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Assessment of archaeometallurgical residues from Uffington, Oxfordshire

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Abstract

This assemblage comprised approximately 13.6kg of archaeometallurgical residues, out of the approximately 17kg of submitted materials.

The residues were almost entirely indicative of ironworking (blacksmithing) employing coal as fuel. 81% of the assemblage by weight was identifiable as complete or partial smithing hearth cakes (SHCs). Most of the remainder (17%) were indeterminate smithing slags, comprising either small fragments of SHCs or other slag pieces from the hearth. 2% of the assemblage was provided y small fragments of vitrified hearth lining.

The smithing hearth cakes ranged up to 614g in weight, but only 3 SHCs out of the 57 measurable examples weighed more than 300g. The SHCs ranged down in a spectrum to small plano-convex slag masses, rather puck-like, in the 60-70g range, with the lightest weighing as little as 36g. Overall, 72% of the SHCs weighed less than 150g, making this assemblage uncharacteristically small, with a mean weight of just 137g.

The SHCs comprises a range of textures, from dense, iron-rich puddle-like slag masses, through 'conventional' forms down to those formed of more prill materials. Approximately 11% of the assemblage was formed by SHCs of a distinctively low density, suggesting a very low degree of loss of iron to the hearth. This wide variation in SHC type suggests that a correspondingly wide range of tasks was undertaken. The typically small size suggests that these tasks were not undertaken for extensive periods, perhaps suggesting the residues were a farm or estate smithy, rather than one undertaking continuous commercial work or artefact production.

In addition to the ironworking, a single sherd of crucible, suggests that casting of copper alloys was undertaken, at least occasionally.

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Methods

The material described here derives from excavations at Station Road, Uffington, Oxfordshire, conducted by Cotswold Archaeology (Project Number 9186). This project was commissioned by Ed McSloy.

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.

Results

Description of residues

The submitted materials amounted to approximately 17kg in weight. Of this, 13.6kg was actually archaeometallurgical residue, with the difference being largely natural rocks, including two substantial blocks of conglomeratic ironstone, believed to be present through natural agency.

Smithing slags

There were 57 more-or-less complete examples of smithing hearth cakes (SHCs), with a total weight of 7.8kg, with a further approximately 2.2kg of fragmented, but still recognisable, examples.

The SHCs showed a wide range of slag density and morphology, but all within a relatively narrow, and low, range of weights. The statistics of the weight-frequency distribution are presented in Table 3.

The densest textures observed in the SHCs was a pale to mid- grey slag, with elongate bladed olivine crystals of 5-10mm in length and a waxy lustre, suggestive of a well-fluxed eutectic texture. Such extremely coarse/dense textures were only observed in broken fragments, none of the entire SHCs is known to possess this texture.

The dense SHCs are of what might be considered conventional form. They are grey, vesicular and contain abundant coke and shale fragments. The upper surfaces often show veins of pale glass, and broad fuel dimples. The bases are typically well formed, with finely dimpled pale grey surfaces. In many cases the margins and the proximal face may be rather more lobate, commonly with a maroon surficial colour. In some instances, the proximal surface shows a fracture where removed from the wall, but in others a non-wetted, lobate, surface may be present. In some instances this proximal surface this surface is planar and aligned at approximately 45° to the upper surface of the SHC.

The low-density SHCs are typically much paler in colour, particularly on their upper surface. They are close in form to slag masses termed ‘tongues’ on some Irish sites (e.g. Young 2012), and presumably similarly indicate a very restricted supply of iron to the hearth. It is likely that the coal shale will have imparted a much more aluminous composition to these cakes than examples fed solely by melting of the hearth wall; this may have produced the unusual pale grey colour.

The weight-frequency statistics (Table 3a) show the SHCs have weights varying from 36g to 614g. The mean is very low (137g) and the proportion of SHCs below 150g in weight is very high (72%). The positive identification of the smallest ‘SHCs’ is problematic – for at very small size they lack clear morphological characteristics. The smallest items here have been characterised tentatively as proto-SHCs – SHC-like masses with a plano-convex or puck-like, discoidal, form, that are interpreted as being capable of developing further if fed with additional materials.

Indeterminate Iron Slag

The slags categorised as ‘indeterminate’ were largely either small fragments not objectively identifiable as parts of SHCs and small rounded slag masses, or nubs, that may have formed separately from the SHC. Other materials grouped here include a small proportion of slags that had been attached to the hearth wall but which did not form part of a true SHC.

Hearth Lining

Some 222g of hearth lining was present, mainly as oxidised fired pieces (so probably from close to the tuyère or blowhole) with a dark sandy glassy slagged surface. No pieces included any blowhole margins, but several pieces came from an abrupt overhanging in which the glassy slag formed lobed edges below an apparently horizontal lower limit of the hearth ceramic

Iron

A few very small pieces of mineralised iron were present in the collection, mostly in the form of elongate thin sections compatible with being nail shanks, although none was specifically identifiable.

Crucible

A single sherd (from (7027), 40mm in diameter and 23mm tall, was from the base of a medium-sized crucible. The sherd some suggestion of having had a flat base, some 27mm in diameter, with walls extending upwards with a sharp angle at 70°to the horizontal. The base was overlain by irregular dimpled slags, probably just flowed melted crucible fabric, but just possibly from an external clay coating. The inner face of the crucible was not seen. The fabric was very fine- grained and grey, where observed without significant overprinting by partial melting.

The external surface showed dimples from contact with the fuel and localised patches of red colouration, suggesting contamination by copper.

Other

The majority of the weight of other materials was formed by two large blocks of conglomeratic ironstone. There was no indication of iron smelting in the residue assemblage, so the occurrence of iron ores was probably entirely natural and coincidental.

Distribution of residues

The stratigraphic distribution of the materials is presented in Table 2. All but 38g of slag (from Area A) derived from Area B.

The residues are not apparently associated with metallurgical features and may represent an area of waste disposal extending around and into a variety of Roman ditches. Normally, some assessment of the likelihood of primary activity in close proximity to the waste dumps can be made through assessment of the associated microresidues (if any), but in this case there are no associated samples. The relatively low proportion of vitrified hearth lining may, however, be an indicator that the residues had been transported for deposition.

The residues occur in the fills of a series of features, with spot-dating covering much of the Roman period. Such a pattern might reflect a truly long-lived nearby smithy, or that waste settled into ditch sags from a point late in the apparent history.

Interpretation

The amount of archaeometallurgical waste recovered from the site is fairly low, but with residues recorded from a compact area of the site within Area B. The residues occurred in a variety of contexts of Roman age.

The weight-frequency statistics of the SHC assemblage show some marked differences with those of other recorded Roman assemblages (Table 3a). Smithies in 'urban' settings at Neath, Carmarthen and Bulmore show mean weights of 200-300g, with only approximately 30% or fewer of the SHCs having weights below 150g.

The typically small size of the SHCs in the present assemblage can, however, be paralleled (Table 3b) at some rural smithies of medieval (e.g. Exminster) or post-medieval age (e.g. Moyveela and Ballykillaboy in Ireland). All of these sites were probably simple smithies supporting small rural settlements in the period before mechanised agriculture. Urban smithies and manorial centres appear to show larger SHCs typically.

The diversity of SHC type at Uffington suggests that the smithy was not too restricted in the type of work it undertook. The dense high iron slags, suggest work periods involving high temperature work, probably involving welding, whereas the low density cakes suggest work in which the iron as not held at high temperatures for extended periods.

The reason for the light weight of the SHCs is therefore likely to be associated with the work period rather than the task. Shorter work periods will produce smaller pieces of slag, as would more frequent hearth cleaning, but there would seem little reason to suppose this was the case. The operation of a smithy in association with a particular farm or estate might fulfil just these criteria – the work would be varied, but not conducted on a large repeated scale.

The presence of a crucible for copper alloy work is not unusual amongst Roman assemblages and the single sherd does not indicate that this was a major activity.

Discussion

The limited archaeometallurgical residues from the site imply the existence of a smithy near to Site B, but not necessarily within the area's limits. The site records do not suggest the presence of metallurgical features (e.g. hearths) with area B, which may therefore have included just the remnants of the area of waste disposal (perhaps a slag dump). A rather similar situation of repeated dumping within a particular area of the ditch system was recorded at Marsh Leys Farm (Young 2011c). As with the Uffington site, there was no direct evidence to indicate this area housed a smithy, and questions of smithy location and duration remained problematic.

The combination of the small size of the SHCs and their variability, suggests that the site was not being used for any form of 'industrial' production, but rather for ironworking to satisfy the, perhaps occasional, needs of an estate or farm.

The use of coal as fuel is typical of blacksmithing over much of Roman Britain. The use of coal, rather than charcoal, affects the whole dynamic of slag production, since contamination within the fuel (low grade coal, or pieces of shale) provides much of the non-iron input to the slag in combination with siliceous material derived from the hearth wall and from any use of siliceous welding flux, whereas for charcoal fired hearths, wall and flux must provide almost all the siliceous component of the slag. Coal-fuelled hearths are therefore 'dirtier' than charcoal-fuelled ones, and may often produce a slag assemblage with a higher proportion of slag outside any SHC. For work periods with little high temperature work, the loss of iron into the hearth may be so low as to preclude the formation of a typical SHC, but instead promote less consolidated 'cinders'. The present assemblage shows a good degree of coherency of the SHCs.

Further work

The material provides a very interesting cross-section of SHC textures, but all united by utilising coal as fuel. To date no detailed examination has yet been made of such an assemblage. A somewhat similar suite of residues from the vicus at Neath (Young 2014a) has been investigated in order to examine the variation of composition of 'gravelly' smithing slags, with variable iron input, in hearths fuelled by charcoal. The further investigation of the composition of a range of coal-fuelled slag cakes across this morphological range would therefore benefit both the understanding of the origin of such materials, and help to shed light on the processes being undertaken by the Uffington smithy. A detailed proposal will be submitted separately.

Irrespective of the commissioning of further work at this stage, the assemblage is neatly constrained in terms of morphology, composition and age; it is therefore an assemblage with considerable future potential and should therefore be preserved as part of the site archive, through deposition in an appropriate institution. The crucible sherd is worthy of illustration in any published outcome for the site.

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Table 1: summary catalogue. All weights in g.

Context	Sample wt.	Item wt.	Item no.	Notes
3572	10	8	4	slag scraps
		<1	1	corroded iron
3617	32	30	1	SHC fragment
7001	324	104	1	irregular fragment of rather gravelly SHC
		46		small , pale grey plano-convex tongue-like mass with coke
		90		small conventional SHC, rusty top, prilly/dimpled base, 55x75x30mm
		76	2	lobate slag fragments, presumably from SHCs
7001	296	140	4	SHC fragments
		134	1	50x65x30mm, small dense SHC
		14	1	lining slag on thin skin of lining surface
7014	256	84	1	55x70x25mm, small prilly SHC with approximately planar top, attached to wall fragment at approximately 45°
		176	10	irregular slag fragments, mostly from SHCs although some might have been isolated blebs
7017	68	66	1	small SHC with wedge profile attached to vertical lining, 40x60x30mm,top of SHC at 45° to wall, base prilly, base particularly maroon, dense
7019	1915	1915	1	conglomeratic ironstone
7021	334	222	1	65x95x45mm, dense, somewhat concavo-convex SHC, top wispy pale, main slag grey waxy lustre, base dimpled
		74	2	SHC fragments
		38	4	indeterminate slag scraps
7023	78	78	2	work slag pieces, one lobate, the other probably an SHC crust - both may be from SHCs
7027	32	30	1	dark lining slag hanging from oxidised-fired wall

Context	Sample	Item	Item	Notes

	wt.	wt.	no.	
7027	16	16	1	sub conical base of crucible, possibly with outer sacrificial layer, but may just be flowed bloated material, local red staining, dimpled;, inside scrubbed but probably not preserved through to inner face. Sherd 40mm diameter and 23mm tall. Probably flat-based c27mm in diameter, with walls >12mm, basal angle c70 degrees,
7028	1160	442	10	fragments of dense SHCs, some of the largest/densest pieces come from pale SHCs with long bladed olivine, others more conventional or prilly
		124	1	very irregular, moderately dense, coke-bearing cake, probably an entire, but irregular SHC
		90	1	irregular pale, fairly low density mass with coke inclusions
		86	1	irregular pale, fairly low density mass with coke inclusions
		72	1	irregular pale, fairly low density mass with coke inclusions
		222	15	low density slag fragments
7029	138	128	1	conical SHC, with slightly lobate maroon top, dense, 45x55x45mm, coke in dimpled base, slightly fractured on proximal side
7033	<1	<1	1	lining slag bleb
7049	114	114	1	rounded mass of pale prilly, probably a deep SHC, 55x55x50mm
7053	174	170	1	dene med dark, slightly worn SHC, proximal surface is planar at 45° to top (stone contact?), top has several large unroofed(?) voids, slag often mid grey and waxy, lots of coke
7063	1240	48	4	vitrified lining, oxidised fired
		228	3	fragments of SHCs with extremely dense slag puddles, two showing wear
		236	12	fragments of slag resembling the denser SHCs
		74	4	fragments of pale dimpled slag with coke, resembling tongue-like pieces
		108	1	50x70x35mm, low dene D shaped SHC, pale top, slightly darker dimpled base, coke
		64	1	45x55x25mm, dimpled nub of lower density dark slag, could be proto SHC
		138	1	65x65x30mm, conventional small dense SHC, broad dimples on top, small on base with coke and shale fragments
		112	1	55x70x40mm, moderately dimpled, nub/SHC with slightly crescentic shape
		54	1	40x55x25mm, small low density probable proto SHC
		62	1	50x55x35(20)mm, small tongue-like SHC
		114	1	irregular block of dense slag, dimpled base, remainder made up of coalesced rounded nubs, not SHC shape, so not able to determine if it is a complete item

Context	Sample wt.	Item wt.	Item no.	Notes

Context	Sample wt.	Item wt.	Item no.	Notes
7065	66	56	3	angular fragments of coke-bearing SHC
		6	1	small rusty concretion or slag fragment
7066	406	110	1	wedge-sectioned SHC, 60x50x35mm, dense maroon slightly bulbous top, slightly prilly base
		286	16	slag fragments, probably most if not all from SHCs
7067	16	16	2	dense dimpled slag pieces
7080	1270	1210	1	block of conglomeratic iron ore
		46	7	fragmented lining dominated glassy slag
7085	492	110	1	conical prilly mass with slightly glassy top, pale grey
		290	1	85x85x45mm, dense conventional SHC, some thin edges knocked off but otherwise intact, slightly biconvex. plus two stones
7087	74	72	4	slag fragments
7087	688	446	1	75x95x45mm, D-shaped SHC, very dense, plano-convex, well-formed, base gently dimpled, small coke fragment impressed into glassy top
		110	1	incomplete small dense SHC in two fragments
		130	3	low density lining slags in irregular nubs
7088	1795	260	1	50x60x35mm, steep side flat topped SHC, with conical dimpled base, some coke clasts, planar flat top
		128	1	75x65x35mm, dense SHC with maroon top with eroded lobes
		196	1	60x80x50mm, very dense SHC, flat top with raised lump to one side, dimpled base
		182	1	70x60x45mm, plano-convex SHC, very dense
		94	1	70x45x30mm, small irregular elongate SHC, with much coke on base
		62	1	55x45x20mm, flat topped SHC (possibly fractured) with dimpled base
		62	1	45x45x225mm, tiny parallel base/top SHC, glassy top , prilly base
		156	1	very irregular SHC, inclined conical shape
		498	28	irregular lobate slags, not SHCs, though some might be fragments, most are nubs
		100	2	SHC fragments
		50	4	vitrified lining fragments

Context	Sample wt.	Item wt.	Item no.	Notes
7092	228	10	4	indeterminate slag debris
		216	1	fragment of dense slag, irregular, dimpled base, possible small sections of tool casts on base plus small potsherd
7093	120	26	1	small gravelly SHC fragment
		90	1	small SHC with flat top and shallow finely prilly base, coke clasts
7101	40	32	1	angular SHC fragment
		10	1	fragment of sandy/gravelly lining slag
7109	4	2	1	vitrified lining fragment
7118	12	6	3	slag scraps
		4	1	reduced fired clay
7119	936	572	1	large SHC attached to vitrified wall - apparently running down wall onto floor. Base of SHC pale dimpled slag as in many isolated examples, top obscured rusty, lots of coke in base, maximum maroon surface is lobate face of slag facing wall
		42	assm	bits probably from above
		224		70x60x55mm, dense SHC, very even on fractured proximal end, very irregular prilly base, planar top with dark glass.
		62	1	fragment of SHC with large raised maroon lobes, and pale prilly base
		16	4	indeterminate slag blebs
		20	1	dense SHC fragment
7132	248	12	1	vitrified lining fragment
		62	1	pale, low density, prilly tongue-like slag mass
		44	1	fragment of dense small SHC, prilly base, smooth top
		50	1	group of dense maroon-surfaced lobes attached to section of hearth wall
		6	1	cluster of amalgamated slag prills
		68	1	fragment of very dense SHC with large bladed olivines, base shows both coke and probable charcoal inclusions
7136	14	7	1	pale glassy lining slag
		7	1	angular dense SHC fragment

7151	2065	174	1	tongue-like SHC, very pale dimpled top, base is denser and somewhat convex, 75x85x45mm, mostly thinner, coke and coal inclusions on both surfaces
		194	1	70x85x45mm, biconvex irregular SHC, possibly folded. Straw and FHS in concretion, top probably original lobate, smooth
		392	1	complex large SHC, microprilly base, coke inclusions
		142	1	60x60x50mm, biconvex SHC, with steep sides, some hints of smooth lobes around horizontal, coke inclusions
		140	1	70x50x35mm, plano-convex SHC, very dense, dimpled top and strongly prilly base, coke inclusions
		90	1	complexly prilly lump, with some maroon lobes, re-entrant on one end suggests pinch by tongs, coke inclusions
		116	1	55x40x40mm, small deep dense SHC, top lobate (looks almost like wrinkled tapslag), coke inclusions, broken proximal end
		118	1	semi-conical SHC, 65x55x60mm, base dimpled, top is partially lobate and maroon, coke inclusions
		102	1	irregular SHC, slightly maroon top, strongly-veined with white glass from melted lining.
		52	1	50x40x25, small plano-convex SHC. Prilly base with coke inclusions. Top has white vesicular glass with copper-coloured Fe oxides in vesicles, mixed with coke and dense slag inclusions
		76	1	slightly worn small SHC, with prilly slag and coke inclusions
		354	15	irregular lobate slags, not SHCs, though some might be fragments, most are nubs
		2	1	small iron fragment, square section - so might be nail shank
		62	1	rusty elongate slag nub - particularly rusty so may contain some iron
		70	1	pale grey prilly slag mass - possibly the proximal end of an unconsolidated SHC with small burr
7151	572	94	1	dense irregular prilly mass - probably an irregular SHC
		80	1	low density tongue like mass, dimpled with coke clasts
		84	1	low density tongue like mass, dimpled with coke clasts
		62	1	low density tongue like mass, dimpled with coke clasts, and large shale clast
		48	2	dense SHC fragments
		198	9	lining slag blebs of various forms, one attached to vitrified lining
7151	434	284	8	fragments of dense SHCs
		42	5	indeterminate and blebby slag pieces
		36	1	sub-circular puck of slag, proto-SHC?, 40x45x20mm, flat, possibly dimpled top and crudely lobed base, abundant coke fragments and pale glassy areas
		64	4	vitrified lining, two of the large pieces show dark slag forming an overhang on a linear margin
7156	<1	<1	1	slag fragment

Context	Sample wt.	Item wt.	Item no.	Notes
7157	24	24	2	SHC fragments

7166	148	86	8	probable SHC fragments
		60	1	lobate tongue-like piece, probably a proto SHC
7168	808	156	1	65x80x45(30)mm, conventional SHC, but rather rusted surface precluding detailed observation
		244	1	80x60x50mm, irregular SHC formed with prilly base and flow lobes on some margins
		122	1	55x75x45mm, low density pale SHC, smooth top, prilly base
		66	1	45x65x30mm, deeply dimpled small tongue like mass with lots of coke, pale grey, prills/lobes well formed
		200	14	fragments of SHCs
7174	312	180	1	irregular mass, with elongate dimpled dense lower section and raised upper section of rusty material, probably a very odd SHC, but just possibly the central section of something larger
		56	1	dense, puck like proto-SHC, distal section is maroon, , base dimpled, very dense
		62	3	SHC fragments
		14	1	lobe of pale slag
7174	4	2	3	Oxidised-fired vitrified lining
7176	34	32	1	lining slag/FAS lump
7176	68	68	1	elongate maroon slag piece, reverse shows horizontal margin of oxidised lining, from shows broken voids, prilly, orientation difficult to determine probably a form of burr with little interaction

Table 2: archaeometallurgical residues by context and facies.Weights in g.

Context	Spot date	SHC high-density	SHC low-density	Indet iron slag	hearth lining	iron	ironstone	crucible	fired clay	*total*
Area A										
3572	RB			8		<1				*8*
3617	MC2-MC3	30								*30*
Area B										
7001		440	46	104	14					*604*
7014	LC2-C4	260								*260*
7017	LC3-C4	66								*66*
7019	C2						1915			*1915*
7021	C2-C4	296		38						*334*
7023	LC2-C4			78						*78*
7027					30			16		*46*
7028		566	248	222						*1036*
7029	C2-C4	128								*128*
7033	RB			<1						*0*
7049			114							*114*
7053		170								*170*
7063	C2+	714	288	188	48					*1238*
7065				62						*62*
7066	LC2-C4	396								*396*
7067	MC3-C4			16						*16*
7080	RB			46			1270			*1316*
7085	C2-C4	290	110							*400*
7087	C2-C4	556		204						*760*
7088	MC2-C4	1240		498	50					*1788*
7092	MC3-C4	216		10						*226*
7093		90	26							*116*
7101	RB	32		10						*42*
7109	MC3-C4				2					*2*
7118	RB			6					4	*10*
7119		920		16						*936*
7132	MC3-C4	112	62	56	12					*242*
7136	MC4-LC4	7		7						*14*
7151	MC2-C4	1884	470	656	64	2				*3076*
7156	MC2-C4			<1						*<1*
7157	RB	24								*24*
7166	MC1-C2+	86	60							*146*
7168	RB	600	188							*788*
7174	MC3-C4	298		14	2					*314*
7176	C2-C4			100						*100*
	total	*9421*	*1612*	*2339*	*222*	*2*	*3185*	*16*	*4*	*16801*

Table 3: Comparison of the SHC weight-frequency distribution with that of other comparable sites.

a. Roman sites in Britain

Site:	Uffington	Neath	Carmarthen	Bulmore	Caerleon Priory Field	Marsh Leys Farm	Cowbridge
Reference:	this study	Young 2013, 2014a	Crew 2003	Young 1999	Author's unpub. data	Young 2005 & 2011	Barford 1996
SHC count	57	47	136	?	18	30	?
SHC min. wt	36	74	100	127	146	60	175
SHC max. wt	614	630	820	770	600	824	700
SHC mean wt	137	244	227	270	294	333	403
% <150g	72%	32%	?	?	11%	23%	?
% <500g	98%	89%	94%	?	83%	77%	?
% <1000g	100%	100%	100%	100%	100%	100%	100%

b. medieval and post-medieval sites in Britain and Ireland

Site:	Exminster	Worcester	Worcester	Moyveela	Ballykillaboy	Gorteens
		35 Mill St	Willow St	Galway	Kilkenny	Kilkenny
Reference:	Young 2014b	Young 2009a	Young 2007	Young 2009b	Young 2010	Dabal & Young 2011
Age:	13th-14th	12th	12th	17th-18th	16th-17th	17th-18th
SHC count	107	23	28	15	106	27
SHC min. wt	32	74	86	44	50	52
SHC max. wt	482	782	770	388	478	748
SHC mean wt	127	233	327	134	134	206
% <150g	77%	39%	18%	73%	70%	44%
% <500g	100%	91%	82%	100%	100%	93%
% <1000g	100%	100%	100%	100%	100%	100%

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