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Assessment of archaeometallurgical residues from Ebrington, Gloucestershire (EGE09 ex)

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Abstract

Archaeological investigations at Ebrington produced an assemble of archaeometallurgical residues from blacksmithing with a total weight of approximately 14kg. The assemblage bears close comparison with other rural blacksmithing assemblages of Roman age.

As well as the dominant (77% of the assemblage by weight) smithing hearth cakes (SHCs), 12% of the assemblage was of indeterminate iron slags (much of which was quite possibly constituted by fragments of SHCs that were too small to be positively identifiable), 6% of low-density slags strongly influenced by melting of the hearth lining and 3% by slagged or vitrified hearth lining. The slags had fuel remnants indicating the use of both coal and charcoal as fuel.

There was also a small quantity (39g; six fragments) of fragments of thin sheets of pale grey bloated ceramic, typically with one surface with a simple green wood-ash glaze and the other with a maroon slag veneer and open pores. None of these fragments was large enough to have a diagnostic shape, but they resemble the clay coatings used during some heat treatments of steel (for carburising, decarburising or other case hardening techniques, or for protecting previously treated areas from further exposure) and, to a lesser extent, those from braising (the joining of iron components using a copper alloy filler metal). Although these pieces cannot be positively identified, they provided a hint that the smith may have been undertaking some more elaborate techniques.

One context produced two fragments (19g total) of fired clay with a texture and oxidation state reminiscent of ceramic moulds, although the material had no diagnostic form. The identification of this material as from moulds is very tentative, but some casting of copper alloys is a common feature of Roman smithy assemblages.

No detailed stratigraphic information was supplied with the assemblage, but the distribution of just 14kg of material over 71 contexts (with the largest group from any context being just 911g) is suggestive of widespread dispersed material, rather than the focus of the metalworking activity having been located within the investigated area.

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Methods

The material described here derives from excavations at Ebrington, Gloucestershire, conducted by Foundations Archaeology (EGE09 ex). This project was commissioned by Tracy Michaels and Adam Jarvis.

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 14kg of materials were examined (Table 1). All of the archaeometallurgical residues that were able to be positively identified were from iron working (blacksmithing). A tiny amount (19g) of the fired clay present would be compatible with an origin as fragments of clay moulds for casting a non-ferrous metal, but were not identifiable as such with certainty.

Smithing hearth cakes (SHCs)

Smithing hearth cakes (SHCs) are the slag masses that typically form below the hot-zone in a smith's hearth. They are formed from a combination of iron lost from the workpiece (through fragmentation or oxidation), molten ceramic (formed from where the hot-zone impinges on the hearth wall) and the fuel ash (mostly alkalis and alkaline earths in charcoal fuelled hearths, but dominantly alumina and silica in coal-fuelled hearths). SHCs may possess a wide variety of morphology and structure, dependent upon materials, technique and process employed by the smith, although the precise relationships are not well-understood.

Certain fragments of SHCs comprised 10.9kg of the assemblage (77% by weight). The SHCs in the Ebrington assemblage are mainly of a small size and very dense. They typically show a finely and deeply dimpled base; most are either plano-convex or slightly biconvex. They are mostly approximately equant or slightly transversely elongated in plan. However, there is considerable variation, including some lower density varieties which are richer in gravelly lining-derived material. Some smaller examples are also less consolidated, with the body of the SHC formed of small slag prills, giving a slightly friable nature and almost granular texture. Most of the SHCs show at least a degree of superficial haematisation giving a maroon superficial sheen.

The overall SHC assemblage included 37 effectively intact examples, ranging in weight from 53g to 628g in weight with a mean of 180g.

There was evidence for both the use of charcoal and coal as fuel. The fuel type was not determinable for 60% of the SHCs, 10% of the cakes showed evidence for coal, 29% for charcoal and 2% showed evidence for both fuels. There appears to be an association between the larger cakes and the use of charcoal. The smaller dense cakes with finely dimpled bases commonly showed no evidence for fuel, but four out of five SHCs of less than 110g with evidence for fuel were coal-fuelled. In contrast eight out of the eleven SHCs of more than 150g with evidence for fuel were charcoal-fuelled, two coal fuelled and one had evidence for both fuels. The seven SHCs with evidence for solely coal fuel ranged from 56g to 202g, with a mean of 126g, the eleven SHCs with sole evidence for charcoal ranged from 78g to 628g, with a mean of 217g.

Examples of SHCs from contexts (1001), (1110), (1117), (1200) and (1231) showed evidence for deformation during extraction when still hot and plastic.

Indeterminate iron slags

There were 1.7kg (12% of the assemblage by weight) of iron slags that were not identifiable as deriving from SHCs. Some of this material, probably most, were fragments of SHCs that were too small to be diagnostic. Other fragments were small blebs and prills that did not form part of the main SHC, or had escaped from it.

Low density slags (lining slags)

There were 0.8kg of low density slags (6% of the assemblage by weight) in the form of blebs and nubs that were not directly attached to remnants of hearth lining, although they were mainly derived from melted hearth lining. Although some of these formed small pads of slag, there were no good examples of the low-density form of SHCs referred to as slag tongues (*sensu* Young 2012a). Some of the examples showed evidence for accumulation of lining slags at the foot of the hearth wall.

Hearth Lining
Hearth lining fragments comprised 3% of the assemblage by weight (0.5kg). This material grades into the lining slag category above. None of the material was particularly diagnostic by shape and there were no pieces yielding information about the nature of the hearth blowhole.

Possible mould fragments
Two small fragments of silty fired clay (total 19g) from context (1064), had an irregular brown surface grading to a darker interior, in one case with a fragment of a very smooth internal surface. The ceramic was tempered with organic material (now voids) with the appearance of straw. These characteristics resemble those of ceramic moulds, but the pieces are too small to determine their nature with certainty.

Possible ceramic coatings
There was also a small quantity (39g; six fragments) of fragments of thin sheets of pale grey bloated ceramic, typically with one surface with a simple green wood-ash glaze and the other with a maroon slag veneer and open pores. None of these fragments was large enough to have a diagnostic shape, but they resemble the clay coatings used during some heat treatments of steel (for carburising, decarburising or other case hardening techniques, or for protecting previously treated areas from further exposure) and, to a lesser extent, those from braising (the joining of iron components using a copper alloy filler metal). Although these pieces cannot be positively identified, they provided a hint that the smith may have been undertaking some more elaborate techniques.

Possible tool moulds
A 10g fragment of thin slag film from context (1066) with a strongly haematised surface has the appearance of a slag film pulled from a metal surface and bent in the process. It is possible that this piece shares an origin with the fragments of possible ceramic coating described above. However, the piece appears (on purely external appearance) to be formed of slag rather than ceramic. This suggests that this piece may be a slag bleb that had adhered to the tip of a tool (tongs) rather than a coating. The piece suggests a bleb of c. 45mm diameter that bears the imprint of a bar 30mm wide – potentially the workpiece, but more likely the tip of the smith's tongs.

Fuel ash slag
Very low density fuel ash slag with a frothy appearance was recovered from contexts (1051) and (1179) and had a total weight of just 51g. Although such materials may form in metallurgical processes, they are also generated by other high temperature processes – such as in corn drying kilns. Neither of these two contexts produced other metallurgical remains, so a non-metallurgical origin may be likely.

Iron
168g of iron fragments were included in the submitted collection. A 'V'-sectioned item weighing 35g from context (1204), perhaps a fragment of a spade-shoe, was the only significant item.

Distribution of residues
The stratigraphic distribution of the materials is summarised in Table 2. No supporting stratigraphic information was available, but the pattern of 14kg distributed over 71 contexts (with the largest group from any context being just 911g) is suggestive of widespread dispersed material, rather than the focus of the metalworking activity having been located.

For the discussion of the significance of the assemblage below, the assemblage has been treated as a single entity. Should subsequent stratigraphic analysis prove the assemblage to derive from more than one period, then those conclusions may need to be revisited.

Interpretation

The assemblage is dominantly, or even possibly entirely, formed of residues from ironworking (smithing). Some evidence for the nature of the smithing undertaken may be gleaned from consideration of the weight-frequency statistics of the smithing hearth cakes (Table 3). The low average weight and the low limits on the weight range are both indicators of these SHCs being residues from blacksmithing – the end use of iron in the production and repair of artefacts (as opposed to bloomsmithing, part of the *chaîne operatoire* of the production of bloomery iron). The weight of the SHC produced between hearth-clearances would depend both on the nature of the work undertaken (higher temperature work leads to greater loss of iron from the workpiece into the hearth) and on the duration of the work period.

In the Roman period, as much more recently, the activities of rural estates provided much work for blacksmiths – with the fabrication and repair of a multitude of craft tools, domestic items, structural fittings and so forth. Assemblages such as the Ebrington example are commonly encountered on rural sites of all types (e.g. Exminster, Young 2014b; Cleevelands, Young 2016; Uffington, Young 2015). Blacksmithing residues from Roman urban settings (e.g. Neath, Young 2013b; Carmarthen, Crew 2003; Bulmore, Young 1999; Caerleon, Young 2013a; Cowbridge, Barford 1996) typically show slightly heavier SHCs than their rural counterparts – probably because the smithy was kept constantly busy, rather than because the work was significantly different. In both cases, most of the work would be fairly light activities; work involving much forge welding (such as in the creation of edge tools or large fittings) would probably be in a minority.

The difference between the weight distribution of the coal-fuelled and charcoal-fuelled SHCs is supported by a very small dataset, but nonetheless is an interesting observation. The statistics, as described above (the seven SHCs with evidence for solely coal fuel ranged from 56g to 202g, with a mean of 126g, the eleven SHCs with sole evidence for charcoal ranged from 78g to 628g, with a mean of 217g) are interesting when viewed in comparison with the data from assemblages from other sites (Table 3). The statistics of the coal-fuelled part of the assemblage resemble those of the assemblages from Exminster, Cleevelands and Uffington, whereas those of the charcoal-fuelled part more closely resemble those of assemblages from urban settings at Neath, Carmarthen, Bulmore and Caerleon. The precise significance of this is uncertain, but may suggest that the Ebrington assemblage includes two distinct components. The type of fuel employed in the smithing as indicated by inclusions in the residues is given in Table 4. The significance of

these context groupings is not understood at present, but it possible a pattern may emerge once they are dated or assigned to a geographical location.
The presence of ceramic debris that might be from moulds for the casting of small non-ferrous metal items is not surprising; most Roman rural smithies seem to have either occasionally undertaken non-ferrous work, or the sites were visited by itinerant non-ferrous metalworkers (although sherds of crucibles are a more common find than fragments of the more friable moulds). The identification of this material is only rather tentative, and it is possible all this fired clay derives from the structure of the smithing hearths.

The presence of the thin sheets of bloated ceramic tentatively identified as metallurgical coatings or 'shrouds', is interesting. This material was too fragmentary to be identified with any certainty. Clay coatings may be used in a variety of metallurgical processes, including heat treatment and brazing.

Comment on the stratigraphic distribution is beyond the scope of the present report, but the widespread, but sparse, nature of the assemblage may suggest the distribution has been produced by relatively casual dispersal rather than concentrated dumping in any particular location.

Further work

The slags from Ebrington are not at present tied to metallurgical structures not do they have precise dating control. Although the overall structure of the assemblage is interesting, it is unlikely that significant additional information could be gained from further detailed analysis, so none is proposed. That recommendation might need to be revisited should the patterns of variation in the assemblage described above become significant in the light of additional stratigraphic information.

The assemblage is however interesting and diverse. It is recommended therefore that the assemblage is deposited with the site archive in appropriate receiving institution.
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References

Barford, P.M. 1996. The metalworking debris from Bear Barn and the Bear Field. Pp. 205-209 *in*: J. Parkhouse & E. Evans, *Excavations in Cowbridge, South Glamorgan, 1977-88*. BAR, British Series, 245pp.

Crew, P. 2003. Slags and other iron-working residues. pp. 333-340 *in:* H. James, *Roman Carmarthen: Excavations 1978-1993*. Britannia Monograph Series 20, Society for the Promotion of Roman Studies 2003.

Young, T.P. 1999. Iron-working residues from Bulmore. *GeoArch Report 99/01*. 3pp.

Young, T.P. 2005. Evaluation of metallurgical residues from Marsh Leys Farm. *GeoArch Report 2005/07*.

Young, T.P. 2011.Metallurgical Residues, p. 112-114 and Appendix IV, p. 178-180 in: M. Luke & Preece, T. *Farm and Forge: late Iron Age/Romano-British farmsteads at Marsh Leys, Kempston, Bedfordshire*. East Anglian Archaeology, Report No. 138, 198 pp.

Young, T.P. 2012. Appendix 3 -. Exploiting the bog -: iron production and metalworking, pp. A3.1 – A3.60 *In:* P. Stevens & J. Channing, *Settlement and Community in the Fir Tulach Kingdom.* National Roads Authority and Westmeath County Council.

Young, T.P. 2013a. Evaluation of archaeometallurgical residues from Priory Field, Caerleon. *GeoArch Report 2013/01, 3pp.*

Young, T.P. 2013b. Assessment of archaeometallurgical residues from Dwr-y-Felin School, Neath (GGAT 677 & 716). *GeoArch Report 2013/11*, 31pp.

Young, T.P. 2014a. Archaeometallurgical residues from Dwr-y-Felin School, Neath (GGAT 677 & 716). *GeoArch Report 2013/27*. 53pp.

Young, T.P. 2014b. Assessment of archaeometallurgical residues from Milbury Farm, Exminster, Devon (ACD478). *GeoArch Report 2014/09.* 16pp.

Young, T.P. 2015. Assessment of archaeometallurgical residues from Uffington, Oxfordshire. *GeoArch Report 2015/30*. 12pp.

Young, T.P. 2016. Assessment of archaeometallurgical residues from Cleevelands, Bishop's Cleeve, Gloucestershire. *GeoArch Report 2016/18*. 43pp.

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

context	source note	sample wt	item wt	item no	item note
?	building 1 area reduction	178	36	2	small irregular slag fragments, possibly from SHCs
			140	2	square fragments from the centres of dense SHCs with dimpled bases and smooth maroon tops
?	area reduction S of building 1	530	146	1	irregular complex SHC, formed of intersecting sheets - stirred by tool? Top surface folded in two - has shale and lining fragments, maroon top. Base grey, finely but deeply dimpled
			98	1	irregular SHC crust fragment,
			107	1	strange deeply dimpled transverse mass - with apparently overhanding wall contact, coal residues in dimples, 45x80x30mm
			108	1	worn fragment of extremely dense SHC crust
			57	1	deeply dimpled/microprilly SHC fragment with abundant fuel waste - apparently coal
?	area reduction N dogleg	43	43	3	irregular iron slag fragments
?	removal of building 1040	71	71	1	most of tiny SHC, 35x50x25mm
A1 u/s		374	118	1	possibly complete SHC, but worn polished surface makes this uncertain, dense, dimpled base, top large open vesicles
			83	1	worn fragment from centre of dense SHC, ropey top, dimpled base with tool marks, maroon
			53	1	complex lining slag on oxidised fired ceramic
			6	1	slagged reduced lining
			75	5	small dense polished worn slag fragments
			35	1	iron bar-like fragment
A1 u/s		117	64	1	unusual elongate maroon surfaced slag attached to wall
			45	3	worn small dense iron slag fragments
			6	1	strange porous spiky maroon clinkery slag with highly glossy surface, low density
A2	trowel clean	144	110	1	block from core of dense SHC, worn and polished
			9	2	low-density iron slag scraps
			7	1	scrap of lining or stone with variable degrees of glazing and slagging on all sides, mostly clear glaze on grey ceramic, locally small areas of dark slag

context	source note	sample wt	item wt	item no	item note
			14	1	dense iron slag fragment with contact with oxidised wall
1001		252	184	1	dense SHC, fractured from proximal attachment, worn and smooth, 65x50x35mm, biconvex, very dense
			66	2	small dense SHC fragments
1001		633	332	1	55x85x70mm, deformed SHC, top smooth maroon, sides finely dimpled, presumably plano-convex, squashed laterally
			329	1	very worn dense SHC, all edges missing, probably concavo-convex, base obliquely conical
1003		122	55	4	irregular grey lining slag
			67	1	fragment of weathered SHC
1028		25	25	1	small SHC fragment ,deeply dimpled base, irregular maroon top with pale shale inclusions
1035		108	33	1	deeply dimpled slag with wispy upper rills, fragment
			74	1	heavily worn core of very dense small SHC, smooth maroon top, finely dimpled base
1035		358	14	1	slagged round stone
			78	1	plano-convex triangular SHC, slag finely prilly giving an almost granular appear, 60x60x25mm, bears charcoal
			6	1	fired lining
			87	2	irregular dimpled spikey lumps
			60	1	spikey lobate lining slag mass with some coarse gravel
			10	1	lining slag fragment with flat quartzose clast 20mm long
			82	10	iron slag fragments
			18	1	lobate nub of lining slag, pale to maroon variegated surface
			1	1	small fragment of coating-like clay with one flat face, thin
1043		112	101	1	SHC with deeply but finely dimpled base, irregular rough wispy top, 55x70x35mm, lightly biconvex, probable sooty shale in top
			10	2	low-density pale grey iron slags
1051		7	7	6	variegated FAS with associated purplish ceramic
1061		126	48	4	fragments of dense SHCs with dimpled bases

context	source note	sample wt	item wt	item no	item note
			52	1	large part of small SHC, locally maroon surfaces, but internally pale, vesicular and gravelly
			4	2	dense flow slag prills with maroon surfaces
			7	1	rounded bleb of lining slag
			10	1	irregularly structured goethitic veined ore
1061		31	31	1	mass of piled lobes of\sandy lining slag with locally maroon surface
1063		550	550	20	charcoal-bearing porous SHC fragments, could all belong to one SHC -too fragmented to be certain
1064		352	98	1	low-density rusty SHC with roundedly lobate base with very broad dimples 55x70x40mm, irregular top, roughly plano-convex
			103	1	part of dense biconvex SHC, base and top both finely dimpled, top maroon
			83	4	low density, maroon, lobate slag fragments
			31	1	irregularly lobate lining slag lump - part of a tongue?
			5	1	slagged oxidised lining
			5	1	concretion on iron
			19	2	fired clay silty, irregular brown surface grading to dark interior, in one case with a fragment of very smooth surface, lots of straw, possible mould fragments
1066		812	163	1	70x80x30mm very low-density porous SHC, possibly rather weathered and may have lost iron, rusty, no real surface detail visible,
			131	1	60x65x35mm, small dense plano-convex SHC with lobate margins, rusty top, base obscure
			147	1	70x70x35mm, rather irregular weathered SHC, neat base smoothly dimpled top raised into strange ring at one end, some gravel, straw accreted to base
			10	1	coating/slag film peeled and bent from tip of 30mm wide tool or bar, maroon and both surfaces, original bleb c45mm diameter
			2	1	35x15mm coating to 5mm thick, 1 planar maroon shiny surface, one grey clay with green glaze, internally dense clay becoming bloated towards green surface
			108	1	irregular transverse mass probably an SHC, 45x85x30mm, slightly crescentic, very rusted
			38	2	iron
			110	12	lobate ion slags
			30	1	margin fragment from dense grey SHC
			53	1	small conical rough slag mass, probably sub blowhole mass, 40x45x30mm, some gravel

context	source note	sample wt	item wt	item no	item note
			17	7	slagged oxidised fired lining fragments
1074		628	628	1	110x100x60(40)mm, large triangular SHC, presumed proximal side has planar non-wetted face, which has 100 degree made with profile of rest of base, top has charcoal, mostly planar but some raised material at mid-length, fuel in basal dimples is abundant but poorly preserved - not clear if all is charcoal, some more structureless
1074		86	86	1	fragment of a very dense concavo-convex SHC, dense crust, very finely dimpled, top irregular dished, probable coal shale on base
1078		9	9	2	slagged oxidised fired lining
1086		31	31	1	irregular puck of slag, rusty top, deeply dimpled base, 40x40x20mm, probably just a fragment of a larger body
1090		118	98	1	rather irregular, lining slag rich SHC; dark upper glass rich in crystals; base irregularly dimpled and prilly/lobate, 75x65x35mm
			19	1	angular low-density SHC fragment
1097		510	79	1	irregular glassy, gravelly mass of slag, low density
			60	1	low-density bulbous slag nub
			19	1	very coarse quartzose gravel bound by maroon slag
			59	8	slagged oxidised-fired lining
			43	1	coarse gravelly lining slag piece
			10	1	maroon surfaced low-density bleb
			6	1	iron fragment
			44	1	low-density lining slag bleb
			57	1	dense SHC fragment
			59	1	folded slag sheet, part or all of SHC
			51	2	irregular dimpled slag fragments
			22	2	porous iron slag fragments
			9	1	contorted and boated violet ceramic fragment
1107		57	57	1	fragments from small SHC with maroon top and mass of maroon-surfaced slag adhering, base worn

context	source note	sample wt	item wt	item no	item note
1109		166	166	1	slightly damaged dense SHC, 55x70x35mm, strangely block- like to, rectangular, vertical sides, then rounded dimpled base below, fuel uncertain, has some charcoal but also probable shale fragments
1110		390	328	1	probably SHC with deeply dimpled base that has been rolled during extraction
			64	2	iron slag fragments
1112		8	8	1	fragment of low-density greenish porous iron slag
1115		74	74	1	fragment of very fresh SHC, maroon top, deeply dimpled/holey base, strongly metallic lustre to fracture
1117		125	101	1	highly deformed small balled-up SHC, dense, base finely dimpled, top probably maroon, shape uncertain
			23	3	slagged and vitrified oxidised fired ceramic
1119		56	56	1	small dense proto SHC, top very glossy maroon smooth, base dimpled with coke fragments, 30x45x25mm
1121		4	4	1	slagged oxidised lining ,with shale clast in maroon slag
1121		108	9	1	fragmented iron
			60	4	nubs of lining-influenced slag
			39	1	fragment of charcoal-rich SHC
1128		16	16	2	broken piece of thick lining slag on oxidised-fired lining
1130		2	2	1	bleb of low-density glassy slag, apparently on shale fragments
1132		19	19	1	small worn porous SHC fragment
1134		243	174	1	60x65x35mm, biconvex SHC with charcoal, neat dense, slightly lobate edges
			40	4	iron slag scraps
			27	1	isolated lobe that probably protruded from a cake, probably from the base
1141		688	24	1	grey clay in irregular ?deformed mass with external greenish glaze, internal possible contact surfaces suggest this may be deformed brazing shroud or similar

context	source note	sample wt	item wt	item no	item note
			61	7	slagged and vitrified oxidised clay; appears to have a boss like form around a blowhole
			189	1	accreted SHC, 60x85x35mm, plano-convex, no details visible
			120	1	heavily accreted equant slag block
			121	1	fragment of moderately dense thin SHC - weathered pale
			41	1	heavily accreted low-density slag lump
			15	1	rounded lump of lining lag, sandy with maroon surface
			84	9	slag fragments
			26	1	flowed maroon topped lobed lining slag - possibly a tongue fragment
			3	1	maroon slag in thin, slightly foliated sheet
1146		45	45	1	dimpled slag lump - just possibly puck but too rusted to be certain
1148		47	47	1	fragment of porous SHC,
1150		188	183	1	60x70x35mm,neat dense SHC, mostly plano-convex, maroon top locally smooth but with elevated irregular margin, base neatly rounded, coal shale fragment on top
			5	1	rounded lining slag bleb, grey, rich in pale crystals
1152		147	91	3	thick lining slag mass on mainly reduced lining
			13	1	lobate nub of lining slag, variably slightly maroon to pale green surface
			39	1	dense slag with small mostly non-wetted wall contact, dimples and voids have coke fragments
			2	1	small fragment of clay coat, one side polished maroon metal contact with deep voids, body pale, bloated, externally rough, maroon slagging passes around one surface, c. 10mm thick
1154		176	141	1	probably small SHC, surface accretion makes identification difficult, 45x70x35mm
			34	2	very irregular low-density porous iron slag fragments
1156		16	16	1	small SHC fragment with maroon surface
1162		9	3	1	slagged and vitrified oxidised lining
			6	1	rounded bleb of low-density lining slag with maroon surface

context	source note	sample wt	item wt	item no	item note
1165		158	158	7	fragments of SHC material - mostly made of amalgamated small prills giving a strangely open textured granular appearance. Probably not all from one item, but all broadly similar
1165		7	7	1	oxidised fired lining with maroon slagged convex surface
1179		44	44	7	pale surfaced FAS, frothy and grey internally, has crudely lobate form, some maroon internal zones (sediment particles) one larger piece seems to contain larger ceramic piece, surface locally white.
1181		32	32	1	small dense fragment of wall attachment from SHC, maroon dimples on base, charcoal inclusion
1186		7	7	1	irregular dimpled lump fragment of green glass, partly devitrified to sandy-buff colour material
1200		226	186	1	probably complete deformed SHC, strongly concavo-convex, but possibly because of fold, 55x80x45mm; finely dimpled base
			31	1	fragment of slightly gravelly SHC
			8	1	lining slag bleb
1202		108	91	1	small puck-like SHC ,surface details obscured by ashy concretion, 60x50x25mm
			17	1	complexly spikey lobate mass of pale greenish lining slag
1204		780	129	1	fragment of porous charcoal rich slag
			156	1	50x65x35mm, rusted and accreted probable small SHC, charcoal -rich
			216	1	most of worn dense charcoal bearing SHC
			100	1	triangular slag-like piece of charcoal-bearing slag with deeply dimpled base
			136	1	core of very dense SHC with all edges missing,
			35	1	iron with V-section – possible part of a spade shoe or similar
1206		6	6	1	irregular fragment of maroon surfaced internally pale grey vesicular and gravelly slag
1216		90	90	1	55x60x30mm biconvex finely dimpled SHC with coke particles
1220		4	4	1	charcoal rich slag fragment with dimpled surface

context	source note	sample wt	item wt	item no	item note
1222		1	1	1	possible coating, 5mm thick curved sheet, interior smooth with vesicle openings, very shiny maroon/cream, outside green convex glazed
1227		272	100	3	very rusty weathered irregular dimpled slag masses - quite possibly SHC fragments
			168	1	70x65x40mm, somewhat triangular biconvex SHC, dimpled base with charcoal, charcoal in holes on top too, low-density, very neatly shaped, very rusty and weathered
1229		234	202	1	70x70x50mm, deep rusty SHC, broken proximal planar sheet , whole things formed of irregular subunits, fuel altered, but possibly coal
			11	1	lining slag on oxidised ceramic
			9	1	ow density lining slag bleb
			13	1	dimpled and lobate SHC fragment,
1231		269	269	1	highly deformed, almost rolled up, medium charcoal-bearing SHC
1233		140	126	1	60x60x35mm square slightly biconvex lobate-edged SHC with charcoal, base rough, top with raised wisps and depyl impressed charcoal
			13	1	low density very shiny wispy slag pieces
1235		307	140	1	SHC, deeply dimpled planar top, base very irregular, 65x70x30mm
			116	1	60x50x30mm, very rusty, probably entire charcoal rich SHC
			40	1	iron - rounded triangle, now starting to explode
			11	1	deeply dimpled slag like SHC base but appears to be small nub
1237		9	9	1	unusual fragment of pale grey bloated ceramic, one side is smooth maroon, the other, and parts of two irregular edges, are maroon and slightly slagged. Probably lining spall, but might just be a coating. 30x25x13mm
1247		692	156	1	large mass of hearth wall, fractured and spalling with abundant lining slag attached
			251	1	transverse SHC heavily accreted, 60x100x45mm, dense, base finely and deeply dimpled, contains charcoal
			257	1	60x95x45mm dense, rusted SHC, with charcoal
			25	2	dimpled and lobate slags - probably SHC margin fragments
1249		6	6	1	bleb of rather low-density dark green slag with broad surface dimples

context	source note	sample wt	item wt	item no	item note
1251		382	163	1	steep side slightly lobate SHC, lining-influenced top, dimpled base with charcoal, 60x65x30mm, minor loss of edges
			219	9	SHC fragments
			0	1	pottery
1255		212	50	1	55x(35)x8mm thin broken slag sheet, dimpled base smooth dark top
			23	1	high vesicular lining slag on rough brown ceramic base
			36	1	dense SHC fragment
			27	1	deeply dimpled sub-blowhole mass attachment fragments
			71	4	prilly open SHC fragments
1256		106	20	3	lining slag fragments
			86	1	SHC fragment with prominent basal toolmarks
1258		134	134	1	70x70x25mm, unusual thin dished (almost leaf shaped) SHC, concave top with centre raised irregular blebby mass, bass deeply dimpled, top deeply haematised
1260		206	182	1	worn and rolled dense SHC, now 60x65x30mm, triangular in plan, smooth rusted surfaces
			24	1	dimpled slag fragment
1262		152	119	3	fragments of charcoal rich SHCs
			9	1	slagged oxidised fire lining
			24	1	porous low-density iron slag fragment
1264		38	38	1	small dimpled pad of lining slag, possibly a tongue like mass but very small
1266		598	465	1	80x100x45mm, oval biconvex SHC, dense worn
			133	1	very irregular mass of slag, strongly lining influenced, some grey, some maroon - very complex shape
1267		16	14	1	flow of dense slag with pale grey surface, also rusty - like a tongue fragment
			2	1	thin glazed sheet of stone or ceramic, pale grey
1273		9	9	1	irregularly fragmented piece of black glassy slag, devitrified white, unusual appearance

context	source note	sample wt	item wt	item no	item note
3001		57	13	2	porous iron slag fragments
			42	1	irregular contact between dense porous iron slag and oxidised wall,

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

context	SHC	indet iron slag	lining slag	lining	iron	poss. mould	poss. coating	tool mould	fuel ash slag	total
B 1 area reduction	176									*176*
reduction S building 1	516									*516*
reduction N dogleg		43								*43*
removal of B 1040	71									*71*
A1 u/s	201	190	53	6	35					*485*
A2 trowel clean	110	23	7							*140*
1001	911									*911*
1003	67		55							*122*
1028	25									*25*
1035	152	202	102	6			1			*463*
1043	101	10								*111*
1051									7	*7*
1061	100	4	38							*142*
1063	550									*550*
1064	201	83	31	5	5	19				*344*
1066	632	110		17	38		2	10		*809*
1074	714									*714*
1078				9						*9*
1086	31									*31*
1090	117									*117*
1097	167	22	255	68	6					*518*
1107	57									*57*
1109	166									*166*
1110	328	64								*392*
1112		8								*8*
1115	74									*74*
1117	101			23						*124*
1119	56									*56*
1121	39		60	4	9					*112*
1128				16						*16*
1130			2							*2*
1132	19									*19*
1134	174	67								*241*
1141	310	207	82	61			24			*684*
1146		45								*45*
1148	47									*47*
1150	183		5							*188*
1152	39		13	91			2			*145*
1154	141	34								*175*
1156	16									*16*
1162			6	3						*9*
1165	158			7						*165*
1179									44	*44*
1181	32									*32*
1186			7							*7*
1200	217		8							*225*
1202	91		17							*108*
1204	508	229			35					*772*
1206		6								*6*
1216	90									*90*
1220		4								*4*
1222							1			*1*
1227	268									*268*
1229	215		9	11						*235*

context	SHC	indet iron slag	lining slag	lining	iron	poss. mould	poss. coating	tool mould	fuel ash slag	total
1231	269									*269*
1233	126		13							*139*
1235	256	11			40					*307*
1237							9			*9*
1247	533			156						*689*
1249			6							*6*
1251	382									*382*
1255	134	50	23							*207*
1256	86		20							*106*
1258	134									*134*
1260	182	24								*206*
1262	119	24		9						*152*
1264										*0*
1266	465	133								*598*
1267		14	2							*16*
1273			9							*9*
3001		55								*55*
total	*10857*	*1662*	*823*	*492*	*168*	*19*	*39*	*10*	*51*	*14121*

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

Site:	Exminster	Cleevelands		Uffington	**Ebrington**	Neath	Carmarthen	Bulmore	Caerleon Priory Field	Marsh Leys Farm	Cowbridge
		SHC	all								
Reference:	Young 2014b	Young 2016		Young 2015	This study	Young 2013b, 2014a	Crew 2003	Young 1999	Young 2013a	Young 2005 & 2011	Barford 1996
	charcoal	coal		coal	mixed	charcoal	?	mixed	charcoal	charcoal	coal?
SHC count	107	57	176	57	37	47	136	?	18	30	?
SHC min. wt	32	50	44	36	53	74	100	127	146	60	175
SHC max. wt	482	530	530	614	628	630	820	770	600	824	700
SHC mean wt	127	176	125	137	180	244	227	270	294	333	403
% <150g	100%	44%	73%	72%	46%	32%	?	?	11%	23%	?
% <500g	100%	98%	99%	98%	97%	89%	94%	?	83%	77%	?

Table 4: evidence for the use of fuel employed in smithing by context

context	fuel
1035	charcoal
1063	charcoal
1074	charcoal
1134	charcoal
1181	charcoal
1204	charcoal
1220	charcoal
1227	charcoal
1231	charcoal
1233	charcoal
1235	charcoal
1247	charcoal
1251	charcoal
1262	charcoal
1109	both
1121	both
area reduction S of building 1	coal
1028	coal
1043	coal
1119	coal
1150	coal
1206	coal
A1 u/s	coal?
1130	coal?
1229	coal?

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