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Evaluation of archaeometallurgical residues from the R402 Enfield-Edenderry: Carbury 1 [11E0406], Carbury 2 [11E0406] & Clonkeen 3 [11E0407], Co. Kildare

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Evaluation of archaeometallurgical residues from the R402 Enfield-Edenderry: Carbury 1 [11E0406], Carbury 2 [11E0406] & Clonkeen 3 [11E0407]

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Abstract

Carbury 1 produced one single small fragment of iron smelting slag, typical of slags accumulating within the pit of a slagpit style of non-slag tapping furnace.

Carbury 2 produced a larger assemblage from a single feature, including residues from both iron smelting and iron working (smithing). The smelting residues are dominantly associated directly with the furnace, including wall fragments and slag that was probably intrusive into the wall around/below the blowhole. The smithing residues include a small smithing hearth cake.

Clonkeen 3 yielded flow lobed slags of indeterminate origin, but possibly also associated with an origin on the wall of an iron smelting furnace.

The residues bear close comparison with other examples of assemblages from iron smelting sites in this part of Ireland. The small size of the SHC from Carbury 2 provides circumstantial evidence for an Iron Age date for that site at least.

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Methods

All materials were examined visually with a low-powered binocular microscope where required. As an evaluation, the materials were not subjected to any high-magnification optical inspection, not to any form of instrumental analysis. The identifications of materials in this report are therefore necessarily limited and must be regarded as provisional. The summary catalogue of examined material is given in Table 1.

This project was undertaken for the Irish Archaeology Consultancy as part of the R402 Enfield-Edenderry improvement scheme.

Results

Description of the materials

Iron smelting

The majority of the materials in this collection are residues from iron smelting. Some of these materials are structural, including a variety of fired and vitrified clay fragments, mainly from around the blowhole area of the furnace and including examples where the furnace wall has been intruded by dense iron-rich slags. The slag from Clonkeen 3 is of indeterminate origin, but may represent highly slagged furnace wall material.

One large block of dense slag from Carbury 2 may be from the zone immediately below the blowhole (although an alternative interpretation of the piece as a smithing hearth cake, SHC, is possible, although that would involve an unusual adhesion to a clay hearth floor).

Other pieces from Carbury 1 and Carbury 2 are of 'flow slag' - prills of dense fluid slag, that have solidified within the fuel bed and/or basal pit packing of the slagpit style of non-slag tapping furnace. The most usual pit packing in Ireland was of wood – and several of these pieces show the moulded surface of a wood or charcoal substrate.

Fine-grained materials from Carbury 2 include small slag droplets, many with a dimple (the so-called coffee-bean spheroids), which also indicates cooling with the fuel bed/pit packing.

Iron working

Besides the possible SHC piece mentioned above, a further, more certain example of a small dense SHC was recovered from Carbury 2. This SHC measured 70x80x50mm (with a bowl depth of 25mm) and weighed 268g. The slightly concave top had impressed charcoal and a superimposed mass of lining slag. The base was irregular and dimpled. The SHC was triangular in plan, rich in charcoal, but still very dense.

Distribution of the materials

The large quantity of materials from fill c29 and c31 at Carbury 2 clearly indicates these contexts have some metallurgical significance. The cuts containing these fills are apparently quite deep in relation to their breadth, which is unlike most pits from early slagpit furnaces- but such dimensions are not unknown.

In slagpit furnaces heat is transferred downwards largely by migration of the slag during the smelt, and so only the very upper levels of the pit sides may show oxidation, particularly in deep pits. The heated zone of the cut may of course be removed by subsequent truncation in many instances – so smelting furnace pits do not necessarily show burning (although many do).

In summary, it is unclear whether the pits containing the residues are furnace pits or simply pits in which waste disposal has occurred.

Interpretation

The assemblage from Carbury 2 was indicative of both iron smelting and smithing. Iron smelting was also evidenced by the single slag fragment from Carbury 1. The material from Clonkeen 3 was indeterminate, but also compatible with an origin in iron smelting.

The Carbury 2 assemblage is indicative of iron smelting in a 'slagpit' style of furnace – a non slag-tapping shaft furnace, in which there is a pit below the furnace to receive the slag generated during the smelt (see Carlin 2008, illustration 5.2). The slagpit furnaces employed in Ireland were intended for re-use; clearance of the slagpit and repair of the damage to the furnace (particularly around the blowhole area) at the end of a smelt would have resulted in the sort of residue assemblage seen here.

The mixed smelting-smithing assemblage with an emphasis on structural materials is rather reminiscent of the collection from Cherryville 12, on the Kildare bypass (Young 2006, 2008). The Cherryville assemblage is associated a 14C date on alder charcoal, with a radiocarbon age of 2271 +/-35, equivalent to cal BC 400-340 / 320-200; thus a date in the 3rd-4th centuries BC is likely if there is no substantial old wood effect.

At Cherryville, the mixed slag assemblage was found as material dumped into both smelting furnaces and other features, so the features yielding the Carbury assemblage cannot immediately be assumed to be metallurgical features without additional evidence – which appears largely lacking (in the absence of traces of *in-situ* burning).

At Carbury, the assemblage is not strictly indicative of age, although the similarity with the material from Cherryville may hint at an Iron Age date, as would the small size of the SHC if associated with primary, rather than secondary smithing. From the early medieval period onwards the size of SHCs associated with primary smithing (from bloom-smithing or bloom-refining) tends to be large and they are typically over 1kg in weight, as opposed to those from secondary smithing (blacksmithing) which are typically less than 850g in weight(e.g. Young in press).

The bogs of Co Kildare appear to have provided a ready source of bog iron ore for smelting over a long period (Young 2003, 2005, 2006, 2008).

Evaluation of potential

The potential of the Carbury 2 assemblage to yield archaeologically-significant information on further investigation depends in part on its age. The assemblage is small and, at present at least, it is unclear whether it is directly linked with features of metallurgical origin. These aspects reduce the potential of the assemblage. However, if the assemblage should prove to be early, then its potential to shed even some light on the relatively poorly understood development of iron smelting in Ireland, might outweigh these negatives. In this case, a small programme of textural and chemical analysis of the associated smelting and smithing remains would be recommended.

Whether or not second-stage analysis of the residues is commissioned, the retention of the materials by the NMI to permit future investigation is strongly advised.

References

CARLIN, N., 2008. Ironworking and production: an evaluation and assessment of the metallurgical evidence*, in:* N Carlin, L Clarke and F Walsh, *The Archaeology of Life and Death on the Boyne Floodplain: The Linear Landscape of the M4*, 87–112, Dublin, National Roads Authority, Wordwell.

YOUNG, T.P. 2003. Evaluation of slag from Celbridge Site 5, County Kildare (01E0306). *Geoarch Report 2003/07*. 5pp.

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 the Kildare town By-pass; Loughlion Site 8 and Cherryville Site 12 (01E0846 ad 01E0955). *GeoArch Report 2005/16*. 8pp.

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

Glossary

Blacksmithing: the working of iron and steel. Often restricted to the secondary smithing – i.e. the smithing of iron to produce or repair artefacts.

Bloom: the crude iron block formed by iron smelting in a bloomery. It may contain voids and inclusions of slag and charcoal. It will require some degree of reworking (bloomsmithing) and/or refining before the iron can be used by a blacksmith.

Bloom refining: the conversion of a raw bloom to useable metal. Often accomplished by bloom smithing, but other techniques, such as remelting, may sometimes have been employed.

Bloom smithing: the smithing of a bloom – often by folding and welding, to convert it into usable iron. Sometimes called primary smithing.

Burr: the zone of interaction between slag and the hearth or furnace wall just below the tuyère/blowhole. Typically seen as a dense lunate slag, with attached highly indurated ceramic, forming a protuberance on the margin of an SHC or FB.

Flow slag: smelting slags that have flowed within the smelting furnace, typically into the basal pit of a slagpit furnace, but have not flowed out of the furnace. Flow slags may include various morphologies: individual slag spheroids, isolated vertical prills, horizontal flows/prills, birds-foot structures.

Furnace bottom (FB): a rather poorly-defined term for the main slag mass formed during iron smelting in a non slag-tapping furnace. If the basal part of the furnace is shallow this may be dense, but if the bottom is deep then a rather low density FB, formed of coalesced prills, is more common. Slag escaping incorporation into the main FB forms flow slag lower in the pit.

Primary smithing: see bloom smithing

Secondary smithing: see blacksmithing.

Shaft furnace: a furnace in which the charge descends under gravity as the fuel burns and the reducing gasses rise. The blast furnace, the bloomery and the early tin smelting furnaces are all shaft furnaces.

Slagpit furnace: a variety of non slag-tapping smelting furnace in which a pit for slag collection lies below the base of the shaft. Slag pits are commonly packed with organic material prior to smelting – which is typically split wood in NW Europe, but may be of cereals or grass (particularly in eastern Europe). Flow slags form where slag descends into the pit and a furnace bottom may form across the top of the pit. This is the dominant form of early iron smelting furnace in Ireland.

Slag flats: formed from an accumulation of slag on the surface of the workpiece (or sometimes on the surface of the smith's tools or other substrate). This accumulation may be formed from slag escaping from the inclusions in the workpiece, formed from melting of the surface oxide layer, or formed from contact with slag drips in the hearth. Slag flats are thicker than flake hammerscale, have one planar but rough surface and one irregular surface.

Slag spheroids: sub-spheroidal particles, often dimpled (coffee bean spheroids), dull in lustre, and less perfectly spherical the spheroidal hammerscale. These spheroids are typically up to about 10mm in diameter. These are mainly slag droplets formed by the dripping of slag within the fuel bed of the hearth. Isolated spheroids may form in non slag-tapping smelting furnaces as a variety of sparse flow slag, but are more common in smithing hearths.

Smithing hearth cake (SHC): the slag cake formed in a smithing hearth by reaction of iron oxides lost from the workpiece with silicate material from hearth ceramic and/or fuel, below and in front of the tuyère/blowhole. They are very variable in form, but are typically plano-convex in shape (although concavo-convex and biconvex forms are common), frequently with a dense lower crust and a less well consolidated upper part. In some cases the top is formed of glassy slag.

Tapping: allowing slag (in the context of a bloomery) or metal (in the context of some other furnace types) to flow from the furnace to cool and solidify outside the furnace. Slag tapping bloomeries have an advantage in being easier to clean and refurbish between smelts compared with non-tapping varieties. They may also (depending on slag viscosity and quantity) assist with a high degree of bloom-slag separation.

Table 1: Summary catalogue of materials by context. Assm. = sieved residue assemblage, SHC = smithing hearth cake, FAS = fuel ash slag.

C	S	weight	number	description
Carbury 1				
4	1	27	1	Classic, dense flow slag in contact with large wood mould
Carbury 2				
29	3	168	1	fragment, possibly of very dense SHC welded onto clay floor; cake has zone of large rounded vesicles just above base, then dense to near top, top haematised slightly and has blisters pulled-up to reveal large crystal terminations below. On one side the cake has good flow lobe-like protrusions extending into the clay. Clay is grey, reduced-fired. If not an SHC could just be a steep burr area slag from a smelting furnace
		52	1	piece similar to above, but slag sheet has tubular vesicles (with exposed crystal terminations and internal spheroidally-arranged large fayalite crystals) and is 'overlain' by oxidised clay. Probably therefore a penetrating sheet near blowhole. Slag has layer of vesicles along layer of interaction with ceramic on both sides
		26	1	reduced-fired ceramic with deep glassy slag, becomes oxidised-fired at one end and the glassy surface curls over - probably a blowhole margin. Slag layer pale with grey surface and rich in gravelly crystals
		10	1	oxidised fired ceramic with blebby lining slag on front
		36	1	piece of rather fragmented reduced fired clay, vitrified on front and side- which has a curvature of 50mm radius approx. This could be from a tuyère margin, but is rather crude - alternatively may more likely be a vitrified fallen fragment of wall
		90	1	reduced-fired gravelly ceramic with vitrified front; lining slag has haematised surface and forms an arcuate raised and overhanging ring on one side. Possibly flowage on wall near the blowhole
		170	3	dense flow slag fragments, all show dense lobes penetrating between charcoal moulds, largest piece shows a distinct prilly/dimpled base. Probably smelting slags
		268	1	SHC 70x80x50mm (bowl depth 25mm), slightly concave top with impressed charcoal, with superimposed mass of lining slag. Base irregular, dimpled, triangular in plan, charcoal-rich but slag very dense
		2	6	tiny slag fragments - mainly lining slag
31	4	309	assm	wide ranging assemblage of small pieces, including flow slags, coffee bean spheroids, dense irregular blebby slag fragments, fired clay (mostly with planar surface and sometimes vitrified), vitrified stone, irregular, granular and rusty slags of 'furnace floor' type. One slag flat type piece around 20mm rod (or wood?)
Clonkeen 3				
3	1	70	3	moderately large slightly flowed lobes of very low density porous slag. Slag dark, highly vesicular, shows dimpled and lobate margins, one piece is slightly denser and is part of a cake margin with almost lobate edge. Appear like iron slag but have morphology closer to FAS

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