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Assessment of archaeometallurgical residues from Hen Gastell

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Dr T.P. Young

Abstract

This was a small assemblage, entirely of residues from the end-use working of iron, blacksmithing. The collection derived from a variety of contexts, with small amounts of hammerscale and other microresidues being recovered from the postholes of a structure surrounding the forge and more significant amounts from a stony deposit overlying the bank; most, however, were from the features of the forge itself.

The forge comprised an irregular hollow, perhaps simply a hollow worn in the working floor, containing a wide variety of residues, a circular pit, perhaps an anvil base, with microresidues, and a small hearth, apparently with microresidues in its primary fills, but a more diverse assemblage in its upper backfill.

The macroresidues included seven smithing hearth cakes (SHCs; of which five weighed less than 170g, a composite example 306g and a large example with an original weight of probably approximately 1kg) and a large quantity of sandy and gravelly slags with a very clinkery appearance. Tiny quantities of coal were recovered, although not from contexts in the forge, but the clinkery appearance of the slags is probably due to partial melting of the gravelly clasts rather than the use of coal as fuel.

Microresidues included hammerscale, but also a large proportion of slag flats – thin films of slag that in many cases show evidence for having encrusted the tip of the smith's tongs.

Three iron objects were recovered – two small fragments of thin metal bar and one small nail.

The residues resemble those of other small medieval forges engaged in the creation or repair of metal artefacts, rather than being involved with the actual production of iron.

Contents

Abstract 1

Methods 1

Results
- Description of Residues
  - Smithing slags 2
  - Indeterminate residues 2
  - Hearth lining 2
  - Glazed stone 2
  - Microresidues 2
  - 'Smithing floor' 2
  - Iron 2
  - Other 3
  - Distribution of residues 3

Interpretation 3

Discussion 4

Further work 4

References 4

Table 1: 5
Table 2: 11
Table 3: 12

Methods

All materials were examined visually with a low-powered binocular microscope where required. As an evaluation, the materials were not subjected to any high-magnification optical inspection, not to any form of instrumental analysis. The identifications of materials in this report are therefore necessarily limited and must be regarded as provisional.

The examined materials are listed in Table 1.

This project was commissioned by Jane Kenney, of the Gwynedd Archaeological Trust.

Results

Description of residues

The submitted materials amounted to an overall total of approximately 7.9kg. The macroscopic collection comprised approximately 900 counted items, with a total weight of 6.1kg, of which approximately 4kg proved to be archaeometallurgical residues in the strict sense (i.e. large after exclusion of concretions and a few pieces of natural rock).

Preservation of the residues was generally good.

Smithing slags

The smithing residues could broadly be divided into two categories – smithing hearth cakes (SHCs) and blebby slags containing much partially melted sandy and gravelly sediment.

The SHCs were generally well-formed, just slightly concavo-convex, dense slag cakes of small size. Included within this category are smaller slag masses, broadly plano- to concavo- convex, but which are too small to have fully developed the morphology of a typical SHC. These may be interpreted as incipient SHCs, limited in size by the amount of slag generated in the hearth. These have been loosely and informally termed proto-SHCs in this account. Taking these and the well-formed SHCs together, there were six reasonably complete examples, weighing 306g, 168g, 104g, 84g, 80g and 72g. The 306g example was a composite cake, including a moderately small SHC attached at its base to an inclined sheet of slag (either an earlier SHC, or perhaps a long-term build-up of slag on the wall/floor of the earth. In addition there was part of a much larger SHC, with a weight of 754g, that might be extrapolated to an original weight in the order of 1kg. This larger cake had a very porous internal structure, with a particularly large void just below the upper surface.

The blebby, gravelly, clinkery slags had clearly formed separately from the SHCs, but they too are assigned to the smithing process. Similar slags have been recorded from other sites with low-level hearths on gravelly substrates, both of medieval (e.g. Exminster, Young 2014b) and Roman (e.g. Neath, Young 2013, 2014b) age. Although a small amount of coal was recorded from the site, there was none from the main forge area 9it occurred mainly in isolated pit [2035] and the clinkery appearance of the slags is attributed to the partial melting of a slightly aluminous substrate.

The SHCs comprised approximately 49% of the macro-residue assemblage by weight and the clinkery slags 39%.

Indeterminate residues

There was a variety of slag that was not easily attributable to the classes of slag described above. This indeterminate material comprised approximately 10% of the macroscopic assemblage by weight. Most of the material referred to this class was in the form of fragments too small to be attributed to the other classes, but a small proportion was of small slag blebs and prills. The use of 'y' in Tables 2 and 3 indicates the presence of indeterminate comminuted slag in the sieved resides samples.

Hearth lining

There were only a few fragments of hearth lining present (2% of the macro-residue assemblage by weight). The only significant piece was part of a blowhole or tuyère from deposit (2003). This piece showed part of the curving margin of the bore, which suggested a diameter of approximately 35-40mm. The presence of tiny blebs, apparently of slag spatter, on the inside of the bore suggest it was open, but the diameter is unusually large for a smithing hearth (more typically the diameter is in the range of 15-30mm) and the possibility that the ceramic was packed around a metal tuyère cannot be discounted.

Glazed stone

The assemblage included numerous examples of small particles of rock, mainly of gravel grade, that have been glazed by heating in the hearth under the fluxing influence of the fuel ash, but which have not undergone partial melting and incorporation into clinkery slag.

Microresidues

The true microresidues included, dominantly, flake hammerscale, with lesser quantities of spheroidal hammerscale. The coarser microresidues included examples of slag spheroids, slag blisters and slag flats.

Hammerscale is associated with the superficial oxidation of iron at high temperature (Young 2014), with spheroidal hammerscale typically indicative of the process of forge (or fire) welding. Slag spheroids are droplets of smithing slag that cooled within the fuel bed of the hearth, without amalgamating into a large mass. Slag blisters are probably mostly formed as flake hammerscale, but are lifted off the surface of the underlying metal by build-ups of gas. Slag flats are thin skins of slag that, in this case, can be attributed to two distinct origins. Firstly they form as veneers of slag on boulders or cobbles that extend into the hearth pit. This type is characterised by a concave basal fracture. The second type forms by the adherence of slag to either the work piece or to the smith's tools. In the latter case, the presence of slag films with a right angle bend are common – having formed in contact with the tips of the smith's tongs or poker.

The true microresidues are accompanied in almost all case by finely comminuted slag debris, derived by the fragmentation of the macroscopic slags.

'Smithing floor'

The term 'smithing floor 'is applied to concretionary material dominantly or entirely formed by the cementation of fine debris from the smithing process (hammerscale, fine slag fragments and droplets, charcoal…). Most commonly, this material was cemented by the corrosion of small included iron particles, and this appears to be the case with the present material. Although a characteristic material of the floor of a smithy (hence the name), the material may also form in other accumulations of fine-grained smithing debris, such as waste pits.

Iron

Three iron artefacts were recorded, two fragments of this iron bar and one small nail. Corrosion products from the weathering of iron were also common in the microresidue collections, but are not always indicated unless certain on the data tables, because of the similarity with iron oxide crusts formed by the weathering of natural rocks.

Other
The macroscopic collections included, in addition to the material described above, small pieces of coal, concretions formed by iron oxides binding the natural gravel (potentially formed by the weathering of iron objects or debris), and also a number of natural materials.

Distribution of residues
The distribution of the residues is illustrated in Table 2 by context and Table 3 sorted by type of feature.

Samples from deposits below the bank (layers (2079) and (2082)) produced tiny amounts of hammerscale and fine slag particles. The quantities were very small and the possibility of intrusion of material from later residue-rich contexts must be considered, although they may genuinely indicate a degree of pre-bank metalworking.

The majority of the residues recovered derived from the cluster of metallurgical features, which bore both the largest assemblages of microresidues and almost all of the macroresidues. Circular pit [2076] contained a broad spectrum of residues in small quantities, but with a rich hammerscale assemblage. Hollow [2067] produced approximately 70% (2.8kg) of the total true macroresidue from the site (4.0kg). In addition there was over 1kg of 'smithing floor' and 0.9kg of fine-grained metallurgical residues. The upper fills of pit [2078] contained a similar assemblage to that of hollow [2067], but the lower fills lacked macroresidues although they were rich in microresidues.

Other pits also yielded residues, with pit [2089] near the southern wall yielding a moderately rich microresidues assemblage. Pits [2035] and [2056] yielded only trace levels of hammerscale, with pit [2035] also yielding coal and coke.

The postholes of the structure produced assemblages of microresidues and comminuted slag debris from almost all the post-pipe fills and many of the packing fills.

The late-stage burnt stone deposits overlying the bank (layer (2003)/(2023)) contained rich hammerscale assemblages accompanied by small quantities of a wide range of macroresidues.

Interpretation

The nature of both macro- and micro- residues clearly indicates that the metallurgical activity undertaken was ironworking. The small size of the smithing hearth cakes and the abundance of flake hammerscale indicates that the work being undertaken was mostly, if not entirely, associated with the end use of iron – in other words blacksmithing.

The macroscopic residues were mainly of two kinds – a clinkery slag formed of glassy slag binding partially melted sand and gravel in blebby, amorphous masses and denser, typically plano- or concavo- convex masses (SHCs). Several of these masses were so small they could not display the typical form of SHCs, so the term proto-SHC has been employed here. These small cakes are interpreted as the early stages of accumulation of a true SHC, and that they would have grown larger given sufficient slag supply. The weight range of the five small SHCs and their incipient equivalents was from 72g to 168g, with a larger piece (306g) being a composite mass of an SHC lying on an earlier denser slag sheet. The exception to these small, dense SHCs, was a partial fragmented SHC weighing 754g (probably originally approximately 1kg). This large SHC had a low density, rather frothy, slag forming much of its upper part.

A total assemblage of just seven SHCs does not permit rigorous comparison with SHC assemblages from other sites, but the assemblage is certainly comparable with others from early smithies. With a range of SHC weights of 72-1000g and a mean weight of approximately 260g for this assemblage, comparative medieval assemblages would include those from:
- Exminster, 'medieval'; SHCs range from 32-482g with a mean of 127g.(Young 2014b)
- Worcester, Mill Street, 12th century; SHCs range from 74-782g, with a mean of 233g.(Young 2009a)
- Worcester, Willow Street, 12th century; SHCs range from 86-770g with a mean of 327g. (Young 2007)
- Garryleagh, Co. Cork, 13th-14th century; SHCs range from 84-802g with a mean of 316g. (Young 2009b)
- Coolamurry (Co. Wexford), of 12th-13th century date; SHCs range from 62-3588g with a mean of 386g. (Young 2008)

It has been argued (Young 2008b) that in Ireland, the presence of a small proportion of larger SHCs in the assemblages of otherwise small SHCs up until the 13th/14th centuries, is due to the need for the smith to undertake some of the final processing of the iron, because iron was traded or moved in an incompletely refined state. The high temperature processing of the iron is a process involving a greater loss of iron, so the slag cakes produced may tend to be larger. That appears, on present evidence, not usually to have been the case in medieval Britain, and fully processed iron may have been the normal form of trade iron. Unusually-sized SHCs that do not fit the main size-frequency distribution for a site, may also indicate another process, such as hearth steel-making.

Another factor that may result in the presence of very small SHCs is the potential use of an iron tuyère, instead of a ceramic tuyère or a simple blowhole. The use of an iron tuyère reduces the degree to which the hot-zone impinges on the hearth wall, and therefore reduces the flow of silicate melt into the hearth. The evidence for Hen Gastell was discussed above and it seems likely that a simple clay blowhole was used, but the only surviving blowhole is sufficiently large that it might have held an iron tuyère.

The introduction of iron tuyères was progressive, and by the early post-medieval period seems almost universal in England, but ceramic tuyères continued in use well into the post-medieval period in Ireland,. The development of the smithy in this period in Wales is entirely unknown; it is not known whether medieval-style floor level hearths remained in use into the post-medieval period, as it is clear they did, at least locally, in Ireland.

In summary, the SHCs from Hen Gastell are small, which may reflect one of a number of contributing factors – including the tasks undertaken, the nature of the hearth/tuyère and the nature of the iron employed. The hearth technology is certainly compatible with a medieval age, but whether such technology continued in use in N Wales into the post-medieval is not known.

The amount of archaeometallurgical waste recovered from the site is relatively low; it is likely that the point(s)

of waste disposal from the smithy lay outside the excavated area. This means it is impossible to provide any estimate of the scale or longevity of the activity. None-the-less, the presence of hammerscale in so many of the sampled contexts indicates that a significant quantity must have been distributed across the site.

The focus of the activity within the excavated area was the cluster of pits towards the northern side of the structure. Most of the residues (70% of the macro-residues from the site) derive from irregular hollow [2067]. The field description implies this feature had no in-situ burning. This may, therefore, be a worn 'working hollow', that became filled with debris. Close to this lay circular pit [2076] contained a broad spectrum of residues in small quantities, but with a rich hammerscale assemblage. It is possible this circular pit held a wooden anvil bock (into the top of which a small metal anvil could be placed). The unusual 'iron' find SF40 came from a shallow scoop to the north of [2076] and requires further investigation. Furthest east of the features was the probable hearth [2078]. This pit was 0.47 x 0.40m and 0.20m deep. This is unusually small for a medieval forge hearth, but not impossibly so (particularly if the hearth was only intended for the working of small objects). The primary fills of this accumulated on micro-residues, but floor material accumulated in the hearth on its abandonment – giving an upper fill somewhat similar to the fill of [2067]. It has been suggested that the red clay within this hearth might be from its superstructure (perhaps particularly a wall between the hearth and the bellows). However, an alternative possibility is that the clay was an attempt to stabilise the pit, for much of the gravelly component observed in the slag may have been derived from the pit sides.

The presence of archaeometallurgical residues in the apparently late deposits overlying the bank may indicate late ironworking, but might also indicate movement of waste materials away from the interior of the enclosure long after abandonment of the smithy.

Discussion

The material is indicative of a blacksmithy undertaking light forge work (evidenced by the small SHCs and by the very small hearth). The residue assemblage is similar to those from other medieval forges where general purpose smithy work appears to have been undertaken. The characteristics of the assemblage are not indicative of date, since late medieval and early post-medieval smithies are almost unknown in Wales.

Medieval higher status sites typical yield evidence for at least some working of copper alloy – but such evidence is entirely lacking in the present material. The closest comparative assemblages are from a variety of site types, including open rural settings (Exminster, Coolamurry) and an urban setting (Worcester).

The scale of the activity cannot be estimated on the basis of the limited material (it is assumed there must have been some off-site dumping of waste), but the permeation of hammerscale into almost all of the adjacent cut features would suggest the activity was not inconsiderable.

Further work

The assemblage provides a very complete assemblage of macro-and micro-residues produced by what may have been a rather limited set of processes. Some detailed analysis and characterisation of these materials would assist in the understanding of the technology employed, aiding both the interpretation of the site and of similar materials when encountered elsewhere. A programme of analysis is therefore recommended and a costed proposal will be supplied separately.

Irrespective of the commissioning of any further work, it is strongly recommended that all the residues are retained for deposition as part of the site archive, as there are so few such assemblages on a national basis.

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Table 1: summary catalogue. Assm = assemblage, FHS = flake hammerscale, SHS = spheroidal hammerscale, SHC = smithing hearth cake

C	S	Sf#	Label	sample wt	Item wt	Item no	Notes
T2 u/s	26		slag	96	96	1	fragment of small SHC, original size not known. Well-formed lower crust with fuel-dimpled base, top largely obscured by concretion
2002	66		cleaning over bank (2018)	88	88	4	irregular rounded nubs of black glassy clinkery slag with locally maroon surface and abundant variably melted clasts.
2003	58		Fe slag	20	20	1	fragment of irregularly-lobed slag nub with glassy surface, apparently has corroded iron inclusion
2003	4	112	fine - metalworking	9		assm	mainly stone, but some maroon slag, slag spheroids, moderate FHS, some SHS, some fired clay
2003	5	113	fine - metalworking	<1		6	variety of slag types, spheroids, lining, dense, and vesicular
2003	5	113	fine - metalworking magnet	<1		assm	small but rich assemblage of FHS, flats, slag fragments, slag spheroid and some stone
2003	6	114	fine - metalworking magnet	<1		assm	stone, trace of FHS and SHS, with iron fragment
2003	8	116	fine - metalworking magnet	<1		assm	slag fragments and blebs with some FHS in v small assemblage
2003	21		furnace lining	38	38	1	oxidised and slagged lining with blowhole preserved on protrusion. Interior of blowhole is slightly vitrified with fine spatter. Blowhole appears to be 35-40mm diameter
2008	18	124	fine - metalworking	2		assm	large pieces of lining slag, with trace of FHS amongst finer stones
2012	9	117	fine - metalworking magnet	<1		assm	stone, trace of FHS and SHS
2014	15	122	fine - metalworking magnet	2		assm	stone with some FHS and slag - the latter curiously finely crystalline
2014	15	122	fine - coal	<1		5	coal fragments
2015	7	142	coarse - slag	10	10	1	black glassy slag binding variously vitrified, bloated and partially melted lithic clasts
2015	7	115	fine - metalworking	<1		assm	stone, trace of FHS and SHS

C	S	Sf#	Label	sample wt	Item wt	Item no	Notes
2023	14	121	fine - metalworking magnet	<1		assm	small sample rich in FHS, slag flats and trace of SHS
2023	16	123	fine - metalworking magnet	<1		assm	concretion, stone, slag, FHS, slag spheroids, some SHS
2023	16	143	coarse - slag	4	4	1	glassy bound lining slag
2023	61		furnace lining	14	14	2	vitrified oxidised fired lining, black glassy vesicular slag. Ceramic has probable leaf impressions
2023	63		Fe slag	78	6	1	rusted Fe object - small nail?
					50	1	dimpled lobate slag nub, possibly part of SHC or incipient SHC, very dense; one end has rusty accretion (probably from iron in slag)
					18	2	blebs of lining slag, pale, glassy
2036	10	118	cinder? Slag?	4		22	coal and coke
2036	10	118	fine - coal	<1		3	coal
2036	10	118	fine - metalworking magnet	<1		assm	stone, trace of FHS and SHS
2042	12	119	fine - metalworking magnet	3		assm	mainly stone, but some FHS and slag flats
2048	13	120	fine - metalworking magnet	<1		assm	slag, FHS and SHS
2053	24	129	fine magnetic material	<1		assm	stone with trace FHS
2056	19	125	fine - metalworking magnet	<1		assm	mainly stone, trace slag and trace FHS
2066	21	104	coarse metalworking debris/slag	670	4	3	vitrified/glazed gravel
					40	12	gravel with adhering slag, in many case glazed also
					4	3	gravel - natural
					226	91	blebby lining influenced slags, mostly with white granule clasts, most maroon surfaced,
					14	9	vitrified slagged lining
					42	13	rough, granular, dense slags
					84	22	dense flowed slag, varying from small good flow slag to more blebby material

C	S	Sf#	Label	sample wt	Item wt	Item no	Notes
					30	16	flats, tool casts etc. only a few show right-angled re-entrants
					226	135	concretionary fragments, mainly rusty, with variably clasts of slag, FHS, charcoal and iron
2066	21	106	fine metalworking debris (magnet)	524		assm	very rich assemblage, dominated by FHS, but with slag flats, slag fragments, slag blebs, slag spheroids, SHS and some concretionary material (lower proportion than in 2099)
2066	21	105	fine metalworking debris	384		assm	assemblage dominated by fine version of maroon, gravel-rich slagged substrate, other material include abundant vesicular to frothy flats, some FS, slag spheroids and prills, vitrified stones ,stones attached to slag, concretions and some laminated rusty spalls (unclear if the latter are from rocks or iron)
2066	21	148	abraded orange ware	<1		1	oxidised fired clay
2066	46		slag 1/2	2412	168	1	90x60x30, small SHC, just slightly concavo-convex, top locally smooth, slightly reddened and with charcoal inclusions, base microdimpled/microprilly, dense
					72	1	70x50x25, small proto-SHC, prilly base (coated with rusted organics), smooth top with slightly lobate margin
					306	1	double SHC, lower sheet of dense slag, overlain by lining rich SHC, 70x95x60 overall, upper SHC 30mm thick
					148	1	dense stone
					104	1	75x65x35, low density SHC, thick gravelly glassy top with stone extending above planar top, lower slag rich in charcoal
					84	1	proto SHC, lobate top with raised centre, strongly prilly base, 60x50x35mm, very gravelly, locally maroon surface
					260	1	block of quartz vein with adhering smithing floor type material - abundant FHS, charcoal and slag
					80	1	50x75x40mm, irregular blebby proto-SHC, strongly maroon, gravelly, very irregular, upper face was crescentic
					158	16	fragments of very dense cemented smithing floor - rich in FS, slag, charcoal etc.
					22	1	iron = 40x20x4mm
					372	35	rounded nubs of low density gravelly lining slag, mostly with slightly maroon surface
					304	7	ferruginous concretions in very coarse gravel some probably associated with iron
					40	13	fragments of gravelly lining slag
					16	1	angular fragment of glass bearing gravel, dense not vesicular
					70	1	fragment from centre of dense concavo-convex SHC with dimpled base and very smooth even top
					162	5	prilly dense slag pieces, probably proto-SHC material
					38	1	lip of SHC with extremely porous interior
					8	1	stone fragment
2066	46		slag 2/2	1815	92	20	small spiky fragments of clinkery lining slag

C	S	Sf#	Label	sample wt	Item wt	Item no	Notes
					122	10	nubs of clinkery lining slag, each low density so possibly coatings on individual clasts
					426	20	multi-lobed clinkery lining slags, some with inclusions of gravel
					280	7	denser slag lumps, one sheet like, but otherwise these do not resemble SHC fragments
					14	1	rounded strip of iron with turned up end, 45x15x3-4mm with end turned up by c4mm
					648	75	coarse concretions with lots of slag, flats and scale, along with charcoal, straw moulds etc.
					40	3	glazed stones
					38	7	natural gravel
					2	1	unusual fired clay with convex iron oxide contact surface one side, one end curves over like blowhole margin - unclear how this could be interpreted – as a plug?
2066	62		furnace lining	16	16	3	oxidised and slightly slagged ceramic
2070	20	126	fine slag	1		3	lining slag, one very porous, the other two dense and clinkery
2070	20	126	fine - metalworking magnet	<1		assm	mainly stone and FHS, with some slag flats
2071	23	128	fine magnetic material	<1		assm	stone with slag, some FHS and SHS
2072	22	127	fine magnetic material	<1		assm	stone with trace of slag and FHS
2075	25	107	metalworking debris	80	<2	1	vitrified/glazed gravel
					16	14	blebby lining influenced slags, mostly with white granule clasts, most maroon surfaced
					6	32	spiky to flowed dense slags
					6	42	flats, tool casts etc.
					44	132	concretionary fragments, mainly rusty, with variably clasts of slag, FHS, charcoal and iron (weight includes some dust)
					<2	8	slag spheroids
					2	1	lining slag with a planar re-entrant face probably picked by tongs/poker
2075	25	108	fine metalworking debris (magnet)	306		assm	assemblage dominated by FHS, with some SHS, also spheroids, slag flats (including re-entrant examples) and other slag debris. Maroon slag and concretions present but in lesser proportion.
2075	57		slag	44	6	1	fired clay
					14	2	dense clinkery slag nubs, maroon surfaced

C	S	Sf#	Label	sample wt	Item wt	Item no	Notes
					26	4	concretions, at least two probably associated with thin sheet of iron
2077	29	110	fine metalworking debris (magnet)	74		assm	assemblage dominated by FHS, some larger flats, maroon spheroids, slag fragments, droplets, lining-rich slag blebs
2077	29	109	metalworking debris	42		assm	mainly blebs of clinkery slags, concretions (several lager ones are probably on iron), FHS, slag spheroids, slag fragments, slag flats and blisters
2077	65		slag	852	754	5	fragmented large piece of SHC. Bowl filled by vesicular dense slag, base with much adhering gravel (must have formed against sediment not fuel), upper part highly vesicular and frothy, top deeply dimpled with fuel, 115x100v70 fragment, bowl 50mm deep, cannot be more than 80% of original, frothy layer effectively single large void underlies most of the top. top pale and plastic/resinous appearing around fuel dimples
					86	1	irregular mass of glassy gravelly slag, rather dense glass, maroon surface
					12	3	small lining slag fragments
2079	26	130	fine - metalworking magnet	<1		assm	stone with trace of slag and SHS
2082	28	131	fine - metalworking magnet	<1		assm	stone with trace of slag and FHS
2082	41	139	porous stone? Slag?	24		38	porous igneous rock
2082	41	138	fine magnetic material	<1		assm	stone with 1 frag of FHS
2090	35	134	fine - metalworking magnet	<1		assm	one large piece of lining slag, moderate amount of FHS, some SHS and some fine slag debris, rest stone
2093	34	133	fine - metalworking magnet	<1		assm	stone with sparse assemblage of slag, FHS and SHS
2097	38	136	fine -slag	<1		1	bleb of clinkery lining slag
2098	32	132	fine - metalworking magnet	8		assm	dominated by FHS, but lots of maroon slag debris and plenty of SHS and slag spheroids. Some flats and large blisters
2098	32	149	ceramic	2		7	oxidised fired clay

C	S	Sf#	Label	sample wt	Item wt	Item no	Notes
2099	33	111	fine metalworking debris (magnet)	196		assm	very rich assemblage of FHS, slag flats, slag spheroids, SHS, maroon slag blebs and lots of ashy concretionary material with HS and charcoal
2099	33	144	mw debris/slag/concretions/iron?	14	6	5	large slag flats with curved concave attachment areas
					2	2	maroon slag fragments
					2	2	concretions
					2	1	vitrified pebble
					<1	1	laminar iron oxides- unclear if spall of rust or from rock
2101	36	135	fine magnetic material	<1		assm.	mainly fine stone, one large piece of clinkery lining slag
2105	42	140	fine - metalworking	4		assm	mainly maroon slag, some stone, one carbonised nut (?),
2105	42	140	fine - metalworking magnet	5		assm	mainly stone, some lining slag, moderate FHS, slag spheroid, charcoal
2105	42	150	burnt clay	<1		1	oxidised fired clay
						1	concretion?
2105	42	141	coarse - slag	8	8	2	dark glassy slag binding partially- melted gravel, some charcoal
2120	40	137	fine - metalworking magnet	<1		assm	stone with some FHS

Table 2: summary of residues by context. For the microresidue assemblages mod = moderate, tr = trace, y = present.

context	notes	macro-residues				microresidues			other				
		SHC	clinkery slags	indet slag	hearth lining	scale	spheroid	flats	glazed stone	smithing floor	iron	coal	conc
T2 u/s	unstratified	96											
2002	cleaning over bank		88										
2003	burnt stone deposit		20	y	38	rich	y	y			y		
2008	packing fill in p/h [2007]				y	tr							
2012	possible post-pipe fill in p/h [2011]					tr							
2014	fill of post-pipe in p/h [2009]					tr						y	
2015	fill of post-pipe in p/h [2007]		10	y		tr							
2023	burnt stone deposit over bank 2018	50	22	y	14	rich	y	y			6		
2036	fill of pit [2035]					tr						4	
2042	fill of post-pipe in p/h [2118]					tr		y					
2048	packing fill in p/h [2011]			y		tr							
2053	packing fill in p/h [2052]					tr							
2056	fill of cut [2055]			tr		tr							
2066	Charcoal and slag rich fill of hollow [2067] 1.60 x 1.10m x 0.15m	1084	1294	406	32	rich		30	84	1032	36		304
2070	fill of post-pipe in p/h [2068]		y			tr		y					
2071	fill of post-pipe in p/h [2052]			y		tr							
2072	fill of post-pipe in p/h [2005]			y		tr							
2075	Charcoal rich fill of small pit [2076], 0.60m diameter, 0.30m deep		32	6	6	rich	y	6	1	44			26
2079	Buried soil 'A' horizon, under bank 2018					tr							
2077	Upper fill of pit [2078]	754	98	y		rich	y	y					
2082	Layer containing burnt bone and charcoal that underlies bank 2116					tr							
2090	Relatively charcoal rich fill of pit [2089], 0.35 x 0.33m, 0.11m deep			y	yes	mod							
2093	packing fill in p/h [2092]			y		tr							
2097	fill of post-pipe in p/h [2092]		y										
2098	heat reddened clay in the base of pit [2078]		y		y	mod	y						
2099	Thin, dark, silty charcoal rich fill in the base of pit [2078]		2			rich	y	6	2				2
2101	Fill of a possible post void at NW end of posthole [2083]		y										
2105	Fill of post void [2106] in posthole [2108]		8		y	mod	y						y
2120	Disturbed packing fill of posthole [2119]					tr							
	Total weighed	*1984*	*1574*	*412*	*90*			*42*	*87*	*1076*	*42*	*4*	*332*

Table 3: summary of stratified residues by type of feature and context. For the microresidue assemblages mod = moderate, tr = trace, y = present.

c	notes	SHC	clinkery slags	indet slag	hearth lining	scale	spheroids	flats	glazed stone	smithing floor	iron	coal
	Deposits below bank											
2079	Buried soil 'A' horizon, under bank 2018					tr						
2082	Layer containing burnt bone and charcoal, underlies bank 2116					tr						
	Burnt stone deposits over bank											
2003	burnt stone deposit over bank 2018		20	y	38	rich	y	y			y	
2023	burnt stone deposit over bank 2018	50	22	y	14	rich	y	y			6	
	Packing fills of postholes											
2008	packing fill in p/h [2007]				y	tr						
2048	packing fill in p/h [2011]			y		tr						
2053	packing fill in p/h [2052]					tr						
2093	packing fill in p/h [2092]			y		tr						
2120	Disturbed packing fill of posthole [2119]					tr						
	Post-pipe fills of postholes											
2012	possible post-pipe fill in p/h [2011]					tr						
2014	fill of post-pipe in p/h [2009]			y		tr						y
2015	fill of post-pipe in p/h [2007]		10			tr						
2042	fill of post-pipe in p/h [2118]					tr		y				
2070	fill of post-pipe in p/h [2068]		y			y		y				
2071	fill of post-pipe in p/h [2052]			y		y						
2072	fill of post-pipe in p/h [2005]					tr						
2097	fill of post-pipe in p/h [2092]		y									
2101	Fill of a possible post void at NW end of posthole [2083]		y									
2105	Fill of post void [2106] in posthole [2108]		8		y	mod	y					
	Minor pits											
2036	fill of pit [2035]			y		tr						4
2056	fill of cut [2055]			tr		tr						
2090	Relatively charcoal rich fill of pit [2089], 0.35 x 0.33m, 0.11m deep			y	y	mod						
	Metallurgical group											
2066	Charcoal and slag rich fill of hollow [2067] 1.60 x 1.10m x 0.15m	1084	1294	406	32	rich		30	84	1032	36	
2075	Charcoal rich fill of small pit [2076], 0.60m diameter, 0.30m deep		32	6	6	rich	y	6	1	44		
2077	Upper fill of pit [2078]	754	98	y		rich	y	y				
2098	Heat-reddened clay in the base of pit [2078]		y		y	mod	y					
2099	Thin, dark, silty charcoal rich fill in the base of pit [2078]		2			rich	rich	6	2			

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