GeoArch

Report 2015/13

Assessment of archaeometallurgical residues from Truro EDC (2014)

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10th July 2015

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Abstract

A total of almost 60kg of material was submitted for assessment. Approximately 76% of the assemblage was associated with the production or working of iron. These materials came from 20 individual contexts (from 16 features), with a further four contexts yielding iron ore. The majority (36kg) of these residues were from iron smelting in a non-slag tapping (slagpit) furnace, but there were also 3.6kg of smithing residues and 4.6kg of residues that could not be assigned to either process with certainty. The evidence suggests that there were at least three iron smelting furnaces ([2345], [2398] and [2567]). Smithing residues occurred in a mixed assemblage in the backfill of furnace [2398], but also in smaller quantities in pits [2387] and [2400]. Unfortunately specific sampling for hammerscale was not undertaken, hindering the recognition of the foci of smithing. Goethitic iron ore, resembling the gossan ores recovered at the Richard Lander School site, was recovered from four features; in one case (ditch [2573]) the ore had been roasted. The character of the smelting strongly suggests that was Iron Age in date, undertaken in non-tapping furnaces with an arch, and accompanied by some smithing of the blooms being undertaken at the same location.

There was also a significant quantity of cassiterite-bearing pebbles and granules contained in various Bronze Age pits (most significantly up to 13kg of cassiterite-bearing material in pit [3417] and 600g in pit [2447], but with small quantities in pits [2494], [2577] and [3372]). The appearance of the larger pebbles is very similar to those recovered from a Bronze Age context at the Richard Lander School site. Although the coarse-grained cassiterite bearing clasts were rounded and probably alluvial, much of the fines in pit [3417] were angular, and are accordingly provisionally identified as having been crushed. None of the certain earlier prehistoric pits yielded any slag, so there is no evidence for the use of the cassiterite for tin-making.

The character of both the Iron Age and Bronze Age assemblages bears close comparison with the similar finds from the Richard Lander site, emphasising their regional significance.

Small quantities of material from unstratified contexts and topsoil included coal, coke, clinker and tin-smelting slag (of probable post-medieval age).

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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. The project follows an earlier phase for which metallurgical finds were separately assessed (Young 2014b).

This project was commissioned by Sean Taylor, of the Cornwall Archaeological Unit.

Results

Description of the residues

Bloomery iron smelting residues

The residues from bloomery iron making are indicative of smelting in a non-slag tapping furnace. There are no tapped slags.

The terminology of non-slag tapping furnace slags is very poorly developed. The term 'furnace bottom' (FB) is widely used, but poorly defined. The term, as used here, refers to the large slag mass that forms below the bloom. This slag mass is typically formed of small coalesced slag prills and films, incorporating much charcoal fuel. Typical material from FBs on the current site ('normal FB' of Table 2) is in highly porous, and often rather fragile, masses, with varying degrees of film-like or prill-like internal structure. Typical material occurs, for instance, in the large blocks present in fill (2581). The slag mass of (2581) demonstrates clearly how the 'furnace bottom' does not always lie on the pit floor, but extends across the furnace from the wall below the blowhole.

Where the FB impinged on the wall below the blowhole, the high temperature of this zone encouraged more rapid reaction and the generation of fluid slags. These may both react with, and eat into, the pit wall at this point, and also flow downwards into the pit. This may generate particularly dense flow slag blocks (comprising amalgamated flows and prills) on the pit wall and at its foot. On some sites the flow slags show extensive flow across the pit floor, but there are very few pieces here that are indicative of sufficient hot, fluid, slag having reached the pit floor to generate such flows. Sections of FBs which formed these more coherent slag amalgamations of flows may form particularly dense and resistant slag blocks. Such blocks form a significant part of the slag assemblage that has survived into the modern topsoils; they are distinguished in Table 2 as 'dense FB'.

Instead, the assemblage shows examples where the down-flow of slag is more general, leading to a large number of small prills of slag, rather than major localised flow. Context (2579), in particular, shows this facies, with almost 5kg of small prills. Where small amounts of fluid slag descend as isolated drops, they may form sub-spheroidal droplets as they cool within the fuel bed. Such isolated flow slag particles are identified in Table 2 as 'fine flow slags'.

Some of these small prills reached the floor of the pit, where together with ash, tiny fuel fragments, small cross-floor flows, slag droplets and part-reacted ore, they solidified into a rough-textured material that has been termed here 'sinter'. It is not clear to what extent this material is a true sinter, but the term provides a useful 'handle'. Because discrimination of the more charcoal-rich examples of these basal deposits (sinters) in the pits from very fine-grained examples of FBs from higher in the pit profiles, is not always practical, the two materials are lumped into a single category, 'fine FB/sinter' in Table 2.

Iron ore

Numerous fragments of goethitic iron ore were recovered. A collection of 45 pieces of ore (total 340g) with fresh fractured surfaces was recovered from fill (2460) of burnt pit [2461]. These pieces show a strong visual similarity to the gossan ores recovered from the Richard Lander School site (Young 2008). The pieces were all fractured down to a sub-25mm grain size (average weight 7.5g).

The fill (2455) of large oval burnt pit [2448] yielded 46g (19 fragments) of roasted goethite ore, some of which was very soft.

The possible Iron Age ditch [2573]/[3340] yielded two pieces of goethite ore (16g from (2572) and a single piece of 126g (3334). The latter piece has a slightly boxstone-like structure, with a core exposing soft ochres – compatible with being the precursor lithology of the soft, dehydrated and fissured material present alongside the hard ore in (2455).

Smithing residues

There were two groups of residues providing evidence for smithing. The clearest macroscopic evidence is provided by the bowl-shaped slag cakes known as smithing hearth cakes (SHCs). Three moderately complete examples were recovered, all from upper fill (2397) of furnace [2398], along with several fragments. The only complete example weighed 1165g, the two slightly incomplete examples had estimated original weights of approximately 890g and 1030g. The SHCs showed neatly rounded bases, slightly concave tops, which were smooth but dimpled and in one case showed signs of starting to 'explode' because of weathering of metallic iron within.

A further plano-convex slag cake, weighing approximately 2050g, also from upper fill (2397) of furnace [2398], was a large SHC-like block, with a smooth, brown, irregular top, a moderately dense lower crust (with included gravel clasts) and very porous internally. The cake measured 200mm by 160mm and was 80mm thick. This block was less convincingly a SHC than the other examples and may instead have been an accumulation of fluid slag from the base of a smelting furnace pit.

Fill (2386) of pit [2387] produced a possible 130g SHC fragment.

The second strand of evidence for smithing was the presence of hammerscale. Unfortunately no rigorous campaign of sampling for archaeometallurgical microresidues was conducted, but flake hammerscale (Young 2012) was present in ferruginous concretions from fill (2399) of pit [2400]. The recovery of hammerscale in concretions formed after deposition within sediments rich in smithing residues is common and is driven by the corrosion of metallic iron in the sediment. Such concretions may be hand-picked during excavation, revealing the presence of micro-residues that were otherwise missed during excavation and sampling. The present evidence is not sufficient to suggest that pit [2340] was a smithing hearth; it may just have received fine-grained waste from the smithy floor.

Flake hammerscale was also present in very small quantities in the fine sediment adhering to the hand-picked macroscopic residues from (2397), the upper fill of furnace [2398]. Given the significant number of SHCs present in this deposit, the relative paucity of hammerscale is significant. It may indicate manual redeposition of the smithing hearth cakes from the primary waste dump of the smithing operation, into the abandoned furnace.

Indeterminate ironworking residues
In addition to the residues that were identifiable as either being from smithing or smelting, there were some fragments of iron slag that could not be attributed to either with confidence (the 'indeterminate slag' of Table 2). Most of the pieces placed into this category possessed features that occur in both basal slag accumulations in smelting furnaces and in SHCs.

Fragments of ceramic furnace materials, fired natural clay and vitrified stones from the furnace and hearth structures occurred widely, and cannot be differentiated into those from furnaces and those from hearths. Most of this material was probably derived from the walls of the cuts of the furnace pits; rather little of the material was a well-prepared clay from the superstructure.

Cassiterite-bearing materials
Two significant collections of cassiterite-bearing cobbles and granules were made. Pit [2447] yield 574g (179 pieces) of such grains from upper fill (2442) and 44g (c. 50 pieces) from the primary fill (2459). Fill (3414) of pit [3417] yielded a total 12963g of cassiterite bearing sediment (including the sieved residues), although the amount of cassiterite will be rather less than this total. The sieved residues include an enormous quantity of cassiterite-bearing material in the 1-2mm grain size range. This suggests, supported by the presence of a fractured large cassiterite-bearing cobble, that the ore has been crushed. Visual examination suggests that the crushed material may not have undergone any beneficiation.

Lesser quantities were recovered from several other features: 4g from fill (2443/2476) of [2494], less than 1g from fill (2576) of pit [2577] and 6g from fill (3218) of pit [3272].

Other materials
Minor quantities of other materials were also recovered, including concretions, fragments of iron, clinker, coal, coke and post-medieval tin slags, as well as various non-metallurgical natural materials.

The tin slag, coal, clinker and fragments of highly bloated ceramic/rock were restricted to topsoil or other unstratified contexts.

Distribution of the residues
Archaeometallurgical residues occurred in numerous features, but with a close focus. The evidence for ironmaking is largely confined to a linear swathe of ground across the middle of Field 2 (with the previously-recorded furnace in Field 1 approximately 200m to the NE). Within this swathe there are three furnaces (from N to S: [2345], [2398] and [2567]).

The northern furnace, [2345], was isolated from other features of metallurgical interest.

The pits ([2455], [2461]) yielding iron ore, and suggestive of an area for ore preparation and roasting lay 20m NE of furnace [2398].These pits formed part of Group 2f. Other pits in Group 2f yielded small quantities of iron smelting residues.

Furnace [2398] also produced evidence for the disposal of waste from both smithing and smelting. Burnt pit [2400] yielding hammerscale lay just to the east of furnace [2398] and pit [2463], also yielding smelting residues, lay just to the west. This cluster of features was Group 2g.

The southern furnace, [2567], lay close to ditch [2573] which produced a small piece of iron ore (with a larger piece collected from its westwards continuation into Field 3.

The deposits containing cassiterite (Pits [2447], [2494], [2577], [3272], [3417]) were scattered across of wide area of Fields 2 and 3.

Description of the metallurgical features
Full investigation of the metallurgical features remains a goal for the analysis phase of this project (with detailed re-evaluation of field records). Some comment may be made on the iron smelting furnaces. Each appears to have a working base approximately 400-450mm in diameter. Each has some evidence for the presence of a basal arch (based on furnace plan for the northern furnaces, [2345] and [2398] and on the possible preservation of a collapse and inwardly rotated arch in the southern furnace [2567].

The burnt pit [2400] (which yielded hammerscale) and is therefore a contender to be a smithing hearth, was a sub circular pit, 0.7m in diameter and 0.2m deep. Pit [2463] was of a similar size (0.9m by 0.6m and 0.2m deep). Either, or both, may have been smithing hearths associated with furnace [2398].

The evidence from the fresh and roast iron ore suggests that pits ([2448] and [2461] or [2450]) within Group 2f may have functioned as ore roasting hearths. Pits [2448] and [2450] are large (each over 2m in diameter); pit [2461] is smaller (0.7m in diameter and 0.35m deep).

Interpretation

The residues from ironworking are indicative of iron production, including the preparation of the ore (probably a gossan ore), the smelting of the ore to form a raw bloom, and the subsequent smithing of the bloom to work the iron down to usable form. The evidence provisionally suggests that the ore roasting was undertaken in large pits, smelting in relatively large-diameter shaft furnaces with a frontal arch and that smithing may have been undertaken in small (700mm diameter) circular hearths.

This evidence complements that, not only from the earlier part of the same site (Young 2014b), but also from the nearby Richard Lander School (Young 2008a), which shows similar evidence within the context of unenclosed settlement, but here the ironworking was apparently taking place within a landscape divided into fields, away from any occupation.

The evidence for the type of furnace employed for iron smelting at the site is limited, but all three show tentative evidence for the presence for a basal arch. Such an arch would have allowed access for clearance of the bloom and slag after a smelt. The variable heat alteration of the pit margin is suggestive of blowing from a point approximately 90-120 degrees from the arch for [2398] and [2567]. Such a furnace style was probably the most common form of Iron Age furnace outside the SE of England.

The style of residue, with very friable FBs, delicate fine prill assemblages and a basal sinter-like deposit, can be paralleled at some Iron Age sites in SW Britain, most notably in some of the northern furnaces at Twinyeo Farm, Devon (Young 2014a). The characteristic build up of ashy debris containing slag and fine fuel particles (the 'sinter') on the floor of the furnace is a feature recorded at several sites in Ireland (e.g. Celbridge, Young 2003; Morrett, Young 2005; Cherryville, Young 2008b). The sinter at Cherryville produced microscopic evidence for the nature of the ore fed to the furnace.

The smithing residues are not tied with certainty to particular hearths, but the occurrence of hammerscale in one burnt pit is highly suggestive. The macroscopic smithing slags comprise a series of relatively large SHCs (weighing 890-1165g, even if the larger 2050g cake is interpreted as a furnace bottom accumulation. Early blacksmithing (the end use of iron for making and repairing artefacts) typically produced small SHCs (e.g. assemblages with mean weights of less than 400g and maximum weights of 850 (e.g. SHC assemblages from Roman smithies at Neath, Carmarthen, Bulmore, Marsh Leys and Cowbridge; Young 2013, Crew 2003, Young 1999, Young 2011, Barford 1996 respectively). In contrast, Roman bloomsmithing slags from Miskin were mainly in the 1kg to 2kg range (author's unpublished data). Iron Age smithing slags are particularly poorly known, but a similar weight range is to be expected. Crew (1998) summarised the assemblage from Crawcwellt West, Gwynedd, as containing larger SHCs of 300-400g, together with smaller cakes of 100-150g. He attributed the larger sizes to bloom refining and the smaller ones to "the final stages of smithing". It should be noted, however, that the smelting furnaces at Crawcwellt were smaller than the present examples, so the bloom, and hence iron-lost on bloomsmithing would be smaller. The SHCs from Richard Lander School site were also smaller than the present examples, but were argued to be from bloomsmithing on chemical grounds; none was complete, with the largest fragment s (which both comprise the majority of their original cakes) weighed 324g and 244g. The weight of an SHC does not, however, just depend on the amount of iron lost to the hearth, for more frequent cleaning of the hearth would yield smaller SHCs. Establishing a model for the bloomsmithing would be a valuable outcome from the analysis phase of this project.

The occurrence of collections of alluvial cassiterite and what currently appears to be crushed cassiterite-bearing ore is a very interesting discovery. The site has produced no evidence yet that any of the metallurgical activity was Bronze Age in date (it all appears to be iron working) – so the deposition of tin ores is not directly linked to any smelting of those ores.

Conclusion

The site presents two quite separate phases of metallurgical activity. Both activities can be paralleled, interestingly, at the Richard Lander School site (Young 2008) on the opposite (west) side of Truro.

The ironworking is probably of Iron Age date. The presence of ore roasting, smelting and bloomsmtihing make this a very good record of multiple stages of the *chaîne operatoire* of iron production. The site has the potential to shed considerable light on this activity.

The specially-deposited cassiterite pebbles are more abundant than those at Richard Lander, making their geological investigation a potentially useful exercise. The presence of apparently crushed ore is perhaps even more significant, because little was known about the processing of cassiterite. Comparison of the pebbles and the crushed residue may be informative about the process. The assessment suggests the fines are a mixed assemblage of crushed cassiterite and gangue that appears not to have undergone any beneficiation. The lack of any metallurgical activity to accompany the deposition, and perhaps processing, of the cassiterite is of great significance in the understanding of the early exploitation of tin. The value of the cassiterite caches is particularly enhanced by their association with structured deposits including datable pottery.

The two groups of material are both worthy of considerable additional analysis to realise their potential. A proposal for such further work will be submitted separately. The material is of great significance and the collection should therefore, subject to further analysis, be retained and deposited with a suitable institution.

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Table 1: summary catalogue

context	sample	field	other	sample wt (g)	item wt (g)	item no	notes
2001		F2	HR?	234			
					234	1	extremely dense, internally flow-lobed slag; weeping and fracture suggests some exploding of internal iron
2289				44			
					44	1	iron rich concretion in sandy charcoal-bearing clay
2335		f2		100			
					20	6	flow slag fragments
					8	3	lining fragments
					68	24	indeterminate iron slag fragments
2344		f2a		182			
					176	36	small assemblage of flow lags, with just a couple of rougher-textured pieces
2344				200			
					128	27	flow slag prills
					52	7	sinter-like material, very black (Mn-rich presumably) with lots of fine charcoal moulds
					8	1	reduced-fired lining
					8	1	glazed pebble
2344	248	f2a		224			
					108	83	flow slag in various forms, including many small spheroids down to 2mm
					4	2	lining fragments
					86	55	rough-textured material, including sinter
2360				14			
					14	1	a thin sheet of corroded iron

context	sample	field	other	sample wt (g)	item wt (g)	item no	notes
2363	253			1	1		highly-fragmented debris, probably a ferruginous lining slag in many fragments
2369				16	16	1	vitrified oxidised lining
2386		F2aa		162			
					24	1	rusty accretion on thin lobate sheet of iron slag
					130	1	accreted slag block, with lower density slag above curved dense crust; probably, but not certainly, an SHC fragment
					2	1	bleb of lining-influenced slag
2397			3 of 4	3390			
					2050	1	large SHC-like block, very irregular top (possibly suggesting an origin as basal furnace slag); internally very porous, but has lower moderately dense crust; 200x160x80(55)mm, base shows multiple paler grey lobes with some included gravel clasts; preserved dimpled/wispy top is smooth, brown and irregular
					372	1	FB-like material with a very large (wood?) mould (55x60mm and >25mm thick)
					720		bits of FB-like material; porous and or lobate
							other fines, mostly sieved in search of hammerscale
2397			2 of 4	4285			
					1165	1	130x125x55mm, plano-convex SHC with neatly formed, slightly dished, top; starting to exploded, very dense. Not washed to avoid exacerbating explosion
					628	1	135x(90)x40mm, 70% of SHC; slightly plano-convex, top dimpled
					164	1	small SHC fragment similar to 628g piece but doesn't join
					74	1	possible SHC edge fragment
					454	1	fragment of burr/attachment to orange wall, dense; could be either furnace slag or SHC; contact 115mm wide and >60mm deep, only extends forward of wall 50mm
					remainder		mixture of porous FB-like material and many pieces of well-developed flow slag prills
2397			1 of 4	3400			
					544	1	fragment from basal crust of either SHC of furnace slag; 140x105x45mm
					380	1	large irregular slag piece with one wall contact, plus some lobes; probably a furnace wall piece
					184	1	probable furnace floor slag, porous
					458	1	very dense slag with contact with orange wall; top smooth and slightly lobate; proximal side of either FB or SHC

context	sample	field	other	sample wt (g)	item wt (g)	item no	notes
					remainder		fragments of FB material, together with some denser pieces of good flow slag around moderately larger charcoal (as moulds).
2397			4 of 4	3965			
					722	1	70%? of SHC; 175x(100)x55(40)mm; irregularly lobate/wispy top, base fairly neat, little crust. Might just be a furnace bottom puddle, but unlikely
					168	1	probable SHC marginal spall
					remainder		fragments of FB material together with many denser pieces of good flow slag around moderately larger charcoal moulds and some good prills. Includes a very dense fragment with flow lobes and granular crust
					486	1	slab like block of FB material, dense with large fuel moulds, one flat face is rather granular slag - unclear if it is an odd lower contact (e.g. onto stone) or a top
2397	263			246			
					120	15	flow slag
					114	18	sintery material, rough, rich in very fine charcoal
					2	1	vitrified shillet piece
2397	263			492			
					34	16	lining and lining-related materials
					136	39	flow slag
					292	130	rough materials - probably basal layer rather than FB
2399				30	30	21	concretionary material, including slag blebs, charcoal and hammerscale, along with a small amount of tiny shillet grains
2403		f2a		552			
					498	7	FB fragments ranging from porous with large charcoal moulds to dense prilly pieces
					8	18	debris from FB material
					46	3	lining slags, two with pale oxidised ceramic to rear
2413				<1	<1	1	fragment of vein quartz
2418		f2a		32			
					12	2	dense flow slags
					22	4	indeterminate iron slag fragments

context	sample	field	other	sample wt (g)	item wt (g)	item no	notes
2442	223		cassiterite	498	498	99	5-35mm pieces, all rounded, some fragments my not be cassiterite
2442	274		cassiterite	76	76	80	up to c12mm
2443/2476	285			4	4	1	small dense rounded pebble - probably cassiterite
2446		f2a		12	12	1	small nub of clinkery slag, porous, with charcoal but also some pale grey melted sediment patches
2449		f2a		862			
					830	1	180x115x60mm, concavo-convex object, either from base of furnace or is an SHC missing its top; slag porous; missing top except at one end where it passes into flow lobes; lower surface mainly a single rough convex surface, but has central additional rusty slag mass
					32	2	stones
2455	272	F2a		46			
					46	19	roasted ore fragments, soft, some very fine grained, fissured and broken
2459	275			20	20	c40	small rounded, polished granules
2459		f2a		24	24	11	granules
2460	277	f2a	1 of 3	340			
					340	45	goethite iron ore,
					1	1	phyllite
2462				290			
					40	6	fragments of ferruginous concretions including slag fragments and charcoal
					10	2	accreted slag fragments
					238	1	dense flow slag from base of furnace, gravel on part of base, prills on other part; large fuel clasts higher with splits suggesting wood; sheet c. 45mm thick
2462	278	f2		306	306	assm	assemblage of small fragments of sinter-like material, including flow slag lobes in ashy and concretionary matrix; many flat sheets and rounded bodies with flat surfaces; all slag is rather pale and appears lining influenced

context	sample	field	other	sample wt (g)	item wt (g)	item no	notes
2466			ore?	166			
					166	1	fractured and possibly burnt quart-rich pebble with low grade iron mineralisation
2471				224			
					172	2	flow slag, one small prill and one very large mass of broad lobes, possible mould of long 10mm stick on top of gravel base.
					54	1	fired shillet-rich ceramic
2480		f2a		54			
					54	4	rather worn and brown fragments of iron slag, gravelly base to one, smooth viscous surfaces on several. Probably but not certainly, FB-like fragments
2566	297			554			
					90	20	flow slags
					294	75	rough materials, some with coarse olivine so mainly FB rather than sinter
					134	22	lining and lining-related material
2572		f2d		18			
					16	1	dark goethite ore
					1	2	reddened goethite ore
2574	299			50			
					32	5	sintery or FB material, porous
					16	6	flow slag
2575	300	f2d		1320			
					38	11	lining and lining-related material
					742	assm	flow slag
					526	assm	rough materials, some basal, some charcoal rich

context	sample	field	other	sample wt (g)	item wt (g)	item no	notes
2576	296			<1	<1	2	one tiny granule of ?cassiterite, other granule may be fired clay
2579	302			5080			
					380	30	fragments of ashy 'sinter'; varying proportions of slag, granules, ash, and very fine charcoal
					88	9	fragments of ceramic, including some vitrified oxidised lining
					remainder	several hundred	small pieces of flow slag, with some occasional larger blocks of coalesced prills
2581	298			2020			
					34	2	lining material
					remainder		fragmented charcoal-rich FB with prilly base. All very friable. Max observed thickness c50mm
2581	298			4145			
					1590	1	190mm wide section of almost straight gravelly pit wall, slightly curving into prilly contact. Orientation unclear. If prilly contact is a base, then wall is overhanging, but other interpretations possible. Charcoal-rich slag adheres to wall and extends out 70-80mm. Towards ?base shows 50mm wide flat mould in orientation close to that of the wall.
					1730	1	large block of internally prilly slag with abundant, mostly modestly sized, charcoal moulds. Orientation uncertain.
							remainder; lots of charcoal mould-bearing debris, with a few isolated and very small dense prills.
2581	298			3585			assemblage of smaller fragments of similar hearth bottom material (largest piece c. 950g).
2581	298			3410		1	single large block of FB material, porous, charcoal rich, internally prilly,
2581	298			3595			
					1660	1	large transverse block showing strong wall slag interaction. Probably foot of wall, possibly overhanging, with dense slag on steep wall and prills below slag mass remainder charcoal-bearing FB material with a few significant pieces with larger flow lobes (good for sampling?)

context	sample	field	other	sample wt (g)	item wt (g)	item no	notes
2588		f2d		18			
					18	1	gravelly lining slag with very rusted accretion
2588	303	f2d		16			
					16	17	mostly rather poor flow slags
unstrat		f2	above 2230	36			
					18	1	grey mudrock with small cavities after pyrite or fossils maybe; with one face heated an glazed with clear ash glaze
					18	1	exploded iron object, elongate, c.4mm wide, outer face of concretion shows suggestion of head- so maybe a nail
u/s		f2 hr	adjacent to pit 2294	<2	<2	4	contorted phyllite
u/s		f2a		40	40	1	flinty grey tin slag with one darker, vesicular surface
u/s		f2c		1860	1860	2	fragments of dense plano-convex slag blocks, 70mm and 60mm thick - potentially from same block but do not join; both bear moderately large charcoal fuel fragments. Almost certainly FB not SHC.
u/s		f2c		94			
					94	1	very dense flow-lobed slag, possibly the central part of a birdsfoot.
u/s		f2c		120			
					94	1	dense slag with abundant charcoal fuel moulds
					14	1	flow slag fragment
					18	1	low-density; section of sandy ceramic from unaltered to highly bloated

context	sample	field	other	sample wt (g)	item wt (g)	item no	notes
u/s		F2a		166			
					2	1	glassy slag, top smoothly lobate, base slightly contorted, locally reddened and rough, probably a tin slag
					162	3	two certainly join, the other might; fragments of dense iron slag sheet with rough base and poorly lobate top, probably but not certainly a smelting slag
3131		f3		30	30	1	ferruginous material, including shale and quartz fragments, probably a poor iron ore or concretion
3131	213	f3		16	16	3	ferruginous material including shale and quartz fragments, probably a poor iron ore
3218		f3a 51		6	6	1	probable cassiterite-bearing pebble
3334				126	126	1	part of hollow goethite concretion from shale; interior has soft ochrey clay
3414	345		cassiterite	192	192	12	12-32mm gravel
3414	345		cassiterite	132	132	27	24 probable good ore, 3 probably not ore
3414		f4	cassiterite	2270	2270	38	mostly >20mm pebbles with cassiterite in varying amounts - mostly not good high grade material
3416	346		cassiterite	9095			fines sieved from residue of pit with cassiterite - extremely dense
3416	346		cassiterite	24	24	3	up to 20mm
3416			cassiterite	1250			
					332	8	cobbles with perhaps a little cassiterite, but probably none in some cases
					696	13	cobbles with density suggesting cassiterite present
					216	1	broken cobble fragment with good mineralisation of cassiterite
?		f3b	box5	4	4	1	flow slag bleb
u/s		f3		64	64	1	fragment of nub of clinkery slag; has a litle shale, brown/maroon surfaces locally but otherwise looks like iron-rich slag

context	sample	field	other	sample wt (g)	item wt (g)	item no	notes
u/s		f4	se 1/2	2	2	1	coal
u/s		f4 w1/2	4201/2	122	122	1	large fractured piece of fine slate-grey slag, has blistered top with red bases to the flat-bottom vesicles, tin slag
5070		f5		46			
					<1	1	dark coarse pottery
					2	1	highly vesicular iron slag
					1	1	coal
					<1	1	coke
					14	1	highly vitrified lining
					26	1	flow slag, slightly odd colours, blueish bloom to lobe surfaces and internally slate grey, very fine; tin slag
u/s		f5		6	6	1	clinkery slag fragment, highly vesicular, almost black
6001		f6		36			
					22	1	bulbous dense slag lobe, reddened surface, so tap slag, but very fine and almot certainly a tin slag
					12	1	highly bloated ceramic or stone fragment
u/s				14	14	1	fragment of ball of clinkery slag. Small shale fragment, reddened, grey vesicular slag

Table 2: residues vy classes and context/features. All weights in grams. Unstratified totals for fields include material from topsoil.

Feature	context	typical FB	dense FB	fine FB/ sinter	fine flow slag	goethite	Indeterminate slag	lining etc.	SHC	scale?	cassiterite etc	tin slag	bloated ceramic	clinker	coal	Concretion	iron	Non met.	*total*
CONTEXTS WITH CASSITERITE-																			
2447	2442										574								*574*
2447	2459										44								*44*
3417	3414										12963								*12963*
2494	2443/2476										4								*4*
2577	2576										<1								*0*
3272	3218										6								*6*
CONTEXTS WITH IRON WORKING RESIDUES																			
2334	2335				20		68	8											*96*
2345	2344			138	412			19											*569*
2361	2360							16									14		*30*
2364	2363							1											*1*
2387	2386						24	2	130										*156*
2398	2397	5661		3110	256		2962	36	3465	yes									*15490*
2398	2471				172			54											*226*
2400	2399									yes						30			*30*
2404	2403	506						46											*552*
2418	2418				12		22												*34*
2448	2446						12												*12*
2450	2449						830											32	*862*
2463	2462			306	238		10									40			*594*
2479	2480			54															*54*
2567	2566			294	90			134											*518*
2567	2574			32	16														*48*
2567	2575			526	742			38											*1306*
2567	2579			380	4612			88											*5080*
2567	2581	16721						34											*16755*
2590	2588				16			18											*34*
CONTEXTS WITH IRON ORE																			
2448	2455					46													*46*
2461	2460					340												1	*341*
2573	2572					17													*17*
3340	3334					126													*126*
UNSTRATIFIED, TOPSOIL AND CONTEXTS WITH NO RESIDUES																			
2414	2413																	<1	*0*
2292	2289															44			*44*
2474	2466																	166	*166*
3132	3131															46			*46*
f2u/s			1954		108		162	18				42	18				18	4	*2324*
f3u/s					4									64					*68*
f4u/s												122			2				*124*
f5u/s							2	14				26		6	2				*50*
f6u/s l												22	12						*34*
	total	*22888*	*1954*	*4840*	*6698*	*529*	*4092*	*526*	*3595*		*13591*	*212*	*30*	*70*	*4*	*160*	*32*	*203*	*59424*

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