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Assessment of materials from Hartley, Co. Leitrim

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Abstract

The residue assemblage from the Hartley Bridge development is dominantly from contexts (103) and, particularly, (123). The assemblage derives entirely from the smelting of iron in a non-slag tapping furnace with a basal pit (a 'slagpit' furnace), that would have been filled with wood before the smelt (which would have had a main fuel of charcoal within the shaft that would have overlain the pit).

Flow slags from the pit are well preserved and may indicate that the pit yielding the slags was the basal pit of a furnace, left uncleared of its lowest slag-bearing fill after its last smelt. Other slags appeared more abraded and may have been dumped into the pit after the smelt.

Potential local sources of ore are discussed, but the furnace is most likely to have smelted a bog iron ore. The 14C evidence suggests a date in the 4th to 3rd century BC, a period in which the basal pits of furnaces from other areas of Ireland are typically approximately 400-600mm in diameter.

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Methods

All materials were examined visually, using a low-powered binocular microscope where required.

This assessment was conducted in April 2023 and was commissioned by Julianna O'Donoghue of Mizen Archaeology. The materials derive from investigations at Hartley, Co. Leitrim (19E0675).

Results

General

The submitted materials comprise approximately 8.6kg, of which 8.1kg derived from context (123). Small quantities of metallurgical residues also occurred in contexts (103) and (107), with a single piece recovered unstratified (dump) from Area 1. Contexts (103) and (120) were also represented by small collections of material that proved entirely natural.

The majority of the slags from contexts (103) and (123) were identifiable as bloomery iron smelting slags. Those that were not positively identifiable as being from iron smelting, were compatible with such an origin. In the absence of any positive evidence for smithing, it is likely that all the slags derive from iron smelting.

The overall summary catalogue is presented as Table 1, with a breakdown of residue type by context in Table 2.

Iron smelting slag

Two types of slag dominate the collection:

Firstly, there are **dense iron slags** (total 2930g), with very low vesicularity, and with some curved surfaces showing adhering indurated furnace wall ceramic. Such slags form through interaction of the slag-forming processes taking place in the lower part of the hot-zone of the furnace with the wall of the furnace at a level just below the blow-hole. The hot iron-rich slag eats back into the wall, which leaves the rounded slag surfaces on cooling and provides a source for slags to flow down into the basal pit down the back wall.

The fragments of burr in the assemblage have not been shown to preserve any original joins, so they are likely not to represent materials from a single furnace clearance, but it is unclear how the total weight would relate (either more or less) to the amount of burr from single smelt.

The largest pieces of burr suggest that the zone of intense interaction had a vertical height of approximately 90mm and it is possible the sub-bloom slag mass (not preserved here) would have had a similar thickness. Because of their variable interaction with the wall, fragments of burr do not provide suitable materials for estimating the diameter of the furnace chamber.

Secondly, there are **flow slags** (total 3257g). These are slags that have chilled during their descent from the hot-zone down into the wood packing of the basal pit. These slags are relatively vesicular compared with typical flow slags and form quite stout, sometimes bulbous flows. They show well developed flow lobes and their margins may show parts of the moulds formed by their flow over and between the wood packing.

One of the largest flow slag fragments has an overall length of 120mm and shows the partial mould of a roundwood fragment with an original diameter likely to be greater than 80mm, which is large compared with typical wood packing.

The flow slags from context (123) are a very coherent assemblage of rather fragile materials and it is likely that they represent the flow slags from a single furnace clearance.

Although it is not possible to determine the likely iron content of the flow slags with certainty, their highly porous nature hints that it might be relatively low, probably suggesting that the melting of the furnace wall had a particularly high input into the generation of these slags.

Slag types present in small quantities include some **sheet-** or plate-like morphologies (total 438g), complexly but poorly lobed slags derived from melting of the **lining** of the furnace walls (428g in total). The sheet slags may in some cases be a part of the slag mass beneath the bloom that would have protruded into the furnace from the burr. Others may be associated with a slag coating that developed on the walls or floor of the furnace.

The finest grade of slag fragments may sometimes only be crudely divided into certain flow slag fragments and into fragments with a **rough** surface, The latter may include fragments of the slag mass from below the bloom, fragments of lining slag and perhaps material from the base of the furnace. Where the slag is so fragmented as to not be identifiable it is listed on Table 2 as **indeterminate**.

Furnace structure

The collection includes 968g of fired and vitrified ceramic from context (123) that is likely to derive from the structure of the furnace. One fragment shows a wedge-like form, possibly indicating its formation just above the blowhole, but no other fragments provide useful morphological information.

Microresidues

There were no formal microresidue samples submitted, so the fine debris present in the bags of sample <165> was sieved at 200μm and picked by magnet. The magnetic particles were mainly either probably corroded iron particles or small fragments of highly vesicular pale slag. There was on hammerscale present.

Interpretation

The material is indicative of iron smelting in a non-slag tapping furnace that employed a wood packing in the basal pit. Such furnaces were the standard form of iron smelting furnace in Ireland from the start of the Iron Age until the later medieval period, although there were variations in the details of the furnaces employed at different periods.

The filling of the basal pit of the furnace with wood probably served two purposes: firstly as the base of the furnace heated up late in the smelt because of descent of slag, combustion of the wood could create space for the growing slag mass and secondly the presence of residual charred wood, or simply voids after the wood, would provide lines of weakness allowing easier breakage and removal of the slag from the pit of the furnace after a smelt when preparing the furnace of the next smelt..

The assemblage is rather variable in its preservation. The flow slags from context (123) are highly vesicular and thus fragile. Despite this, they show little sign of abrasion. In contrast, some of the dense burr-associated slags show a very slight abrasion. Such a difference might be simply due to the physical force required for the extraction of the burr from the furnace after the smelt, but it may hint that the deposits are of slightly mixed origin, with some materials deposited directly from furnace clearance (or remaining in-situ in the furnace), others perhaps residing in the environment a little longer before deposition.

Assemblages such as this may occur in-situ in furnaces – with the flow slags indicating a lack of clearance of slag from the lower part of the pit after the smelt and the denser slags either being released during decay of the abandoned furnace shaft or are lumps thrown back into the abandoned furnace after cleaning the bloom. It is unclear from the descriptions provided whether the pit containing these materials is compatible in morphology with being the basal pit of a furnace.

The smelting was associated with a 14C determination of 2219+/-24 BP, which is equivalent to a calibrated 2σ date of 381BC – 338BC (18.1%) and 326BC – 198BC (77.3%). Furnaces of this period (fourth to second century BC) elsewhere in Ireland have been shown to be represented in the archaeological record by their basal pit, which has an approximately circular cut of between 400 and 600mm, rather larger than typically seen in later furnaces (after the second century BC). Such furnaces include those on sites including:
Ballydavid (Co. Tipperary; Young 2009b),
Ballykeoghan (Co. Kilkenny; Young 2009c)
Cherryville (Co. Kildare; Young 2008b)
Cloncollig (Co Offaly; Young 2008c)
Clonrud (Co. Laois; Young 2008f)
Derryvorrigan (Co. Laois; Young 2008d).
Leap 1 (Co Laois; Young 2009a)
Lismore-Bushfield (Co. Laois; Young 2008e)
Morrett D (Co. Laois;Young 2005)
Newrath Site 35 (Co. Kilkenny; Eogan pers. comm.)

The location of the site, within an extensive area of restricted drainage with peat forming in hollows of the drumlin topography (although the site itself lies on the edge of till deposits), would suggest that most likely source of ore for the smelting would be a local bog iron ore.

Although it is most likely that ore would have been local, it is also worth remembering that Carboniferous strata with siderite concretions, worked in the 18th-19th century Arigna ironworks and at several earlier sites between the 16th and 18th centuries, lie only some 10km to the north around the southern end of Lough

Allen. These siderite ores, or just possibly bog ore deposits derived from their weathering, may have also been worked as a resource prior to the foundation of the post-medieval ironworks, for the medieval 'Book of Invasions' places the arrival of the *Tuatha De Dannan* (including *Goibniu* the smith god) on Sliabh an Iarainn, and a medieval avatar of *Goibniu*, *Gobán Sa*or, is said by some to have had a forge in the valley below (Kelly 2020). The area thus has some mythological association with early iron production.

Further work

Detailed laboratory investigation and elemental analysis would be capable of providing further evidence for the nature of the ore employed in the smelting operation.

The assemblage is significant for its occurrence in an area from which few other similar assemblages have been recovered. The residues should those be included in full within the deposited site archive, whether or not further analysis is undertaken.

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Table 1: summary catalogue, weights in g, assm = assemblage of fine material, s/h = spoil heap.

context	sample	label	item wt.	item no.	notes
A1 s/h	261		15	1	dense greenish flow slag, small flow lobes with superficial dimples on both upper and lower faces, one angular re-entrant which may be small fuel mould
103	s82		210	75	flow slags - small prills, amalgamated fine prills, and spheroids
			92	30	rough, porous and charcoal-bearing slags
			18	5	stones
			20	assm	dust/debris
103	246		<1	ass	Iron-stained clay
107	263		14	1	Small, rounded piece of iron slag, dimpled base
120	262		7	1	small fragment of weathered fossiliferous limestone, iron stained
123	165	bag 1 of 2	2450	5	dense blocks of slag from fragmented burr and associated materials
			428	1	complicated mass formed of amalgamated lobes of lining influenced slag
			754	1	block with some charcoal-bearing porous slag with smooth top, grading down into lobes forming a planar base
			2020	86	amalgamated flow slag, some with contacts against margin, some with large, rounded fuel moulds
			2	1	oxidised fired clay
			16	13	ceramic debris
			178	assm	flow slag debris
			168	assm	dust and debris (sieved: see text)
		bag 2 of 2	124	4	stones
			266	10	vitrified and slagged oxidised fired lining
			480	3	dense slags with burr developed on some
			288	16	dense slag in slightly lobate forms and in basal sheet fragments
			18	10	fired cermaic
			150	1	moderately dense slag sheet fragment attached to a sheet of more lining-dominated material - precise formation of this is unclear
			80	1	flow lobed low-density slag
			158	assm	indeterminate slag fragments and dust
123	260		666	assm	abraded lumps of oxidised fired ceramic, a few small pieces show somewhat indurated smooth faces, also one small prill of low density slag

Table 2: total weight of classes of archaeometallurgical residues (g) by context.

context	dense slag (incl. burr)	flow slag	sheet slag	lining influenced slag	rough fine slag	indet. slag	lining ceramic	debris and dust	*context total*
A1 s/h		15							*15*
103		210			92			20	*322*
107						14			*14*
123	2930	3032	438	428			968	326	*8122*

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