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Evaluation of residues from M1
Northern Motorway (J2009):
Platin/Lagavooren 1 (01E0822)

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Abstract

This site yielded a small, but unusual and important, assemblage of archaeometallurgical residues weighing a total of 1.4kg.

The majority of the metalworking evidence appears to derive from a single phase of activity within the eastern part of the site, with the residues preserved within a series of gullies and pits. The residues indicate small scale activity encompassing both the smithing of iron, probably for very small tasks, and the casting of small objects in copper alloy.

The principal evidence for copper-alloy working is provided by sherds of what appear to be very small crucibles. The fabric of the crucibles is uncharacteristically porous. However, an interpretation as crucibles is favoured. The small volume of the crucibles would indicate that only very small items were being cast. The crucibles have no known analogues in the Irish Iron Age, but may resemble examples of the 7th- 8th centuries AD. A single clay mould was for an as-yet unidentified object. The style of work being undertaken could have been handled in a very small temporary hearth. Such a hearth may have been located for the purpose within pre-existing gully c24, or the remains of the hearth may have been dumped into the gully after use.

A few denser pieces of slag probably indicate iron-working, but they are extremely small (<100g), suggesting that any forge work did not involve extended periods of work and probably did not include large amounts of forge-welding.

In summary, the metallurgical activity involved the fabrication of small items in both bronze and iron, compatible with activity seen on other high-status sites of early medieval age and the 'royal' sites of the Iron Age. The activity does not appear large scale and it is unlikely that any of the features on the site were created deliberately for metalworking purposes.

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Background

This report is an evaluation of archaeometallurgical residues from Platin/Lagavooren 1 (01E0822) on the M1 Northern Motorway development excavated by Rob Lynch, on behalf of Irish Archaeological Consultancy Ltd.

Methods

All materials were examined visually and using a low-powered binocular microscope where necessary. As an evaluation, the materials were not subjected to any high-magnification optical inspection not to any other form of instrumental analysis. The identifications of materials in this report are therefore necessarily limited and must be regarded as provisional.

It should be noted that after washing the overall weights of the material submitted in many cases differs significantly from those originally recorded.

Description

Description of the residues

The catalogue for this site is presented in appendix 1.

Approximately 1.6kg of material was submitted for investigation. The material is described under the facies categories employed in Table 2.

Possible smithing hearth cakes: the assemblage included 323g of iron slag (6 pieces) which were interpreted as possible smithing hearth cakes (SHCs) or parts thereof.

These slag pieces typically showed a dense slag layer, up to a maximum of about 12mm thickness, lying on an altered sandy substrate and overlain by irregular lining-influenced slags. One piece showed a more exposed surface to the dense slag, with a rather wrinkled surface. None is a classic smithing hearth cake, but they share with the SHCs some common elements of structure. None of the pieces formed a complete slag cake, but the original weight of these cakes would have been less than 100g.

Indeterminate iron slag: two small fragments of dense slag were not certainly parts of the possible SHCs described above (although they occurred in a context yielding one of the possible SHCs).

Fuel ash or lining slag: 359g of slag from a variety of contexts has been referred to this category. Fuel ash slags are typically highly vesicular, fragile, glassy slags, formed by partial melting of loose silicate material (particularly the soil substrate into which a hearth has been cut) under the fluxing influence of the alkali elements in the fuel ash. Lining slags are also often rather glassy slags, but formed from molten material sloughed from the partially melted hearth wall or tuyère. They are typically denser than fuel ash slags and carry residual quartz grains or pebbles derived from the ceramic. In hearths or furnaces where there is no significant addition of iron to the melt, then these two classes can be quite intergradational. To add to the problems of their differentiation, the glass phase of the present material has suffered from considerable alteration and locally dissolution.

The typical material of this facies on this site comprises rounded, blebby masses of mixtures of vesicular pale glass and derived gravelly pebbles.

Vitrified lining: pieces of vitrified lining from this site are also quite badly weathered. They show two distinct varieties of original ceramic. In a few cases the vitrified lining was quite conventional in appearance with the surficial glass layer adhering to an indurated oxidised fired sandy ceramic. Many of the pieces however, show a quite distinctive highly foliated, white fine-grained ceramic.

Fired clay: this category includes low-fired clays, almost all of which showed an oxidised firing, in amorphous forms. Much, if not all, of this material may be from non-metallurgical origins, such as burnt daub, or material from domestic hearths and ovens. This facies shows a different distribution on the site (Table 2) to the other facies, supporting its mainly non-metallurgical origin here.

Crucible: the site yielded a number (between 13 and 15) of small ceramic fragments interpreted as crucible sherds. They are quite delicate varying in thickness

from 3-9mm. Most had quite porous interior surfaces and vitrified external surfaces, with a clear glaze bearing patches of red staining which is presumed to be cuprite (copper oxide).

The most common form for these sherds was hemispherical, with an external diameter of 20-25mm and with an internal void 10-12mm in diameter. One side of these hemispheres is flattened, but it is unclear where this flattened surface lies within the overall form of the crucible. These are interpreted as the bases of crucibles, giving a minimum of 6 vessels.

Although most sherds were from the stout, if small, bases of crucibles, one sherd appears to be from the side of a small crucible, with a height probably not much over 30mm. The internal void appears quite constricted above the basal hemispherical part. Externally the side constricts slightly above the hemispherical section giving a slightly concave profile.

Also present was a small fragment of elongated vitrified ceramic, tapered at one end, and of a similar fabric to the crucible sherds. This piece might be interpreted as a handle from crucible of a type with a long, rod-like handle (as opposed to a pinched handle). One fragment of vitrified ceramic resembles a pinched handle, but is not convincingly a crucible sherd and is more likely to be a piece of lining slag.

Despite its unusual porosity, this material is interpreted tentatively as being from crucibles. Porous technical ceramic does occur in the clay coatings (wraps or shrouds) applied during the brazing (coating with bronze) of ironwork. Clay shrouds do not normally occur in such small pieces however.

Mould: Context 71 (upper fill of c70) contained one fragment of mould of oxidised fired clay. The object cast in the mould has not been identified. The part of the object cast in this fragment of the mould was 22mm long by 6mm deep in preserved section, with metal at least 3mm thick. At one end the object would have been 4mm wide with central groove giving a bilobed section. It widens to 10mm at other end of the mould with the surface curving through 90° after 5mm, the running straight for 15mm then straight to the other fractured end. Over this distance the central groove widens to a 5mm wide hollow, of which the surface has spalled off so the details are unclear – it is therefore uncertain whether the piece had a central section between the lobes or was openwork (and therefore having a narrow ‘Y’ shape).

Iron: the archaeometallurgical residues collection included several pieces of iron:

- Context (c220) produced a small, highly corroded possible nail together with a small concretion probably cored on an unseen fragment of iron

- Context (c239) yielded a 12g piece of amorphous corroded iron

- Context (c312) yielded a small equant fragment of iron weighing 2g

- Context (c283) produced three lengths of square-sectioned iron rod, 5mm wide, with lengths of 70mm, 40mm and 25mm. Each piece lies within a concretionary overgrowth. It is unclear whether these items form a single artefact (in which case it would have to have been at least 140mm in length).

Distribution of the residues

The distribution of the various facies of residue is presented in Table 2.

The various components of Structure A yielded only 2g of fuel ash slag. Such slag can be formed by processes other than metallurgical activity. The gully c8 and nearby pit c247 yielded most of the fired clay from the site, but such material need not be of metallurgical origin, and in this case, given its spatial separation from other residue types, is almost certainly not related.

Deposits within Structure B yielded 29g of fuel ash/lining slag, plus 28g of vitrified hearth lining. The hearth lining (from c274) contains part of the blowhole through which a metallurgical hearth was blown.

The majority of the residues derived from the E part of the site (gullies c28, c26, c24, c70 and pit c251). This material included 308g of iron slag, 328g of lining/fuel ash slag (some with embedded crucible fragments), 80g of vitrified hearth lining, 27g of crucible sherds (13 pieces) and 12g of mould, together with a small amount of undiagnostic fired clay. In particular appears focused towards the western end of gully c24 and pit c70. The upper fill of the gully (c24) [C25] has a ¹⁴C date between cal. 160BC and 60AD suggesting that much of the material seen here is of Iron Age date.

Specific comments on the Stratigraphic Report:

The construction of the archaeometallurgical catalogue allows the following alterations to the information in the stratigraphic report:-

1. Section 3.4, c398 contained lining slag that was not necessarily from iron working.
2. Section 3.4, c275 did not contain slag
3. Section 3.4, c274 contained a piece of hearth wall (including the blowhole), not crucible.
4. Section 3.4, c272 contained two tiny fragments of fuel ash slag, not crucible
5. Abandonment of Structure A, c257 contained fired clay, not demonstrably a mould fragment
6. Abandonment of Structure A, c312 contained a tiny slag fragment, but not crucible.
7. Section 3.6, C203 did not contain slag

Discussion

This site apparently presents an extremely rare example of an Irish Iron Age site undertaking bronze casting. The sparse comparative sites include Ballydavis (Co. Laois; unpublished) and Tara (Co. Meath; Crew & Rehren 2002).

The key artefactual evidence from this site is that provided by the crucibles. The crucible sherds are small, but appear to indicate very small vessels, with an outside diameter of less than 25mm, probably a height of less than 40mm and possibly with a handle.

The fabric of the crucibles is very porous. Although the fabric in fact now appears too porous to have functioned as a crucible, there may be two factors needing account. Firstly Crew & Rehren (2002) have

argued for material from Tara (albeit for material of very different form to the present crucibles) that the Iron Age crucibles may show properties intermediate between those of the Bronze Age (organic-rich fabrics chosen to increase insulation for crucibles heated from above) and the early medieval period (highly refractory materials to allow good conduction of heat inwards for vessels heated from below). This theme was reiterated by Bayley & Rehren (2007), who also (their Table 1) identified the use of integrated-lidded crucibles as an aspect of this transition. A second consideration may be that glassy material produced during firing of the crucible may have been destroyed by weathering; the vitrified furnace linings and glassy slags from this site certainly show a high degree of alteration.

An alternative explanation would be that these materials are not crucibles at all, and represent brazing shroud fragments. Brazing is a technique used to apply a decorative or protective bronze coating to iron artefacts. Brazing experiments conducted by the authors showed that when a ceramic brazing coat fails, (i.e. cracks), copper rich residues may adhere to the external ceramic surface in a similar form to those seen on crucibles. In this case, the fine, thin walled fabric would suggest that small objects were being coated, possibly pins or tacks of some kind. Brazing has not, however, been recognised in Ireland before the early medieval period (e.g. Young 2009, in press), no brazing shrouds as thin as the present material have been reported in the literature and the interpretation of these sherds as being from crucibles must be the preferred interpretation.

If the interpretation of the sherds as being from crucibles is accepted, then attempting to reconstruct their morphology raises further questions. They are quite unlike the open styles of crucible seen in the Iron Age of Britain or, so far, in Ireland.

Small crucibles, sometimes with handles and sometimes with lids are characteristic of the early medieval period. The crucibles from this site are not sufficiently complete to be identifiable, but some features suggest that it may be a form which would have been lidded, but it is not clear whether, if lidded, it would have had a separate lid luted on (commonest in 6th-8th centuries) or have been a pinched form with integral lid (which appear in the 7th century and possibly survive as late as the 10th). The shape of some sherds is suggestive of a similarity with the pinched form Dunadd Type D (for which the internal volume ranges down to 1cm³) although this is far from certain. At Dunadd, the type D vessels appear to have been used for silver and gold. Irish finds of pinched crucibles of this type include material from Ballinderry II crannog (Hencken 1942), Carraig Aille II (Ó'Riordáin 1949) and Correnearry (Davies 1942). The type is also known from the Brough of Birsay, Orkney (Curle 1982) and from various sites in Scandinavia. On the other hand, if the rod-like piece of vitrified ceramic is a crucible handle, it more closely resembles one from a crucible larger than those represented by the other sherds, particularly perhaps resembling material from Garryduff (O'Kelly 1962, fig 21, 374; Craddock 1989, no. 169) of 7th-8th century date.

The iron slags are all very small; there are none of the large SHCs which so typify early medieval ironworking in Ireland. However, it is possible that any ironworking was very limited in the task attempted. If, for instance, the ironworking involved merely forming objects such as ring pins from stock iron, then the iron losses to the hearth might be very small indeed.

In summary, the evidence from the metalworking is for a small-scale activity. There would be parallels for such activity on early medieval, and possibly Iron Age, high status sites. The evidence from the crucibles is not unambiguous, but they appear to resemble examples of an early medieval age.

Evaluation of potential

This assemblage is small, but of great significance. Further analysis is therefore recommended. The analysis should include analysis of the crucibles to attempt to check the nature of the metal(s) that were being worked. Further typological study of the crucibles is also recommended as is further attempts to identify the object represented by the mould. The analysis of the iron-working slags and associated materials is also recommended to produce a rounded account of the activity being undertaken.

The material assumes even greater significance because of the Iron Age ^{14}C date, which is at variance with the current typological identification of the crucibles as being probably of 7th-8th century date.

The analysis of this material has a high potential for significant results. The material certainly requires retention.

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Appendix 1. Catalogues of material

Site: Platin/Lagavoreen 1 (01E0822)

context	sample no (#find)	weight (g)	quantity	description
4	308	33	1	small fragment of slag, possibly from SHC. Top green, glassy with some charcoal, lower part more dense with smoothly lobed /dimpled base
8	328	72		oxidised fired clay debris
27	316 (#3)	13	1	low density vesicular fuel ash slag
27	316 (#7)	24	3	small fragments of slag: 2 pieces of iron-rich slag in a sheet form, 1 piece is an iron-poor lining/fuel ash slag
27	316 (#7)	6	1	quartz-rich fired clay furnace lining, highly vitrified and slagged
27	316 (#7)	150	2	indeterminate slag, both pieces very dense slag with signs of flowage. May be two very small SHCs
71	(#2)	12.1	1	fragment of mould of oxidised fired clay. The cast object would have been 4mm wide with central groove at one end, widens to 10mm at other, swinging 90° after 5mm, 15mm then straight to fracture, central groove widens to 5mm wide hollow, but broken, so details unclear. Part of object overall 22mm long by 6mm deep in preserved section, with metal at least 3mm thick.
71	312 (#3)	21	5	gravelly lining slag, with dark glass, resting on very coarse quartz-rich ceramic
71	312 (#4)	46	(2)	indeterminate slag, has superficial layer of lining slag, lying on denser slag attached to reduced fired ceramic. Where the slag is exposed it is maroon on the surface suggesting this is from near blowhole – could be SHC fragment from a very small hearth.
71	312 (#4)	1	2	fuel ash slag
182	313	34	1	indeterminate slag - possibly part of tiny SHC
182	313	2.1	1	low density vesicular fuel ash slag
182	313	9.3	1	low density gravelly fuel ash slag
203	317	33	1	limestone
208	319	42	1	weathered veined limestone
209	(#1)	28	1	fragment of fired clay, very fine soft pale grey fabric, paler to outside, with very fine mineral temper (56x39x11mm)
220	306 (#1)	16.1	3	low density lining slag attached to almost white ceramic at rear
220	306 (#1)	14.5	5	low density fuel ash/lining slags in complex blebby lumps
220	306 (#2)	50	4	low density lining slag – very heterogeneous material with pebbles, dark, pale and green glasses all in amorphous mass
220	306 (#3)	8	2	low density fuel ash slag

<i>context</i>	<i>sample no</i>	<i>weight (g)</i>	<i>quantity</i>	<i>description</i>
220	306 (#5)	8	2	low density fuel ash slag
220	306 (#6)	7.6	2	Low density gravelly slags
220	307 (#6)	15	1	Low density slag grading into dark dense slag with lobes
220	306 (#7)	3.3	1	small crucible base fragment, 6 to 4mm thick, vitrified on external surface , dark glass film on interior, flat base, clear external glaze, tiny mark of cuprite
220	306 (#7)	27	8	low density fuel ash slag
220	306 (#8)	17	2	fired clay, oxidised on one surface, almost vitrified on the other – conventional orange lining with some coarse grit
220	306 (#9)	24.9	1	fuel ash slag, vitrified material binds gravelly debris, passes into denser black glassy slag at one end
220	306 (#9)	12	1	corroded iron - possible nail fragment
220	306 (#9)	9	2	weathered vitrified clay, oxidised on rear surface – hearth wall?
220	306 (#9)	11.5	2	low density vesicular fuel ash slag in rounded blebs – very weathered
220	306 (#10)	0.9	1	Crucible fragment, external clear/pale grey glaze, internal surface not seen
220	306 (#11)	13	1	low density lining slag, in irregular rounded lump
220	306 (#12)	20.56	3	blebby gravelly lining slag, low density
220	306 (#13)	17.4	1	iron rich concretion with occasional charcoal residues, uncertain if cored on iron or slag
220	306 (#13)	31.8	4	vitrified hearth wall with strongly laminated white ceramic behind
220	306 (#13)	6	2	small fragments of vitrified lining or lining slag
220	306 (#14)	3.1	1	Sherd from base of crucible, hemispherical but flattened on one side. Internally shows slight traces of brazing like internal glazed coat with bubbles
220	306 (#15)	11	1	indeterminate slag, lining slag with admixed, dark slag amongst gravel
220	306 (#16)	26	1	fuel ash slag, vitrified material binds gravelly debris, passes into denser black glassy slag at one end
239	310 (#1)	3.5	1	small crucible fragment, 23mm external diameter, 5-7mm thick, possible base, slight vitrification on exterior with red tinge, most likely cuprite (copper oxide). External surface deeply cracked
239	310 (#2)	12	2	corroded iron
255	(#1)	17	1	Glassy lining slag, of various colours (1 tiny reddened area might indicate copper-contamination), binding gravelly material
255	(#2)	2.1	1	Rounded crucible base? Pale glaze with extensive cuprite reddening, has odd hollow in base internally
255	(#2)	0.9	1	Small 'crucible' fragment, fabric as above
255	(#2)	.6	1	Small 'crucible' fragment, fabric as above
255	(#2)	1.3	1	Small 'crucible' fragment, fabric as above
255	(#2)	3.0	1	Lobed object with circular scar – could be a pinched crucible handle? Probably just bleb of slag attached to crucible sherd
255	(#3)	4.4	1	30mm long ceramic rod, cross section oval, 15x11mm. Slight external transparent glaze with a few red minute dribbles. Internally porous but solid. Rounded tip. Internal flaw corresponds to traces of seam on exterior. Possible straight crucible handle.

<i>context</i>	<i>sample no</i>	<i>weight (g)</i>	<i>quantity</i>	<i>description</i>
255	(#3)	2.8 & 2.4	2	conjoining fragments of semi-hemispherical external form, slightly flattened one side, internally porous, truncated smooth surface bubbly glaze internally, suggests sub-angular rectangular dished hollow with rounded corners, 18mmx13mm. Walls 3-5mm. External transparent glaze with red flecks, overall bowl external dimensions, 24mm x 22mm x 14mm deep.
255	318 (#4)	18.8	7	low density fuel ash slag
255	(#5)	2.2	1	hemispherical crucible base with central hollow, as #2, 2.1g piece above
255	(#5)	3.5	1	side of crucible? 26mm high, base probably hemispherical (part only preserved) but constricts slightly above, some possible slag occluding cavity – but otherwise cavity is inverted mushroom shape internally
255	(#6)	14.8	1	mass of lining slag with 2 sherds of 'crucible' entrapped, both with some red copper staining. All very quartz-rich
257	(#4)	9	1	lightly fired, partially oxidised fired clay, with vitrified reduced very slightly convex surface
263	320	60	(2)	indeterminate slag, broken piece with slightly concentric structure, base shows flowed lobes penetrating in sandy ceramic –could possibly be tiny SHC
272	(#1)	1.5	1	fuel ash slag?
	(#1)	0.6	1	stone
	(#1)	0.2	1	fuel ash slag/
274	(#1)	28	(2)	one side of blowhole 20mm diameter with adjacent vitrified wall face, broken in two. Very quartz rich pale fabric – almost like a crucible. Local dark glass developed but no real slag and no trace of copper staining
275	311	22	1	natural chert
282	314 (#1)	42	2	weathered basalt
282	324	35	1	lightly oxidised fired clay
282	324	11	2	lightly oxidised fired clay
283	309 (#1)	7	(4)	concretion formed around corroded iron, 5mm square cross section by 70mm in length
283	309 (#4)	48	2	concretions surrounding corroded iron – 5mm cross section square, one 40mm long one 25mm long
283	327	287		several blocks of hard fired oxidised clay
312	304 (#2)	0.7	1	fuel ash slag
312	307 (#4) (says 14 on object)	5	1	Small fragment of ceramic-like material, resembles pointed base, internal diameter 1.5mm, height 22mm (at highest point), small finger sized depression in centre, rounded base - very weathered appearance. Formed of coarse sand bound by very little – might be natural concretion, does not resemble fabric of 'crucibles'
312	307 (#6)	2	1	small fragment of corroded iron
312	326 (#3)	<1		powdered oxidised-fired clay

<i>context</i>	<i>sample no</i>	<i>weight (g)</i>	<i>quantity</i>	<i>description</i>
325	315	12	2	mica-rich rotten rock
327	#1	0.4	1	sandy fuel ash slag in amorphous shape – could be slag or failed ceramic
334	325	8	1	fragment of red sandstone, spalled from pebble
398	305	26	6	low density fuel ash/gravelly lining slag
	<i>total</i>	<i>1570</i>		

Table 2: summary of distribution of residue classes (in g) by context

context	?SHC	Indet. slag	fuel ash or lining slag	vitrified lining	fired clay	crucible	mould	iron	natural
4	33								Natural
8					72				Cut of ditch 8: N side of structure A
257					9				Upper fill of C8: N side of structure A
312			1		<1			2	5 Upper fill of C318: S side of Structure A
325									12 Lower fill of C318: S side of Structure A
327			1						Upper fill of C318: S side of Structure A
334									8 Upper fill of C318: S side of Structure A
398			26						Fill of C22: N side of Structure B
272			3						1 Upper fill of C271: S side of structure B
274				28					Main fill of C271: S side of structure B
275									22 Fill of C271: S side of structure B
203									33 Primary fill of gully C28 (N of C26)
27	150	18	19	6					Upper fill of C26
208									42 Upper fill of C26
209					28				Lower fill of C26
220			245	74		7		29	Main fill of C24
239						4		12	Fill of C24
255			46			16			Fill of C24
71	46		7				12		Fill of linear gully C70 (S of C24)
182	34		11						Primary fill of linear gully C70 (S of C24)
263	60								Primary fill of pit C251
282					46				42 Fill of pit C247
283					287			55	Fill of pit C247
<i>totals</i>	323	18	359	108	442	27	12	98	165

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