GeoArch

Report 2009/43

Evaluation of archaeometallurgical residues from the N8 Fermoy-Mitchelstown, Ballinamona 2, Co. Cork, (E2429)

Dr Tim Young
15th December 2009

Evaluation of archaeometallurgical residues from the N8 Fermoy-Mitchelstown, Ballinamona 2, Co. Cork, (E2429)

Dr T.P. Young

Abstract

Ballinamona 2 produced evidence for iron smelting in slagpit furnaces from a variety of pits, at least some of which represent the basal pits of such furnaces. The nature and purpose of the various features is discussed, and an earlier Iron Age date indicated as likely for the smelting technology, although the smelting in Areas 1 and 2 may not have contemporary.

The site produced little evidence for smithing. Those slag cakes provisionally identified as from smelting are small, again tentatively supporting an Iron Age date.

Contents

Abstract 1

Methods 1

Results 1

Interpretation 3

Evaluation of potential..... 4

References 4

Catalogue 6

Methods

All investigated materials were examined visually, using a low-powered binocular microscope where necessary. For microscopic residues a general statement of the nature of each assemblage was recorded (Table 1). As an evaluation, the materials were not subjected to any high-magnification optical inspection, nor to any other form of instrumental analysis. The identifications of materials in this report are therefore necessarily limited and must be regarded as provisional.

Results

Description of the iron smelting residues

The smelting slags were typical of those from a non-slag tapping slagpit furnace. Several distinct facies of slag were present:

1**. flow slag**: flow slags occur as spheroids, blebs and prills, typically of dark dense slag, with smooth surfaces. This material is interpreted as cooling during or after descent through the packing of the basal pit of the slagpit furnace. The smallest particles are individual frozen droplets of slag. They may show impressions (dimples) from contact with the packing or fuel (and are then given the term “coffee bean spheroid”). In some instances aggregates of individual spheroids may form. More persistent flow results in the formation of a prill. These may involve vertical flow or horizontal flow on the pit floor. Aggregates of prills may form, and these may form moulds around the pieces of wood/charcoal present in the pit packing. Further aggregation leads into a continuum with the more massive slags described below.

2**. amalgamated descending prills of flow slag**: the flow slag prills may become amalgamated where there as more persistent flow from a particular point in the furnace. This may occur particularly near the blowing side of the furnace, where temperatures are highest. The resultant stalactitic masses may show divergent flow of the molten slag where it reached the pit floor, leading to a “birds foot” structure. Good examples of “birds foot” structures in this assemblage indicate drops of at least 120 up to at least 200mm. The

stalactites will commence blow the level of the bloom, so these lengths indicate minimum pit depths.

3. **massive pit margin slags**: where flow slags have completely amalgamated, particularly close to the blowing side of the furnace, they may generate more massive-appearing slags (sometimes still revealing a flow- lobed contact with the pit wall, or internal chilled surfaces). At the foot of the blowing wall these may include moulds of large wood fragments. At the top of the blowing-side of the pit there may be a large burr developed below the blow hole. These slags may show significant local interaction with the wall even below the burr.

Fill [c136] in pit [c135] yielded a substantial burr, indicative of prolonged reaction between iron-rich slag and the adjacent furnace ceramic. The form of the burr suggests that the ceramic was overhanging. It is not clear whether this was because it was a true tuyère, or a bulbous protrusion from the wall (the later blowhole in furnace [c397] at Derrinsallagh 4 appears to have been of this type; Young 2008g) or a simple blowhole through a shaft, the base of which overhung the pit margin, as proposed for Adamstown 1 (Young 2006b).

4. **Furnace structural ceramic**: within the basal pit the wall is usually reduced-fired (grey; because of a lack of oxygen at this level), but further into the surrounding natural oxidised-firing (red) may occur, where oxygen has been drawn from/though the sediments. Fragments of reduced-fired material within the pit assemblages may either be pieces fallen from higher in the pit or may actually have been in-situ. Higher in the furnace oxidised firing becomes more significant as oxygen becomes more available. Strong oxidised firing is typically seen around the blowhole. Vitrification does not normally occur with the pit, but appears around the blowhole and may continue a significant distance up the shaft above the blowhole. Peak alteration of the walls occurs around and just above the level of the blowhole – a level that is commonly not preserved in truncated slagpit furnaces.

This assemblage shows a predominance of fragments of reduced-fired material, with only a small proportion of oxidised fired and vitrified material. There are no pieces which provide good indication of shaft morphology.

A blowhole margin was seen in a fragment from [c9] in pit [c10], which indicated a blowhole of 25mm diameter, a size frequently seen in smelting furnaces.

5**. Pit floor fines**: several assemblages of material from sieving (from [c136], [c186] and particularly [c456]) show the small scale residues commonly found associated with the very base of the pits of slagpit furnaces. Most of the residues in these assemblages are fine-scale equivalents to flow slags, including spheroidal droplets (including forms with dimples generated by contact with the fuel particles – the "coffee bean" spheroids) and small prills, together with small broken fragments from larger flow slag bodies. In addition there is a substantial quantity of fine, apparently amorphous, ferruginous particles which are probably ore dust.

A notable absence from the assemblage was any slag attributable to a "furnace bottom". These large slag blocks have been recovered from other sites, where they can be seen to have formed in the upper part of the pit just below the bloom. The absence of this material from Ballinamona provides some circumstantial evidence to support the idea that the smelting slag assemblages in pits are the remnants of the bases of furnaces rather than waste pits.

Description of the iron smithing residues

A number of pieces of slag were identified as possible smithing hearth cakes (SHCs). The identification is not certain, because plano-convex slag blocks can occur within smelting assemblages, as zones of enhanced interaction between slag and wall, as puddles of slag on the pit floor, and as denser sections in the upper parts of the "furnace bottom". In this instance the possible SHCs include 4 examples that appear very likely to be true SHCs (1 from c007, 3 from c036) and 1 example that is probably not (from c055; probably an example of slag-wall interaction).

All of the likely examples are small:

c007 (waste pit c008) 184g 70x70x20 mm
c035 (furnace? c036) 342g 85x80x30 mm
c035 (furnace? c036) 138g 80x(40)x40 mm
c035 (furnace? c036) 200g 75x70x30 mm

The example from c007 and the 200g example from c035 both show signs (cracking, magnetism) that indicate they contain significant pieces of metallic iron.

Description of the metallurgical structures

In area 1, two "bowl furnaces" were identified during excavation ([c10], [c25]), each associated with a "waste pit" ([c8], [c12]). Furnace [c10] was described as 0.55m in diameter and 0.22m deep. Such dimensions are typical of those of the basal pits of slagpit iron smelting furnaces, even though it is possible these dimensions exaggerate the cut slightly (since it is not clear if commonly-recorded "linings" in such pits are indeed linings). The second "furnace" [c25] was larger and contained a more complex set of infilling deposits. The morphology of the pit is more complex than a typical slag pit furnace, the photographs show less sign of heat alteration than for the adjacent furnace [c10] and the cut appears to show a concave side (in plan) facing [c10] suggesting it may have been cut respecting the superstructure of furnace [c10]. There remains, therefore, some doubt as to whether [c25] is actually a pit from an iron smelting furnace, or whether it served some other purpose.

The two adjacent "waste-pits" were described as "1.25 m in length, 1.05 m in width and up to 0.45 m in depth and were filled with a mixed material consisting of reddish brown soil with charcoal and slag". Pit [c8] contained 1.9kg of smelting slags and 1.3kg of fired clay (probably furnace superstructure debris); pit [c12] contained just 380g of slag and 40g of fired clay. Large pits in metallurgical settings may be associated with the production or storage of charcoal; there is also the possibility that large pits might have been dug to acquire and process the clay required for the furnace superstructures.

In area 2, furnace [c497], described as 0.43m in diameter and 0.32m deep, represents the basal pit of a slagpit iron smelting furnace. This furnace appears to have been abandoned with very little clearance of the waste from its last smelt; there were 10.1kg of slags remaining in the furnace pit.

In addition to the features that were sufficiently burnt to suggest to the excavators that they might be of

metallurgical origin, there were a number of shallower pits in Area 1 which may be the truncated basal pits of slagpit furnaces:-

[c14] 0.47x0.38x0.11m (90g of flow slag)
[c18] 0.47x0.46x0.22m (6.5kg of smelting slag)
[c36] 0.56x0.44x0.21m (1.9kg smelting slag & 3 SHCs)
[c56] 0.48x0.46x0.18m (1.6kg of smelting lags)
[c126] 0.40x0.28x0.14m (566g of smelting slags)
[c135] 0.47x0.38x0.10m (c900g of smelting slags)

The intense heat within a slagpit iron smelting furnace is concentrated around the level of the air blast (typically just above the original ground surface) and within the lower part of the shaft. The main mechanism for heat transfer into the pit will be the movement of slag, which may provide the prolonged intense heating necessary to fire the surrounding clay. Once the basal pit becomes truncated, through agricultural or other activity, the deeply heat affected upper walls of the pit (just below the air blast) may be removed, leaving the much less obviously heated bottom of the pit.

Less certain are a group of associated pits with somewhat larger dimensions:

[c6] 0.75x0.62x0.27m (c1.8kg of smelting slags)
[c41] 0.87x0.50x0.19m (740g of smelting slags)
[c51] 0.60x0.49x0.10m (150g of slag)
[c54] 0.51x0.60x0.17m (no slag)

One associated pit was much too large for a smelting furnace and contained no slag (although it did contain a concretion around corroded iron). Its dimensions (1.24x1.17x0.44m) were similar to the two “waste-pits” flanking furnace [c10].

Interpretation

This site presents an interesting array of features associated with iron smelting. The interpretation of the residues is straightforward; they are residues from iron smelting in slagpit furnaces, with just a few pieces that may possibly be from subsequent smithing. The structures are rather more complicated to interpret. There are two reasonably certain slagpit furnaces, but there are probably at least eight slagpit furnaces altogether.

The cluster of pits interpreted here as being possible bases of smelting furnaces in Area 1 were rather similar in terms of size, being clustered around 0.44m mean diameter; slightly narrower than the pit [c10] identified as a smelting furnace during excavation (0.55m diameter). The isolated furnace in Area 2 was 0.43m in diameter.

A tentative developing chronology for Iron Age furnaces would suggest that furnaces with the wide (i.e. >0.40m) simple slagpits are likely to be earlier than the slightly smaller arched furnaces (and other possible furnace types) which seem to appear in about the 1st Century BC.

Furnaces with slagpits of greater than 0.40m diameter are known outside the current road scheme from:

Adamstown 1 (Co. Waterford): Slagpit :0.53 x 0.47m and 0.15m surviving depth with 18.3kg of in-situ residues. (Young 2006b)

Ballydavid AR26 (Co. Tipperary), six furnaces with slagpit diameters >0.40m. Associated 14C dates suggest a date in the 3rd-1st centuries BC. The apparent 8th-5th century BC date for the isolated furnace c157 is very early. (Young 2009b)

Ballykeoghan AR9 (Co. Kilkenny), 2 slagpits, one 0.45m in diameter with 18.3kg of in-situ residues, the other 0.40x0.50x0.10m (undated) (Young 2009d)

Cherryville 12 (Co. Kildare): 320-200 cal BC. Four slagpits 0.45 - 0.50m diameter. (Young 2008a)

Cloncollig (Co Offaly) The pit (007).is described as being 0.57 x 0.60m and 0.32m deep. A 14C date on oak charcoal from the basal layer of the furnace gave a date of 261 – 94 cal BC (Young 2008b)

Clonrud 4 (Co. Laois). The working dimensions of the two slagpits (0.41m x 0.39m and 0.46m x 0.41m) are moderately large. Two dates suggest 4th-1st centuries BC (Young 2008f)

Derryvorrigan 1(Co. Laois) appears to have working diameters of approximately 0.40m (Young 2008d).

Leap 1 (Co Laois). F007 has a diameter of 0.40m. It is not directly dated, but there are earlier Iron Age 14C dates from adjacent features (Young 2009a)

Lismore-Bushfield 1 (Co. Laois). A cluster of 5 furnaces with diameters >0.40m. Furnace 3 gave a 14C date on alder charcoal of 90BC to AD80. (Young 2008e)

Milltown/Ballynamorahan AR3 (Co. Kilkenny). A complex furnace structure, possibly with a central working hollow linking two furnaces with frontal arches, 0.45x0.55m and 0.40x0.50m; 1st century BC / 1st century AD (Young 2009c)

Morrett D (Co. Laois): 170 cal. BC- 30 cal AD and 770-410 cal. BC for charcoal pits, 370-110 cal BC and 400-200cal BC for ring ditches. (Young 2005)

Newrath Site 35 (Co. Kilkenny): 400-200 cal. BC and 350-40 cal. BC (Eogan pers. comm. 2006)

Tullyallen 6 (Co. Louth): Slagpit: 0.47 x 0.50m and 0.18m deep with 17.5kg of in-situ residues. (Young 2003)

Other Iron Age sites appear to have smaller diameter furnaces. Those at Derrinsallagh 4 (Young 2008c) appear to be mainly approximately 0.30m working diameter (ignoring all arguments about whether any lining is present within a broader cut). The example with a furnace arch that was excavated in detail (Young 2008g) was rather irregular in plan but was approximately 0.36m diameter at the level of truncation (although slightly wider towards the base because the pit sides were overhanging). These smaller furnaces seem to appear from the 1st century BC and continue well into the first millennium AD.

The interpretation of the evolution of later furnaces is however built on very few sites and the actual situation may be much more complex. Three furnaces from Gortnahown 2, interpreted to be of Early Medieval age, are simple pits, with a mean diameter of approximately 0.47m, well within the size range of earlier Iron Age examples. An example from Carrigoran, Co. Clare (Young 2006c) of late 9th to 11th century age was also wide, with a diameter of 0.50m.

Later medieval furnaces are not well known, but there are some suggestions that, despite yielding rather similar residues, they were less sunk into the ground than earlier furnaces in order to make furnace clearance through the frontal arch easier.

The limited evidence from the site for smithing comprises a small group of small SHCs. Small-sized SHCs such as these would typically be interpreted as being indicative of blacksmithing, with the bloomsmithing that is required to work raw blooms into usable iron usually producing larger SHCs. However, although Iron Age smithing is not yet well known in Ireland there are indications that the SHCs produced during bloomsmithing at this period were much smaller than those produced later in the early medieval period. In North Wales, Crew has shown SHC sizes of 100-200g and 300-400g were particularly significant at the Iron Age iron-production site of Crawcwellt West, with the heavier group representing the initial bloom consolidation and the smaller ones from the later stages of working to bar iron. This corresponds well with the small amount of material from Ballinamona. Cherryville, Co. Kildare (Young 2006a), produced evidence for SHCs range up to about 1kg (although the weights of the larger examples were estimated from broken fragments).

Current evidence would suggest therefore, with some qualification, that the iron smelting at Ballinamona 2 is probably of earlier Iron Age date.

Evaluation of potential

The value of further analytical investigations of the Ballinamona residues is limited by the rather incomplete residue assemblages that are present within most of the probable furnaces in Area 1. The different size, as well as the geographical separation, may suggest that the furnace recorded from Area 2 is of a slightly different age. The smelting activity in neither area is currently dated by ^{14}C.

Given the lack of complete assemblages of slags from the furnaces it would not be possible to construct full mass-balances after the approach of Thomas and Young (1999a and b). However, a limited programme of analysis would allow comparison of the process and raw materials with those from other sides. The residues in furnaces [c18] and [c497] form the most complete suites for this purpose.

Understanding of the chemical composition of the smelting slags and the original ores would also help with interpretation of the smithing slags if they were to be analysed (since bloomsmithing slags inherit part of their composition from the smelting process). As noted above, little work has been undertaken on Iron Age smithing in Ireland and analysis of the smithing slags from Ballinamona would help advance understanding (in a similar way to the recent advances on the understanding of early medieval smithing through analyses of several relevant suites of slags).

In summary, a limited programme of chemical analysis of both examples of smelting and smithing slags is recommended, accompanied by microstructural investigations of the smithing slags.

References

CREW, P. 1999. Crawcwellt West excavations 1986-1989. A late prehistoric ironworking settlement. *Archaeology in Wales*, **38**, 11-16.

THOMAS, G.R. & YOUNG, T.P. 1999a. A graphical method to determine furnace efficiency and lining contribution to Romano-British bloomery iron-making slags (Bristol Channel Orefield, UK). *In:* YOUNG, S.M.M., BUDD, P.D., IXER, R.A. and POLLARD, A.M. (eds). *Metals in Antiquity*, British Archaeological Reports International Series, **792**, 223-226. Archaeopress, Oxford. [ISBN 84171 008 3]

THOMAS G.R. & YOUNG, T.P. 1999b. Bloomery furnace mass balance and efficiency. *In:* POLLARD, A.M. (ed) *Geoarchaeology: exploration, environments, resources*, Geological Society of London, Special Publication, 165, 155-164

YOUNG, T.P. 2003. Evaluation of slag from Tullyallen 6, Co. Louth (00E00944). *Geoarch Report 2003/10*. 2pp. + 2 figs.

YOUNG, T.P. 2005. Evaluation of archaeometallurgical residues from the Heath-Mayfield N7 development (03E0151, 03E0966, 03E0461, 03E0603, 03E0633, 03E0679, 03E0602, 03E0635). *GeoArch Report 2005/12*. 28pp.

YOUNG, T.P. 2006a. Evaluation of archaeometallurgical residues from the Kildare town By-pass; Loughlion Site 8 and Cherryville Site 12 (01E0846 ad 01E0955). GeoArch Report 2005/16. 8pp.

YOUNG, T.P. 2006b. Evaluation of archaeometallurgical residues from sites on the N25, Co. Waterford (Woodstown 6, Adamstown 1,2,3). *GeoArch Report 2006/15*. 38pp.

YOUNG, T.P. 2006c. Evaluation of archaeometallurgical residues from Carrigoran, Co. Clare (98E0338). *GeoArch Report 2005/18*. 12pp.

YOUNG, T.P. 2008a. Archaeometallurgical residues from Cherryville Site 12, Kildare Bypass. 01E0955 *GeoArch Report 2007/24*. 33pp

YOUNG, T.P. 2008b. Evaluation of metallurgical residues from Cloncollig 2, Co. Offaly, NTB06, A033/E2850137. *GeoArch Report 2008/09*. 4pp

YOUNG, T.P. 2008c. Evaluation of Archaeometallurgical residues from the M7/M8 Contract 2: Derrinsallagh 4 (E2180). *GeoArch Report 2008/23.*

YOUNG, T.P. 2008d. Evaluation of Archaeometallurgical residues from the M7/M8 Contract 2: Derryvorrigan 1 (E2193). *GeoArch Report 2008/26.*

YOUNG, T.P. 2008f. Evaluation of Archaeometallurgical residues from the M7/M8 Contract 2: Lismore-Bushfield 1 (E2220). *GeoArch Report 2008/27.*

YOUNG, T.P. 2008e. Evaluation of Archaeometallurgical residues from the M7/M8 Contract 3: Clonrud 4 (E2167). *GeoArch Report 2008/30.*

YOUNG, T.P. 2008f. M7/M8 Contract 2. Detailed recording of furnace C397, Derrinsallagh 4 (E2180), *GeoArch Report 2008/34*.

YOUNG, T.P. 2009a. Evaluation of archaeometallurgical residues from the M7/M8 Contract 1: Leap 1 (E2131) *GeoArch Report 2009/03*

YOUNG, T.P. 2009b. Evaluation of archaeometallurgical residues from the M8/N8 Cullahill-Cashel: Ballydavid AR26 (E2370), *GeoArch Report 2009/30*, 7 pp.

YOUNG, T.P. 2009c. Evaluation of archaeometallurgical residues from the N9/N10 Waterford-Kilcullen, Site 3-5, Milltown/ Ballynamorohan, Co. Kilkenny (E2499), *GeoArch Report 2009/38*, 12 pp.

YOUNG, T.P. 2009d. Evaluation of archaeometallurgical residues from the N9/N10 Waterford-Kilcullen, Site 6-9, Ballykeoghan, Co. Kilkenny (E2500), *GeoArch Report 2009/49*, 3 pp.

sample	context	feature	weight	no	notes	propn
4	5	pit c005	160	6	flow slags	
			228	2	reduced-fired wall	
			47	5	indeterminate slag scraps	
4	5	pit c005	1400	1	large block of wall/floor angle - very dense flow down wall and mingling with wall, narrow flows extending off across floor	
38	7	pit c008	1330	39	fired clay mainly oxidised, some vitrified, including one with re-entrant and one the looks like small piece of tuyère margin	
			1195	91	flow slags, mainly in narrow flows	
			184	1	very dense SHC like small disk plano-convex, 70x70x20mm, contains metallic iron	100
			492	9	other indeterminate iron slags, some charcoal-rich, some more massive	
5	9	pit c010	488	assm	mainly stone, some reduced fired (and sometimes vitrified) lining, plus flow slags	
6	9	pit c010	778	assm	fired clay, some vitrified and oxidised from around blowhole and one possible blowhole margin fragment 25mm diameter	
			10	3	flow slag	
12	11	pit c012	152	6	flow slags	
			232	30	rusty material, possibly "sinter"	
			42	5	oxidised vitrified lining	
			14	2	stones	
9	13	pit c014	90	9	flow slags	
10	17	pit c018	2425	1	conjoins 1020g block (in other bag) to form block from blowing wall, ventral possible burr, thin block extends out to length of 260mm, maximum 120mm high and extending in from wall 60mm, wall strongly overhanging, smooth flow surface is actually wall contact, non-wetted lobed surface is on floor suggesting sheet flow descending wall, lobes extend off horizontally at various heights into charge. burr extends out an additional 30mm, smooth surface just like vertical wall below, very odd geometry!	
			536	14	flow slags	
			484	1	block of variable altered wall with rusty slag adhering	
			80	1	rusty material similar to slag on wall above	
			76	10	scraps	
10	17	pit c018	1020	1	massive block with accumulated flows with non-wetted surface against wall, slightly tap slag like top and dimpled base - very dense	
			820	17	variably-reacted wall - all reduced-fired except for a piece of about 2g	
			336	16	small pieces of charcoal-rich slag or "sinter"	
			2545	95	flow slags in varying-sized pieces, mainly narrow flows but some more massive blocks around large wood	
19	23		212	assm	mainly stone, but some fine flow slag debris	

sample	context	feature	weight	no	notes	propn
14	19/20	pit c 025	174	5	oxidised-fired vitrified clay	
			1740	c85	flow slag, mainly in rather delicate prills, including "birds foot" structures, with ghosts of large wood	
			30	1	sinter	
21	26	linear cut c027	336	1	flow slag	
			160	2	lining slag balls	
			394	1	dense angular slag lump	
			626	5	variable altered reduced-fired walls	
23	26	linear cut c027	546	10	flow slags in moderately large pieces	
			628	2	massive slag (wall foot?)	
			206	9	indeterminate slag scraps	
			312	3	variably altered wall, reduced, one piece vitrified	
29	35	pit c036	226	2	heavily altered wall	
			60	4	indeterminate slags	
			318	4	flow slags	
			288	1	dense slag block - foot of wall	
			342	1	possible SHC, dense dished top, 85x80x35mm	100
			138	1	80x(40)x40mm (of which bowl 30mm) part of SHC, raised lump on one margin, dense bowl with flat puddle in centre of top	
			68	1	strange flap of green glassy slag overlying more rusty material	
29	35	pit c036	298	13	flow slags	
			12	2	rounded section glassy slags from coatings on a round poker? 16mm diameter	
			200	1	75x70x30 small SHC like block, plano-convex, contains some metallic iron	100
			64	4	oxidised-fired vitrified lining	
			500	15	indeterminate slags	
			8	2	vitrified lining, oxidised-fired	
28	42	pit c041	592	15	flow slags, in quite stout prills	
			148	16	slag scraps - includes "sinter", lining slag and charcoal-rich materials	
34	50	pit c051	90	5	flow slags	
			60	12	indeterminate slag scraps	
41	55	pit c056	182	1	SHC-like object, but probably slight burr on vertical wall, with accumulation of a thin skin of slag against grey reduced wall	
			146	1	grey reduced wall	
			592	17	flow slag	
			662	9	dense slags, in broken blocks, probably foot of wall slags, more amorphous than flow slags	

sample	context	feature		weight	no	notes	propn
74	99	pit c100		170	1	concretion on iron	
86	127	pit c126		404	assm	mainly stone with flow slag and a few pieces of lining slag	
87	127	pit c126		522	25	flow slags	
				24	5	rusty sintery slags	
				20	4	vitrified lining fragments	
93	136	pit c135		340	assm	mainly stone but some reduced-fired clay, sinter, slag scraps and coffee bean spheroids, many multiple	
94	136	pit c135		208	1	reduced fired, all deeply vitrified, dark surface	
				338	1	remarkably well-developed burr, outer raised lip suggests original whole burr was 140mm wide and 80mm deep. Grey sediment contact on all but last 20mm, shape almost hints at projecting tuyère - but could be more planar, dense "bowl" 22mm thick has second raised ridge at 80mm diameter. Viewed from rear clay looks like tuyère base, oval 120-140mm wide, could be only 80mm high if symmetrical. Rear skim of tuyère face just 5mm thick	
94	136	pit c135		372	27	flow slags, mainly small pieces, one large block with large wood impressions	
				78	7	oxidised-fired vitrified lining	
				128	5	irregular rusty iron slag with charcoal	
				14	10	slag scraps	
521	185	pit c025		1085	1	large "birds foot" structure, drop of 160mm on to curved base	
				1245	1	"birds foot" structure onto sharply angled base at 200mm	
				1820	52	flow slags, mainly delicate (medium) prills, but a couple of wide flat basal flows	
				2935		grey/buff fired wall and general dust	
121	186	pit c025		770	assm	fine ash, charcoal dust and silt with charcoal and angular flow slag fragments	
400		furnace c457		6175		flow slag, largest block 1795g shows wall contact and prills extending down onto flat lying wood at base, maximum height 120mm, wall overhanging.	
400		furnace c457		3445		flow slag	
400	400	furnace c457	>215 retent	210		fine flow slag fragments, spheroids	
425	456	furnace c457		342	assm	good assemblage of flow slag fines, prills, coffee beans and multiples spheroids, lots of fine rusty particles that may be ore/part-reacted ore	
448	521			706	assm	carbonised grain	

Table 1: summary catalogue by context and sample. Assm = assemblage of material from flotation/sieving

GeoArch

geoarchaeological, archaeometallurgical & geophysical investigations

54 Heol y Cadno,
Thornhill,
Cardiff,
CF14 9DY.

Mobile: 07802 413704
Fax: 08700 547366
E-Mail: Tim.Young@GeoArch.co.uk
Web: www.GeoArch.co.uk