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Evaluation of archaeometallurgical residues from the Richard Lander School, Truro (RLS 04)

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Abstract

The collection of 16.2kg of material included 12.3kg of archaeometallurgical residues, approximately 2kg of iron ore and 0.1kg of tin ore. The archaeometallurgical residues from Iron Age contexts included evidence for both iron smelting and iron working, as well as working of copper alloy. In-situ metalworking evidence was extremely limited, with a deposit of hammerscale in House 6 the most likely example; in general the low level of residue accumulation suggested that the focus of metallurgical activity might be outside the investigated area. The ringditch of House 6 yielded macroscopic slags from smithing, as well as crucible fragments and residues from copper alloy working. The ringditch of House 6 also yielded several pieces of a substantial tuyère. In contrast, the ringditches of houses 3 and 5 (in particular) yielded slag assemblages dominated by slags from iron smelting. Internal features in House 1, and to a lesser extent House 4, yielded quantities of a goethite iron ore. Houses 1, 4 and 9 yielded just small quantities of residues.

Features in the area of the Bronze Age activity, Area F, yielded no slags, but the fill of posthole 6608 (C6607) contained four broken pebbles of tin ore.

Contents

Methods

All the macroscopic material from the collection was inspected visually (and with a low-powered stereo-microscope where necessary) and recorded to a spreadsheet (Table 1). Descriptions and interpretations of material are necessarily limited by this approach.

Results

Residue description

Iron smelting residues

Residues identified as being derived from iron smelting comprised 9.08kg of the total assemblage of 12.25kg. Of this, 7.59kg of smelting slags were recovered from the ringditch of House 5.

The smelting slags were those typical of iron smelting in a low-shaft furnace with a basal slag-pit. In common with other examples of this style of furnace, the slags suggested that the basal pit was packed with large pieces of charcoal or, more likely, wood.

The assemblage contains several slabs of material, which have been generated by interaction between descending slag (evidence by numerous descending slag prills) and the floor of the furnace. Commonly on sites where bog ores were being smelted (perhaps the most common source of ore in described Iron Age furnaces) the base of the pit becomes coated in a porous sinter; the lack of such material in this assemblage provides supporting circumstantial evidence for the smelting of rock ores (like those from House 1 and 4).

Iron ore

House 1 yielded 22 pieces of iron oxide ore, probably goethite, totalling 1.93kg, from a variety of contexts and 4 small pieces of similar ore (total 24g) were recovered from a posthole in House 4. The ore is layered, with variously alternating bands of more- and less-dense ore (picked out as brown and yellow layers), or alternating coarsely crystalline and botryoidal layers, or even layers of goethite separated by voids. In the large specimens the ore seems to have a boxstone morphology. Some associated pieces of low-grade material bear a small proportion of quartz.

The goethitic ore is of uncertain origin, but it is probably significant that the mines which impinged on the site in the 19th century (East Wheal Falmouth) were part of a complex which, slightly to the west, was amongst the most significant producers of iron ore from gossan (the oxidised upper levels of veins of sulphide mineralisation in which iron is concentrated) in the region (Wheals Falmouth and Sperries produced 10,474 tons of iron from gossan in 1832-4 and 1860-72; Dines, 1956 p. 431). The iron ore is likely therefore to have had a local origin.

Iron working residues

Residues from iron-working (smithing) were not particularly abundant on the site, and no well-formed examples of smithing hearth cakes (SHCs) were retrieved. House 6 yielded almost all of the certain macroscopic smelting slags from the site (as well as having a deposit of smithing microresidues, hammerscale). None of the smithing hearth cakes (SHCs) was certainly complete, with the largest fragment (which comprised the majority of the original cake) weighing 244g and with two smaller (and just possibly complete) examples weighing 136 and 144g

Tuyères

Although small pieces of vitrified ceramic occurred widely on the site, certain tuyère fragments are restricted to finds from the ringditches of houses 5 (258g) and 6 (800g).

Preliminary investigations of the tuyères suggests that the material from House 5 has fired to an unusual lilac colour, which may be the result of the clay composition, but might alternatively indicate use in non-ferrous metalworking.

The specimens from House 6 suggest an elliptical or eccentric shape to the face of one tuyère (of which there are several fragments), with a bore of approximately 20mm diameter. Another fragment, probably from a different tuyère appears to show a flat side – possibly the base. A third group of fragments are in a very shale-rich fabric, but is rather poorly preserved.

Other archaeometallurgical ceramics

There are many small fragments of probable vitrified hearth/furnace lining from a wide variety of contexts across the site. A very large number of these show a very dark glass, which bears an abundance of crystals of quartz, sometimes with very little glass binding the abundant crystals.

Concentration of clasts from the wall ceramic into the glassy slag phase is a common phenomenon, but external sources of the crystals might also be possible (e.g. welding flux or even quartz gangue from iron or tin smelting).

Other residues

Some of the iron slags (678g), particularly much of the slag in small fragments, is not attributable with confidence to either smelting or smithing. This material includes small isolated horizontal prills, massive vesicular slags, slags rich in small charcoal fragments and material consisting of a single flow lobe.

A rather distinctive facies of low-density slag, which has the appearance of coagulated micro-spheroids, was recovered in small quantities from, amongst others, House 4 (C3039 and C3045), and somewhat similar material from House 3 (C2542). These bear some similarity to sintered material from domestic hearths and ovens recorded by Young from Bornais (S. Uist). These slags are not, therefore, necessarily the product of metallurgical activity.

Other material

The collections include a variety of materials that are not archaeometallurgical, including quartz porphyry material from the dyke, small granite pebbles and some silicified green metamorphic rock.

Archaeological materials include a few small fragments of pottery plus some coke-like material, of which some at least is burnt bone.

Tin ore

The examples of tin ores are alluvial pebbles bearing material apparently from very coarse-grained veins. The quartz crystals appear to be up to 15mm in length. The pebbles are very dense, indicating a high proportion of cassiterite.

Residue distribution

House 1 yielded 22 pieces of iron oxide ore, probably goethite, totalling 1.93kg, from a variety of contexts. Much of this (9 pieces, 1.73kg) came from C4093, the fill of the hearth/furnace below 4036. The slag assemblage from House 1 was small (543g), so it is unlikely iron smelting was undertaken in the structure, despite the assemblage of circular pits with burnt fills. Although the ore was recovered from one of these “hearths”, it does not appear to have been significantly burnt, and may have not been involved in the burning activity. It is conceivable that the pits might have been used to roast ore prior to smelting as was commonly done with iron ores, but there is no direct evidence of this, although two tiny pieces of ore from the ringditch (total 8g) did contain haematite and might have been roasted.

House 3 produced only a small slag assemblage, with a single block of iron smelting slag from the ringditch providing 806g of the 910g assemblage.

4 small pieces of goethite ore (total 24g) were recovered from posthole 3151 in House 4, but the total slag assemblage from the house was only 42g.

House 5 was characterised by a large quantity (7.58kg) of iron smelting slag, accompanied by three fragments of tuyère, within the ringditch. The ringditch also contained a large quantity of stone, so it is possible the smelting slags were brought in from elsewhere with the stone. There was no indication of a smelting furnace associated with the structure.

House 6 provided evidence for a range of metallurgical activities, although the volume of residue recovered was small and therefore the scale of the activities is hard to establish. Iron working (smithing) is indicated by the occurrence of a deposit of hammerscale within the house (possibly an accumulation on the working floor), and by smithing slags in the ringditch. 387g of indeterminate hearth lining and 800g of probable tuyère material from the house give evidence for the nature of the hearth. Sherds of a small crucible and some copper alloy residues suggest that some copper-alloy working was also carried out in this house. House 6 did not provide direct evidence for a hearth.

House 9 yielded just 93g of residues.
Ditch 7011 produced a block of slag and attached wall from the basal pit of a smelting furnace.

In Area F a posthole (C6608) contained four broken pebbles of quartz and cassiterite, forming a high-quality ore, from an alluvial source.

Interpretation

The evidence from the site suggests that a wide variety of metallurgical tasks were undertaken during the Late Iron Age phase. Iron was smelted, probably from local goethite gossan ore, using the low shaft furnaces with basal slag-pits that are the norm for the Iron Age in Britain. The slag from these pits would have been cleared between smelts, and has subsequently become incorporated into a range of contexts across the site. The location of the smelting furnaces remains unknown.

The details of such slag-pit furnaces have not been fully published, despite being widely recognised. The terminology and typology of these furnaces is muddled and obscured by local usage (see discussion in Pleiner, 2000), but a widespread use of this spectrum of furnace types seems to have occurred across Europe in the first millennium BC. Examples include some from East Yorkshire (Clogg 1999; Halkon 1997), Berkshire (Hartshill Copse, author's unpublished data) and Surrey (Brooklands, Hanworth and Tomalin 1977). There is some evidence that, in the Bristol Channel area at least, the advent of slag tapping furnaces occurred well within the pre-Roman Iron Age, and slag-pit furnaces have not yet been recorded within the sphere of influence of the Forest of Dean orefield (Thomas 2000).

The most complete treatment of non-slag tapping furnaces from the British Iron Age is the study of examples from North Wales by Crew (1987, 1989, 1998) and their subsequent experimental modelling (Crew 1991). These examples do not, however, have a large basal pit, and do not show the moulds of large wood fragments in the basal slags.

Good examples of furnaces of the slag-pit type have now been recognised from the Iron Age of Ireland, where the technology continues in use much longer (Young 2003, 2005b).

House 1 produced a moderate amount of iron ore. The questions as to whether the ore was stored there, if was roasted in a hearth within the house, or whether the large quantity of choice ore in the pit was a deliberate burial, are at present not determinable.

There is evidence for iron-working in House 6, but the slag assemblage (2388g total) is small, and it is uncertain whether this was a significant activity. The small amount of residue hints that it was not a large-scale activity, such as would be required for the refining of the raw blooms being produced by the smelting elsewhere on site. The few surviving SHCs are of small size and are suggestive of blacksmithing.

Non-ferrous metalworking is also indicated in House 6, with the occurrence of sherds of a small crucible and associated copper-alloy residues. The presence of tuyères in the ringditch of the house is interesting, and it will be important to determine whether these were used for the iron- or copper alloy-working (or both).

The find of tin ore within a posthole in Area F is extremely interesting, but at present there is no evidence that tin was being smelted on the site in the Bronze Age. Clearly tin ore was handled on the site, and placement of these pebbles in the posthole may have been deliberate.

Evaluation of potential

The archaeometallurgical residues from the site have potential to enhance understanding of the development of mineral exploitation in the area. The potential of the site is somewhat limited by the small size of the assemblage and by the lack of in-situ evidence, but clearly the site was involved in a wide variety of metalworking and metal-producing activities, and elucidation of these would be of great value and significance.

In particular, analysis and investigation of the iron smelting should be able to enhance provenancing of the ore material and to confirm whether the ores found on site were similar to those being smelted. Although the site lacks in situ smelting remains, the slag assemblage should be sufficient to work towards a mass-balance for the smelting operation (Thomas and Young 1999a and 1999b), which will provide data on the yield of the process.

The iron working evidence is rather sparse, but the possible occurrence of tuyères associated with the smithing residues is significant and unusual. Analysis will help to determine whether the tuyères were employed for the iron or non-ferrous working.

The archaeometallurgical ceramics also include furnace/hearth-lining material with a high proportion of quartz. Further analysis is desirable to determine whether this material reflects use of a quartz-rich lining, use of a quartz flux in smithing, or even possibly whether some of this lining material may result from smelting of the quartz-rich tin ores.

The non-ferrous metalworking debris from the Late Iron Age contexts should also be examined to determine, if possible, what sort of alloy was being worked.

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				smelting slag	smithing slag	indet. Slag	lining	tuyère	burnt stone	concretion	goethite	Cu materials	Tin ore	natural	iron	Slag Total
Area A																
Area A - ditch 1000																
u/s	near 1001	2.38	granite pebble											2.38		
Area A - Primary fill of ditch 1014 (=1000)																
1025		2.68	small lump of concretionary mud - rich in quartz grains and charcoal pieces - not slag											2.68		
				0	***0***	***0***	***0***	***0***	***0***	***0***	***0***	***0***	***0***	***5.06***	***0***	***0***
House 1																
House 1: Cleaning over 4006 house																
4007		44	piece with rough base and dimpled top, 20mm thick, probably small piece of SHC, but might just be basal furnace layer			44										
		1.9	small worn grain of vesicular grey dense iron slag			1.9										
		0.86	small chip of fired clay				0.86									
		0.85	pale slagged lining				0.85									
		1.43	in 2 pieces, small piece of fired slate, fired and exploded						1.43							
4007		4.56	goethite ore - dark goethite in coatings on and through yellow rock								4.56					
		4.43	iron rich rock with quartz veins and vugs								4.43					
4007		4.83	2 pieces of dense grey vesicular iron slag, locally redish tint, and with zone of abundant quartz grains			4.83										
4007		7.77	goethite ore								7.77					
4007		22.91	irregular block of lining slag with all sorts of ceramic and crystal part melted inclsions, generating white, black, red and blue glasses, one area of surface shows wrinkly ?magnetite coating				22.91									
				0	***0***	***50.73***	***24.62***	***0***	***1.43***	***0***	***16.76***	***0***	***0***	***0***	***0***	***75.35***
House 1: Ringditch																
u/s	h1 base of ring gully s side	17.66	broken in 3. Slag with basal contact with lots of quartz, top shows mixing. Internally vesicular, 2 bits from tip of lobe are very vesicular and have platey olivines			17.66										

4001	11.8	corroded iron object										11.8	
4001 <200>	1.36	2 coffee bean-like blebs, larger one broken in half, both internally dark and vesicular			1.36								
4001 slot 3	25.37	dished piece of lining with very pale sandy material, below vitrified layer. Vitrified layer rather altered but some browny glss. Sandy material contains large bleb of Cu-weathering product. Some possible Cu residue on dished vitrfied surface too				25.37				*			
	62	irregular slaggy mass, mostly lining-dominated but some fayalitic. Lots of quartz clasts, some finely crystalline slag. Lower face with descending lobes, very irregular			62								
	1.6	goethite ore fragment							1.6				
4001	29.72	layered goethite ore - yellow softer and darker harder layers on 5mm scale, curved concentric surfaces							29.72				
4002 slot 1	22.74	dense vesicular slag fragment, 1 edge rich in charcoal - smithing slag?		22.74									
4013	174	rather degraded slab of slag from floor of hearth or more likely furnace	174										
	92	block of goethite ore with 2 frags. Crystalline layers plus botryoidal coatings							92				
	8	two small pieces of ore with some haematite - not clear if natural or roasted							8				
	18	5 pieces of microprilly slag with tiny charcoal moulds and flat/dimpled basal surface			18								
	14	2 small cubes probable of smelting slag - charcoal impressions on one and arcuate cooling surface on the other	14										
	2	clinker from bone?											
	4.25	lining slag				4.25							
	6.27	natural quartz-rich vug									6.27		
	5	fine debris, including 2 tiny sherds of pot											
4013	8.3	greenish lining slag full of crystals with multicoloured glass				8.3							
	2.85	2 pieces of weathered dense slag prill			2.85								
4015 slt 10	4.12	corrded Fe object (nail point?)										4.12	
	12.03	thin slab of vesicular grey slag - slightly odd looking - somae has v dark, v fine equant texture - almost like fine coke			12.03								
4020	78	slab of dense dark slag, base rough, top has charcoal dimples, base convex so could be smitihing slag			78								
			188	***22.74***	***191.9***	***37.92***	***0***	***0***	***0***	***131.32***	***0***	***0***	***6.27***	***15.92***	***440.56***

House 1 - internal features															
House 1 - upper fill of hearth 4023															
4022 q3	592	8 pieces of ?lava - large quartzs in fine matrix											592		
	472	2 pieces of silicified green rock with quartz veins and vugs											472		
House 1 - Fill of posthole 4046															
4047	3.38	small bleb of slag with slag with very dark Fe-slag like surface but probably lining dominated, lots of included rock chips				3.38									
House 1 - Fill of pit 4050															
4051	24.1	lining slag in 3 pieces, black glass (low volume) binding abundant crystals				24.1									
House 1 - Fill of posthole 4054															
4055	34.52	iron rich concretion - may conceal metal/artefact							34.52						
House 1 - Fill of hearth/furnace below 4036															
4093	1730	8 pieces of goethitic ore								1730					
4093 <239>	0.63	pot													
	1.03	small piece of goethite ore								1.03					
4093 <239>	46	5 pieces of goethite ore								46					
			0	***0***	***0***	***27.48***	***0***	***0***	***34.52***	***1777.1***	***0***	***0***	***1064***	***0***	***27.48***
House 3															
House 3 - ringditch															
2501	8.26	dense dark slag belb with lots of accreted fine organics			8.26										
2510	26.57	dense vesicular slag with large charcoal impressions, one end has lots of quartz, irregular blebby lobe			26.57										
2524	7.62	c14 pieces of pale vesicular lining slag				7.62									
2529 slot 8	7.57	vitrfied lining, rear fired pink				7.57									
2530 slot14a	806	rusty furnace bottom slag in 3 pieces, with large included charcoal	806												

2534 slot 2	24 dark slag on red lining. Lots of included large quartz, slightly plasticy lustre, superficial glass has rotted yellow				24									
2539 sl15	12.9 2 very weathered dense slag horizontal prills	12.9												
	10.04 grey quartz-rich slags, some streaks of brown glass			10.04										
2541 #16	3.04 fragment of vitrified lining. Rear fired pink				3.04									
2542 sl10	1.57 similar to 3045/3039 - grey glassy vesicular slag with globular texture (cf. Bornais hearth sinters?)			1.57										
		818.9	***0***	***46.44***	***42.23***	***0***	***0***	***0***	***0***	***0***	***0***	***0***	***0***	***907.57***
House 3 – internal features														
House 3 - fill of posthole 2571														
2572 <424>	2.35 dark slag bleb - rather irregular in shape and rather weathered			2.35										
		0	***0***	***2.35***	***0***	***0***	***0***	***0***	***0***	***0***	***0***	***0***	***0***	***2.35***
House 4														
House 4 - Ringditch														
3036 s21	bag of charcoal-rich ashy sediment - a charcoal sample													
3037 <406>	11.8 coarse slag with very large charcoal moulds	11.8												
3039	14.7 low density slags as 3045, pale grey glassy slag			14.7										
3045	12.02 extremely low density lining slags, with very high vesicularity, one part is made of coagulated spheres, 5 pieces			12.02										
		11.8	***0***	***26.72***	***0***	***0***	***0***	***0***	***0***	***0***	***0***	***0***	***0***	***38.52***
House 4 – internal features														
House 4 - Fill of stakehole 3095														
3096 <432>	3.09 unusual glassy slag, dark with reddish tint, lots of included quartz-feldspar and vesicles, piece is well rounded and looks water-rolled. Has generally rather plasticy appearance			3.09										
House 4 - Fill of posthole 3151														
3152 <436>	24 4 pieces of goethite ore							24						
House 4 - Fill of stakehole 3155														
3156	2.26 coke													

		0	***0***	***3.09***	***0***	***0***	***0***	***0***	***24***	***0***	***0***	***0***	***0***	***3.09***
House 5														
House 5 - Ringditch														
3501 <601>	2.85 small broken piece of dark vesicular slag - probably a hollow flow lobe			2.85										
3506 slot1a	922 furnace floor slag accumulation, stalactite at one end connected with smooth-topped flow passing over, and into, charcoal bed	922												
	632 furnace wall-foot material with dense slag on edge with lots of coarse quartz, passing into material with pendent prills	632												
	50 3 small pieces broken from above large pieces	50												
3506	2175 large piece of furnace bottom with basal flow, brecciated material on base, glassy slags at one end and quartzite piece fused to top	2175												
	398 basal flow slab, rather weathered, end bent to make rather convex base	398												
	772 rusty iron slag mass- probably another furnace bottom piece but not certain	772												
	178 good slag flows between very large charcoal/wood pieces	178												
	36 small piece of dense slag flow	36												
3506 slot1a	1340 large piece of complexly-flowed basal slag mass, good evidence for large charcoal/wood, base is prilly, 4 other pieces probably derived from this	1340												
3511 sl2a	56 broken up furnace slags - very rusty, some smooth surfaces, lots of friable crusts	56												
3515	924 block of slag enclosing large charcoal pieces - good charcoal present	924												
	166 piece of metamorphosed sandstone? - cf quern-like pieces in 4022											166		
	280 2 pieces of vein quartz											280		
3516	258 3 pieces of possible tuyere - has lilac colour to one unglazed side					258								
	106 dense well flown slag blebs surrounding large charcoal moulds	106												
		7589	***0***	***2.85***	***0***	***258***	***0***	***0***	***0***	***0***	***0***	***446***	***0***	***7850***
House 6														
House 6 - Buried soil														
4502	0.15 tiny lining slag fragment				0.15									
4502	14.23 dense slag in stacked small lobes and prills, not certainly but probably a smelting slag. Had small speck of Cu corrosion in attached soil, but not part			14.23										

		of slag													
4502	11.8	corrosion around small disc? of iron. Concretion rich in hammerscale and charcoal												11.8	
			0	***0***	***14.23***	***0.15***	***0***	***0***	***0***	***0***	***0***	***0***	***0***	***11.8***	***14.38***
House 6 - Ringditch															
4500 u/s	46.62	dense slag in crude lobes - resembles other furnace floor material from this house	46.62												
4501	78	slab of slag with smoothly lobed, possibly blown top. Some ashy and charcoal-rich material adhering, base probably smooth but concreted with charcoal and some slag, probably part of a small SHC		78											
4501	258	large piece of possible tuyere, 20mm hole, face extends 55 in one direction and 35 perpendicualrly					258								
	40	small piece of glazed tuyere face					40								
	138	11 lining pieces				138									
	26	dense furnace floor skin	26												
	2	indet. iron slag			2										
4501 batch2	80	same tuyere as above					80								
4501 batch2	132	same tuyere as above					132								
4501 slot 10a	242	major part of small SHC. 120mm diameter and 35mm thick. Base smoothly dimpled, top concave, concreted.		242											
	22	probably broken from above shc piece		22											
	36	piece of vitrified lining with right angle bend - face strongly vitrified, protruding quartz pebbles are glazed green, side becomes less vitrified. Face has ridge raised along one side, by about 10mm. Side is very slightly concave. Maybe edge of straight-sided tuyere block?					36								
4504	154	substantial slab from wall or floor of bowl-shaped feature. Very dense slag bearing some charcoal and quartz with very abrupt wall contact, some grass-like material in wall side corrosion - but may be secondary. Possibly furnace floor material - but if so then bowl-like floor not flat			154										
4504	18.96	vitrified lining, ceramic wall coverd in quartz-rich debris. Larger quatzose fragments have transparent green glaze				18.96									
	9.51	vitrified lining, surface very quartz-rich but also has raised ?magnetite patches, deepely vitrified into fabric				9.51									

	86	possiby from edge of SHC, top covered in charcoal, lower dimpled, lower part of slag grey dense vesicular, upper charcoal-rich with some lining-influenced material on top	86				
	13.08	vitrified and slagged piece of slate, slag has a couple of very large quartz pieces with a clear green glaze		13.08			
	45.19	irregular slag lobe, rough charcoal top, smooth dimpled base - like a tiny SHC		45.19			
	2.63	small fragments of low density slag		2.63			
	17.39	2 sherds from thick-walled crucible				17.39	
	0.11	large dense spheroid		0.11			
	13.32	broken fragment of grey vesicular slag, like possible smithing slags above		13.32			
	3.2	Cu slag- vitrified and oxidised material lying on(?) layer of coarse rounded sand grains				3.2	
	8.21	4 pieces of low density, presumably lining-influenced slag, vesicular, pale, weathered, 1 piece has Cu droplet				8.21	
	6.69	corrosion ball around iron object, accretion has charcoal and flake hammerscale					6.69
	2.62	vitrified and slagged piece of quartz-veined slate		2.62			
	1.22	quartz-rich lining slag, quartz has translucent green glaze			1.22		
	3.56	weakly vitrified lining			3.56		
4512 slot 3a	9.14	lining slag - crystal hash in black glass on slightly pink ceramic			9.14		
4516 13 slot	3.46	curious honeycomb material with black internal striated surfaces - looks like a fired organic material - probably not slag					
4517	136	probable small SHC, rather covered in accretion in places, and rather irregular. Might be part of larger very thin slabby SHC possibly	136				
	9.64	piece of lining slag with clast-rich black glass, where pebbles protrude from dark glass they have clear green glaze			9.64		
	7.71	rusted vesicular iron slag fragment		7.71			
	4.4	reddish lining with black glassy vitrified layer			4.4		
	4.92	4 small pieces of lining slag			4.92		
4517 <701>	1.38	lining slag			1.38		
	7.43	lining slag			7.43		
	0.99	black material with long bladed crystals - looks more like ore than slag, but is low density - pyroxene? Tourmaline?					0.99
4522	6.47	dense grey iron slag in thin sheet with one smooth surface and one with charcoal moulds		6.47			
	12.99	3 pieces of lining and lining slag - varies from sandy to gravelly			12.99		

4522 <704>	2.93	4 pieces of vitrified clay plus debris			2.93									
	0.55	bleb of lining slag - black glass with quartz-feldspar crystals			0.55									
4524 <710>	10.97	fragment of sheet with sediment on base, top with charcoal contact - possibly like basal furnace material from gully		10.97										
	3.23	small rough lobe with microprilly base		3.23										
4524 slot 1	230	1 large, 1 small (2g) pieces of concretion, probably around iron						230						
	14	as above						14						
	254	15 main pieces plus debris of tuyere/lining - right angle bends hint at tuyere, shale-rich frabric with clasts aligned along possible tuyere axis				254								
	30	slagged quartz-rich stone - like clinker but with quartz-rich bands					30							
	28	4 small pieces of Fe-slag		28										
5424 slot 1a (=4524 ?)	32.15	vitrfied lining. Has deeply vitrified red ceramic overlain by variable glass with patches of fine crystalline ?magnetite. Some of the glass is highly weathered and has turned to a brown leathery powder. This piece needs analysis			32.15									
	82	20 further pieces related to above. The orangey slate-rich ceramic is deeply vitrified red - becoming very hard. Some of this material developed maroon crusts (like Brawdy material). The reddish material is overlain by a weathered pale gey vesicular slag and by variably altered black glass. Locally with a magnetite? rich surface			82									
	32	dirt and fines from above			32									
4525 slot 2	144	attachment of SHC to wall. Wall staright, SHC at about 45degrees, transverse in shape 50x100mm, distal part flipped down suggesting extraction damage and maybe removal of another part. SHC has blown top and rather gravelly base - but distinct from wall		144										
	13.21	reduced-fired lining overlain by black glass with crystals.			13.21									
4535 slot 16	82	irregular lobe cf 28g u/s piece. Vesicular iron slag with some concretion with charcoal and flake hammerscale, dimpled lower face		82										
			72.62	***790***	***289.3***	***384***	***800***	***30***	***244***	***0***	***28.8***	***0***	***0.99***	***6.69***	***2336***
House 6 internal features														
House 6 spread of burnt material														
4552 <746>	0.39	vitrified clay			0.39									
House 6 - fill of postpipe 4555														
4556	2.98	4 small pieces of lining slag, some internal patches of red-brown glass, but may not be more than melted stone			2.98									

House 6 - depost of hammerscale															
4579			good samples of hammerscale - mainly flake but some spheroids												
House 6 - fill of posthole 4592						6.68									
4593 <743>		6.68	2 pieces of well flown greenish olivine-rich prill												
House 6 unstratified															
u/s	h6 entrance 4528 to 4530	28	rather irregular rusty slag lobe with dimpled base (with adhering clay with charcoal and flake hammerscale) and irregular rough top		28										
				0	***28***	***6.68***	***3.37***	***0***	***0***	***0***	***0***	***0***	***0***	***0***	***38.05***
House 8															
House 8 - ringditch															
5526		15.07	corrosion ball including slag fragments and charcoal - no hammerscale seen							15.07					
				0	***0***	***0***	***0***	***0***	***0***	***15.07***	***0***	***0***	***0***	***0***	***0***
House 8 – internal features															
House 8 - fill of posthole 5538															
5539		0.91	small pebble - not slag										0.91		
House 8 - fill of posthole 5565															
5566 <922>		1.24	altered sst										1.24		
				0	***0***	***0***	***0***	***0***	***0***	***0***	***0***	***0***	***2.15***	***0***	***0***
House 9															
House 9 - ringditch															
6005 slot18a		35.8	curious lining slag, glass rich in crystals on top, grey crystalline slag below, all very weathered and veined with rust,				35.8								
		13.74	fragment of dense coarse slag with large charcoal moulds- probably a small piece of furnace bottom	13.74											
		8.57	4 small pieces of lining slag, rather rusted, may be derived from 35.8 piece above				8.57								
6030		4.23	small dimpled slag bleb, dense, with charcoal impressions			4.23									
6030 or h9 sl1 6031		30.23	irregular lump of indeterminate vesicular Fe-slag			30.23									
				13.74	***0***	***34.46***	***44.37***	***0***	***0***	***0***	***0***	***0***	***0***	***0***	***92.57***

Area F

Area F - fill of pit 6500

6501	0.99 also dust, coked bone probably													

Area F - Fill of pit 6515

6514	1.32 coke													

Area F - Fill of posthole 6608

6607	136 4 broken pebbles of tin ore										136			
		0	***0***	***0***	***0***	***0***	***0***	***0***	***0***	***0***	***136***	***0***	***0***	***0***

Ditch 7011 (Access Road project)

7012	320 piece from base of wall in smelting furnace, lobate floor slags have undercut side. Side is so intensely vitrified it has red glassy layer below overlying black glass. This vitrified mterial is presumbly just below burr. Very unusual.	320												
	70 11 bits broken from above	70												
	5.33 pebble											5.33		
	8.96 small piece indeterminate Fe-slag			8.96										
		390	***0***	***8.96***	***0***	***0***	***0***	***0***	***0***	***0***	***0***	***5.33***	***0***	***398.96***
	overall	**9084**	**841**	**678**	**564**	**1058**	**31**	**294**	**1950**	**29**	**136**	**1530**	**34**	***12225***
													Overall total	**16228**

Table 1: Catalogue of materials submitted as archaeometallurgical residues

	smelting slag	smithing slag	indet. slag	lining	Cu materials	tuyère	burnt stone	concretion	goethite	Tin ore	natural	iron	**Slag Total**
Area A - ditch 1000											5.06		**0**
House 1													
House 1: - cleaning over 4006 house			51	25			1		17				**75**
House 1: - ringditch	188	23	192	38					131		6	16	**441**
House 1 - internal features				27				37	1778		1064		**27**
House 3													
House 3 - ringditch	819		46	42									**908**
House 3 - internal features			2										**2**
House 4													
House 4 - ringditch	12		27										**39**
House 4 - internal features			3						24				**3**
House 5													
House 5 - ringditch	7589		2.85			258					446		**7850**
House 6													
House 6 - buried soil			14	<1								12	**14**
House 6 - ringditch	73	790	289	384	29	800	30	244			1	7	**2365**
House 6 - internal features		28	7	3									**38**
House 8													
House 8 - ringditch								15					**0**
House 8 - internal features											2		**0**
House 9													
House 9 - ringditch	14		34	44									**93**
Area F										136			**0**
Ditch 7011 (Access Road project)	390		9								5.33		**399**
totals	**9084**	**841**	**678**	**564**	**29**	**1058**	**31**	**294**	**1950**	**136**	**1530**	**34**	**12254**

Table 2: Summary of distribution of archaeometallurgical residues.

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