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Assessment of archaeometallurgical residues from Post Farm, Thornbury (LPF17)

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Dr T.P. Young

Abstract

The assemblage comprised approximately 3.6kg of, almost entirely, ironworking residues. The residues were from sixteen contexts, some currently dated as prehistoric and some as Roman.

Although small quantities of residues were recovered from various ditches and grave-fills, most were recovered from a small suite of features. Some of these features were recorded during field work as 'kilns' or 'furnace bases'; it is possible that some or all of these features may have been smithing hearths. Full re-evaluation of these features should be undertaken.

The majority of the residues are identifiable as having been produced during ironworking (blacksmithing). Non-ferrous metalworking was indicated by a single piece of lining slag contained a small fragment of copper corrosion products and, possibly, by a small ceramic fragment that might be from a mould.

The smithing residues were dominated by dense iron slags, of which 1.67 kg are identifiable as being from smithing hearth cakes (SHCs) and 0.82kg were smaller slag lumps (and fragments not specifically identifiable as being from SHCs). In addition, there were 258g of fragments of hearth lining and 797g of lining slags. Bulk sampling produced rich assemblages of microresidues from several contexts, mostly fills of the possible hearths. The microresidues were dominantly flake hammerscale, blisters and slag flats. Spheroidal hammerscale was rare in the samples. Several thin pieces of vitrified ceramic were recovered that may be from metallurgical coatings. The residues showed evidence only for the use of charcoal as fuel.

The SHC assemblage was small, so the weight-frequency statistics are of limited reliability, but they indicate an assemblage comparable with some of the lightest known from other Roman rural sites.

The assemblage thus indicated a low level of metallurgical activity, probably comprising light blacksmithing work (rather than heavy welding) and some use of copper alloys. The possible cermaic coatings may hint at the use of some sophisticated techniques.

Contents

Abstract 1

Contents 1

Methods 1

Results 1

- General description of the assemblage
- Ironworking residues
  - Smithing hearth cakes
  - Other dense slag
  - Lining slags and hearth lining
  - Other ceramic materials
  - Micro-residues
- Non-ferrous metalworking residues
- Other materials
- Distribution of the assemblage

Interpretation 2

Further work 2

References .....

Table 1: summary catalogue
Table 2: residue classes by context and phase
Table 3: comparison of the weight of SHCs

Methods

All materials were examined visually, using a low-powered binocular microscope where required. As an assessment, 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.

This assessment was conducted in November 2017, and was commissioned by Ed McSloy of Cotswold Archaeology.

Results

General description of the assemblage

The assemblage comprised approximately 3.6kg of material, almost all of which probably derived from iron-working (blacksmithing). Non-ferrous metalworking was indicated by a single piece of lining slag contained a small fragment of copper corrosion products (from context (3666)) and, possibly, by a small ceramic fragment that might be from a mould (from context (3627)).

The smithing residues were dominated by dense iron slags, of which 1.67 kg are identifiable as being from smithing hearth cakes (SHCs) and 0.82kg were smaller slag lumps (and fragments not specifically identifiable as being from SHCs). In addition, there were 258g of fragments of hearth lining and 797g of lining slags. Bulk sampling produced rich assemblages of microresidues from several contexts, mostly fills of the possible hearths. The microresidues were dominantly flake hammerscale, blisters and slag flats. Spheroidal hammerscale was rare in the samples. Several thin pieces of vitrified ceramic were recovered that may be from metallurgical coatings.

Ironworking residues

Smithing hearth cakes

The ten intact smithing hearth cakes (SHCs) were small, but generally well-formed. They ranged in weight from 58g to 232g (although this largest example may not have been quite complete), with a mean of 121g.

They were very variable in detail. Many were iron-rich, with dense slag and oxidised, dished tops (i.e. were concavo-convex in overall form), although some possessed a planar top with green glassy, siliceous slag covering all or most of the upper surface. Many were slightly prilly below.

In all cases where the fuel was observable, or the morphology of the dimpled surfaces interpretable, the fuel was charcoal and not coal.

Other dense slag

This category includes small pieces of dense slag, some in the form of isolated prills and blebs, but others are likely to be fragments of SHC, although not identifiable as such. Many of these showed dimpled surfaces where they had been in contact with the fuel.

Lining slags and hearth lining

Fragments of oxidised fired lining (typically of a very fine fired clay) and of blebs and sheets of lining slag were abundant. The most informative fragment was a piece from context (3666) in which half of a blowhole through fine, well-processed ceramic was preserved. The blowhole had been 21mm in diameter. Interestingly, the bore of the blowhole continued forward as a rounded passage through adhering prilly slags. The form appeared to have been kept open by the air blast, rather than suggesting slag clearance by rodding.

Other ceramic materials

The collections from contexts (3690), (3640) and (3666) contained thin sheets of vitrified ceramic with a characteristic texture – showing the appearance of typical vitrified cermaic on one convex surface, but the opposing surface bore a thin skin of dark, maroonish or brownish, iron-rich slag. Such materials may have two distinct origins – from the removal of soft slag fragments from the hearth with the smith's tongs (as interpreted, for instance, for the material from Hen Gastell; Young 2016c, Figure 3), or as a thin layer of cermaic applied to the surface of a ferrous workpiece as part of its metallurgical treatment (e.g. for brazing; Young 2012b), as part of the heat treatment of the ferrous material (as suggested for material from Plot 20.02 of the Wormington to Sapperton pipeline; Young 2011b, 2014d), or as a means of holding components together prior to forge welding (as possible for some of the ceramics from Pit 209 at Gussage All Saints; pers. obs.).

Micro-residues

Four contexts (the contexts labelled (3690), and contexts (3627), ((3638) and (3666)) produced good assemblages of smithing microresidues. These were dominated by flake hammerscale (often in particularly rough, spotted and thick forms), scale blisters and slag flats (see Young 2011a for terminology). Spheroidal hammerscale is rare, or even absent; small spheroidal droplets are probably slag droplets from within the fuel bed of the hearth.

Non-ferrous metalworking residues

These were limited to just two pieces:
- a single piece of lining slag contained a small fragment of copper corrosion products (from context (3666)). The slag into which the metal fragment became incorporated was identical to the main body of lining slag fragments, which were otherwise attributable to ironworking
- and, possibly, by a small fragment of grey, reduced-fired ceramic that might be from a mould (from context (3627)). The identification of this piece is uncertain, and the piece might just be a tiny fragment of domestic pottery.

Other materials

In addition to the archaeometallurgical residues, the assemblage contained pieces of coked organic matter from fills of pit [3613]. Although coke itself is the organic residue from the incomplete combustion of coal, it is unclear whether the present material is from the burning of coal. Other organic materials may also form coke, and this may be more likely in a prehistoric context..

Two contexts (the material labelled (3690) and context (3627)) produced small pieces of corroded iron. In

some cases, these appeared to be small nails. Although smithing residues often contain iron waste, this does not mean that iron objects found with smithing waste need be directly associated with the activity.

Distribution of the assemblage

Three features currently attributed to Phase 1 produced materials submitted for assessment. Of these, fills (3614) and (3625) of storage pit [3613] produced small quantities of coked organic matter. This material is likely to be non-metallurgical (see above). The other two (fills of pits [3690] and [3960]) produced small quantities of blacksmithing waste, including slag, hearth lining, smithing microresidues, and possible cermaic coatings, as well as small pieces of iron metal (including probable small nails).

Similar suites of smithing residues were recovered from several features of Phase 2 that were interpreted during excavation as being potentially of pyrotechnological use: kiln [3626], kiln [3639], furnace base [3663] and furnace base [3665]. The presence within these features of both smithing macro- and micro-residues suggests that they may be smithing hearths (if not simply waste pits).

Small quantities of residues were also recovered from ditches [3003], [3661], [3739], [3774] and [3776], as well as from graves [3169] and [3514].

Interpretation

The assemblage is somewhat unusual. Other assemblages of Roman smithing residues from both sides of the Severn Vale tend to be dominated by materials in which coal had been the fuel (e.g. Brett *et al.* 2010; Young 2016a, Young 2017). Although local availability may have governed fuel usage, it is also possible that charcoal use may tend to reflect an earlier age.

The assemblage of SHCs is small, so the weight-frequency statistics (Table 3) need to be taken with care. They show, however, an assemblage at the very light end of the spectrum of Roman rural sites, and significantly lighter than assemblages from more urban settings (e.g. the small towns of Carmarthen and Ware or the vicus at Neath, as shown in Table 3). Control of SHC size, an indicator of iron loss to the hearth, is through two main factors – the amount of work undertaken in a work-period between hearth clearances and the temperature of the work (hotter processes, such as welding, increase the rate of iron loss). The amount of work undertaken between clearances may, perhaps, be more in a continuously operated urban smithy, than it might be in a rural smithy, operated on an 'as-needed' basis.

The microresidues are dominated by tabular particles and when taken with the small SHCs, this may indicate light blacksmithing work, with little welding, which would tend to generate more spheroidal hammerscale (although other factors also play a role).

The presence of evidence for copper alloy working is also interesting, although relatively common on Roman sites. The presence of the possible ceramic coatings may be indicative of complex tasks being undertaken, in which control of carbon, or the holding-together of small components, is required.

The occurrence of residues as fills within probable prehistoric storage pits is another interesting aspect of the site.

Taken together, these characteristics raise the possibility that the site was unusual and although the evidence for the metalworking is low in total weight, and the evidence is for light iron smithing, it may have been undertaking some specialist activity.

Further work

The somewhat unusual nature of the evidence from the site makes further investigation desirable. Any such analytical programme should focus on gathering further information from the microresidues and possible ceramic coatings, in an attempt to determine their nature and purpose.

Whether or not further investigation of these interesting materials is commissioned, the residues are of sufficient significance that they should be deposited as an integral part of the site archive with the identified receiving institution.

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Table 1: summary catalogue. SHC = smithing hearth cake, FHS = flake hammerscale, SHS = spheroidal hammerscale, assm = assemblage. Weights in gram.

Context	Sample	Type	Sample wt.	Item wt.	Item no.	Notes
3004				50	1	approximately half a small SHC; lobate top; slightly prilly base; includes some pale slags
3171				2.8	1	tiny dimpled dense slag fragment
3515				28	1	SHC fragment; grey vesicular dimpled slag on base, then lining influenced layer, then very dense slag layer with bright shiny crystal faces, then very sharp change from coarse grey to glassy sandy lining slag
3614			634	98	1	70x50x25mm; dished top; concavo-convex SHC; top maroon smooth evenly dished; slightly incomplete; internally some vesicles, variegated dense/lining material and abundant charcoal to 10mm,
				16	2	possible fragments from above SHC
				88	1	natural conglomerate
				78	9	fragments of resurfaced piece of vitrified oxidised lining; initial surface is curved, thinly-vitrified; later two surfaces vitrified
				176	1	broken in 2, two-layer SHC, each layer roughly 60mm diameter; deeply-dimpled base and tops; top layer shows charcoal in form of twigs; variegated colour; coarse olivine crystals on surface
				44	1	small lobate slag mass; greenish dimpled base; top is slightly glazed lobe; some edges turned up
				76	1	most of small dimpled SHC; almost entirely lining material; large vesicles
				18	1	lobate brown surface lining slag fragment
				12	1	small fragment of thin SHC crust
						remainder of weight formed by fine debris
3614				1.2	1	fragmented coke - probably one original piece
3625				9.2	assm	coke, highly vitrified and in places flowed
3627			292	68	1	small irregular SHC; 50x70x30mm, transverse; dished top, almost smooth; dimpled base; dense, all iron-rich
				38	6	vitrified oxidised lining fragments
				58	1	plano-convex SHC with uplifted edge; gravelly, green glassy top; gravelly, dimpled iron-rich base
				62	12	small lobate blebs of lining slag
				8	1	small fragment of highly vesicular iron slag
				6	1	lining slag cored on flat rectangular piece of uncertain nature, possibly just a flap from lining

Context	Sample	Type	Sample wt.	Item wt.	Item no.	Notes
				32	1	flat lobe of dense slag; smooth top to lobe; base is planar or lightly concave, and rough with hints of the outlines of component flow lobes.
				6	1	small amount of lining slab binding together various small lobes of pale lining slag.
				4	1	small sherd of grey sandy ceramic; smooth convex surface, inner side is rough; this may be simple pot sherd or a mould fragment
3627	3037	finds from samples	284	82	60	fragments of lining slag
				182	41	fragments of lobate/prilly dense slag
				6	2	fragments of corroded iron - one small sheet the other square rod (nail shank?)
				10	1	gravelly/sandy lining slag with a backing of grey silty ceramic
3627	3037	magnetic fines from residues		10.07	assm	rich assemblage dominated by FHS, much is course and rough externally, many blisters; little or no SHS, but some probable slag droplets, some fired clay and other debris
3638	3043	finds from samples	1090	122	13	dense prilly iron slag
				168	18	lower density lining slags and fragments of lining-dominated SHC-like material
				66	1	80x55x30mm, tongue-like lining slag pad
				162	1	irregular slag mass with dimpled surfaces, dense, possibly an SHC folded double
				78	1	50x50x25mm, dense puck of iron slag, probably a small SHC
				120	1	part of a small dense SHC
				56	1	prilly SHC fragment
				100	1	incomplete small SHC broken in 2; dimpled base; large central cavity; biconvex, 60x70x25mm for main section with some pendent lining slag lobes at proximal end
				64	1	approximately half a small dense SHC, prilly base, smoothly lobate top
				40	1	lining slag sheet - unclear if a complete cake
				88	4	dense lobate slag pieces
				6	1	lobate lining slag; gravelly; with one lobe having a smooth clay attachment surface
3638	3043	magnetic fines from residues		7.49	assm	rich assemblage dominated by FHS, with some very coarse scale/flats with both sandy and dense layers; some spheroidal particles of uncertain origin, together with other debris
3640			366	122	1	60x70x30mm, plano-convex dense SHC; has small patch of lining slag lying on top on one side; top single large dense lobe; base prilly and dimpled; charcoal impressions on all sides and top

Context	Sample	Type	Sample wt.	Item wt.	Item no.	Notes
				40	8	fragments of vitrified and slagged lining, mostly oxidised
				19	7	variety of ceramic materials, ranging from grey fired clay with a flat face, through to bloated materials, also with a flat face and with iron-rich skin.
				64	5	dimpled dense iron slags in irregular pieces
				28	14	scraps of highly vesicular lining slags
				36	2	larger lobate pads of lining slags
				66	1	50x75x30mm, irregular slab-like fragment of a small SHC; green glassy on top, dense iron slag below
3662				28	1	concave slagged and vitrified oxidised-fired fine-grained lining - probably from near blowhole as shows strong changes in oxidation
3666			174	20	9	fragments of vitrified oxidised fired lining
				58	7	irregular blebby pieces of lining slag - some highly bloated
				34	3	irregular dimpled/prilly fragments of SHCs
				18	1	dense rounded slag lump
				20	1	21mm half-blowhole in fine red ceramic (as fragments) with attached prilly dense slag forming forward protrusion to blowhole
				5	1	irregular bloated ceramic fragment with 50x20mm inner face with iron slag film; suggests a coating applied to an elongate object
3666	3042	finds from samples	156	52	17	pale low-density highly vesicular lining slag, in small blebby lumps
				8	1	pale low-density lining slags in fragment with dimpled side - probably the edge of an SHC
				1	1	small fragment of vitrified lining
				18	1	dense blebby and gravelly lining slab with small lump of copper corrosion products
				74	10	blebby denser iron slags
3666	3042	magnetic fines from residues		11.31	assm	rich assemblage dominated by FHS, some coarse, some flats with hammer-crushed slag also present; rare SHS, slag droplets, slag fragments and other debris
3690	3038	finds from samples	292	145	100	fragments and blebs of low density vesicular lining slag
				2	3	pieces of vitrified oxidised lining
				120	26	prilly and/or dimpled blebs of dense iron slag
				0.75	1	slightly vesicular pale grey clay containing an oxidised fired ceramic clast

Context	Sample	Type	Sample wt.	Item wt.	Item no.	Notes
				9	5	small pieces of corroded iron embedded in charcoal-rich accretion; at least two appear to be small nails, one is small piece of sheet
				2.6	2	dense iron slag with flat detachment surfaces, thin but irregular sheets
				5.2	3	thin sheets of sandy lining slag with iron-rich detachment surfaces, in one case showing straight right-angled margin
				5	1	thicker lump of lining slag with almost planar slightly ferruginous detachment surface
3690	3038	magnetic fines from residues		9.36	assm	rich assemblage dominated by FHS, some thick examples and many blisters; lots of rough and spotted examples, some spheroidal particles, not certainly SHS but probably, slag fragments and other debris
3692	3050	magnetic fines from residues		0.01	16	small assemblage with 7 pieces of FHS, remainder slag and ferruginous concretion
3740				2	1	small fragment of slagged oxidised fired lining
3775				64	1	dense lobate slag mass, possibly an original lump but may be a part of something bigger
3777			48	46	3	moderately-low density fragments; two possibly simple lumps, one more certainly from an SHC
3961			232	232	1	broken SHC; internally shows tubular vesicles leading up into open clotted texture crystalline slag; top largely worn away

Table 2: summary of the distribution of residue classes by context and phase. SHC = smithing hearth cake. All weights in g. Cu - one of the lining slag fragments from this context contained Cu-weathering products. Weights are rounded to the nearest gram.*

Context	description	cut	phase	SHC	dense	lining	lining slags	mould?	iron	fines	coating	coke		*total*
3614	Second fill of storage pit	3613	1									1		*1*
3625	First fill of storage pit	3613	1									9		*9*
3690	Pit cut	3690	1		120	3	150		9	9	8			*299*
3692	Second fill of pit	3690	1							<1				*0*
3961	Single fill of pit	3960	1	232										*232*
3004	Upper fill of ditch	3003	2	50										*50*
3171	Single fill of grave	3169	2		3									*3*
3515	Single fill of grave	3514	2	28										*28*
3627	Upper fill of possible kiln	3626	2	126	222	48	156	4	6	10				*572*
3638	Slag, possibly part of kiln structure	3626	2	580	210		280			7				*1077*
3640	Fill of possible kiln structure	3639	2	188	64	40	83				y			*375*
3662	Single fill of ditch	3661	2			28								*28*
3664	Fill of possible furnace base	3663	2	378	44	96								*518*
3666	Fill of possible furnace base	3665	2	42	92	41	128			11	5		(Cu*)	*319*
3740	Single fill of ditch	3739	2			2								*2*
3775	Single fill of ditch	3774	2		64									*64*
3777	Single fill of ditch	3776	2	46										*46*
			total	*1670*	*819*	*258*	*797*	*4*	*15*	*37*	*13*	*10*		*3623*

Table 3: comparison of the weight-frequency distribution of smithing hearth cakes from Post Farm with those from other Roman blacksmithing assemblages. All weights in g. Exminster, Clevelands, Uffington, and Ebrington are small rural sites; Neath, Carmarthen and Ware reflect more urban locations.

Site:	Post Farm, Thornbury	Exminster	Cleevelands		Uffington	Ebrington	Neath	Carmarthen	Ware
			SHC	all					
Reference:	This study	Young 2014a	Young 2016a		Young 2015	Young 2016b	Young 2014a	Crew 2003	Young 2014b
	charcoal	charcoal	coal		coal	mixed	charcoal	?	charcoal
SHC count	10	107	57	176	57	37	47	136	72
SHC min. wt	58	32	50	44	36	53	74	100	36
SHC max. wt	232	482	530	530	614	628	630	820	952
SHC mean wt	121	127	176	125	137	180	244	227	246
% <150g	100%	100%	44%	73%	72%	46%	32%	?	82%
% <500g	100%	100%	98%	99%	98%	97%	89%	94%	100%

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