural materials: Field 2 topsoil produced a single fragment of goethitic iron ore, probably from a gossan. The cavities within the rather porous goethite texture contain a fine, dark mineral, possibly a manganese oxide. The

material is superficially similar to the gossan fragments from the Richard Lander School site (Young 2008a). The present site lies along-strike from the Richard Lander School – and a minor extension of the same vein system into this area is possible, although not documented. Alternatively the ore fragment may have been transported from elsewhere by human agency.

The Area 6 testpits (Field 5) produced a single small fragment of azurite/malachite copper ore. An ore such as this would be from the supergene zone, and potentially spatially associated with the goethite iron ores. As with the iron ore piece, it is not known whether this piece has been imported or is derived directly from the underlying geology.

Other: the E spoil of Field 2 produced a single complex small bleb of melted clear glass. The surface of the piece has thin grey slag film. The most likely interpretation of this piece is that it is a fragment of modern lead glass that has been melted and partially oxidised.

Description of the metallurgical feature

Furnace [1077]: The basal pit of this furnace was preserved, although some details are obscure, possibly because of damage to its northern side. Well indurated pit lining was present on the SW side of the pit, and to a lesser extent to its NW and E. The degree of induration probably suggests that the furnace was blow from the SW and that the level of the blowing was not far above the level of preservation. The likely working internal dimension of the last use of the pit was approximately 400mm diameter, although the overall pit was 600 x 700mm and 300mm deep. Although a reduced fired clay lining appears to have been present in the upper, indurated, part of the wall, much of the residue from the pit shows interaction of slag with probable natural material (a shillet-rich material). The poorer preservation of the N side of the pit may just possibly suggest that there was access to side for pit-clearance.

The collapsed superstructure filled much of the pit where the main slag mass might have been expected to be, so presumably this was cleared after the last smelt, prior to collapse of the furnace. The collapsed material include significant pieces of vitrified wall from the blowhole area (but unfortunately not providing any evidence or the blowing arrangement itself), but also parts of the upper, low-fired, superstructure. Insufficient material survived to be able reconstruct any furnace detail.

Interpretation

The most archaeologically-significant aspect of the assemblage is the slagpit bloomery iron-smelting furnace. Whilst the technological interpretation of the material is straightforward, at least on a broad scale, the dating remains uncertain.

Slagpit technology was in wide use in the British Iron Age, although the details are quite variable and there is no clear evolutionary story yet. Some early examples are very large (e.g. Hartshill Copse, Berkshire, Young 2005), but more modest slagpits appear to characterise the examples of the mid- to late- Iron Age, including those of SW Britain (Dungworth 2011; Young 2008a, 2011, 2013, 2014). The examples from the Iron Age of SW Britain all apparently had a wood pit-packing. At Twinyeo Farm, Devon (Young 2013, 2014) the residues were variable, but two furnaces (not directly dated) contained in-situ assemblages of small flow slags, somewhat similar to those of the present site. A separate deposit of furnace residues was dated (SUERC-50274; 400-350 cal. BC and 310-200 cal. BC) to the 3rd or 4th centuries BC, but was dominated by large slag pieces indicative of more substantial slag flows to the base of the slagpit. In other areas of Britain, but not yet in the SW, moderately dense, sub-discoidal, slag bocks have recorded in the upper part of the pit of Iron Age furnaces (e.g. Hartshill and Eversley, Young 2005, 2012), with a low proportion of individual fine slag prills beneath. Such tabular forms of furnace bottom (FB) have also been recorded in several earlier Iron Age furnaces from Ireland (e.g. Tullyallen 6, Young 2003; Adamstown 1, Young 2006). The presence of slagpits solely with fine flow slags may be the results of either later truncation or the post-smelt removal of such a main slag mass without full clearance of the underlying pit.

Examples are also known of early medieval slagpit furnaces in the region, including two sites in Hemyock, Devon (author's unpublished data) and at Burlescombe (Reed *et al*. 2006). None of these examples included assemblages with abundant fine flow slags; the Hemyock sites mostly showed substantial basal flows below deep, porous, slag blocks (furnace bottoms; FBs) and the Burlescombe furnaces showed very large, deep, porous, but coherent, slag masses.

The fundamental controls (size of smelt, chemistry of ore and lining, smelting rate, furnace morphology, pit size and shape, blowing arrangement etc.) on the detailed morphology of the residues produced during slagpit smelting are not well understood. Thus, the patterns of differing residue style described above cannot currently be used to interpret the details of either the technology or the dating. Although the present example most closely resembles Iron Age comparators (in Britain and Ireland), that observation remains of unknown significance.

The presence of a fragment of goethite iron ore, probably of gossan origin provides some circumstantial evidence that the site might have exploited similar ores to the Iron Age site at Richard Lander School, west of Truro (about 5.5km WSW of the present site). It is not known whether the ore fragment has been brought-in from outside the immediate area or whether gossans outcrop at or near the site itself (none has been mapped by BGS and no nearby workings were recorded by Dines 1956).

The broad similarity of the residues and ore provides circumstantial evidence that the iron smelting furnace [1077] may be of Iron Age date, but an early medieval age remains possible. The poor state of preservation of the furnace means that details of the technology and even the precise dimensions of the furnace remain unclear.

Conclusion

The main aspect of interest on the site is the in-situ furnace. The furnace is currently undated and further comment may be able to be made when any dating programme is complete. An Iron Age date seems likely, although unproven, through comparison of residues and possible resource with the Richard Lander School site, 5.5km WSW.

Poor preservation of the furnace and the survival of only a very small suite of residues, means that a large further programme of further work would not be justifiable. Instead, a small programme is recommended, involving chemical analysis of a sample of the smelting slag and of a sample of the ore. This would aim to test a potential relationship between the two materials and also to assess any similarity with the materials from Richard Lander School site. Retention of the residues from the smelting furnace within the site archive is recommended.

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Table 1: summary catalogue by context. assm = assemblage comprising numerous (uncounted) pieces.

	Context	Label		Wt (g)	No.	Notes
Field 1						
	1001	slag/clinker		20	1	angular fragment of cherty tin slag; top (?) is highly vesicular and carries relict quartz grains.
	1001	slag/coal/clinker		4	1	coal
<58>	1011	slag		4	1	slightly maroon-surfaced ball of clinkery partially-melted rock with quartz and feldspar
	1011	slag?		4	3	burnt organic material - probably charcoal
	1044			248	1	slab of well-vitrified oxidised-fired furnace wall. Glass surface has embedded/adhering small (2-3mm) rusting particles - probably part-reacted iron ore
	1071			14	3	friable charcoal rich slaggy material (plus 1 2g angular quartz grain)
	1002	Sn slag		532	assm	slag pit assemblage - c. 90% prills / 10% iron-impregnated fuel waste
	1002	slag/coal/clinker		46	1	partially melted poorly sorted wall material, with various lithic clasts in varying degrees of partial melting/bloating
<72>	1069	#1		200	1	block of highly contorted partially-melted wall material
<72>	1069	#2		188	1	slab of well-vitrified oxidised-fired furnace wall. Slag surface has embedded/adhering rusting flecks - probably part reacted iron ore. Very similar to fragment from 1044.
<72>	1069	#3		862	1	charcoal-rich iron slag attached to large fragment of pale green pit wall
<72>	1069	#4		138	1	rough vesicular iron slag adhering to very gravelly, partially-melted wall
<72>	1069	#5		78	1	rough iron slag adhering to very gravelly, partially-melted wall
	1069	furnace lining		338	assm	mostly, but not entirely, oxidised-fired pieces, many with smooth internal face but no significant morphologies
<72>	1069	furnace superstructure	[block lift]	4725	assm	3125g of debris after large fragments picked; 1600g larger fragments which include 6 pieces (522g) of well vitrified material (locally with rusty flecks) and 8g (2 pieces) of prills; the remainder is mostly unvitrified or poorly vitrified; the potential sub-blowhole material appears gravelly whereas the unvitrified material and the flecked material is less gravelly.
	1070	Sn slag		1195	assm	slag pit assemblage - c. 60% prills / 40% iron-impregnated fuel waste
	1067	furnace lining		624	assm	comprises: probable pit lining with grey clay with organic temper, reduced fired, bleached white on surface, 20 pieces, 172g 8 pieces, 172g, dense dark slag prills penetrating into clay and shillet - possibly wall, but may be pit base 2 pieces, 74g of complex flow slags around fuel or wood moulds 174g, 6 pieces of iron oxides and slag binding fuel debris; contains some discrete blebs/prills

	Context	Label		Wt (g)	No.	Notes
Field 2						
	2001			174	1	very dense slag in complex sheet form, with some large wood impressions
	2001			174	1	fragment of dense slag sheet 35mm thick, one flat face is large wood imprint, other impressions on perpendicular fracture. Slag quite highly vesicular despite density
	2001			128	1	v dense iron ore, possibly with manganese-rich cavity fills
	2001			98	1	dense flow slag with prills descending between fuel lumps to a flat basal surface
	W spoil			90	1	very dense slag, although vesicular, with wood impressions
	W spoil			32	1	very dense slag with wood/charcoal impressions and a very coarse equant olivine texture
	E Spoil			4	1	bleb of clear colourless glass with surface turned to a lead-grey wrinkled slag; melted lead glass?
Field 3						
<161>	3037	fired hearth	[block lift]	3900	assm	fragmented fired gravelly clay-rich shillet; no longer intact
Field 4						
	A4 testpits	ironstone?		80	1	slightly vesicular glassy slag, very dense, tin slag
Field 5						
	A6 testpits	copper ore		18	1	rounded nub with green core of elongate sweeping crystals (malachite), possibly end of sheet 13mm thick, overgrown by 5-6mm of dense blue vitreous-appearing azurite

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