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Evaluation of Archaeometallurgical Residues from the M8/N8 Cullahill-Cashel: Ballydavid, AR26 (E2370)

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Evaluation of Archaeometallurgical Residues from the M8/N8 Cullahill - Cashel: Ballydavid, AR26 (E2370) (revised version November 2009)

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Abstract

AR26 yielded 29.3kg of macroscopic archaeometallurgical residues. These residues were almost entirely residues from the smelting of iron in slagpit shaft furnaces. Indeed, most of the residues were recovered from pits with evidence for in-situ heating, which are interpreted as the basal pits of these slagpit furnaces. Only very small quantities of residues were recovered from other contexts, apart from a dump within the fill of the enclosure ditch.

The dating of the iron smelting activity is somewhat problematic, and is discussed further. The furnaces are of a size to fit with the earlier Iron Age 14C dates (diameters of >0.40m). One of the "furnaces", c179, is too large to be taken as a simple slagpit furnace and may have been a smithing hearth or charcoal kiln.

Contents

Methods

All investigated materials were examined visually, using a low-powered binocular microscope where necessary. All significant macroscopic materials were summarily described and recorded to a database (Table 1). For microscopic residues a general statement of the nature of each assemblage was recorded. 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

The macroscopic residues from AR26 are almost entirely those from iron smelting in a non-tapping slagpit shaft furnace. The residues encountered on AR26 include:

Flow slags – these are the dominant slag form in the AR26 assemblages. Flow slags are slags that have flowed within the furnace and have cooled to solidify in a variety of forms. Varieties showing relatively unhindered vertical flow may occur in the body of the furnace, forming isolated or compound stalactitic forms, or particularly on the blowing-wall of the furnace where complex multiple forms may accumulate as a sheet adjacent to the wall. Low flow rates may result in the formation of individual droplets of slag which may solidify as sub-spheroidal particles, often with dimples from contact with fuel particles, giving a characteristic "coffee bean" morphology.

Once the flows reach the floor of the slagpit they may start to flow lateral, giving rise to flow-lobed material superficially similar to tapped slags (but usually with the surficial oxidation which often gives tapped slags a maroon colour).

The flow slags may amalgamate (particularly close to the foot of the blowing wall) to give more massive, dense slag blocks. These blocks (e.g. c177/8) may show the moulds of the large pieces of wood which were packed into the basal pit prior to smelting. The same moulds can been seen as "ghosts" picked out by the course of descending prills (e.g. c159).

"Sinter" – this facies of residue comprises masses of agglutinated brown grains or iron ore and small slag blebs and flows. It is likely that much of the cementation of these particles is due to secondary iron oxides, but the name is retained for now, for it conveys the fabric of the material. This material probably accumulated on the floor of the slag pit early in the smelt as fine ore particles dropped through the charge before reacting completely.

Furnace ceramics – the assemblages contain significant quantities of fired clay, both as particulate debris with the fills and in-situ. In general the furnace is much cooler below the level of the blowhole, so the walls of the slagpit are generally not vitrified, although considerable induration of the blowing wall side may occur because of heat transfer from the descending slags.

Around and above the blowhole, temperatures are much higher and the wall material may become vitrified. In general the walls of the pit will have been

held under mainly reducing conditions, so will be grey or buff in colour. Around the blowhole and in the walls of the shaft oxygen is more readily available so the ceramic will be oxidised fired to a red or orange colour.

The walls of the shaft will not be deeply vitrified so will degrade to give orange-red deposits, frequently seen as the upper deposit within the furnaces.

Tuyères – the site yielded no examples of ceramic tuyères. Several pieces of fired clay had been listed as tuyère sherds (from c163 and c165). These were fired to a buff brown colour and were in the form of apparently slightly curved cylinders. However, the curvature of the cylinders was too small for tuyères (suggesting an object of about 40mm diameter) and there was no trace of a central hole. It also appears that none of the pieces showed a true external surface around more than about one quarter of the circumference. They may perhaps be part of the furnace structure itself. The interpretation of these objects is uncertain. Their origin is slightly problematic too – they are listed from c163 and 165 in the catalogues and on the specimens; c165 is a middle fill of furnace pit c167 and c163 is void. In the finds section of the prelim report the same specimens are described as being from c93, a lower fill of ditch c60.

Microresidues: flot sample 75 from context c90 contained some probable archaeometallurgical microresidues including small (<1mm) spheroids (possibly spheroidal hammerscale) and small slag fragments, alongside some fine coal dust. This assemblage might be indicative of a sparse collection of iron-working residues, but superficially similar material can be produced during the burning of coal (and even occasionally peat) in non-metallurgical contexts.

Distribution of the residues

Most of the residues recovered came from the fills of the probable furnaces:

C142: 4kg
C157: 2.9kg
C161: 8.3kg
C172: 1.9kg (plus 2.1kg of fired clay)
C169: no slag recovered, just fired clay
C167: 0.7kg

(C179: 3kg)

A further 2.4kg of residues were recovered from deposit c168 – a possible dump of furnace waste including clay as well as slag – within the lower part of the fill of the enclosure ditch (c60).

1.1 kg of rather blebby flow slags were recovered the fill of c118 (a hole under the cottage fireplace)

Finds from elsewhere on site were limited to single small piece of slag from burnt pit c71 (52g) and four pieces from the upper fills of enclosure ditch c60 (1.44kg).

Unproductive flot residues

Inspection of flot residues for metallurgical material proved negative for samples from contexts c46, c203, c210, c229, c256, c280, c290, c295 and c310.

Interpretation

Although the general interpretation of AR26 as having been the location for iron smelting in slagpit furnaces, the details are less clear.

There are a few pertinent 14C dates:

C156 (lower fill of "furnace" c157): 765 - 416 BC
C171 (lower fill of "furnace" c172): 374BC – 191 BC
C168 (dump in ditch c60): 32 BC - AD 127

The excavated dimensions of the furnaces vary markedly:

C142: 0.52 x 0.50 x 0.21
C157: 0.46 x 0.42 x 0.29
C161: 0.30 x 0.46 x 0.48
C172: 0.69 x 0.63 x 0.31
C167: 0.45 x 0.40 x 0.30
C169: 0.62 x 0.44 x 0.19

(C179: 1.27 x 0.90 x 0.20 not a furnace?)

The furnaces also occur in a variety of places:

C169: cut into middle fill (c90) of ditch c60
C172: cut into upper fill (c86) of ditch c60
C157: NE corner of site
C161: NE corner of site
C142: close outside enclosure entrance
C167: SW corner of site.

(C179: SE corner of site)

In addition the deposit c136 below the fireplace of the cottage contained flow slags and may possibly represent another furnace, or a pit with metallurgical waste much older than the fireplace.

The combination of the dates from the features in the ditch are somewhat problematic, but suggest that the filling of the ditch (with its early furnace C169; dump C168 of 1st century BC/AD date and late furnace c172, apparently of 4th-2nd centuries BC) must have been in the period of perhaps the 3rd-1st centuries BC. The 8th-5th century BC date for the isolated furnace c157 is very early. The sizes of the furnaces in the NE of the site and close to the entrance are all rather similar and indicate pits of around 0.50m diameter. If this is a true cut diameter, then this resembles other examples of early furnaces. There are a growing number of slagpit furnaces with 14C dates indicating an Iron Age date. Many of these have a moderately large diameter (taken here as 400mm or more):

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 2009)

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)

Cherryville 12 (Co. Kildare): 320-200 cal BC. Four slagpits 0.45 - 0.50m diameter. (Young 2008a)

Newrath Site 35 (Co. Kilkenny): 400-200 cal. BC and 350-40 cal. BC (Eogan pers.comm. 2006)

Morrett D (Co. Laois): 170 cal. BC- 30 cal AD and 770-410 cal. BC for charcoal pits, 370-110 cal BC and 400-200cal BC for ringditches. (Young 2005)

Adamstown 1 (Co. Waterford): Slagpit :0.53 x 0.47m and 0.15m surviving depth. (Young 2006)

Tullyallen 6 (Co. Louth): Slagpit: 0.47 x 0.50m and 0.18m deep. (Young 2003)

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)

Derryvorrigan 1(Co. Laois) appears to have working diameters of approximately 0.40mes (Young 2008d).

Other Iron Age sites appear to have smaller diameter furnaces. Those at Derrinsallagh 4 (Young 2008c) appear to be mainly approximately 0.30m working diameter (ignoring all arguments about whether any lining is present within a broader cut). The example with a furnace arch that was excavated in detail (Young 2008f) was rather irregular in plan but was approximately 0.36m diameter at the level of truncation (although slightly wider towards the base because the pit sides were overhanging). These smaller furnaces seem to appear from the 1st century BC and continue well into the first millennium AD.

The recorded size of furnace c179 is too large for a slagpit furnace basal pit. The slag recovered from this feature are certainly smelting slags, but include only 6 significant pieces, totalling 3kg. A sparse assemblage of large blocks is commonly an indication of dumped, rather than in-situ, material. The size of c179 is more compatible with it being either a smithing hearth or a small charcoal kiln.

In summary, the smaller furnace pits fit both in terms of size and date with an emerging group of earlier Iron Age furnaces with slag pits between 0.4 and 0.6m diameter. The other furnaces may either be a more complex furnace type, or the excavated plan deviates from the simple sub-circular case for some other reason.

The nature of thee deposit below the 18th century hearth remains problematic. The slag assemblage is not as clear as some of the other furnaces, but there is no reason to suspect this is other than a slagpit smelting furnace assemblage – and if that identification is correct any connection with the hearth is likely to be coincidental.

Evaluation of potential

This site is interesting for being of an apparently very early age, although other sites of similar age are known on other sectors of the M8.

Investigation of the nature of the apparently elongated furnaces would be desirable to clarify their nature.

Analytical investigation of a suite of residues from a representative furnace (C161 has the largest suite of residues and is also likely to be early, given the 14C date on the adjacent furnace c157) would assist both the characterisation of the smelting process, and, in conjunction with other sites, helping to establish the geographical variability of the smelting process chemistry.

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. 2006. 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: Derrinsallagh 4 (E2180). *GeoArch Report 2008/23*.

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

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. 2009 Evaluation of Archaeometallurgical residues from the M7/M8 Contract 1: Leap 1 (E2131) *GeoArch Report 2009/03*

sample	*context*	*weight*	*no*	*notes*
274	2	12	2	small scrap of lining influenced slag
99	46	flot sample		stone
81	69	flot sample		52g piece of very dense flow slag, remainder of material is mainly stone, but there are some rounded strongly magnetic pieces that may be ore particles
75	90	flot sample		rich assemblage with lots of spheroidal hammerscale,, some flake hammerscale, lots of organic material which appears to be coal reside
45	136	1140	48	rather poor flow\slag from furnace floor - crudely lobate but not well developed
		8	1	vitrified oxidised lining
18	139	334		assemblage of fragments of "sinter" with botryoidal overgrowth, a few pieces of flow slags, some coffee bean spheroids, in a background of fired clay and stone
20	140	2240	138	flow slag, but about 250g is more dominated by a very dense sinter
20	140	1720		small pieces of flow slag and small sinter fragments probably in roughly equal proportions, much of the slag is in the form of coffee bean spheroids
26	155	632	24	dense flow slags
		126	7	vitrified lining material
		146	8	dense slags with trend to include sintered ore?
26	155	534		fines mainly sinter, but some slag and piece of corroded iron, together with a significant amount of fired clay and vitrified lining
27	156 (bag 1)	282		fines mainly sinter and\ stone, but some flow slag blebs
27	156	804	52	flow slag, in rather stouter flows than some other contexts
	(bag 2)	322	5	dense lag from against wall, 1 piece is a burr fragment
		32	1	vitrified wall
		10	1	iron?
29	158	1400	46	pieces of flow slag, mainly in very fine prills - some large blocks the small prills appear to curve around large fuel moulds
		776	25	large pieces of vitrified lining - in very strange rounded lumps, suggesting failure
		28	1	corroded iron
		184	45	small pieces of flow slag
		158	57	small pieces of vitrified lining

sample	*context*	*weight*	*no*	*notes*
29	158	500		fine material with some flow slag fragments, but this is ostly fired clay bedris - including a number of pieces with a bright blue glaze
30	159 (bag 1)	2290		rich assemblage, flow slag debris, fine sinter fragments lots of coffee beans and small spheroids
30	159 (bag 2)	1535	57	flow slag pieces, in v delicate descending prills, these pick out the ghosted shapes of large wood fragments
31	160	290	32	pieces of flow slag, mainly delicate prills, but down to spheroids
		106	19	vitrified wall and stones
		82	15	spiky slag and/or sinter
31	160	1000		flow slag in small pieces, coffee beans, ore debris and sinter
"tuyère" finds				these are fragments of reduced fired clay – the largest of which is slightly oxidised fired on outside and roughly cylindrical and they are curved, but have no bore and are too small for tuyères
#29	165	60		
#107	165	20		
#108	163	6		
#109	163	15		
#110	163	20		
33	165	252		small pieces of flow slag, spheroids, possible ore and sinter
36	165	316	21	flow slag in fairly thin prills and lobes (thinner than 171) not as thin as some others
		24	1	"sinter"
66	168	676		oxidised fired clay
67	168	1035	4	dense slag attached to wall, clearly some interaction so near burr, one piece has some pendent prills
		126	3	lobate flow slags
		496	13	massive iron slags related to the wall slags above
		78	3	slagged oxidised fired lining

sample	*context*	*weight*	*no*	*notes*
115	168	4	1	chip of vitrified oxidised lining
			356	2 pieces of dense slightly lobate slag attached to grey wall - gravel from wall appears to be incorporated into slag - so probably close to the burr
			74	2 pieces of dense flow slag
116	168	flot sample		stone with a few pieces of slag
70	170	flot sample		stone, lots of grains of what appears to be fired clay, 1 angular slag fragment
77	170	340		strongly oxidised fired clay - fired to a slightly orangey red
78	170	1815	45	vitrified and/or reduced fired furnace lining, only one fragment shows oxidised firing locally and this is strongly overhanging, suggesting overhanging blowhole area
72	171	1640	65	dense dark flow slag - in much bigger lobes and prills than some of the material from this site
74	171	276		blebby flow slag with lots of coffee beans and fine particles of possible sinter/ore
91	177	flot sample		mainly stone, but a few pieces of microprilly slag
94	177/178	2700	3	blocks of dense flow slag attached to reduced fired wall, show evidence for very large pit packing
		376	3	slag/ lining slag on reduced fired wall
111	183	498	16	variable fired and indurated ceramic, mostly reduced but some oxidised
112	183	438		oxidised fired clay
132	197	280	1	block of dense slag attached to reduced fired wall
160	197	1050	2	large blocks of massive grey, slightly cavernous slag, some charcoal inclusions, slightly prilly base, probably part of the furnace slags but no clear identifying factors
203	203	flot sample		natural stone
93	210	flot sample		natural stone
149	221	110	1	indeterminate amorphous fragment of dense slag
169	229	flot sample		stone, possible fired clay

sample	*context*	*weight*	*no*	*notes*
171	256	flot sample		natural stone
221	280	flot sample		natural stone
256	290	flot sample		natural stone
262	295	flot sample		natural stone
265	310	flot sample		natural stone

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