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Evaluation of archaeometallurgical residues from the Kilcullen Service Area: Halverston 1 (E4385) & Kilgowan 1 (E4387)

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Abstract

Halverstown 1produced a small quantity of both microscopic and macroscopic smithing (iron-working) debris from a deposit (Context 13) likely to be a waste deposit directly associated with a smithy, if not the fill of a smithing hearth itself. Two isolated macroscopic slag pieces, also likely to be from smithing were recovered from the fills of a souterrain and an adjacent pit, but material from the base of the souterrain proved to be natural. One other context produced tiny slag fragments from sieved residues. The residues are not indicative of age.

The material supplied from Kilgowan 1 was not of metallurgical origin.

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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 Kilcullen Service Area project.

Results

Description of the residues

Iron-working macroresidues

Macroscopic smithing residues include a large ‘double’ smithing hearth cake (SHC) from c114. This SHC appeared to be the result of a partial clearance of the hearth (or possibly just the first SHC being knocked into the lower part of the hearth, rather than being removed) between smithing sessions. Although the resultant composite slag cake was quite large, the individual sections were of a typical size for an SHC produced during blacksmithing.

A fragment from a fill (c119) of a souterrain was probably also from an SHC. A concavo-convex piece from c13 might have been from a small SHC bowl, but was more likely from the burr (the region of attachment of the SHC to the hearth/tuyère ceramic). Other slag pieces from c13 might also have been fragments from SHCs, but were not conclusively so.

Some of the slag fragments from c13 were in the form of dimpled slag sheets – which may too have been SHC fragments, but slag sheets may form in the heath outside the SHC, most notably around and below the blowhole in some hearths.

Iron-working microresidues

Various small particles of residue were recovered, principally from c13. These include the microresidues known as spheroidal hammerscale (SHS) and flake hammerscale (FHS), formed from the superficial oxidation of the workpiece. There were also slag droplets from within the fuel bed – including examples of dense iron slags as well as blebs of iron-poor slag derived largely from melting of the hearth ceramic (lining slag). Some of droplets of dense slag are characteristically dimpled where they solidified in contact with fuel particles, forming so-called 'coffee-bean' spheroids.

Assemblages of microresidues were observed, not only in the separated material, but within the concretions and accretionary material adhering to slag pieces. This style of occurrence suggests that the microresidues were widely distributed within this context.

Sieved material from c27 included angular slag fragments, probably derived from degradation of macroscopic slag material.

Other materials

The collection from c13 at Halverston 1 includes several small concretions, which have formed during the diagenetic redistribution of iron from corroding metal. This might be either from iron particles contained within slag or simple metal fragments.

Non-metallurgical materials

Materials from c129 at Halverston 1 were slightly decomposed grey limestone with pale calcite veins.

Materials from Kilgowan 2 c14 included a small fossil coral and a piece of burnt (coked) organic matter of uncertain original nature.

Interpretation

The assemblage from Halverston 1 is indicative of iron-working using charcoal fuel. Although the evidence is very limited, the small size of the SHCs and the overall small size of the assemblage suggest that this iron-working was secondary smithing, commonly known as blacksmithing. This is the production and/or repair of artefacts, rather than smithing as part of the process of iron-production.

The interpretation of the feature yielding the residues from c13 at Halverston 1 may need further investigation. The assemblage is strongly suggestive of the residues which accumulate on a smithy floor or in associated features. The feature is not necessarily itself a smithing hearth (unless there is good evidence for heating), but might be one of a variety of features (worn floor hollow, anvil base, structural posthole, drainage gully...) that commonly accumulate such residues around a smithy.

The larger slag fragments from other contexts on the site are compatible with an origin in the same smithing activity, although need not be directly related.

The residues from Halverston 1 are not indicative of any particular age (although are clearly Iron Age or later and coal tends to replace charcoal as fuel in Irish smithies during the 19th and early 20th centuries).

The materials from Kilgowan 2 are not indicative of metallurgical activity.

Evaluation of potential

This material has no potential for further detailed analysis to yield significant additional information.

The material is not of high priority for retention.

References

DUNGWORTH, D. & WILKES, R. 2009. Understanding hammerscale: the use of high speed film and electron microscopy. *Historical Metallurgy* 43, 33-46.

YOUNG, T.P. 2011. Some preliminary observations on hammerscale and its implications for understanding welding. *Historical Metallurgy,* **45,** 1, 26-41.

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, as opposed to the smithing involved in the production of billets or bar iron from raw iron blooms.

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.

Flake hammerscale (FHS): flake-like particles formed by the surficial oxidation of hot iron in air (Young 2011). The iron oxide layer will detach from the workpiece because of differential thermal contraction or during deformation of the workpiece when hot-worked at the anvil. The thin scales fall from the workpiece and will accumulate mainly close to the anvil (although some will be lost elsewhere in the forge and even in the hearth). Flake hammerscale has planar surfaces, one of which is typically very smooth and reflective, the other only slightly less so.

Secondary smithing: see blacksmithing.

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.

Spheroidal hammerscale (SHS): spheroidal particles of typically less than 2mm. Often these are vesicular or hollow. Mainly formed (Dungworth & Wilkes 2009; Young 2011) when, mainly during forge welding, the iron is heated sufficiently for the surficial oxide layer to melt; when the two sides of the weld are closed, the molten oxide is expelled. This process is often enhanced by the addition of a welding flux – particularly where quartz sand is used. The melt coalesces into droplets and chills in flight to form spheroidal hammerscale. Typically they have a shiny surface with a metallic lustre and a close to perfectly spherical shape (unless deformed by impact).

Table 1: Summary catalogue of material by context. Assm = sieved residue assemblage, FHS = flake hammerscale, SHS = spheroidal hammerscale, SHC = smithing hearth cake.

C	S	cut	label	weight	number	
Halverstown 1, E4385						
13	3	11		160	assm	c60 hand-picked small (<4mm) spheroids, smallest may be SHS, but most apparently droplets unpicked material includes some larger (up to 8mm) 'coffee bean' spheroids magnet picks up much fine amorphous material but also some good FHS larger fragments include some very iron-rich slag in blebs and complex shapes as well as iron-poor lining blebs
13	25	11		148	2	concavo-convex slag resting on altered sandy gravel. Upper dished surface is covered with imprints of fine charcoal - either an unusual SHC or a burr. In section, the slag is very fine grained and fairly vesicular
				54	2	pieces of a highly weathered slag sheet, with charcoal dimples on one side, now very altered, fresh break - not whole piece
				124		dense lump of very rusted slag - appearance is coarsely granular - could be effect of weathered microprills; an odd dense slag
				60		small spiky slag mass with rounded surfaces of dense iron rich slag, but very porous, slightly granular appearance
				34		accreted slag piece - dimpled sheet? Contains iron. Accretion is a slag rich deposit
				36		accreted piece of dimpled slag, attached sediment is rich in charcoal and has some FHS
				26		small concretion, contains iron, sediment rich in slag debris - core of concretion of uncertain composition
				46		concretion of indeterminate slag fragment - contains iron (washings have slag blisters and some lining slag droplets)
27	5	21		1.5	assm	mixture of materials, mainly natural, but including a few grains of slag (angular fractured pieces)
114	26		large pit west of souterrain	520	1	double SHC, upper example is c.90x55x30mm, fused to lower example (90x75x20mm) that may just be a crust fragment from a larger SHC. Base of lower example quite rough, top of upper is smooth and dimpled
119	27		upper fill of souterrain	72	1	dense vesicular iron slag in somewhat plano-convex shape, could be broken margin of an SHC (probably), but just might be a flow - there is too much accretion to see surface details
129	28		bottom of souterrain	110	4	fragments of weathered veined limestone - natural
Kilgowan 2, E4387						
14	1	12	slag?	2.8g	2	2 main pieces, both broken: first is piece of burnt coked organic material, the second is a fossil coral

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