# GeoArch

Report 2013/32

# Assessment of archaeometallurgical residues from Britonstown, Co. Wicklow

Dr Tim Young
16th December 2013

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**Dr T.P. Young**

## Abstract

*This report outlines an assemblage of approximately 2.1kg of metallurgical residues recovered during excavation of cist burials at Britonstown, Co. Wicklow in 1980. The assemblage is mainly residues from iron-working (smithing), including probable fragments of ceramic tuyères, which suggest a sixth century AD or later date.*

*The assemblage also includes a few blocks of flow slag, which are possibly, although not certainly, from iron smelting. Other fragments include pieces of smithing hearth cakes, but no complete examples. These pieces appear mainly to be from small cakes, which would very tentatively suggest that the site was more likely to have been involved with blacksmithing than bloomsmithing.*

*The site adds to the growing number of early medieval cemeteries for which a spatial association with iron-working is known.*

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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.

The 'slag sample 1' was very dusty as received and so was rewashed. The washings and dust from the bag were wet-sieved at 90µm to extract any micro-residues present.

This project was commissioned by Maeve Tobin, of Irish Archaeological Consultancy.

## Results

### *Distribution of materials*

The assemblage was derived from two contexts: the fill of a pit, labelled pit 4 on the bags (but Pit A in the published report) and an apparently separate deposit of slag, charcoal and burnt clay ('Slag sample 1'), described on an enclosed label as *'iron slag between 98 and 103cm all from l.h.s. of trench towards quarry edge. Intermixed with large quantities of charcoal and burnt soil, no feature discernable'*. It is unclear if this latter material is that referred to by Bourke & Clinton (1983/84, p. 368) when they stated that slag was found 'sporadically in the area around the burials'.

### *Description of materials*

***Smithing hearth cakes (SHCs):*** fragments from SHCs were particularly abundant in 'slag sample 1'. There were no certain complete SHCs and the largest fragment weighed 370g. None of the fragments need have come from a particularly large example of an SHC. Where internal features were observed, the SHC fragments showed a moderately vesicular internal structure of fine-grained slag. No particularly coarse-grained textures were observed.

One fragment (probably from the upper part of small SHC) showed a rather haematised surface, probably indicative of formation very close to the tuyère.

***Other smithing slag:*** .the assemblage included many fragments of slag in the form of slag sheets and other morphologies not immediately reconcilable with an origin within an SHC. These are most likely to be smithing slags and either fragmented parts of SHCs or slag from adjacent areas of the hearth (such as adjacent to the tuyère)

***Flow slag:*** several pieces of dense flow slag were present. These showed dense flow prills passing through the fuel bed, to form moulds of medium-sized charcoal. One piece shows the flow prills terminating to form a curved, intermittent, non-wetted margin.

Flow slag that has chilled around very large fragments of wood/charcoal may be diagnostic if iron smelting. These fragments are around somewhat smaller moulds and so may be from smithing, in which process prilly slags may also be formed, albeit much less commonly. The present material is thus ambiguous, although suggestive of iron smelting. It should be noted that none of the likely SHC fragments showed a markedly prilly base.

There are also various examples of flow slags indicative of horizontal flow. These typically are rather dull (unlike the smooth-surfaced flows associated with the fuel moulds), with various adhering materials, suggestive of flow through the dirty hearth base fuel residues. Once again, such material is ambiguous, although more likely to be found in the context of iron smelting than iron working.

***Lining slag:*** there were several fragments of lining slag, some merely slag drips from furnace ceramic or stone, others probably originating as vitrified wall, from which all the adhering unvitrified material has been lost

***Vitrified hearth lining:*** three large and six small fragments of vitrified hearth or furnace lining were present. They were mostly oxidised-fired, but one fragment was reduced fired. There was one fragment of oxidised fired clay with no vitrified surface and a much finer fabric that perhaps may not have been a metallurgical ceramic.

One of the fragments bore part of the margin of a 22mm diameter blowhole. Such a size is typical for blowholes in both smithing hearths and smelting furnaces. The largest block of vitrified ceramic showed a curving, rearwards turned, outer margin. This is strongly suggestive of the outer margin of the face of a tuyère of typical early medieval/medieval aspect.

***Fuel ash slag:*** Fuel ash slag was present as numerous tiny fragments from the sample labelled 'slag from pit'. These fragments have similar properties (very fragile, pale and highly vesicular/bloated) and are possibly the remains of a single piece that has disintegrated post-excavation.

***Iron:*** A small, curving, 2g corroded fragment of either iron or iron and slag was present in the sample labelled '*burnt material at the bottom of the p*it'. The fragment is too small to comment in detail on its nature or significance.

A second tiny corroded bleb was present in the sample labelled '*slag from pit'*.

***Microresidues:*** the dust and washings from '*slag sample 1*' produced a small quantity of both flake and spheroidal hammerscale. These are good indicators of smithing, but the tiny quantity of material available precludes more detailed comment.

## Interpretation

The assemblage is dominated by materials interpretable as being from iron working (smithing), but not all fragments are certainly so. In particular, the presence of flow slags is suggestive of iron smelting. In addition, the size and shape of the pit itself, is more suggestive of the base of a 'slagpit' iron smelting furnace than it is of a smithing hearth, although even this is not unambiguous.

The residues present in '*slag sample 1'*, apparently from outside the pit, compare closely in nature and preservation to the spreads of smithing debris adjacent to the smithing hearths at Coolamurry (Young 2008a), although the smithing hearths at that site were much larger than the small pit at Britonstown.

It may be significant that all the certain fragments of SHCs derived (apparently) from outside the pit and all the fragments of dense flow slag occurred within the pit. Against this split, however, it should be noted that the probable tuyère material (most likely associated with smithing and not smelting) occurred within the pit.

The presence of ceramic likely to be fragments of a tuyère is important, for the use of ceramic tuyères appears, on current evidence, to be a featured introduced into smithing technology in Ireland in the early medieval period, with no certain examples predating the sixth century AD.

The site forms an interesting addition to the considerable number of known sites where iron-working and burial took place in close proximity in the early medieval period, although with variable overlap in space/time. Examples include ecclesiastical sites such as Ballykilmore (5$^{th}$-7$^{th}$ century smelting and smithing associated with or predating the earliest phase of enclosure and burial; Young 2012), as well as the settlement-cemeteries at Parknahown (Young 2009), Lismore (Young 2008b), and Camlin (where the activities were in adjacent, non-overlapping parts of the enclosure; Young 2011a). Williams (2010, Table 1) has suggested this relationship is important for enclosed sites, rather than unenclosed cemeteries. Although some authors (e.g. Williams 2010) place this relationship within the sphere of the 'ritual', a far more prosaic explanation in terms of use of 'communal' space is arguably more appropriate, particularly where that space is constrained by enclosure.

It should also be noted that early medieval parallels also exist outside Ireland, with an early medieval unenclosed cemetery at Parc Cybi, Holyhead, Anglesey (immediately east of Britonstown, across the Irish Sea), including several pits with smithing waste and one apparent grave-cut largely filled with smithing waste (Young & Kearns 2010).

## Evaluation of potential

Further laboratory analysis of the materials would be possible, in order to determine whether the flow slags

are associated with smithing, or whether they do indeed indicate iron smelting. Whilst smithing might be expected to be a general component of rural life in the early medieval period, smelting would be an activity restricted to locations with appropriate natural resources. Smelting has not been previously identified in the more upland areas of Co. Wicklow, although it is well-known from the adjacent lowlands of Co. Kildare.

## References

Bourke, C & Clinton, M. 1983/84. Three long cists at Britonstown. *Journal of the Co. Kildare Archaeological Society*, **16**, 366-370.

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

Williams, M. 2010. Transformations: assessing the relationship between ironworking and burial in early medieval Ireland. *Trowel*, **12**, 31-45.

Young, T.P. 2008a. Archaeometallurgical residues from Coolamurry 7, 04E0323. *GeoArch Report 2006/10*. 46pp.

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

Young, T.P. 2009. Evaluation of Archaeometallurgical residues from the M7/M8 Contract 1: Parknahown 5 (E2170), *GeoArch Report 2009/21*, 21 pp.

Young, T.P., 2011a. Archaeometallurgical residues from the N7 Castletown to Nenagh scheme, Camlin 3 (E3580), Co. Tipperary. *GeoArch Report 2011/23*. 62 pp.

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

Young, T.P. 2012. Appendix 3 -. Exploiting the bog -: iron production and metalworking, pp. A3.1 – A3.60 *In:* P. Stevens & J. Channing, *Settlement and Community in the Fir Tulach Kingdom.* National Roads Authority and Westmeath County Council.

Young, T.P. & Kearns, T. 2010. Evaluation of archaeometallurgical residues from Parc Cybi, Holyhead (GAT project No. 1701). *GeoArch Report 2010/21*, 26pp.

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# 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.

*Bleb*: a small rounded particle or textural component, often a droplet or prill.

*Bloomsmithing*: The process of reworking a raw bloom, through repeated reheating and hammering, to reduce its content of slag, to remove unwanted inclusions and to draw out the remaining slag into elongate inclusions. The end product may be a bar or billet. Usually taken as an alternative term for *bloom- refining.*

*Blowhole:* A hole through a furnace or hearth wall through which air is blown. A blowhole may be a perforation in a hearth/furnace wall, or may be cavity of a tuyère.

*Flake hammerscale (FHS):* flake-like particles formed by the surficial oxidation of hot iron in air (Young 2011c). 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.

*Flow slag*: slag that has been very fluid and mobile, but which has stayed within the furnace and has not been tapped out of it.

*Fuel Ash Slag* (FAS): slag formed by the partial melting of hearth wall or substrate under the fluxing influence of the ash (inorganic component) of the fuel. Fuel ashes are often very rich in alkali and alkali earth elements that may lower the melting point of silicates.

*Lining Slag*: Slag formed from the complete or partial melting of hearth or furnace lining.

*Prill*: a small aggregate of a material, either a spheroidal droplet or a runnel, formed from a melted liquid and either occurring as a discrete particle or as an inclusion within another material.

*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.

*Smithing*: the activity involved in forming a metal object, including, but not limited to, forging metal and joining metal by welding.

*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 2011b) 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).

*Tuyère*: a tubular artefact (usually of ceramic or metal) to carry the air-draft into the fire of a hearth or furnace.

*Vesicle*: a void or pore, usually rounded and formed as a preserved gas bubble in a solidified melt.

*Table 1: summary catalogue of archaeometallurgical residues and associated materials from Britonstown, by bag. Assm. = assemblage*

| Sample | Sample Note | Sample weight | Item weight | No. | Notes |
|---|---|---|---|---|---|
| sample 1 | | 1160.6g | | | the slag lumps were washed; with washings and dust sieved at 90micron - residue contains both flake and spheroidal hammerscale |
| | | | 370 | 1 | dense SHC fragment, lower bowl with fuel dimpled surface, possibly laterally compressed therefore hard to assess surviving proportion. >90mm long and about 50mm deep, upper layer dense, ferruginous surface deeply dimpled, interior below upper 20mm is very finely vesicular/charcoal-bearing, upper 20mm is dense but coarsely vesicular |
| | | | 108 | 1 | dense thin slag sheet heavily accreted with deposit with charcoal, other fresher plant material and ash |
| | | | 66 | 1 | marginal fragment from SHC, base microprilly, interior very porous, up to 27mm thick |
| | | | 72 | 1 | porous SHC fragment very similar to above - and possibly from same cake, up to 30mm thick |
| | | | 42 | 1 | porous SHC fragment very similar to above - and possibly from same cake, up to 35mm thick |
| | | | 24 | 1 | fragment of vesicular SHC material, dense |
| | | | 38 | 1 | slag sheet with microprilly base and porous top with moulds of fine charcoal |
| | | | 26 | 1 | indeterminate open-textured microprilly slag fragment |
| | | | 120 | 1 | dense slag piece in elongate shape, with basal section of long flowed lobes c. 85x30x15mm, with more amorphous slag on top in places; possibly from the margin of a larger slag cake (e.g. distal base of SHC or the upper rim of FB) |
| | | | 74 | 1 | tabular piece of slag 60x40x20mm. Base microprilly, top maroon with smooth lobes, in places, but wispy. Probably an oxidised small SHC fragment |
| | | | 40 | 2 | lower density slags in lobate forms - one certainly mainly lining material, the other more iron-rich |
| | | | 42 | 1 | dense wedge-shaped slag fragment - probably the margin of a small SHC |
| | | | 106 | 17 | indeterminate small slag fragments |
| slag from pit | | | 2 | 1 | drip of slag attached to partially-melted quartz rich pebble |
| | | | 2 | 1 | slightly exploding rusty bleb - unclear if this is a slag bleb with enclosed iron or simply corroded iron |
| | | | 80 | 2 | rounded slag lumps of porous slag, compatible with SHC fragments, but not certainly so |
| | | | 8 | many | fragmented fuel ash slag fragment - highly bloated, pale, fragile |
| | | | 16 | 1 | irregular, thin, slightly maroon-surfaced, slag sheet |
| | | | 6 | 1 | oxidised-fired hearth wall with well-vitrified dark surface |
| | | | 2 | 1 | flow lobe/prill of lining slag |
| Pit 4 | Bag 1 of 3 | 314.6g | 102 | 1 | substantial block of vitrified furnace/hearth wall. Swells outwards at more oxidised end, but terminates at fracture of approximately 100mm diameter rather than a blowhole. This is presumably just a fracture, outer edge shows slight backwards curve - so possibly a tuyère face fragment |

| Sample | Sample Note | Sample weight | Item weight | No. | Notes |
|---|---|---|---|---|---|

| | | | | | |
|---|---|---|---|---|---|
| | | | 162 | 1 | block of flow slag with medium-sized charcoal moulds, one face appears to be a non-wetted intermittent margin. Moulds to >30mm |
| | | | 34 | 1 | lining slag, from face of reduced-fired lining, highly vesicular/bloated |
| | | | 18 | 1 | rough textured, possibly slightly lobate, slag fragment |
| Pit 4 | Bag 2 of 3 | 262g | 156 | 4 | rough-surfaced, but partly flowed slags, with admixed material with fine charcoal/porosity. Broadly similar to 88g group in bag 3 |
| | | | 58 | 1 | lining slag, possibly peeled from the wall since the rear is markedly convex with fragmented ceramic (or may come from genuine indentation in wall…). Adhering wall mainly reduced fired. Slag layer thick and highly vesicular |
| | | | 30 | 1 | oxidised-fired wall with part of blowhole surviving on a slight protuberance. Dark vitrified surface. Blowhole apparently 22mm diameter |
| | | | 6 | 4 | scraps of vitrified lining |
| | | | 6 | 1 | oxidised-fired ceramic |
| | | | 6 | debris | |
| Pit 4 | Bag 3 of 3 | 359.3g | 198 | 6 | dense flow slag passing between medium-sized charcoal moulds |
| | | | 56 | 3 | somewhat obscured by concretion, but scrappy, dull, slightly lobate slags with abundant fine charcoal/porosity. All contain some metallic iron |
| | | | 88 | 4 | somewhat flowed material, similar to 3 pieces above but without iron inclusions. No smooth-surfaced lobes as in the 198g group |
| | | | 12 | 2 | scraps of fired clay - 1 oxidised, 1 reduced with vitrified surface |
| | | | 5 | debris | |
| bottom of pit in burnt material | | 2.1g | 2 | 1 | curved, slightly irregular piece of iron (or iron and slag), now slightly exploding, curves through roughly 90 degrees of arc of 18mm radius, section at thickest 8x4mm including corrosion. 30mm long |

GeoArch

*geoarchaeological, archaeometallurgical & geophysical investigations*

Unit 6, Block C,
Western Industrial Estate,
Caerphilly,
CF83 1BQ

*Office:* 029 20881431
*Mobile:* 07802 413704

*E-Mail:* Tim.Young@GeoArch.co.uk
*Web:* www.GeoArch.co.uk