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Assessment of archaeometallurgical residues from Weston-under-Penyard, ALI-EVAL15161

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Abstract

This was a small assemblage (29.7kg of residues, 138 pieces, from 9 distinct contexts) of material selectively hand-picked during excavation. The assemblage was dominated by macro-residues from iron smelting in slag-tapping bloomery furnaces.

The smelting residue assemblage was slightly unusual in containing an exceptionally high proportion of slag rods/runners, together with a significant amount of furnace slag, compared with the amount of tapped slag that cooled outside the furnace. To some degree this may reflect sampling bias with a hand-collected assemblage, but none the less, the proportion of runners/rods is significant.

The tapped slags in the assemblage included no complete cakes; the largest was an incomplete thin cake weighing 1.26kg. The tapped slags were variable, from extremely porous sheets to deep, dense flows with almost no vesicularity.

Furnace slags were frequently encased in concretion (perhaps because of the weathering of metallic iron), so although abundant in the assemblage, detailed observation is lacking. The furnace slags were, on the whole, apparently very dense materials; there was a lack of the porous, charcoal-rich varieties commonly encountered.

The runners and rods were an important part of the assemblage. Many of the pieces containing runners, were examples of complex objects in which multiple runners/rods were stacked vertically. Several pieces appeared to show a junction between runners and the gently-inclined side of a slag bowl. These observations suggest that the rods/runners were made by solidification of slag in a hole forced through the furnace fill to drain the slag bowl as it formed – and that this must have been undertaken on multiple occasions during one smelt.

Similar smelting residues have been encountered on other sites smelting the iron oxide ores of the Bristol Channel Orefield, suggesting a particularly dominant furnace-type in the region.

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Methods

All materials were examined visually with a low-powered binocular microscope where required. 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.

As no environmental or other sieved samples were submitted for examination, the matrix removed from the specimens from context (203) was collected, sieved and sampled with a magnet, as a substitute, in order to check for microresidues. The examined materials are listed in Table 1.

This project was commissioned by Thomas Wellicome, of Archaeological Landscape Investigation.

Results

Description of residues

The submitted materials amounted to an overall total of approximately 29.7kg after re-washing. The material had rather variable preservation. Some of the material was very well preserved, but other pieces showed strong leaching and concretion formation. There appeared to be some correlation of poorly preserved/accreted material with furnace slags, which may indicate that a component in the development of concretions was the alteration of metallic iron. The summary catalogue of the material is presented in Table 1.

Bloomery iron smelting residues

Most of the collection comprised flowed slags, including those which had cooled outside the furnace (tapped slags or tapslags) and those which cooled inside the means of tapping to form slag rods and runners. The assemblage also included a significant amount of slag that was interpreted as furnace slag, slag that cooled inside the furnace structure.

Tapped slag: the tapped slag was rather variable in preservation (mostly good, but some from (203) rather leached). The assemblage included no complete cakes; the largest was an incomplete thin cake weighing 1.26kg (from (203)). The tapped slags were variable, from extremely porous sheets to deep, dense flows with almost no vesicularity.

Furnace slag: the specimens of furnace slag were mostly angular fragments, coated in concretion, with few useful morphological characteristics. Some broken pieces showed a coarsely crystalline microstructure with abundant intercrystalline voids.

Slag runners/rods: The assemblage contains a range of elongate slag bodies, ranging from 15mm diameter 'rods', up to 50mm wide 'runners'. The difference between rods (sub-circular in section) and runners (flat topped with indications of flow on the upper surface) is not clear cut. Several of the objects change nature within their preserved length (the maximum preserved length of any object is 200mm). The external surfaces bear a variety of textures (where visible through the concretion), with both sandy-surfaced and fuel dimpled textures common. In several cases the objects are intersecting, or slightly 'Y' shaped.

Particularly interesting are examples where multiple rods/runners are fused together. The most common form of this is where multiple rods/runners are fused together in an apparently vertical array.

One heavily concreted example of slag (from (203)) shows what appears to be two rods extending laterally from the gently inclined margin of a bowl-shaped furnace slag.

Smithing slags

There were no complete, certain examples of smithing hearth cakes (SHCs), but several fragments that may possibly derive from SHCs were recovered. Each of these might alternatively be interpreted as a furnace slag from iron smelting.

Microresidues from iron smithing were recovered in small quantities from the washings from context (203), see below.

Indeterminate residues

The indeterminate residues from the site were large highly fragmented debris that could not show sufficient morphology to be classifiable into one of the main groups.

Concretions

The macroscopic collections included, in addition to the material described above, two types of concretions. The major concretion formed around some of the specimens, particularly those of furnace slag, has been mentioned above. The concretionary material was not particularly rich in minor slag, scale or charcoal clasts, and is likely to be a cemented variant of the pit fill. These concretions are therefore likely to be post-depositional.

Context (203) also produced a large block of concretion formed of layers of fine to medium grained residues. Finer fragments of slag were almost entirely missing from the hand-picked collection from the same context. Either the pit fill was layered with fine slag deposits that were not sampled, or, perhaps more likely, this block of sediment was cemented after it is initial deposition in another location, then broken up and redeposited into context (203) as an indurated block.

Microresidues

The washings of the matrix of samples from context (203) produced slag debris plus a limited quantity of both flake and spheroidal hammerscale. Hammerscale results from the oxidation of iron at high temperature, and is indicative of smithing.

Distribution of residues

The distribution of the residues is illustrated in Table 2. None of the assemblages appears to be indicative of primary waste disposal from smelting and it is likely that the deposits are secondary accumulations. The material from (706) was much more worn than from the other contexts – indicating a higher degree of residuality.

Interpretation

The nature of the deposition of the assemblage from Trench 2 is unclear. The evidence described above suggests that none of the features was a primary location for slag deposition. The mixture of metallurgical and domestic waste also supports the secondary nature of the deposition.

The small amount of material from Trench 7 (706) derives from a gully [705] (Wellicome 2015, 20); the residues are all very worn, indicating that they are residual materials perhaps supporting a late date for this feature.

The macro-residues are probably all derived from iron smelting in a slag-tapping bloomery furnace.

The chief interesting facet of the assemblage is the large number of rods/runners and particularly in their

occurrence as 'stacks'. These multiple rods/runners are best interested as repeated attempts to drain the slag bowl during the smelt, by rodding a hole through arch-blocking or ashy furnace floor. As each rodded hole became chocked with cooled, a subsequent hole was rodded at a higher level. It is this repeat use of a rod (or poker) that allows the rods (the slag casts of the holes produced by rodding) to be apparently intersecting or divergent.

All characteristics of the assemblage can be matched at other Roman sites smelting Forest of Dean iron ores, with a more detailed discussion given below.

Discussion

The assemblage indicates the nearby presence of Roman smelting activity and, to a lesser extent, of smithing too. Thus although the evaluation only revealed secondary slag deposits, it is likely that primary deposits and the originating furnaces and hearths are not far away.

Despite previous work at *Ariconium*, the precise nature of the Roman smelting technologies employed in the area remains poorly understood. This site has yielded abundant slag rods/runners and these may be fundamental to understanding, but have been very controversial. They have been interpreted as slag infillings of tuyères, tapping holes and other orifices of the furnace. In fact, most such items do not show evidence for having formed in contact with furnace ceramic at all, but rather to have filled a cavity in soft sediment or fuel debris. They have been observed on the base of flat-floored dome like furnaces in the Weald (author's unpublished observations), but in the Forest of Dean they appear to be associated more with furnaces with a bowl-like floor, that required draining during the smelting, presumably through a rodded cavity (e.g. the furnaces described by Fulford & Allen, 1982).

Rods/runners are an important element of the assemblage at sites in and around the Forest of Dean such as Peterstow (Young 2012), Cannop (Young 2011) ,as well as in the wider hinterland of the Roman melting of Forest of Dean ore (e.g. Worcester, McDonnell & Swiss 2004). They are also found in association with a group of residues including massive furnace slags with roundwood and ore clasts found, for instance, at Cardiff (Young & Kearns 2011). These occurrences need further investigation, but to date not one well-preserved Roman furnace has been recorded to modern standards in the entire area.

This means that should any new furnaces be discovered in the region, they should be investigated and recorded in great detail.

In the present case, further examination of the property, perhaps by geophysical means, might be desirable in order to determine whether any postulated 'nearby primary source' of the residues recovered from the evaluation lies within the proposed development area.

Further work

The interpretation of slag rods and runners is, as yet, uncertain. Much more work is required to understand them, and the furnaces from which they derive. Should further work be undertaken at this site, then the importance of such an investigation should be considered. However, the poor dating of the present material, and the lack of association with metallurgical structures, means that further investigation of the present material would not be appropriate.

No further work on the present assemblage is therefore recommended. The material should however, be included within the site archive for appropriate deposition.

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Table 1: summary catalogue by bag and context. Weights in g.

context	sample wt	item wt	item no	notes
202	76	76	1	block of variably-fired furnace ceramic, fine paste with sandy temper
203	4355	4355	1	concretionary mass of large angular slag fragments resting on yellowish clay with some pebbles; slag fragments include large blocks of vesicular furnace slag, fragments of tapped slag (showing secondary haematisation); mass shows some cracking after washing - so probably contains some corroding iron.
203	3135	1095	20	tapslag, mostly dark with slightly maroon surface and fairly small flows; one piece shows lower flows but upper sheet with strongly haematised planar top
		102	1	small weathered burr fragment, tightly curled, one long thin edge (upper), the other rather thicker
		478	5	porous granular slag, all fractured, but unclear how many original pieces there have been, appears to have a curved cross section, like an SHC section or furnace slag margin
		104	1	irregular block of very fine grained ceramic, mostly reduced, but one oxidised edge, block deeply fractured
		128	1	slightly curved block of dense granular slag, furnace slag or SHC fragment
		702	1	block containing four slag rods conjoined and intersecting, way up not easily determinable, 40mm, 25-20mm, 25 constant and 20mm to 0.
		354	5	slag rods of c20mm diameter
		104	1	runner, 40mm wide with rough base and lobate top
		36	3	narrow slag rods or prills
		32	1	edge of slag flow or cake with raised lip, lowered interior with smooth maroon top and microdimpled base; dense
203	3218	378	1	block of conventional tap slag cake. Has sandy base. Joins 878g piece in bag below.
		1420	1	concretion. Appears to mask double slag rod (each 30mm diameter, two together 70mmwide) passing from inclined margin of furnace slag bowl
		1420	1	large concretion, uncertain slag core, also contains sherd of buff-coloured pottery
203	3122	878	1	block of conventional tap slag cake. Has sandy base. Joins 378g piece above to form part of cake c200mm across and 30-35mm thick
		626	1	large block of probable furnace slag - at least two surfaces show hits of slag rods
		318	1	large block of vitrified and bloated furnace ceramic with a grey/pink colour
		802	1	large slag 'runner, 50mm wide, thickens in one direction with fracture, suggesting this is one half of a divergent double, fracture where the two parted.
		498	1	large runner c40mm diameter, smooth lump on end could be where met furnace interior, base rough rounded, probable top shows a few free lobes

context	sample wt	item wt	item no	notes
203	3889	54	2	sand coated slag rods of c15mm diameter, sand coated, just very slightly sinuous
		2175	1	large block, probably of furnace slag. Some cracking occurring - so may contain some iron, 150x100x70, accreted so surface not visible and some adhering tapslag
		580	1	very dense block of reddened tap slag. Strongly red top with adhering furnace ceramic. Internal lobing not entirely visible apart from near base - which is itself probably a horizontal fracture. So, some slight similarity with some of the CC material
		580	1	two adhering 50x25mm runners with slightly different orientations. Both show rough, but not sandy bases and slightly lobate tops
		226	1	c35mm diameter rod - mainly with microdimpled surface
		274	1	complex amalgamated rods, but poorly preserved
203	4055	4055	1	230x180x80, large slab of smithing floor-like material, no certain smithing material - identifiable components Are tap slag and charcoal, but fine details not clear
205	666	666	1	complex stacked runners, lowest c28mm diameter, upper 40x15mm runner, middle section confused, sandy surfaces
205	636	636	1	triple decker runner piece, lowest 30x25mm possibly splitting laterally, middle 50x35, upper 50x20 with lobed top, but sharing common side with middle layer
206	1025	1005	1	large block of furnace slag, probably from side of furnace or tapping channel, some hints that it could be interpreted as three stacked 65mm wide runners
		20	bits	
208	394	394	1	complex rod like object which appears to be 2 or 3 complexly intersecting original rods, each of 25-30mm, dimpled surfaces
209	336	336	1	large irregular block of fired sandy ceramic - variable grey /maroon surface over pink grey ceramic, some areas of black sandy glass
210	8	8	1	deeply red tapslag lobe
210	148	148	1	deeply indurated and slagged furnace wall fragment, approx. 60mm of altered/slag material before grey ceramic reached
706	256	150	1	weathered and worn block from side of tap pit or runner
		2	1	small tapslag lobe fragment
		92	4	irregular granular slags indet.
		12	1	spall of natural indurated siltstone

context	sample wt	item wt	item no	notes
1005	4384	2318	48	tapslag
		534	7	slightly chaotic appearing furnace slags - very irregular masses
		422	4	massive angular furnace slag fragments, slightly granular porous texture
		134	1	curved crust c10mm thick, with slag adhering to both concave and convex sides. Quite possibly a SHC but might be a furnace slag crust
		80	1	fragment of runner, 40mm wide, 35 deep, with flow slag like top
		466	5	poorly preserved runner fragments, some associated with junction with furnace slags
		402	1	dense lump, fractured from a larger mass, strongly curved on one side suggesting either a burr or more likely the margin of a wide runner (if so c70mm wide and 40 deep as a minimum)
		28	bits	

Table 2: summary of residues by context and class (in g).

context	tap slag	furnace slag	runner/ rod	lining	indet	stone	mixed concretion	total
202				76				*76*
203	2931	2801	5050	422	740		9830	*21774*
205			1302					*1302*
206			1005		20			*1025*
208			394					*394*
209				336				*336*
210	8			148				*156*
806	152				92	12		*256*
1005	2318	956	948		162			*4384*
total	*5409*	*3757*	*8699*	*982*	*1014*	*12*	*9830*	*29703*

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