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Evaluation of archaeometallurgical
residues from the Kildare Town Bypass,
Co. Kildare;
Loughlion Site 8 and Cherryville Site 12
(01E0846 and 01E0955)

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Abstract

Materials from Site 01E0846, Loughlione Site 8, were dominated by pieces of natural iron and manganese rich rocks. A single small fragment of worn slag also occurred.

Site 01E0955, Cherryville Site 12, yielded slag from a cluster of truncated furnaces and an associated feature. Slag was obtained from six of the eight supposed furnaces and from the related F9. With the exception of just a few fragments, all of the slag was compatible with production in a bloomery furnace with a basal pit, as have been recognised elsewhere in this area. These furnaces, as argued elsewhere, would have had a low shaft above the basal pit, and should not be termed bowl furnaces.

The total amount of slag was rather small (16.3kg) and the assemblages in the furnaces were not as complete as seen on some other sites. Two styles of assemblage were found: in-situ fines from iron smelting found in 2 features and probably a third and coarse grained iron smelting slags (and occasional smithing slags) appearing in post-abandonment contexts within a variety of larger features. It appears likely that at least some of these features are non-metallurgical, and at least two have morphologies suggestive of corn-drying kilns.

In all, four of the features found (F2, F6, F7, F8) may have been the basal pits of iron smelting furnaces, and had diameters of 0.45 to 0.5m. This is similar to the size of some of the larger furnaces at Morrett and those at Jamestown on the N7 in Co. Laois (20 and 14km SW of Cherryville), and to that at Tullyallen in Co. Louth.

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Methods

This report is an evaluation of archaeometallurgical residues, mainly slags, from sites on the Kildare bypass excavated for Valerie J Keeley Ltd (VJK). In addition to the evaluation of the residues, comment is also made here on the significance of the associated structures.

The archaeometallurgical residues have been evaluated by brief visual inspection and the use of a lower-powered binocular microscope. Descriptions and interpretations of material are necessarily limited by this approach.

Site information is based on copies of an interim report supplied by VJK.

This report should not be taken as a final interpretation of the materials described herein, but is a brief catalogue, description and interpretation of the materials, together with an evaluation of their potential for further post-ex investigation with recommendations for the form those investigations should take.

This report makes extensive reference to a previous unpublished reports written for VJK, in particular a summary of the evidence for the nature of early Irish iron smelting furnaces (Young 2003c) based on finds from four sites evaluated for VJK (Young 2003a, 2003b, 2003d).

Loughlione Site 8

Residue description

The material collected from Site 8 is listed in Table 1. The majority of the material is natural. Several of the pieces are mineralised rocks of various kinds exhibiting iron or manganese enrichment.

The sole piece of anthropogenic archaeometallurgical residue is a small worn lump of charcoal-rich iron slag from c102. It cannot be identified more precisely.

Cherryville Site 12

Results

Residue description

The material collected from Cherryville Site 12 is listed in Table 2. It falls into two groups: contexts bearing assemblages of probably *in-situ* fine-grained residues and those bearing reworked assemblages of larger residue pieces.

The fines assemblages (c8 F2; c4 F6; c3 & c17 F7) comprise small (typically less than 10g, many less than 2g) fragments of several distinct classes of residue:

- dense descending slag prills
- "coffee-bean" spheroidal slag droplets
- dull slag blebs
- porous material resembling sinter
- sandy lining material
- lining-dominated slag

Assemblages of this type can be interpreted as being the product of smelting. Very similar material has been recovered from furnaces elsewhere together with diagnostic macroscopic slag assemblages (Young 2003a, 2003b, 2003c, 2003d, 2005c). In some circumstances somewhat similar material has also been recorded from the base of smithing hearths (Young 2006a, 2006b). Further analytical work is required to clarify the differentiation of the two origins, but a high proportion of prills and the absence of hammerscale, indicate an origin in smelting for the current material.

Rather more diagnostic is the assemblage from c45 (F2), which contains some good examples of brittle, shiny, lobate slag flows. These resemble the flows of a tapped slag, but on several studied sites these have been observed, or interpreted, to be flows crossing the floor of the basal slag pit of a non-slag tapping furnace (Young 2003b, 2003c, 2005c),

The coarser residue pieces include a single example of a smithing hearth cake (c6, F4). The piece of SHC is apparently approximately 33% of the original cake, giving the whole an approximate weight of 1115g. There are also several dense pieces of burr (the zone of a slag cake below the blowhole, where fluxing of the iron-rich debris by the ceramic wall results in wall damage and the formation of a dense fayalitic slag), but it is not possible to determine whether the burr fragments are from SHCs or from smelting furnace bottoms (c9 F3; c6 F4; c5 F5).

The assemblages of coarse residues include several examples of slags which closely resemble the texture of the cross-floor flows described above, but which

appear to involve mainly descending slags, and which characteristically flow between extremely large pieces of wood or charcoal (c5 F5; c6 F4). This texture is one of the most diagnostic of smelting in a non-slag tapping furnace with a basal pit (e.g. Young 2003c, 2005b and 2005c)

One slightly unusual aspect of assemblages from F4 and F5 is the presence of some extremely large blocks of vitrified lining and lining slag. This material includes 2.8kg from F4 and 0.8kg from F5. None of the lining material provides evidence for superstructure morphology that is easily interpretable. Some of the material at least seems to form slabs with vitrification on both sides, possibly indicating a piece of furnace superstructure that has fallen into the furnace during use. Somewhat similar highly vitrified slabs occurred at Cappakeel West (Site F) on the Heath Mayfield scheme (Young 2005c).

Two pieces of slag from c6 (F4) are suggestive of having been formed in the crust of a furnace bottom. These are not certainly from smelting, and would be worthy of further analytical investigation.

Residue distribution

Feature 1: a 0.75m diameter cut (c23; labelled F8 on the supplied Figure 8), lined with clay, reducing the working diameter to about 0.55m. The profile of the feature as worked was only gently concave and approximately 0.1m deep. This morphology is unlikely to have been a smelting furnace. It yielded no slag. Its use remains unknown.

Feature 2: a circular, bowl-like cut (c44; described as 0.46m in diameter, although the supplied diagram, Fig. 5, shows a 0.56 diameter cut), with a clay lining. The surviving working volume shows as 0.50m wide on the supplied figure, with a surviving depth of about 0.12m. The lowest of the deposits within the feature, c45, contained a good assemblage of horizontal slag flows, and the uppermost fill (c8) yielded a slag fines assemblage of a sort to be expected to accumulate within the fuel and ash in the lower part of a smelting furnace. This feature can be interpreted as the truncated base of smelting furnace.

Feature 3: this was a figure-of-8 shaped feature (c36). The lower levels of this feature contained little slag (c72, c75, c81) contained a few sporadic lumps of smelting slag. The final fill of the feature (c9-36) was a stony layer containing a significant quantity of smelting slag. It would appear likely that c9-36 represents an abandonment context, in which the hole was filled with debris from elsewhere. In this interpretation the underlying sterile clay (c72) might well represent collapse of the original superstructure after abandonment. The original use of the feature is unknown, but there is no evidence from the residue assemblages that it was metallurgical; an interpretation as a corn drier seems plausible.

Feature 4: this was a large bowl-shaped feature (c29). The natural is burnt. The edges become steeper upwards. The feature has a single fill (c6) according to the report text, but a second context (c24) is listed as a fill in the table and also yielded a small quantity of slag. The working volume was subcircular, up to 0.80m wide and 0.33m deep. The residue content of the main fill (c6) is heterogeneous and does not represent material left *in situ* on abandonment. This means that the residue content of the fill is not an indicator of use. One

characteristic of this assemblage is the presence of large pieces of vitrified ceramic from a hearth/furnace wall; this is similar to the post-abandonment fill of feature 5, see below. The use remains unknown, although it may be significant that this feature is much larger than the surviving remains of the probable smelting furnace Feature 2.

Feature 5: this was a keyhole-shaped feature (c19). It has a western, bowl-shaped component, with a working volume approximately 0.80m in diameter and 0.48m deep. The eastern, ramp-like component was approximately 1m long. Two pieces of slag occurred in the early fill of the ramp area (c27), but were not necessarily associated with use of the feature. The main fill of the feature (c5) was an assemblage of smelting slags and pieces of vitrified ceramic wall in rather large pieces. This material will represent material dumped from elsewhere after abandonment of the feature. It may be significant that this assemblage is very similar to that in the fill of feature 4.

Feature 6: This was a heavily truncated feature, 0.54x0.4m and 0.09m deep (c18). The slags are rather indeterminate and occur in very small pieces. The origin of this assemblage is not immediately apparent, but may be from smelting or smithing (further analysis may clarify this) and may well relate to usage of the feature.

Feature 7: This was a bowl-shaped feature (c17). The observed fills appear to relate to usage of the feature. The form of the feature is slightly irregular, subcircular in plan, 0.48m in diameter. The associated slags are dominantly fines, with a significant proportion of descending prills, implying that usage was probably smelting, and further analysis may confirm this.

Feature 8: This was a heavily truncated feature, 0.45m in diameter with a surviving depth of less than 0.08m (c14). It yielded no slag.

Feature 9: This was an irregular feature, 1.40m x 1.10m with a maximum depth of 0.25m (c41; note this does not correspond to the feature labelled F9 on supplied Figure 8). It had several charcoal-rich fills, one of which (c7) yielded four small pieces of probable smelting slags. The slags probably do not relate to usage.

Interpretation

The features comprising Group A of Cherryville site 12 are rather heterogeneous.

Within the group there are some smaller features that may well be the remains of smelting furnaces. These include F2 and F7, which contain slag assemblages suggestive of *in-situ* smelting residues, F6, which yielded a more indeterminate slag assemblage, and F8, which yielded no slag. These features are characterised by a bowl-like shape, with rather steep edges where well-preserved, and with a diameter of approximately 0.45m

A group of larger structures include some for which a non-metallurgical origin seems likely, including the figure-of-eight structure F3 and the keyhole-shaped feature F5. Structure F3 and to a lesser extent structure F5 resemble features identified as corn-driers elsewhere.

The bowl-shape end of the keyhole feature, F5, was about 0.8m in diameter, and this may provide a link

with features F1 and F4, which were of about the same size. F4 had a very similar slag component of its fill following abandonment to F5. Both assemblages had a high proportion of vitrified lining or superstructure, together with large pieces of smelting slag as well as some pieces certainly (F4) or possibly (F5) associated with smithing. F1 yielded no slag. Shallow pits of 0.8-1.2m in diameter have been interpreted on other sites (e.g. Coolamurphy Site 7; Young 2006) as smithing hearths, but the features at Cherryville seem rather too deep and they have not yielded significant quantities of smithing residues

The function of the irregular feature, F9, is uncertain. The charcoal-rich nature of its fills may possibly suggest it was a pit involved with charcoal production although it appears more irregular than the charcoal production pits located on various sites on the Heath-Mayfield project (dimensions quoted in Young 2005c).

The large slag lumps deposited in various features complement the fines left *in-situ* in the furnace bases. The material includes dense slag flows down the furnace blowing wall, stalagmite-like accumulations where persistent slag drips from the main slag cake/bloom mass have reached the furnace floor and also various charcoal-rich slag pieces which may be associated with the main slag mass.

Non-slag tapping low-shaft furnaces producing residues of the types seen here appear first in continental Europe (Pleiner 2000), but have spread to Britain by the 6th century BC (e.g. Young 2005a) and possibly rather earlier. They become widespread in Britain during the Iron Age (e.g. Clogg 1999; Crew 1987, 1989, 1998; Halkon 1997) where their morphology has been studied in detail and their operation modelled experimentally (Crew 1991). In Ireland, their truncated remains have usually been misidentified as so-called bowl furnaces (e.g. Scott 1990). New data from the many recent road-schemes (e.g. Young 2003a, 2003b, 2003d, 2005c) as well as from more research-oriented excavations (e.g. Young 2005b) are beginning to allow revised interpretation of the Irish examples (e.g. Young 2003c). The furnace type is rarely found in Britain after the Roman conquest, but survives in Ireland, possibly as late as the 18th Century. The reason for this survival in Ireland seems to be the furnace type's suitability for smelting the widespread bog iron ores. In Britain the use of a slag-tapping furnace becomes almost ubiquitous from the late pre-Roman Iron Age, with rock ore usage being dominant from the same period.

Evaluation of potential

Cherryville Site 12 has potential to enhance understanding of development of iron production in central Ireland. The site may be compared and contrasted with other iron smelting sites recorded to the SW of Kildare on the N7 Heath Mayfield project (Young 2005c) and at Celbridge Site 5 in NE Co. Kildare (Young 2003b). The interpretation of this industry will be greatly enhanced by having a series of sites of different ages documenting development in technology.

It is recommended that representative material from the fines in features identified as probable smelting furnaces (F2 and F7) be analysed, along with material from the less easily identified assemblage from F6. Macroscopic slag material is unfortunately not directly associated with the fines assemblages, but the collection from F4, although not in a primary deposit,

potentially provides a suite of common origin, with a varied selection of the slag types commonly found in iron smelting.

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Table 1. Catalogue of residues from Loughlione Site 8

<i>context</i>	<i>find</i>	<i>weight</i>	<i>notes</i>
19	30	106	2 pieces of igneous rock plus one 37.8g piece of mineralised rock - now Fe oxides but may have been sulphide originally before oxidation
34	19	74	iron ore - dense botryoidal goethite with bright ruddle layers, cased in white clay
65	21	4.28	small Fe or Mn rich concretion in 3 pieces
102	29	46	32 stone, 14 very worn charcoal-rich slag piece
topsoil	7	160	52g broken Fe or Mn ore lump; 106g 6 pieces of stone

Table 2. Catalogue of residues from Cherryville Site 12, organised by feature

context	find	weight (g)	notes
Feature 2			
45	215	352	18g 1 piece slag rich in fine charcoal; 92g piece with flow lobed base, top missing, inside has free large olivine crystals; 240g 37 pieces of tap-slag like floor flows, very brittle, very shiny; 2g 2 crumbs of charcoal-rich slag
8	122	804	38g 9 pieces of very sandy lining and lining slag, has some organic temper; 506g 50 pieces of dense prilly slag, mainly descending, shiny dense, dark, one piece is very thin flow between floor and flat wood piece; 90g 24 pieces of duller and/or less dense blebby slag; 156g basal sintery material - this is fine like that from Celbridge, a few bits of included flow blebs.
Feature 3			
72	383	20	1 small corrosion ball, 3 small dimpled slag pieces, 1 exploding accreted slag fragment
C9-C36	309	1590	326g 11 pieces of vitrified lining; 20g 2 pieces of stone; 80g 2 pieces of corrosion/concretion; 8g 2 tiny blebby slag pieces; 30g shiny complex descending prill; 662g 5 pieces of burr or shc material, massive, dense, has some attached sediment; 374g 3 pieces charcoal rich massive slag; 64g 2 pieces of lobate slab with granules (ore?) on lower surface.
C9 (36)	53	586	178g 5 pieces of vitrified lining/lining slag (all reduced-fired), 220g large block of dense slag with very large charcoal moulds; 60g very dense slightly granular slag nub; 52g dense slag with moderately large charcoal moulds and sediment contact; 72g 3 pieces of amorphous dense slag.
81	238	278	34g vitrified lining piece; 238g irregularly prilly/micropilly/blebby slag coalesced around poor medium charcoal moulds- possibly from Tullyallen-style furnace bottom
75	381	76	1 piece of dense slag with the moulds of large charcoal pieces
68 within 36	240	158	76g several pieces of stone; 76g 2 lumps of Fe-corrosion/concretion
Feature 4			
24	382	66	28g vitrified lining; 36g partially flow-lobed material; 2g fine debris
6	47	332	2 pieces of granular hearth bottom: one very hard, dense and plano-convex, suggests dish-shaped base with side springing up at 50-60 degrees, the other irregular and not certainly from furnace base. Big piece has lots of small slag fragments apparently welded to top of true basal flow - itself mixed into the underlying clay and possibly ash
6	47	2804	46 pieces of vitrified lining and lining slag, 2 pieces in particular are extremely dense and massive thick blocks
6	47	368	Part of moderately small, dense smithing hearth cake. Top concave. Suggestive of original cake of 130mm diameter - making this piece about 1/3. Crust 20-30mm thick. Upper and lower faces both fairly smooth.
6	47	280	3 small pieces of very dense burr material
6	47	1080	16 indeterminate pieces of dense slag
6	47	144	finer and dust
6	47	1595	20 pieces of dense slag with descending prills and sheets and/or enclosing very large charcoal fragments. Largest piece is 652g and has slightly radiating prills.
6	47 (2/3)	386	66g 13 pieces of lining + associated lining slag; 92g 12 pieces of dense prilly material; rest small pieces of dull, indeterminate or coarsely crystalline iron slags

Feature 5

5	37	3175	large material, 816g 13 pieces of lining and lining slag; 518g 3 pieces of flowed and charcoal-rich material attached to wall; 740g 7 pieces of probable descending smelting slag in prills and large charcoal moulds; 204g piece of large burr; 896g 10 pieces of amorphous dense slag
27	49	260	94g possibly worn but ash-covered slag lump with charcoal inclusions and moulds in dense massive piece; 158g very dense piece of burr-type development, but dense slag appears to be a sheet attached to the lining, rather than being of a characteristic burr shape

Feature 6

4	27	516	176g 16 pieces of lining/lining slag - note that only two tiny pieces are oxidised fired; 82g small dense prilly slag pieces; 258g duller slag pieces - still mainly fairly dense
4	27	682	approximately 110 small indeterminate slag pieces

Feature 7

17 (=16+11)	34	438	260g 10 pieces of descending prills and blebs, brittle, shiny; 178g granular/sintered furnace floor material with at least 2 fused-in low density blebs, in many pieces down to dust size
3	380	140	10g 5 pieces of dense prilly slag; 2g 3 coffee-bean slag drops; 28g 14 pieces of dull blebby slags; 2g 4 pieces of lining debris; rest is sintery basal material
17	23	1.58	chert

Feature 9

7	155	146	72g large block of vitrified lining material; 52g fairly small lobes around charcoal moulds; 12g single flow lobe; 10g charcoal-rich tiny piece
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Others

104	36	0.96	chert
142	210	9.34	slightly mineralised ?porphyritic andesite
190	384	1.11	4 small concretions of Fe-cemented sand - probably natural

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