GeoArch

Report 2010/14

Evaluation of archaeometallurgical residues from the N7, Castletown to Nenagh (Derrinsallagh to Ballintoty), Contract 1, Park 1, E3659

Dr Tim Young
20th July 2010

Evaluation of archaeometallurgical residues from the N7, Castletown to Nenagh (Derrinsallagh to Ballintoty), Contract 1, Park 1, E3659

Dr T.P. Young

Abstract

The assemblage includes a total of 12.8kg of examined material. In-situ archaeometallurgical residues were confined to two areas of the site. Towards the centre, feature c4 was an unusual stone floored smithing hearth. This was associated by unusual flowed slags which would normally be identified as being from iron smelting, but in this case they probably originated in a reaction between the slag and sandstone flags.

In the east of the area an isolated pit is interpreted as the rather truncated basal pit of a slagpit iron smelting furnace. Its large diameter raisse the possibility that it may be relatively early.

Post-medieval ditches in Area 2 yielded three certain or possible smithing hearth cakes. Pits in Area 1 yielded one certain and one possible pieces of residual iron smelting slag.

Contents

Abstract 1

Methods 1

Results

Description of the residues
Iron-smelting slag 1
Iron-smithing slag 2
Oxidised fired clay 2
Other materials 2

Distribution of the residues 2

Interpretation 3

Evaluation of potential 4

References 4

Tables
1. Summary catalogue 5

Methods

All investigated materials were examined visually, using a low-powered lens where necessary. All items were logged to a database (Table 1). As an evaluation, the materials were not subjected to any high-magnification optical inspection, nor to any other form of instrumental analysis. The identifications of materials in this report are therefore necessarily limited and must be regarded as provisional.

Results

Description of the residues

Iron-smelting slag
The assemblage from fill c564 provides a good collection of the various residues found in the base of the basal pit of a slagpit iron smelting furnace. At a fine grain-size there are small droplets of slag (coffee bean spheroids) and other blebby slags, which often grade into the sinter-like material, which is probably a mixture of small particles of slag with debris that has fallen through the furnace during smelting (charcoal fines, small ore particles...). Larger pieces of slag are mainly flowed slags, forming substantial prills and flows, often forming moulds around large wood or charcoal fragments.

Slags which would normally be identified as smelting slags were recovered from hearth fill c3, but there are good reasons for believing that in this instance these flows were the result of reaction between the smithing slags and the sandstone hearth base.

An isolated lump of smelting slag was recovered from pit c341 (fill c342). This was from the area of slag accumulation at the foot of the blowing wall in a non-slag tapping slagpit furnace. It was present in this pit merely as residual material.

A similar occurrence of dense slightly weathered slag was a block of dense slag from fill c1051 of pit c1050. This was of uncertain origin but was very dense and slightly curved, suggesting it may have been a burr (the zone of slag-wall interaction just below the blowhole) from smelting furnace

Iron-smithing slag
The focus of smithing residues from the site is the hearth c4. This hearth shows evidence for having been constructed with a sloping floor formed of sandstone flags. The western end of the main flagstone shows a smooth surface where it has been eroded by reactions in the direct blast from the tuyère. In front of the zone eroded by the blast, the sandstone has been eaten away through reaction with the iron slag and a substantial smithing hearth cake-like mass now remains embedded with a deep hollow on the surface of the stone. The mass is fairly even texture with just a single possible internal chill line. The uppermost part of the cake becomes more granular, with much fine-grained charcoal, but it is likely the very top surface of the cake has been worn away and it was originally smoother, as is preserved in some areas.

Associated small slag pieces are mainly within-hearth materials: small scale flows and other slags which formed within the fuel bed. The strange flow slags, including a long greenish cylinder , that are associated with this fill appear similar to smelting slags, but it is possible that they are unusual slags formed by the fluxing reaction between the iron slags and the sandstone flagstone.

The fill of hearth c4, context c3, also yielded a single concretion containing hammerscale. This suggests that the context may have contained hammerscale, but unfortunately this was not identified by the sampling strategy employed.

Three pieces which may have all been SHCs were recovered from post-medieval ditches in area 2 (contexts c525, c560, and c606). The piece from c525 (670g) was a difficult piece to interpret and was either a small SHC fused to an earlier example which had not been cleared from the hearth, or it was a single larger SHC deformed when hot. Fill c560 produced a dense piece of slag (360g), with the shape of a well-formed SHC, but the accreted sediment completely hid the slag within. That from context c606 was a 120g fragment from an SHC, heavily accreted with sand.

Oxidised fired clay
A single sherd of oxidised clay with a slightly vitrified gently convex surface from fill c82 may be from the side of a tuyère.

Other materials
A single small piece of fired clay from fill c82 is very unusual. It is a triangular sectioned prism 13 by 8 mm by 40 mm in length. Two faces at an angle of 70 degrees are apparently vitrified and impregnated by shiny iron oxides. This piece is either clay impregnated by secondary iron oxides from decay of an iron object, or the clay was used to cover the surface of a piece of iron while it was heated.

Distribution of the residues

The residues occurred in several cut features across the site, described here from SW to NE.

In area 1, slag was reported from early medieval feature cut c341, fill c352, but much of this proved to be weathered limestone blocks, plus a small concretion on some corroded iron, but there was one substantial block of iron. This was a very weathered dense block from foot of the pit in a slagpit iron smelting furnace and was likely to have been residual in this context.

Pit c293 (fill c292) yielded a single 1g slag bleb and the remainder of the 1774g sample was a natural iron-manganese pan cementing a sandy gravel.

Hearth c4, fill c3, was an interesting metallurgical feature, at least in part a smithing hearth. The general fill of the feature (samples 1 & 6) contained a variety of materials including a large amount of material with the appearance of a sinter and coated with a very dark secondary oxide coating (probably rich in manganese). This was accompanied by several fragments of large dense brittle flows. These either showed charcoal moulds or were circular in section indicating flow through the fuel bed of a hearth or furnace. These materials would all normally be interpretable as iron smelting residues from a non slag-tapping slagpit type of furnace.

The same context (sample 2) also yielded some concretions around weathering iron, one of which contained a substantial amount of hammerscale.

The western component of the pit (which was overall 0.98m x 0.33m x0.12m and had a figure of eight shape in plan) was floored with stone, with the western extremity having a particularly large stone slab into which a cake of slag was fused (see above). This and the occurrence of the hammerscale are indicative of smithing (blowing a smelting furnace from a tuyère right at the base would not work). There are several possible interpretations of feature c4:

- Firstly, it might be a simple structure with a western stone-floored smithing hearth and a larger working hollow to the east. The hollow was filled with a variety of materials upon disuse. It is possible that the reaction between the slag and the sandstone floor might have been able to produce a well-fluxed slag able to flow and to generate the prills found. A stone floored hearth at Parknahown 5, Co. Laois (Young 2009b) was associated with internal lobed, flowed sheets of slag.

- Secondly, it is possible that the figure of eight structure represents two separate features – a smithing hearth and a furnace base, that were not differentiated during excavation.

- Thirdly, it is conceivable that the figure of eight structure is that of a smelting furnace (compare for instance the example from Derrinsallagh 4, Co. Laois; Young 2008f), partially reused by the smithing hearth.

Unfortunately, the nature of the field observation and recording do not permit discrimination with certainty between these possibilities. On balance, an interpretation of the unusual slag assemblage as having been generated by the reaction between slag and sandstone in a smithing hearth is preferred.

The adjacent pit c83 (0.61m by 0.58m and 0.16m deep) yielded a small assemblage of resides from a charcoal rich deposit. The residues are rather indeterminate within-hearth or within-furnace blebs and other materials, together with a small sherd probably from a tuyère and a small fragment of heat altered clay of uncertain origin, but just possibly associated with

some sort of heat treatment of an iron artefact. These materials are almost certainly from smithing, although they too might be a mixed assemblage.

Pit c1050 (fill c1051) produced a single weathered dense slag block. This might have been part of a dense SHC or possibly the dense slag from the area below the blowhole in an iron smelting furnace (the burr). The weathering on this isolated piece suggests it may have been residual.

In Area 2 three isolated single slag finds from fills c525, c560, and c606 all from possible post-medieval ditches were all of probable SHCs.

Finally, pit c561 (fill c564) yielded 900g of flow slags and sinters, the typical pit floor assemblage of a slagpit iron smelting furnace. The pit is recorded as being 0.7m by 0.58m and 0.15m deep, but a more accurate gauge of the working dimensions of the pit can probably be made from the dimensions of the fill, c564, given as 0.58m diameter by 0.15m deep. It is most likely that the pit is the basal pit of the slagpit furnace, rather than being merely a pit in which the residues accumulated. If this is so then the large diameter of the pit is striking.

Interpretation

The site includes three distinct features which may be associated with metallurgical activity (pits c4, c83, c561). Interpretation of these features is not straightforward.

The stone-floored hearth in pit c4 is unusual. If the SHC forms low in such a hearth it may react with and fuse to the stones and make cleaning the hearth very difficult – or perhaps impossible without replacing the stone lining. Another unusual stone hearth, though not of quite the same morphology, was recorded at Gortnahown 2 (Young 2009e) and also at Parknahown 5 (Young 2009b), both of early medieval age.

The reason why such a structure would be used is difficult to answer, but it is possible that the intention was to form the SHC much higher in the hearth, but the position of the tuyère became altered, became too low and the ensuing SHC generation was similarly too low in the hearth. Since the slab was inclined, it may be that with a fresh tuyère the hotzone was far enough out into the hearth that the slag did not reach the sandstone, however, with use the tuyère shortened, and the air blast entered the hearth immediately adjacent to the margin of the stone slab, causing slag generation in the location found, and the hearth would have needed to be refloored or abandoned.

For pit c561 an interpretation as the basal pit of a smelting furnace seems likely, but the diameter of the pit is unusually large. Most slagpit furnaces of working diameters of >0.45m have been associated with furnaces that have been dated to 5th-1st century BC.

The following sites have given evidence for large diameter furnaces within this period

> Ballydavid AR26 (Co. Tipperary), six furnaces with slagpit diameters >0.40m. Associated 14C dates suggest a date in the 3rd-1st centuries BC. An apparent 8th-5th century BC date for the isolated furnace c157 is suscpiciously early. (Young 2009c)
>
> Cherryville 12 (Co. Kildare): 320-200 cal. BC. Four slagpits 0.45 - 0.50m diameter. (Young 2008a)
>
> Cloncollig (Co Offaly): the pit (007) is described as being 0.57 x 0.60m and 0.32m deep. A 14C date on oak charcoal from the basal layer of the furnace gave a date of 261 – 94 cal. BC (Young 2008b)
>
> Clonrud 4 (Co. Laois): the working dimensions of the two slagpits (0.41m x 0.39m and 0.46m x 0.41m) are moderately large. Two dates suggest 4th-1st centuries BC (Young 2008e)
>
> Leap 1 (Co Laois): F007 has a diameter of 0.40m. It is not directly dated, but there are earlier Iron Age 14C dates from adjacent features (Young 2009a)
>
> Lismore-Bushfield 1 (Co. Laois): a cluster of 5 furnaces with diameters >0.40m. Furnace 3 gave a 14C date on alder charcoal of cal. 90BC to AD80. (Young 2008d)
>
> Milltown/Ballynamorahan AR3 (Co. Kilkenny): a complex furnace structure, possibly with a central working hollow linking two furnaces with frontal arches, 0.45x0.55m and 0.40x0.50m; 1st century BC / 1st century AD (Young 2009d)
>
> Morrett D (Co. Laois): 170 cal. BC- 30 cal. AD and 770-410 cal. BC for charcoal pits, 370-110 cal. BC and 400-200 cal. BC for ring ditches. (Young 2005)
>
> Newrath Site 35 (Co. Kilkenny): 400-200 cal. BC and 350-40 cal. BC (Eogan pers. comm. 2006)

Similar furnaces are known from the following sites, for which there is no direct dating, but for which an early age is suspected:

> Adamstown 1 (Co. Waterford): Slagpit :0.53 x 0.47m and 0.15m surviving depth with 18.3kg of in-situ residues. Furnace undated but associated with Bronze Age features (Young 2006b).
>
> Ballykeoghan AR9 (Co. Kilkenny), 2 slagpits, one 0.45m in diameter with 18.3kg of in-situ residues, the other 0.40x0.50x0.10m (undated) (Young 2009f)
>
> Derryvorrigan 1(Co. Laois): this site appears to have furnaces with working diameters of approximately 0.40m (Young 2008c).
>
> Tullyallen 6 (Co. Louth): slagpit: 0.47 x 0.50m and 0.18m deep with 17.5kg of in-situ residues. (Young 2003)

Early medieval furnaces of this size range are known from:

> Gortnahown 2, co. Cork ([c548] - 0.48 x 0.46 x 0.28m; [c566] - 0.52 x 0.40 x 0.30m; [c703] - 0.52 x 0.44 x 0.19m; possibly 5th-7th centuries AD; Young 2009e)

Carrigoran, Co. Clare, a furnace with a diameter of 0.50m dated to the late 9th – early 11th centuries AD (Young 2006a).

Some later medieval examples seem to be relatively large, but in general are poorly known. They comprise examples without deeply sunken basal pits and with frontal arches to facilitate slag (and bloom?) removal. These are therefore quite distinct from the isolated single pit as seen at Park 1.

Further dating of the example at Park 1 is therefore desirable, if possible.

Evaluation of potential

The occurrence of iron smelting at Park 1 comprises a rather limited suite of coeval residues and as such is not a priority for further analytical investigation.

The smithing remains at Park 1 are unusual, because of the interaction with the stone floor of the hearth. Further analysis could usefully be employed to examine the relationship of the materials here and to confirm whether the large flows are indeed from the smithing hearth, or whether they are from a phase of smelting in or around this structure. However, such analysis would be unlikely to alter the main interpretation of the site.

Accordingly no further analysis is recommended at this time, although the material is sufficiently significant to be worthy of retention for possible analysis in the future.

References

YOUNG, T.P. 2003. Evaluation of slag from Tullyallen 6, Co. Louth (00E00944*). Geoarch Report 2003/10*. 2pp. + 2 figs.

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. 2006a. Evaluation of archaeometallurgical residues from Carrigoran, Co. Clare (98E0338). *GeoArch Report 2005/18*. 12pp.

YOUNG, T.P. 2006b. Evaluation of archaeometallurgical residues from sites on the N25, Co. Waterford (Woodstown 6, Adamstown 1,2,3). *GeoArch Report 2006/15*. 38pp.

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

YOUNG, T.P. 2008b. Evaluation of metallurgical residues from Cloncollig 2, Co. Offaly, NTB06, A033/E2850137. *GeoArch Report 2008/09*. 4pp

YOUNG, T.P. 2008c. Evaluation of Archaeometallurgical residues from the M7/M8 Contract 2: Derryvorrigan 1 (E2193). *GeoArch Report 2008/26*.

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

YOUNG, T.P. 2008e. Evaluation of Archaeometallurgical residues from the M7/M8 Contract 3: Clonrud 4 (E2167). *GeoArch Report 2008/30*.

YOUNG, T.P. 2008f. M7/M8 Contract 2. Detailed recording of furnace C397, Derrinsallagh 4 (E2180), *GeoArch Report 2008/34*.

YOUNG, T.P. 2009a. Evaluation of archaeometallurgical residues from the M7/M8 Contract 1: Leap 1 (E2131) *GeoArch Report 2009/03*

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

YOUNG, T.P. 2009c. Evaluation of archaeometallurgical residues from the M8/N8 Cullahill-Cashel: Ballydavid AR26 (E2370), *GeoArch Report 2009/3*0, 7 pp.

YOUNG, T.P. 2009d. Evaluation of archaeometallurgical residues from the N9/N10 Waterford-Kilcullen, Site 3-5, Milltown/ Ballynamorohan, Co. Kilkenny (E2499*), GeoArch Report 2009/38*, 12 pp.

YOUNG, T.P. 2009e. Evaluation of archaeometallurgical residues from the N8 Fermoy-Mitchelstown, Gortnahown 2, Co. Cork, (E2426). *GeoArch Report 2009/41*, 49 pp.

YOUNG, T.P. 2009f. Evaluation of archaeometallurgical residues from the N9/N10 Waterford-Kilcullen, Site 6-9, Ballykeoghan, Co. Kilkenny (E2500), *GeoArch Report 2009/49*, 3 pp.

Table 1: summary catalogue by context. Weights in gram.

context	*sample*	*notes*	*weight*	*no*	*description*
3	1	cut 4	302	17	dense brittle flows, mainly large, slightly greenish, some around large charcoal, some more circular cross-sectioned
			92	12	fragments of dense slag in poor flows, with dull irregular surfaces- possibly coated in the sinter?
			36	1	sintery material, coated in botryoidal dark cements
			60	1	dimpled basal crust overlain by granular material
			16	1	weathered sintery material with accreted sediment
3	2	4	42	2	2 pieces of accretion on probably iron. One is very rich in charcoal debris, the other is extremely rich in flake hammerscale
3	6		108	c40	mainly sintery irregular particles with heavy black botryoidal overgrowth. 1 piece good dense brittle flow, 1 poor flow and 1 blebby lining slag of vitrified sandstone pebbles bound by small amount of iron slag
3	13		3510	1	block 230x190mm with slag fused onto sandstone slab, with hole eroded in slab below slag. Smooth raised lip of slagged stone at one end then SHC-like slag mass 195x190mm, up to 40mm thick in centre, fused to stone on base, diamond shaped smooth blown patch 50mm long at proximal end then smooth to irregular top distally. lots of fine charcoal (dust almost) dispersed within top layer of cake, but possibly originally more of the top was smooth. upper part of blown lip of sandstone is black, lower part is brown. lip also has slight raised “tidemark”. If this, and the slag top were horizontal, then the stone slab was originally 50mm thick and dipped about 30 degrees into the hearth.
3	13?		2490	7	6 large stones from hearth base, 1 with some adhering slag, 1 loose piece of slag sheet with central voids and polished surfaces
82	43		208	bulk	mixed materials, almost half is dense slag with spiky or blebby forms, probably one third appears to be concreted sediment on iron, there are a few pieces of lining slag and one sherd possibly from a tuyère margin. The most interesting piece is a wedge of fired clay 13x8x32mm with two faces iron rich and highly polished - suggestive of metal contact. These meet at a discontinuous apex with an angle of 70 degrees, where the apex is missing the area between looks as if at reached vitrification and flowed slightly. The vitrification extends in about 2mm - inside that the clay is pale and appears unaltered
292	3	1 of2	1355	bulk	natural Fe-Mn pan of sandy gravel with some charcoal
292	3	2 of 2	418	c155	natural sandy/gravelly Fe-Mn pan
			1	1	small dark slag bleb
352	5		1095	2	weathered limestone blocks
352	4	cut 341	366	1	large dense block of amalgamated flow slag. Has apparent sediment contacts on two parts of what appears to be the top face - so may have formed at the foot of the blowing wall in a hollow cut back into the wall? Chilled flow lobe surfaces almost entirely etched off - so probably residual
352	274		6	1	concretion on now hollow artefact, c20x5x1.5mm, unclear if rest of concretion houses another piece of iron - if so this would be thin sheet, roughly 20x20mm

context	*sample*	*notes*	*weight*	*no*	*description*
525	3	cut 524	670	1 (broken in 2)	dense slag block of complex shape. Probably broken when hot, so microdimpled base now fragmented onto several surface. Some smooth lobate areas are likely to be the original top. Most likely a strongly deformed SHC – alternatively it is a small SHC (100x90x30mm) grown on top of a previous similar one oriented vertically)
560	1	cut 543	360	1	95x70x45mm, vesicular slag block encrusted in accretion dominated by fine charcoal, also some quartz-rich pebbles. Probably an SHC inside this - but impossible to be certain
564	2	cut 561	442	20	fresh dark flow slag, much in quite large prills
			334	12	charcoal-rich slags grading to poor flow slags
564	542	retent	100	many	natural gravel
			550	c350?	well preserved fines, mainly flows around small charcoal, grading into fused ash and possibly sinter. Often coated in secondary Mn oxides, flows mainly dense small shiny, grades into duller, often vesicular blebby slags and into sinter. The sinter is bound by a pale glassy fuel ash slag, rare coffee beans
606	4	cut 605	120	1	irregular shaped slag with dimpled base and charcoal rich core - heavily concreted in sandy sediment. Probably part of a small SHC
1051	100	cut 1050	164	1	dense slag piece - possible from lower part of thick SHC or from a burr, variably vesicular, some smooth internal surfaces (rather like some subdivisions with the c3 cake), looks worn, so may be residual

GeoArch

geoarchaeological, archaeometallurgical & geophysical investigations

54 Heol y Cadno,
Thornhill,
Cardiff,
CF14 9DY.

Mobile: 07802 413704
Fax: 08700 547366
E-Mail: Tim.Young@GeoArch.co.uk
Web: www.GeoArch.co.uk