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Assessment of archaeometallurgical residues from Tidworth, Wiltshire (ACW338)

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Abstract

Archaeological investigations at Tidworth produced a small assemblage (approximately 10kg) of archaeometallurgical residues from blacksmithing. The residues include material across of wide range of slag types, suggesting a range of activities. There are very few smithing hearth cakes so their weight-frequency statistics must be treated with caution, but they appear to resemble those of assemblages from other smithies of the period in Britain.

One piece of slag derived from melting of the hearth lining infilled a small piece of curved iron. It is just possible that this represents the damaged tip of an iron tuyère – for which this would be a very early date.

The collections also included three very small fragments of imported Mayen lava querns.

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Methods

The material described here derives from excavations on land off Pennings road, Tidworth, Wiltshire [SU237475], conducted by AC Archaeology Ltd (Site code ACW338). This project was commissioned by Emma Firth.

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, nor to any form of instrumental analysis. The identifications of materials in this report are therefore necessarily limited and must be regarded as provisional.

Results

Description of residues

A total of approximately 10kg of materials from 23 contexts was examined, of which 9.9kg was archaeometallurgical residue. This was all either certainly or probably from iron working, with the details suggesting the end use of iron (blacksmithing) rather than smithing as part of the actual production of iron.

Smithing hearth slag cakes

The majority of the residues (5kg) were slags that accumulated as a distinct slag mass within the smithing hearth. Where slags occur in front of and below the air blast they may form a discrete slag mass that is termed a ***smithing hearth cake*** (SHC). SHCs may be attached to the hearth wall just below the blowhole. They typically have a sub-oval shape in plan and are plano- or concavo- convex in profile, but may have a very wide range of shapes and structures.

In this assemblage there is a marked dichotomy between very dense SHCs with a high iron content and pale, rather blebby, low-density slag masses formed largely of melted hearth ceramic. Somewhat similar low-density slags are a significant component of some early medieval slag assemblages from Ireland, where they have a typical morphology of slab-like overall shape, a glassy top, and pendent prills of more iron rich (and hence originally more fluid) slags below; these have been termed ***slag tongues*** (Young.2012).

The two forms may be considered as parts of a spectrum of smithing slag cake morphology and composition. In this assemblage, it was possible to measure or estimate the likely original weights of twelve such cakes. The five cakes with weights below 175g are also of the low-density, blebby type, whereas the seven cakes weighing more than 175g are conventional dense SHCs.

Many of the densest SHCs are present as angular fragments. These appear fresh, rather than worn, so the breakage may be as the result of their removal from the hearth, either from physical damage or thermal shock.

A somewhat unusual slag texture is provide by several pieces showing intermediate textures – including both otherwise conventional SHCs which contain prills of low-iron slag (e.g. the 236g block from context (299)) or low density prilly masses with occasional prills of dark, iron-rich slag (e.g. the 29g fragment from context (136)). These pieces emphasise how the hearth slags were generated from two sources – the lining and the workpiece, with the tow sources blending in different ways to form slag masses at different points on the spectrum of composition and morphology.

Other smithing slags

Some 4.8kg of the residues were slags which could not be attributed to an origin within a SHC or equivalent slag mass. Some of this material will be from SHCs and other such masses, but too fragmented to permit identification as such. Much of the dense slag in this group is charcoal rich. Such slags may form the upper parts of smithing hearth cakes, but are very friable and once detached from the usually denser basal section, may be hard to recognise. Other materials present may be slags associated with the wall of the hearth – such as down-wall flows of partially melted lining.

One such piece of lining-related slag (appearing in Table 3 in the 'iron' column for context (257)) lay in the core of a curved sheet of iron, 25mm across and 32mm long. Although this may simply be a part of the smith's work lost into the hearth, one possible interpretation is that this represents a fragment of the partially-blocked tip of an iron tuyère; if so, a rather unusual find.

Hearth lining
There was very little hearth lining present in the collection (a total of just 55g), despite a large proportion of low density slags derived from the lining of the blacksmith's hearth.

Other materials
The submitted collection contained few materials other than the residues from blacksmithing described above. There were three tiny fragments from imported Mayen lava querns (from contexts (158), (349) and (350)), 38g of concretions and one small piece of iron (2g; from context (311).

Distribution of residues
The stratigraphic distribution of the materials is summarised in Table 2.

Interpretation

The assemblage was derived from blacksmithing, the end use of iron. With the exception of context (299), the fill of pit [324], the assemblage was sparsely distributed, suggesting that the area was not close to the source of the residues. The low proportion of hearth lining may be also an indicator of transport of an assemblage, with a higher proportion of the relatively fragile hearth ceramic being incorporated in assemblages dumped closer to the smithy.

The total number of recorded SHCs and equivalent masses was small (twelve examples), with several being very tentative estimates of original weights. This precludes detailed comparison of weight-frequency statistics, but the statistics of the assemblage do resemble those of the few other blacksmithing sites known from the period (Table 3).

In the Roman period there appear to be two broad groups of blacksmithing assemblages, one from rural farmstead/Villa sites with a mean cake weight of less than 150g, and a more urban group with mean weights typically in the range 200-300g. This has been interpreted (e.g. Young 2016) as the difference between individual rural estates undertaking occasional and light work versus more continuously working general purpose smithies, situated mainly in larger settlements.

There are no described farmstead assemblages known from the earlier medieval period in Britain and the assemblages' from manorial centres are more similar to those of both contemporary and Roman urban assemblages. The Tidworth assemblage falls into this category. The weight-frequency statistics for its SHCs bear comparison with 12th century assemblages from Worcester (Young 2007, 2009b as well as with an 11th-12th century assemblage from the fortified site at Hen Gastell, Gwynedd (Kenney 2016; Young 2015a), although this latter assemblage is also very small. What little is known suggests that later medieval SHC assemblages may be typically heavier, perhaps reflecting a greater availability of iron and the more widespread use of iron for larger items.

Thus, although the assemblage is small, it is potentially representative of the macroscopic waste produced by a manorial or village smithy in the earlier medieval period. It is probably indicative of general purpose work, with a variety of light to moderate tasks undertaken (leading to the spectrum of hearth cake types), rather than industrial production.

The possible presence of a fragment of a wrought iron tuyère amongst the residues is interesting. Earlier medieval blacksmithing is usually assumed to have continued to use a simple blowhole in the ceramic wall of the hearth, but iron tuyères were certainly in use by the later medieval period. They appear to have been typical in blacksmithing by the late 17th century (Moxon 1703), and there are references to tuirons of uncertain purpose (either smelting or smithing) of much earlier date (e.g. the Byrkeknott accounts of 1408 (Myers 1969, 1005-1008).

The presence of small fragments of Mayen lava amongst the deposits may hint at an earlier, rather than later date for those contexts, within the overall Saxo-Norman range.

Further work

The slags form an interesting assemblage, because, despite the small size of the collection, there are very few equivalent assemblages of the period. The material should therefore be deposited with the site archive in an appropriate institution.

Because the material is not (at least at present) closely dated, because it is a small collection and because it is not associated with any metallurgical structures, further analysis is unlikely to generate significant additional understanding. Consequently no further analysis of the material is recommended at this stage.

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Table 1: summary catalogue of macroscopic materials. All weights in g.

context	sample	sample wt.	item wt.	item no.	item notes
107		216	214	1	prilly, dense, charcoal-rich mass, 70x65x45mm, possibly entire SHC but nature means edges are poorly defined, so it might just be part of larger cake
136	1	30	29	1	unusual pale lining slag (as in tongues), bearing sparse dark iron slag prills and blebs
150		15	15	1	very pale lining overlain by glassy lining slag - variously black, white, and green; in layer up to 20mm thick
152	9	3	3	2	friable broken slag prills with charcoal
152	4	4	4	1	crystal-rich frothy lining slag
158	8	1	1	1	tiny porous rock chip with white and black phenocrysts in grey mass - Mayen lava
215		87	86	1	possibly complete dense tongue; smoothly lobate on rusted top; base pale, with pendent prills obscured by accretion; 55x75x30mm
216		4	4	2	grey vesicular iron slag in angular chips
257		113	21	1	curved piece of iron, overall 25 x 25mm, rounded angle and 30mm long, filled with lining slag with chert clast; perhaps part of a c.32mm diameter tuyère tip?
			90	1	slag mass formed of gravelly slag, maroon with clear glaze upper surface and pendent prills below - but very irregular and 'spikey'
259	16	1	1	1	dark lining slag with white chert clasts
263		8	2	1	prill of greenish gravelly lining slag
			8	1	vitrified oxidised fired lining; black glassy slag
263	17	32	30	6	scraps of prilly and blebby slags
263		85	84	1	worn and rusted slag piece; probably a SHC fragment

context	sample	sample wt.	item wt.	item no.	item notes
294		10	10	1	angular fragment of rusty, very vesicular, grey slag
299		7670	332	1 (2)	broken SHC, complete, 110x75x45mm, plano-convex, some broad ridges and dimples on rusty top, bit mostly flat; base shows pendent lobes with pale structure around charcoal clasts; internally porous, conventional, where seen (towards tip)
			106	1	sub-blowhole mass; lower part formed of large pale lobes, some showing down-wall elongation, upper part has lobes flattened by blast and turned maroon; distal part is rusty and has iron inclusion, 40x65x55mm
			544	1(3)	SHC fractured in 3, mostly complete but upper part missing - so unroofed to pale vesicular material over 1/3 of top; 105x140x50mm, part of top hollow, but mostly top is worn with very large vesicles in frothy upper layer; base shows fuel dimples; fracture shows fine-grained weathered conventional appearance
			180	1	65x90x35mm, small SHC, with slightly dished top, rich in fuel moulds; base well-formed but worn through to vesicular material in places
			214	1	very dense mass of pale prilly/lobate material, probably around piece of iron, not of SHC form, irregular
			1437	24	mostly angular fragments of very rusty slag, rich in medium-sized charcoal with prominent white rims round charcoal areas
			420	7	angular fragments of slag with low density large prills, surrounding medium sized charcoal; one fragment shows wall contact with white material between slag and wall
			108	1	rounded nub of very dense rusty slag - probably has an iron inclusion; charcoal moulds on one side
			172	1	elongate mass of large pale prills, 60x100x50mm, transverse prilly mass
			80	1	prilly mass of lining slag forming open mesh; top slightly maroon
			128	1	elongate mass of very pale prills, with planar wall contact on one narrow end
			224	5	irregular fragment of cavernous slags formed of pale prilly and dimpled low density slags around medium charcoal
			140	13	irregular fragments of pale low density slag
			262	12	fragments and bodies of low density slag in large flow lobes and gravelly masses (blebs or coated clasts linked into a meshwork by glass)
			236	1	fragment of irregular sub-blowhole mass; shows thin lining slag on oxidised wall to top, passing into a curved foot-of-wall mass formed of separate prills of low and high density slag; 60mm above bend, then swings to 110 degrees to wall; 110mm down planar top/front, up to 80mm wide
			146	1	small fragment of similar mass

context	sample	sample wt.	item wt.	item no.	item notes
			196	10	fragments possibly from one of the two above cakes, ranging from oxidised wall with pale slag coat, to mixed composition dense slag
			510	1	substantial fragment of dense concavo-convex thin SHC, probably 75% of entire cake, (110)x(125)x40mm
			106	1	small fragment from dense SHC
			38	2	small slag scraps that are particularly rusty - contained iron
			624	27	scraps of dense slags
			164	assm.	dust and small fragments
			760	11	angular fragments of very dense SHCs with deep dense crusts, bases very hard, smooth crusts, dimpled with small fuel dimples; internally shows randomly-oriented large olivine
			254	1 (2)	broken part (probably around half), of small dense SHC; 35mm deep dense crust; upper surface covered in crystal terminations in centre, overlain by other granular material towards edge - suggest major unroofing; deeply dimpled base, overlain by with dense slag no vesicles and randomly-oriented medium olivine; top 5mm of bowl has granular olivine as on exposed surface
			240	5	fragments of dense SHC, sufficiently similar to be from same cake
299	19	696	168	75	small fragments of slag with no obvious signs of flow; many show charcoal moulds
			194	28	dense slag in prills, blebs and amalgamations
			38	5	small concretions with strangely lobate or grooved clay; with rusty iron
			94	1	angular fragment of SHC with very thick dense low vesicularity crust
			126	22	pieces of low density slag, mainly in large blebby pieces - much could be classified as gravelly lining slag; many pieces contain coarse inherited clasts
			32	4	fragments of lining slag with wall contacts or adhering to ceramic
			28	1	fragment from margin of dense SHC
			16	3	angular fragments of low density slag
299		221	45	1	dense prilly slag lump; contains iron
			38	1	fragment of brown charcoal-rich slag (SHC margin?) with adhering accretion
			93	5	slag with prills between small charcoal moulds; mostly dark, one pale slag, one variegated; one piece includes a fragment of a smooth, dark, dimpled upper surface
			16	1	irregular mass of rough slag with fragments of lining slag and charcoal
302		27	27	2	fragments of lining slag showing multiple flowed layers

context	sample	sample wt.	item wt.	item no.	item notes
309		86	9	3	slag blebs
			75	3	SHC fragments
310		300	98	3	dense dark broken lumps containing iron; appear to be pale charcoal-rich slags containing iron
			196	7	porous slag fragments mostly from rather low density blebby masses, but some more charcoal-rich
311		88	18	1	gravelly lining slag prill
			5	2	dense slag prill
			4	2	lining slag prill
			3	2	natural iron oxide pebbles
			2	1	iron fragment
			11	3	dense blebby slags
			40	1	dense charcoal-rich slag lump
312		16	16	1	fragment from the base of an SHC, with abundant included sub-spherical clay pellets up to 7mm
316		5	4	2	fragments of rusty vesicular iron slag
331		27	26	1	crudely ‘birdsfoot’-like mass of gravelly ling slag; abundant white chert fragments
348		73	26	1	very dense microprilly lump
			45	1	fragment of SHC in grey slag with dimpled base and abundant included gravel and 2-4mm rounded clay pellets
349		232	195	c30	80 wide SHC, uncertain length if all the fragments here belong to one SHC; shows curve towards to lining contact at one side; neatly plano-convex SHC but formed of rather low-density slag with abundant chert clasts
			37	1	part of contact with wall of identical slag mass - might be part of above but no join found
349		7	7	1 (2)	very low density porous grey rock with pale and dark phenocrysts - Mayen lava; in thin sheet
350		43	5	1	porous Mayen lava fragment
			35	3	scraps of grey vesicular iron slag

context	sample	sample wt.	item wt.	item no.	item notes
364		100	23	1	margin of tongue-like piece; pale slag forms a smooth rounded margin, which passes to brown prilly slags with fuel moulds below
			76	1	biconvex broken piece of variegated dark/pale slag with abundant charcoal, overlain by polished secondary oxide crust

Table 2: summary of materials by context. All weights in grams.

context	SHC	tongue	gravelly slag	other low-density	other high-density	hearth lining	iron	lava	concretion
107	214								
136				29					
150						15			
152				4	3				
158								1	
215		86							
216					4				
257		90					21		
259				1					
263	84			2	30	8			
294					10				
299	3860	358	388	800	2937	32			38
302				27					
309					9				
310	75			196	98				
311			18		60		2		
312	16								
316					4				
331			26						
348	45				26				
349	232							7	
350					35			5	
364		23			76				
total	*4526*	*557*	*432*	*1059*	*3292*	*55*	*23*	*13*	*38*

Table 3: Comparison of the SHC weight-frequency distribution with that of other assemblages from blacksmithing. Weights in gram.

a. Roman sites in Britain

Site:	Cleevelands	Exminster	Uffington	Neath	Carmarthen	Bulmore	Caerleon Priory Field	Marsh Leys Farm
Reference:	all Young 2016	Young 2014a	Young 2015b	Young 2013, 2014b	Crew 2003	Young 1999	Author's unpub. data	Young 2005, 2011b
fuel	coal	charcoal	coal	charcoal		mixed	charcoal	charcoal
SHC count	176	107	57	47	136	?	18	30
SHC min. wt	44	32	36	74	100	127	146	60
SHC max. wt	530	482	614	630	820	770	600	824
SHC mean wt	125	127	137	244	227	270	294	333
% <150g	73%	77%	72%	32%	?	?	11%	23%
% <500g	99%	100%	98%	89%	94%	?	83%	77%

b. medieval sites in Britain

Site:	**Tidworth**	Hen Gastell	Worcester 35 Mill St	Worcester Willow St	Prior Park Cricklade total	Worcester Deansway (period 8)	Worcester Deansway (period 9)	Burton Dassett
Reference:	**this study**	Young 2015a	Young 2009b	Young 2007	Young 2008b	McDonnell & Swiss 2004	McDonnell & Swiss 2004	McDonnell 1992
Age:	**Saxo-Norman**	11th-12th	12th	12th	11th-15th	11th – 13th	13th-15th	14th- 15th
fuel	**charcoal**		charcoal	charcoal	charcoal			
SHC count	**12**	7	23	28	17	61	32	60
SHC min. wt	**80**	72	74	86	156	168	144	130
SHC max. wt	**680**	1000	782	770	794	1490	1800	1670
SHC mean wt	**265**	260	233	327	329	492	499	550
% <150g	**33%**	57%	39%	18%				
% <500g	**75%**	86%	91%	82%	82%			

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