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Archaeometallurgical residues from High Island, Co. Galway (95E0124)

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Dr T.P. Young

Abstract

Materials of metallurgical origin indicate that a pit below Cell B was associated with the smithing of iron and probably also for the working of non-ferrous metals. The pit itself yielded an assemblage of fines, indicative of accumulation within a smithing hearth. The morphology of the feature is compatible with it being a hearth. The adjoining area 8 yielded a small plano-convex smithing hearth cake, compatible with the sort of macroscopic slag that might be expected to have been generated alongside the within-hearth fines. The same area also yielded a fragment of the tip of a tuyère, also of a type compatible with a smithing hearth.

The hearth pit also produced remains of an incomplete thin-walled crucible, apparently bell-shaped, but possible part of lidded form, in a soft white (pipe clay) fabric with an organic (hair?) temper and sporadic large grains of mica schist. The crucible may have failed before use.

The submitted material was, however, dominated by corroded iron fragments (mainly nails) and examples of natural iron mottling and panning.

Contents

Methods

All material was examined under a low-magnification stereo microscope. Material was selected for further analysis as appropriate.

Crucible material was examined to determine the chemical composition of surficial slag phases using the Energy Dispersive X-Ray Fluorescence (ED-XRF) Eagle II instrument at English Heritage, Fort Cumberland, Portsmouth, with the kind assistance of Dr Justine Bayley. The samples were analysed in a normal atmosphere to produce only qualitative indications of metal presence.

Whole-specimen chemical analysis for major elements was undertaken using fused beads on the Open University Earth Science Department’s Wavelength-Dispersive X-Ray Fluorescence (WD-XRF) system. Whole-specimen chemical analysis for minor and trace elements was undertaken on the Inductively-Coupled Plasma Mass Spectrometer (ICP-MS) in the School of Earth, Ocean and Planetary Sciences, Cardiff University. The chemical analyses are presented in Table 2.A catalogue of the material is presented in Table 3.

Results

Natural Materials

The collection contained a large number of specimens of iron oxide concretionary materials, ranging from diffuse mottles, through to substantial iron-rich crusts (in some cases well-enough formed to be considered as bog iron ore), as well as some magnetic iron oxide pieces, probably derived from weathered copper-bearing mineral veins.

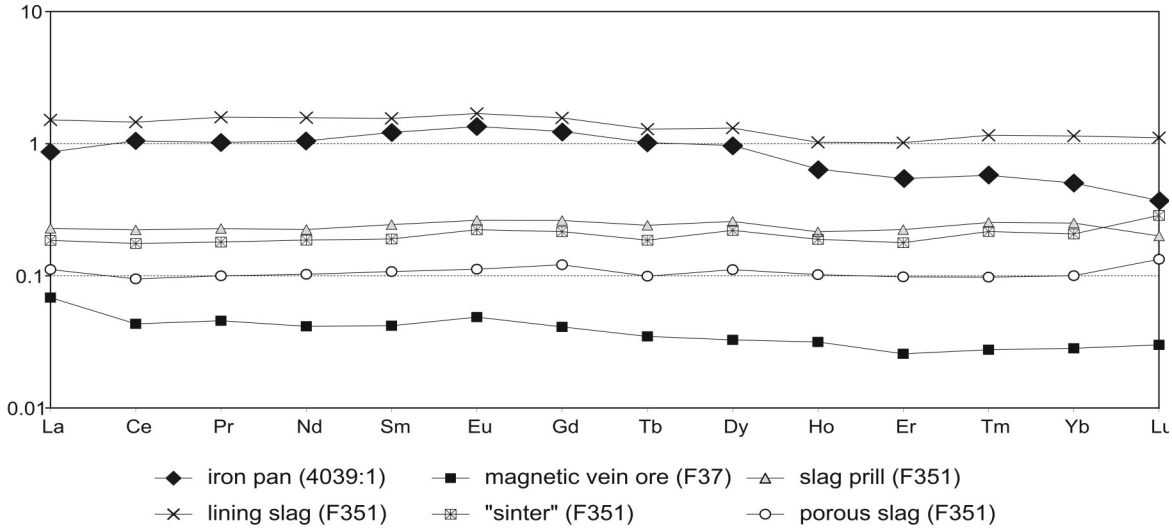

Figure 1. Upper crust normalised rare earth element profiles for samples from the metalworking pit and two potential ore types. Normalisation factors after Taylor & MacLennan 1981.

Analysis was undertaken of a specimen of a well-developed iron pan crust (F4039:1) and of a piece of vein mineral (F37) to determine their composition on the basis to aid the investigation of whether the iron slags recovered from the site might have been from smelting.

Iron pan

The major element analysis of the material shows a moderate degree of iron enrichment (36.3% of iron quoted as Fe_2O_3), with a low manganese content (0.24% MnO; bog iron ores typically have a fairly high manganese content). The loss on ignition was very high (26.3%, if all iron was present as Fe^{III}), suggesting that the iron was present in strongly hydrated minerals.

The silica to alumina ratio is much lower (1.4) than for the slag material described below (suggesting a clay-rich mineralogy for the host sediment). The material shows most elements broadly in line with their contents in the slag (although diluted by additional iron in the slags), indicating that despite some mineralogical differences the host of the iron crust, and the material contributing silicate material to the slags was broadly similar.

Phosphorus is high in the iron crust (5.04% quoted as P_2O_5). Iron oxides (like goethite) are known for their ability to scavenge phosphorus under certain circumstances.

The rare earth elements (REE) show an upper crust normalised profile (Figure 1) with a humped profile centred on europium. The light REE show a slight relative depletion, but with a more marked relative depletion for the heavy REE.

Magnetic vein ore

The major element analysis shows that iron is the dominant element (89.1% calculated as Fe_2O_3). The loss on ignition is 8.7% (when iron is calculated as Fe^{III}). This suggests that the iron mineral is mainly hydrated (the LOI for pure goethite or lepidocrocite, the common iron oxyhydroxides, FeO.OH, is 10.1%), and the fairly strongly magnetic nature of the specimen suggests either the presence of a small proportion of magnetite (Fe_3O_4) or of maghemite (γ-Fe_2O_3).

The upper crust normalised REE profile (Figure 1) shows very low levels of REE (Σ REE is only 6.92ppm) with a fairly constant increase in depletion from the light REE to the heavy REE.

Archaeometallurgical materials

The "Hearth Pit": slags

Dull, blebby slags, many of which appear to be dominated by lining material, dominate the assemblage of residues from the pit. Some of the blebby material is fused and mingled with the porous, sintery-appearing, type of residue, which may form on the base of both smithing hearths and smelting furnaces. Alongside these mainly low-density slags there are prills and spheroids of denser slag, together with some shiny dense slag films. Residues resembling these may be found in both smithing hearths and smelting furnaces. Although the highly magnetic nature of this material and the presence of a small quantity of flake hammerscale, favoured an origin in a smithing hearth, some analytical work was undertaken, to compare the composition of the potential iron ore resources of the island with the slag composition (Table 2), in order to determine whether an alternative interpretation of the slags as smelting residues would also be possible.

	No.	*Wt.*
Sintery material	136	97.95g
Prills	21	34.70g
Blebby slags	124	114.85g
Slag spheroids	33	4.22g
Slag films	7	1.31g
Flake hammerscale	9	0.6g
Other fines		6.36g
Corrosion around iron	1	1.47g

Table 1. Summary of slag fines recorded from the pit 347/351.

The major element analysis of the slags (Table 2a) show that the sintery material, the prills and the small porous slag piece (which had tentatively been

identified as possible ore), are all slags and have a closely similar composition. These three have an extremely high iron content (77-81% calculated as FeO) and a fairly high phosphorus content (0.9 – 1.3% P_2O_5). Silicon and aluminium are extremely low (SiO_2 5.4 – 9.8%; Al_2O_3 1.7 – 3.1%). The silica to alumina ratio is remarkably constant (2.6 – 3.1). The lining slag, in contrast, has a low iron content (32.7% expressed as FeO) and much higher silica and alumina contents (38.9% and 11.7% respectively). The silica to alumina ratio is close to those of the other slags (3.31). The other elements expected to be derived from the lining (magnesium, calcium, sodium, potassium, titanium) are all elevated in the lining slag.

These major element data suggest that the slags are effectively mixtures of a slightly variable, but broadly comparable silicate component, with iron oxide. The extremely iron-rich nature of the slags indicates a low degree of fluxing by silicate material, a feature common when a tuyère is used in a smithing hearth, but which is not encountered in bloomery iron smelting.

The minor and trace element content of the slags is largely derived from the lining of the hearth (or melting of the tuyère tip). The majority of the elements appear to maintain a fairly constant ratio with aluminium.

The upper-crust normalised rare earth element profiles (Figure 1; normalisation factors after Taylor & McLennan 1981) show a fairly horizontal profile for the lining slag, compatible with its origin from melted soil or subsoil. The profiles for the slag prill, the sinter and the porous slag (which had been considered as a possible piece of ore) are very similar (i.e. horizontal), suggesting their silicate components may also be derived from sediment. In contrast both the potential iron ore materials show a slight relative heavy REE depletion. The iron pan material has an overall REE content close to upper crust average, but slightly depleted in the heavy REE elements. The magnetic iron ore sample shows a very low REE content, varying from 0.07 of upper crust levels for La to 0.03 for Lu. These properties indicate the slags are unlikely to have been derived from smelting either of the ores.

The "Hearth Pit": crucible

The hearth pit contained four sherds, three of them conjoining, of a small crucible, 25mm high in a very fine grained pale fabric (pipe clay), very pale buff near the surface, but pale grey in the core (F347:1). The fabric bears sporadic large particles (up to 3mm) of micaceous schist (compatible with a local origin) and a widespread organic temper, apparently of hair. The body of the crucible shows two layers with a tendency to delaminate. This appears to be an incoherency in the clay during fabrication, rather than a deliberate feature.

A soft pale fabric is not common in Irish crucibles, but has been recorded in early christian material from Dunmisk (Ivens 1989).

The main sherd includes the base of the crucible, which has a maximum thickness of about 6.5mm. The wall of the crucible thins rapidly upwards, being less than 3mm thick at 18 mm above the base and 2mm immediately below the rim. The rim is rather widely splayed, with an apparent diameter of about 32mm. Only a short length of rim is preserved, however, so it is possible that this flared profile is a result of the preserved section passing up through a pouring lip. The crucible is not complete enough to allow firm identification of its morphology. It is possible that the flared profile represents the pouring lip of a lidded crucible, rather than an open form. In particular the profile of the present material bears close comparison with that of the pinched crucibles illustrated from Dunadd (Lane & Campbell 2000; Type D, illustration 4.48, no. 187).

A sherd from close to the rim was examined for any metal traces using the ED-XRF, but no metal contamination was found either on inner or outer surface. Both inner and outer surfaces of all the sherds were visually inspected for indications of slag or vitrified deposits, but none were found.

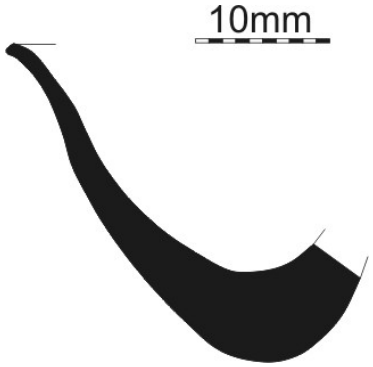

Figure 2. Crucible from F347/351. The profile most closely resembles an integral lidded crucible (compare Lane & Campbell 2000; Type D, illustration 4.48, no. 187) of 7th-10th century date.

It seems likely that the flaw in the centre of the fabric may have caused the crucible to fail before use at high temperature.

Other materials

Only a very limited number of archaeometallurgical materials were recorded from other contexts:

F618:2: 4.9g of moderately dark, vesicular, dense slag, attached to a small area of oxidised lining.

F8099?: Probably the majority (>80%) of a small dense smithing hearth cake (SHC), top smooth, base rough with slightly dimpling onto fuel bed at margins. 330g

F852:1: 34g fragment from the lower side of the tip of tuyère. The curvature is very low, suggesting this is the flattened base of a tuyère with a sub-circular cross-section.

F888:2: 4 tiny pieces (total 1.58g) of vesicular lining slag bearing sand grains.

Interpretation

The chemical studies clearly indicate that the slag fines are from iron-working, not iron smelting. The "hearth pit" and its residues can be compared with a rather similar Iron Age assemblage from feature 1056 at Ballydavis 2 Site A, Co. Laois (unpublished report, Young 2005). The fines assemblage is also close to those recovered from hearths and dumps at Coolamurry Site 7, Co. Wexford (unpublished report, Young 2006) of uncertain age. Assemblages with prills

and spheroids, representing slag dripping through the fuel in the hearth, indicate a fines assemblage generated within the smithing hearth, rather than the common style of smithing fines assemblage, dominated by hammerscale, which is generated on the floor of the workshop. That does not necessarily indicate that the deposit is actually a smithing hearth; it may simply be a deposit formed from cleaning-out the smithing hearth.

Consideration of the form of the feature, with a somewhat elongate shape, a shallow depth, a well-marked edge (at least on some sides), does, however, suggest that it may indeed have been a smithing hearth. There is insufficient certainty in the plan of the feature to be clear of the orientation of the hearth, but it is possible that the hearth was blown from the north, with the area south of the possible stone partition being the base of the hearth proper, with the small depression being associated with preparation of a hollow for slag accumulation immediately in front of the tuyère. The stakehole north of the partition might, in this scenario, be associated with mounting the bellows.

The SHC is rather small (with an estimated maximum original weight of about 410g), suggesting it was produced during blacksmithing, rather than during the refinement of raw iron.

The assemblage contains little capable of providing a date for the assemblage. The crucible is not sufficiently complete to be identifiable, but some features suggest that it may be a form which would have been lidded; it is not clear whether, if lidded, it would have had a separate lid luted on (commonest in 6^{th}-8^{th} centuries) or have been a pinched form with integral lid (which appear in the 7^{th} century and possibly survive as late as the 10^{th}). The presence of a tuyère suggests an early christian age, for they are not well documented in the Iron Age.

The crucible is suggestive of a similarity with Dunadd Type D, although this is far from certain. At Dunadd, the type D vessels appear to have been used for silver and gold. Irish finds of pinched crucibles of this type include material from Ballinderry II crannog (Hencken 1942), Carraig Aille II (Ó'Ríordáin 1949) and Correneary (Davies 1942). The type is also known from the Brough of Birsay, Orkney (Curle 1982) and from various sites in Scandinavia.

The significant quantity of iron panning and mottling is likely to be due to oxidation of iron-rich water within the sediment. Weathering of iron-rich rocks has probably generated most of the iron (although degradation of iron-working residues and iron artefacts may also have provided a small contribution), The iron can be carried in solution when reduced (as Fe^{II}), but on oxidation precipitation of Fe^{III} oxides will occur. Such oxidation may occur where reduced soil waters flow into a more oxygenated environment, and in particular may occur at the limits of oxygenation during summer drying.

Summary

Although the fines that accumulate amongst the ash and fuel in the base of smithing hearth are very similar to those in the base of a smelting furnace, the detailed analysis undertaken on the material from c347/351 provides strong evidence that these were formed in a smithing hearth. Circumstantial evidence for identification of the area as a smithy comes from other finds from the adjacent area 8, which yielded several fragments of macroscopic smithing slag and part of the tip of a tuyère.

The nature of the pit itself is unclear; it may be part of a smithing hearth, or it may be a pit used for disposal of the hearth ash. The presence of fragments of a crucible in the pit suggests that the smithy may have also undertaken some work with non-ferrous metals.

The crucible-type is uncertain but extremely tentative reconstruction of its form may suggest it was a lidded type, perhaps a pinched, integral-lidded, form, which would have a 7^{th} - 10^{th} century range.

References

Curle, C. L. 1982. *Pictish and Norse finds from the Brough of Birsay 1934-74*. Society of Antiquaries of Scotland, 140 pp.

Davies, O. 1942. Contributions to the study of crannógs in south Ulster. *Ulster Journal of Archaeology*, **5**, 14-30.

Hencken, H.O'N. 1942. Ballinderry Crannog No. 2. *Proceedings of the Royal Irish Academy*, **47C**, 1-76.

Ivens, R.J. 1989. Dunmisk fort, Carrickmore, Co. Tyrone, excavations 1984-1986. *Ulster Journal of Archaeology*, **52**, 17-110.

Lane, A. and Campbell, E. 2000. *Dunadd, an early Dalriadic capital*. Oxbow.

Ó'Ríordáin, S.P. 1949. Lough Gur excavations: Carraig Aille and the Spectacles. *Proceedings of the Royal Irish Academy*, **52C**, 6-111.

Taylor, S.R. & McLennan, S.M. 1981. The composition and evolution of the continental crust: rare earth element evidence from sedimentary rocks. *Philosophical Transactions of the Royal Society*, **A301**, 381-399.

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. 2006. Evaluation of archaeometallurgical residues from N30 Moneytucker – Jamestown, sites 1, 4, 5 and 7 (04E0329, 04E0326, 04E0325, 04E0323). GeoArch Report 2005/13. 20pp.

(a) sample	SiO_2	Al_2O_3	FeO	MnO	MgO	CaO	Na_2O	K_2O	TiO_2	P_2O_5	LOI	total	*Fe_2O_3*	*LOI*
4039:1 iron pan	15.27	10.90	32.54	0.24	1.38	1.42	1.11	0.96	0.34	5.04	29.94	*99.13*	*36.16*	*26.32*
F37 magnetic ore	0.49	0.13	80.15	0.02	0.20	0.16	0.04	0.05	0.02	0.14	17.59	*99.00*	*89.08*	*8.67*
F351 prilly slag	7.52	2.93	81.37	0.11	0.59	1.38	0.20	0.16	0.19	1.15	4.36	*99.95*		
F351 lining slag	38.86	11.74	32.66	0.14	1.47	3.46	2.52	3.19	0.73	1.30	3.39	*99.47*		
F351 sintery slag	9.81	3.05	76.88	0.12	0.69	1.53	0.25	0.30	0.21	1.30	6.15	*100.28*		
F351 porous slag	5.43	1.65	80.85	0.10	0.64	0.82	0.19	0.20	0.11	0.86	7.47	*98.34*		

(b) sample	Be	V	Cr	Co	Ni	Zn	Ga	Rb	Sr	Y	Zr	Nb	Mo	Sn	Cs	Ba
4039:1 iron pan	2.18	70.61	34.5	40.71	52.9	72.8	8.00	12.55	367.8	13.4	349.5	6.52	1.54	1.42	0.40	311.5
F37 magnetic ore	0.32	0.77	34.3	22.05	131.6	52.3	1.82	0.95	55.9	0.9	323.8	1.42	1.17	16.44	0.28	103.1
F351 prilly slag	0.52	21.01	8.1	0.96	48.9	25.9	6.18	2.04	95.1	5.9	288.4	2.79	0.47	0.18	0.55	150.9
F351 lining slag	2.65	100.09	58.1	31.27	73.8	103.2	18.09	82.59	269.6	25.9	591.4	22.98	2.61	3.49	1.48	822.4
F351 sintery slag	0.50	26.65	14.9	2.22	34.7	18.5	5.11	3.55	84.7	4.7	372.0	4.47	0.96	0.80	0.38	155.6
F351 porous slag	0.12	7.40	8.8	1.06	58.9	30.9	2.59	1.57	41.2	2.6	352.6	2.56	0.87	2.96	0.31	148.2

(c) sample	La	Ce	Pr	Nd	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu
4039:1 iron pan	26.02	67.23	7.25	27.34	5.47	1.19	4.71	0.65	3.40	0.51	1.25	0.19	1.11	0.12
F37 magnetic ore	2.05	2.77	0.32	1.08	0.19	0.04	0.16	0.02	0.11	0.03	0.06	0.01	0.06	0.01
F351 prilly slag	6.86	14.25	1.62	5.82	1.10	0.23	1.00	0.15	0.90	0.17	0.52	0.08	0.55	0.06
F351 lining slag	45.45	93.25	11.26	40.88	7.00	1.49	5.96	0.83	4.59	0.82	2.34	0.38	2.52	0.36
F351 sintery slag	5.57	11.25	1.28	4.85	0.86	0.20	0.82	0.12	0.77	0.15	0.41	0.07	0.46	0.09
F351 porous slag	3.34	6.07	0.71	2.67	0.48	0.10	0.46	0.06	0.39	0.08	0.23	0.03	0.22	0.04

(d) sample	Hf	Ta	Pb	Th	U
4039:1 iron pan	9.26	0.49	7.36	9.19	9.26
F37 magnetic ore	8.17	0.15	17.69	0.52	0.15
F351 prilly slag	7.95	0.36	5.52	3.25	1.34
F351 lining slag	16.08	1.77	5.21	11.20	6.09
F351 sintery slag	9.86	0.39	6.34	2.54	1.24
F351 porous slag	9.03	0.22	8.76	1.17	0.44

Table 2. Chemical analyses

(a) major elements, expressed as weight% oxide. Iron is expressed as the Fe^{II} oxide. LOI = loss on ignition. For the iron pan and magnetic ore specimens iron is also quoted as the Fe^{III} oxide, with corrected LOI

(b) – (d) trace elements, expressed in parts per million (ppm).

nd = not determined, < = below detection

Table 3. Catalogue of material, organised by bag and box.

context/find	*sample*	*area*	*label*	*weight* (g)	*number*	*class*	*description*
Box 1							
?						artefact	nail fragments
F4			nail N side of church			artefact	corroded iron piece rusted on to schist fragment.
F4:7			X-ray 7			artefact	iron corrosion
F29:1			X-ray 12			artefact	iron corrosion (these could be natural?)
F55:1						artefact	copper alloy debris
F202:2			X-ray 11			artefact	nail fragments
F214a:1			X-ray 9			artefact	nail
F215:1			X-ray 1			artefact	nail
F215:5			X-ray 6			artefact	nail
F217a:1			X-ray 13			natural	weathered copper ore
F221:1			X-ray No 8 iron nail			artefact	curved piece of corrosion
F221:2			X-ray 4			artefact	iron rod
F221:3			X-ray 2 slag			natural	Mn mottling
F232:1			X-ray 3			artefact	iron fragment
F243:1			X-ray 10			artefact	flattened piece of iron with abundant organic materials in corrosion
F299:1			X-ray 14, iron nail			artefact	nail, dome head, square shank
F305:1			X-ray 5			artefact	nail head?
Box 2							
F57 (grave 37)	00AF		iron			natural	probably mainly Fe ore, but 1 piece is magnetic and probably rust
F93C:1		1	ferrous (fragm)			artefact	corroded Fe (magnetic) - but too tiny to make much of…
F93M	00o	1	iron pan?			natural	tiny Fe concretion
F232:1						natural	Fe crusts
F436:2		4	iron lump			artefact	iron in concretion (this is counterpart to F448:2)
F438:3		4	metal lump	5.66	1	artefact	laminated Fe cemented in concretion - probably totally corroded piece of iron
F448:1			metal?			corrosion	small stone with adhering Fe rich material - may be iron corrosion products
F448:2		4	metal pieces and stone attached			artefact	rather iron-rich porous cemented sand attached to larger stones, iron coats small organic material too, cored on a corroded iron artefact - rectangular cross section seen approx 20x7mm, counterpart to F436:2
F448:4		4 baulk				natural	Fe ore ball
F478	99o		peat?			natural	organic residue of some sort - peat residue quite possible
F478	99o		metal			natural	Fe crusts
F489	99AB		metal bits/rust			natural	Fe ore

F493	99Z		remainder given to J Connolly TCD for XRF			natural	Fe ore
F493	99Z		hollow metal piece			natural	annular iron pan crust
F496:1		4	iron pieces			natural	Fe mottles
F496:2		4				natural	Fe crusts
F703	98AD		metal bits			natural	small dense iron pan fragments
F850:1		8	iron			natural	hollow hemispherical Fe-crust
F854	00AC	8	natural iron pan?			natural	Fe crusts and mottling
F874	01E	8	metal?			natural	Fe mottles
F874:1			metal/iron pan			natural	Fe ore
F888:2		8	Fe bits	1.58	4	slag	4 pieces of vesicular slag, locally clear brown, locally black with sand grains, lining slag
F889:1		8	iron			natural	Fe crusts
F890	01q	8	ferrous?			natural	Fe-rich crusts
F4018:1 west		4	metal bits			natural	Fe mottling
F4022:1		4	metal bits			natural	moderately high grade iron pan mottles
F4037	01u		iron			natural	Fe mottles
F4076:1			iron			natural	iron pan granules
F4076:2			iron			natural	iron pan granules
F4076:4			iron frags			natural	Fe mottling
F8014	01y	8				natural	Fe crusts
F8014	01y	8	natural iron pan?			natural	Fe crusts
F8020	01Z	8	?			natural	small dense iron pan fragment, and 0.09g curious black glassy material - might be slag but probably organic
F8020	01Z		metal/iron			natural	Fe crusts
F8060:1		8	ferrous fragments			natural	Fe crusts
F8064		8	Cu alloy in soil			artefact	corroded Cu alloy

Box3a

F37	found left elbow					natural	strongly magnetic material, which is quite well foliated. There are patches and grains of Cu-corrosion associated. This is probably a piece of weathered Cu-ore.
F200:201	11		rabbit dist.			natural	labelled bag has some rust, associated unlabelled bags have natural material, including weathered Cu ore
F201	1	T2				natural	fragments of Cu veins, lots of secondary alteration. Some apparent grains of metallic copper
F202	10	T2				artefact	nail, square shank, rounded domed head
F401:1		4	iron object			artefact	iron object
F430:4		4	nail			artefact	nail, strongly magnetic
F430:5		found in section	lump of iron			artefact	nail
F435:1			metal			artefact	iron disc

F436:1			artefact	concretion around corroded artefact, magnetic
F436:3		iron lump?	artefact	magnetic corroded iron (disc?)
F436:4		iron nail?	artefact	magnetic concretion around probable nail
F436:5	4	iron nail	artefact	nail shaped lump of corrosion, magnetic
F436:6	4	iron lump	artefact	magnetic corroded nail in concretion
F438:2		metal thing?	artefact	elongate iron object (nail shank?) magnetic concretion
F445:1	4	corroded nail	artefact	magnetic corroded nail
F452:1		metal object	artefact	magnetic concretion - possibly nail shank visible
F457		metally bits found with bone	artefact	corroded iron artefact
F457:1		metal lump	artefact	slightly magnetic lump - right shape for a nail
F457:2	4	possible nail	artefact	nail in small concretion with strongly magnetic debris
F457:4	4	metal	artefact	corroded nail? In 4 pieces, strongly magnetic
F457:5	4		artefact	strongly magnetic amorphous lump - presumably artefact
F461:1	4	metal lump	artefact	concretion around corroded artefact, magnetic
F478:5			artefact	corrosion in gravel - quite likely to be an artefact
F496:3	4	iron bits	natural	Fe crust
F803:2	8	iron	artefact	strongly magnetic nail shank?
F805:2			artefact	corroded iron, probably a nail, but non-magnetic
F805:3			artefact	irregular corroded material with shells. Magnetic, possibly a nail
F806:1			artefact	iron object
F811:1			artefact	corroded nail - non magnetic
F811:3	8	nail	artefact	nail
F825:1	8	ferrous object	artefact	irregular magnetic concretion - worth X-ray?
F825:2	8	ferrous object	artefact	nail?
F825:2	8	poss ferrous nail	artefact	looks like nail shank but non-magnetic, coated in pale layer with organic tubules
F829:1	8	corroded nail	artefact	nail from morphology - but this corroded piece is non-magnetic
F4014:1	4	iron object	artefact	magnetic concretion - presumably iron artefact
F4020:1			artefact	magnetic hollow corrosion tube - nail?
F4020:2			artefact	iron nail head in concreted sediment
F4022:1	4	decayed metal	artefact	strongly magnetic iron object
F4030:2		iron head.stud	artefact	multi-layer Fe concretion around lobate organic/Mn core. The material is magnetic, so may indeed by an artefact.
F4031:1		iron	natural	pot-shaped non-magnetic concretion, pale coloured crust
F4032:1			natural	Fe crust
F4038:1		iron nail head	natural	non-magnetic bog-ore concretionary sheet
F4045:1		iron lumps	natural	mainly non-magnetic concretion pieces - some dome shaped and hollow, but doesn't seem to be corrosion
F4045:2	4	iron object	natural	Fe crust
F4076:3		iron nail	natural	iron pan granules - some tubular

F4076:5			iron (nail?)			natural	non-magnetic - a iron pan concretion - conical shape as seen in other examples
F8014:1		8	find			natural	iron pan granules
F8045:1			iron object			natural	hollowstone-like concretion, non-magnetic, probably natural.
Box 3b							
F4039:1						natural	Variable but locally very high grade Fe ore hosted in a coarse sediment
Box 3c							
F1:3,4,5		T1	from NE end gable wall			artefact	nails
F201:7	6	T2				artefact	bent nail
F4036:1						natural	big mass of iron crusts associated with coarse sediment
Bag 4 slag							
F347	98ar	bag D	crucible and iron (given to Jacqui Connolly TCD)	**47.41**	**total**		
				0.81	2	slag	magnetic spheroids, 5-7mm
				16.14	9	slag	dense prilly material flown around charcoal voids
				5.83	4	slag	pale lining slags in blebby form
				10.36	7	slag	dark slags, slightly flown and blebby, continuous with more sintery material
				14.27	56	slag	granular, sintery and organic-rich dark material, mainly magnetic
F351	00g	3	slag	**194**	**total**		
				8.66	2	slag	dense slags in small prills surrounding small charcoal clasts
				1.83	11	slag	poor spheroids / "coffee beans"
				3.42		slag	magnetic fines
				6.93	2	slag	possible ore fragments
				1.47	1	slag	corrosion around probable iron piece
				83.68	80	slag	sinter of iron rich material with lots of fine organics, merging into slightly flowed material, much of this is magnetic
				86.9	108	slag	lining slags and other pale, low density material, much of this is magnetic
				192.89			total of measured items
				1.11		slag	other debris (by subtraction)
F438:1		4	iron slag			natural	high grade iron pan - arcuate botryoidal crusts
F623:1		6	iron slag?			natural	iron pan cementing angular gravel
F618:2		6	slag	4.9	1	slag	small piece of dark slag, vesicular, moderately dense. With some oxidised lining attached to rear
F4032:2			iron slag			natural	slightly granular Fe-crust
F8099?		8	from spoil heap	330	1	slag	probably majority (>80%) of small dense SHC, top smooth (although a little coated) , base rough, slightly dimpled at edges

Box 5							
F347				2.73	4	artefact	Sherds from small conical crucible, fabric organic-tempered (hair?), white, very fine-grained, 1 small sherd shows possible slag wisps on outside but otherwise no residues visible. Crucible very small, probably less than 30mm tall.
F351	00g	3		**1.06**	**total**		
			metal	*0.6*	9	slag	flake hammerscale
				0.24	2	slag	magnetic slag films
				0.22	1	slag	magnetic slag disk
F351	00g		metal/lead?	**16.36**	**total**		
				0.78	4	slag	crude magnetic spheroids/"coffee beans", 4-7mm
				0.66	1	slag	magnetic slag sheet
				9.9	10	slag	microprilly material ,surrounding small charcoal voids
				0.19	3	slag	magnetic slag films
				4.83	3	slag	blebby lining slags, dull, slightly magnetic.
F351	00g		metal drop	0.8	16	slag	spheroids, the smallest (c 2mm) are the neatest, larger ones are less regular, all magnetic, and mainly dark.
Box 8							
F852:1			burnt clay?	34		artefact	fired clay piece with angular slagged tip and less fired slightly curved surface. Probably part of the lower side of clay tuyère - if so the base must be rather flat, but flattening on the base of an otherwise subcircular tuyère is not uncommon.

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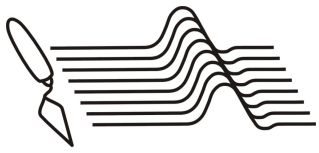

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