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Evaluation of archaeometallurgical
residues from Mucklagh, Co. Offaly
NTB06, A033/E2845

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Abstract

This site has yielded a total archaeometallurgical residue of approximately 41kg. The majority of the assemblage (33kg) derives from just two contexts (009 and 010), which appear to be later post-medieval in age.

The residues are dominated by smithing hearth cakes (SHCs; 26.2kg of the assemblage is certain SHC material, and much of the indeterminate material is likely to be small fragments of SHCs). The 66 measurable SHCs show a size range from 98g to 1206g, with a mean of 373g. Such a size distribution is typical of residues deriving from a blacksmith's smithy, rather than from the refining of raw iron. Such SHCs will only form in hearths where there is a ready supply of slag-forming silicate material from the melting of the ceramic surrounding the air inlet of a side-blast hearth. The air inlet in this instance appears to be a large-diameter ceramic tuyère. The fuel employed was charcoal. Several of the SHCs show a gravelly basal layer – suggesting the hearth was floored with gravelly material, or perhaps more likely a floor-level hearth dug into gravel deposits.

The assemblage is thus extremely conservative in the use of charcoal, ceramic tuyères and possibly a floor-level hearth; features which are typically replaced by coal, cast iron tuyères and a waist level hearth respectively by the 19th and 20th centuries (waist-level hearths and the use of coal may appear much earlier in some areas). The dating evidence for Mucklagh is imprecise, artefactual evidence suggesting 18th-19th centuries and ¹⁴C only indicating the deposits are post-late 17th century. This appears to be an example of the late survival of essentially a medieval style of forge into the dawn of the industrial period, when cheap distribution of coal (initially by canal, which reached Tullamore in 1798) and of mass-produced iron tuyères led to standardisation of what is commonly thought of today as the "traditional" forge.

A similar example of late survival of this technology has been recorded at Ballykilmore, Co. Westmeath, less than 20km NE of Mucklagh, where the use of floor-level hearths, ceramic tuyères and charcoal fuel is also attested in a post-medieval context, although there also associated with bloomery iron smelting.

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Methods

All materials were examined visually, using a low-powered binocular microscope where necessary. All significant materials were weighed and recorded 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

The catalogue is presented in Table 1. The materials are all either certainly from iron-working (smithing) or compatible with that origin. There are no materials in the collection which can be attributed with any high degree of likelihood to an origin in any other activity.

The residues are dominantly macroresidues, although some of the sample retents do include a very small proportion of microresidues. None of the micro-residues contains significant proportions of hammerscale. This suggests that micro- and macro-residues became separated by the disposal process. This is a common observation and is usually taken as an indication that the smithy might be swept clean of micro-residues (which tend therefore not to move far from the point of origin), whereas the macro-residues (slags) would be removed from the forge hearth and disposed of by carrying or throwing to a suitable location, and thus tend to be further removed from the smithy.

The most interesting microresidues are those from C005. This retent assemblage contained abundant small slag droplets, which were consistent with those formed within the charcoal bed of a smithing hearth (compare the assemblage from Coolamurry described in Young 2008a).

The slags are dominantly smithing hearth cakes (or fragments thereof), there appear to be few other unconsolidated hearth slags, and there are relatively few pieces of hearth ceramic or wall-bound slags.

The collection of 66 complete, or almost complete, SHCs constitutes about 60% of the total assemblage by weight. Much of the remainder of the collection is formed by slag fragments, which although indeterminate, are probably SHC fragments.

Vitrified lining and lining slags contribute less than 2kg of the assemblage (<5% by weight). The form of the tuyères is largely evidenced by the shape of slag pieces broken from the tuyère face; there are no good tuyère fragments providing direct evidence for their shape. The slag attachment scars provide evidence for low-curvature tuyère margins, in one case in C009 suggesting a radius of about 90mm, but in others (e.g. C010) there is almost no curvature. This perhaps suggests that the tuyères might have been similar to the large oval ones at Ballykilmore (Young 2006).

Many of the SHCs show inclusions of small pebbles on their bases. This suggests that the hearth base was either a very pebbly ceramic, or that that the hearths were excavated into a gravelly deposit.

Interpretation

This assemblage forms a coherent group of iron working (blacksmithing residues), of a style fairly well-known from sites ranging in age from the earlier Iron Age to the medieval period, but, perhaps surprisingly, not very well documented from the post-medieval period.

Between the 16th and 20th centuries there were a variety of technological changes within blacksmithing in Ireland, and broadly similar changes can be observed elsewhere, although the precise timing of different changes varies by location.

The changes include:

1. the shift from floor-level to waist-level hearths
2. the change from charcoal to coal or coke as fuel

3. the adoption of cast iron tuyères (or tuy iron as blacksmiths call them), usually with water-cooling, in replacement of earlier ceramic tuyères and blowholes.

4. the change from paired bellows to the double-action great bellows (or in the 20th century to squirrel-cage blowers and powered blowers).

These changes will have appeared at various times in different places and the details are very poorly known. Indeed change (4) is not currently detected in the archaeological record.

It is likely that change (1) may have occurred earlier in urban settings or in areas of strong Anglo-Norman influence.

Change (2) will have occurred earlier in areas where coal occurs or in areas with easy trading with the coal-producing areas (particularly sites on the east coast). In the context of Mucklagh, the arrival of the canal in Tullamore in 1798 is likely to have led rapidly to cheap coal becoming available. However, even in areas where coal was plentiful individual smiths may have continued using charcoal through preference (there are anecdotal accounts of some smiths working in the South Wales coal mines using charcoal well into the mid-20th century!).

Change (3) will have occurred when cheap mass produced castings became widely available in the 19th century. It is likely that the use of a waist level hearth would be a prerequisite for adoption of an iron tuyère. The nature of the blowhole in forge hearths immediately before the adoption of the iron tuyère is unknown. It is assumed that ceramic tuyères continued to be used in Ireland, and limited archaeological evidence suggests these are large objects compared with the smaller medieval varieties.

The Mucklagh assemblage shows clear evidence that changes (2) and (3) had not been adopted and evidence that suggests change (1) had not either.

The significance of the Mucklagh assemblage therefore hinges on its age. The artefactual evidence appears to push the assemblage (if in-situ) into the 19th century on the evidence of a few sherds of glass bottle. The ¹⁴C evidence is also not especially helpful; the two data samples have curves that markedly differ from each other, but which broadly indicate a post-late 17th century date. However, a age bracket of 18th-19th century places this assemblage very late in the history of a style of iron working which has its roots back in the early Iron Age.

Persistence of early styles of iron-working and iron-production in this area are also being evidenced by on-going investigations at Ballykilmore, Co. Westmeath, less than 20km NE of Mucklagh. This site shows a late phase of iron-production largely within the upper fills of a ditch surrounding an Early Christian and medieval cemetery and church. The iron working here is interpreted (Young 2006) as representing iron production, with both bloomery iron smelting and the subsequent bloom refining being undertaken on the site. The age is currently uncertain, but appears to be in the bracket of 16th – 19th century, and it is to be hoped that this will be refined before publication.

The Mucklagh slags occur mainly in a linear feature (gully), towards the SW end of which there are some discrete, smaller, charcoal-rich deposits. (C004, 005, 008). C005, and to a lesser extent C008, yielded a good microresidue assemblage, indicative of within-

hearth residues. These three oval deposits may represent discrete deposits dumped during cleaning out of a smithy hearth. Alternatively, it is not impossible that they actually represent hearths themselves. The amount of heat transfer onto the very base of a smithing hearth may be very limited, and scorching limited to the upper part of the side near the tuyère. Metalworking hearths and furnaces are not uncommon in the butt ends of ditches. Unfortunately, the residue assemblages by themselves cannot indicate whether a charcoal deposit is *in-situ* in a hearth, or dumped.

Evaluation of potential

This assemblage is significant for being the residues from what must have been an extremely widespread activity, but which has remained largely obscured in the archaeological record.

Further investigation of the chemical composition of the slags would be interesting; partially to establish baseline data for material of this age and partly to determine whether any significant differences exist between this late material and earlier residues in the same tradition.

The value of any further work is however somewhat limited by the lack of clear association with metallurgical structures, and by the considerable uncertainty over the age of the assemblage. Thus although the detailed analysis of these slags would be of interest and would further archaeometallurgical knowledge, it would be unlikely to impact on the immediate understanding of this site in a significant manner.

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context	sample	label	weight	notes	dimensions
001	001	slag	1206 186 314 215	large SHC broken in 2, spoon shaped, crust to 15mm, thin granular fill in bowl small protrusion below blowhole, semicircular rear hints at tuyère but no real sides, non-wetted surface of slag below horizontal lip which must have jutted 40 mm below blow hole curious SHC which has basal contact, blebby/lumpy/gravelly top - and apparently a hole blown in side with smooth maroon surfaces, low density 2 pieces of flat slabby dense crust	175x140x60
004	003	slag	383 159 294 143 249	curious extremely dense SHC with red smooth top, dense body and microprilly base lump of limestone - natural probably >75% of SHC with glassy top, vesicular body and dense lower crust incomplete thin SHC, dense base, glassy top - similar to tongue below but denser semi-circular slab of lining-dominated material - low-density SHC or tongue, top pale green glass with shallow dimples, internally very vesicular, base has some rusty lobes	95x90x40 115x(75)x40 90x130x45
004	006		178	c40 small slag pieces	
004	006	metallic debris	24	small slag fragments mainly low density lining related materials	
005	003	prill	10	bag of slag droplets, 2mm regular to 10mm irregular, c60 droplets	
005	003	whole retent of metallic debris	224	mixture of smooth dense blebs and rusty granular slags rich in very fine charcoal	
005	008	1 of 1	298 617	possible folded SHC - now rounded lump c45 slag pieces	
005	008	metallic debris	36 139	fine slag detritus tiny rusty SHC, deepest at one end,	70x65x50
007	002	slag	830 425 546 121 449	large irregular SHC, probably slightly incomplete, has very dense lower crust and some prills inside the bowl irregular slightly low density SHC with glassy top most of SHC with glassy top and dense bowl, edges missing, but probably >90% fragment from margin of small conventional SHC dust and 9 pieces of mainly low density slag	145x115x55 120x110x45 130x(85)x45
007	002	metallic debris	30	a bag of mainly prilly and blebby slags, one piece probably from SHC basal crust, but others free slags from bed	

008	005		237 possible SHC, biconvex, rusty	80x75x35
			574 15 pieces of slag	
008	007	metallic debris	84 bag of slag debris - mainly fragments	
008	007	slag	396 bag of sub-50mm slag pieces, some ash covered lobes and prills but lots of broken fragments of rather blebby/lumpy slag	
009	016	1 of 4	36 bag of small slag fragments and blebs - mainly the granular/lumpy components of the SHCs	
			612 large SHC broken in 3, bowl 30mm deep, lots of gravel towards the top, well formed dense but vesicular plano-convex shape, bowl smooth externally	140x95x55
			188 irregular smooth top dense SHC with smooth base and irregular blebby projections around edges	100x75x40
			215 irregular smooth top dense SHC with smooth base and irregular blebby projections around edges	105x70x30
			212 about half a dense well-formed SHC, lumpy base, top variable smooth and friable	95x(50)x40
			83 curved irregular sheet of gravelly lining slag	80x60x35
			16 45mm long nail with folded end	
			260 irregularly shaped mass of SHC-like slag - but shape odd - could be deformed?	95x70x50
			161 slab of dense slag	80x65x30
			49 2 pieces of vitrified lining	
			1338 54 pieces of slag	
			109 attachment of friable slag to blowhole or to tuyère - but difficult to orientate	
009	016	2 of 4	437 curved mass of failed lining slag sitting on base of wall	130x115x50
			798 sub-conical dense SHC, lower bowl to 35mm deep, top wedge to 35mm on proximal side, 15mm distally	110x95x70
			422 slabby dense SHC, straight proximal contact, plano-convex form	115x95x40
			343 biconvex friable lining-rich SHC, mainly void space inside	115x90x60
			234 SHC with thickest part proximally, base dimpled/lobate. Top glassy and covered in large pebbles	115x90x35
			283 lining slag showing tuyère contact, slag dimpled, tuyère margin curved, suggesting radius of maybe 90mm	100x80x65
			199 small dense SHC with glassy lining lag top	75x80x35
			155 curved slab of dense crust - not clear what the original cake size would have been	
			124 small slag lump probably from tuyère front	
			104 small moderately dense SHC with glassy top	75x65x25
			238 3 slabs of vitrified lining	
			698 28 pieces of slag and lining	
009	016	3 of 4	381 dense but hollow SHC with contact on end, rusty base, charcoal dimples on top	95x85x50
			134 small flat SHC dense, dimpled top	75x60x25
			402 SHC with glassy top sheet, slightly lobed base, smooth inclined ceramic contact proximally	115x85x50
			162 low density SHC with many rock clasts	90x60x40
			166 broken SHC, estimated to be 70% of original, many rock clasts	90x(60)x40
			164 low density SHC with much gravel, granular appearance	65x90x45

			98	low density friable SHC	70x60x35
			171	low density SHC with flat dimpled top	80x60x45
			175	dense semi-circular slab, probably a SHC	90x60x25
			138	dense slab not certainly SHC	
			153	dense slab not certainly SHC	
			913	35 pieces of low density slags like the SHCs above	
			285	3 slabs of vitrified lining	
009	016	4 of 4	381	triangular low density SHC, deepest proximally, glassy gravelly top, very friable	105x105x60
			808	friable SHC. Has tuyère contact at one end, smooth in front, then beyond that appears very granular and lumpy for distal half, lower surface dimpled distally, but is smooth below tuyère contact	160x110x65
			271	friable slabby SHC, top dark glass, pale friable below	100x80x45
			238	dish shaped irregular SHC, dark glassy top	100x100x30
			274	friable lumpy/granular SHC with crudely triangular shape, deepest proximally	100x75x45
			118	thin dense SHC, very iron-rich slag with charcoal as impressions and embedded on top, bottom very slightly dimpled	90x60x20
			124	low density lump/granular SHC	90x70x30
			299	dense flat-topped conical SHC deepest proximally	90x75x40
			159	irregular vesicular low-density lining-rich biconvex SHC	85x75x35
			280	moderately dense SHC, slightly irregular, granular base	90x80x50
			130	2 pieces of slagged lining	
			914	20 pieces of slag	
009	014	slag removed from sample	193	neat oval SHC, dense, granular appearing (not pebbly)	80x80x25
			189	rubbly small protrusion attached below 23mm diameter blow hole, not a real SHC	90x105x55
			1364	large collection of up to 50mm pieces of slag - mainly in hearth blebs and prills and lining slag lumps	
009	014	metallic debris	142	small slag fragments and blebs - mostly pale lining related materials	
010	012	1 of 4	929	20 pieces of slag	
			572	10 pieces of vitrified lining - one of which is hood from above blowhole, another shows a dense slag lip possibly on base of very large diameter (almost) straight tuyère	
			460	neat shallow SHC, probably formed on hearth base. Glassy top with pebbles, well formed basal crust	145x90x45
			321	low density plano-convex SHC with glassy top, large gravelly pebbles and lots of voids	110x95x45
			211	irregular lump of dimpled slag, has attachment of oxidised lining locally	
			296	irregularly developed SHC with lining rich top, prills and flows from distal base	
			172	part of a dense SHC with a well-developed basal crust	
			177	part of small neat dense SHC- probably less than half here	
			160	block forming part of small dense nub-like SHC with large charcoal inclusions	
010	012	2 of 4	1194	30 pieces of slag	
			908	large conventional SHC - possibly 85%, vesicular dense bowl, smooth blown top with adhering gravel, also gravel in parts of bowl	110x130x65
			505	very deep dense bowl, incomplete top	(80)x80x50

			273	very low density gravelly SHC	90x100x55
			339	dense deep small SHC with very gravelly glassy top	90x80x50
			462	dense conventional SHC, small part missing, very dense, glassy top	80x100x45
			110	very strange piece of lining slag - has attachment to "wall" with well marked edge - possibly tuyère edge, but also non-wetted surface at right angles - could it have had another material below tuyère in the wall?	60x85x50
			139	very irregular possible SHC, contains charcoal but also one dense piece which might be mineral coal	80x70x40
			145	small irregular SHC with granular base and locally smoothish top	80x60x30
			155	possible small irregular SHC, rusty, might be part of something bigger	90x60x45
			113	thin tongue-like slab, smoothish top lobate base - all low density lining material	80x75x25
			145	3 pieces of vitrified lining	
010	012	3 of 4	11	bag of small slag fragments	
			748	11 pieces of slag of indeterminate form	
			165	small SHC, fairly well formed and dense, bowl has slightly biconvex form	80x65x40
			744	well formed SHC with lobate margins and a glassy top - which has large gravelly lump proximally, base granular hard dense	125x110x50
			247	small vesicular but dense SHC, deepest proximally, oval in plan	90x70x40
			200	irregular small friable SHC, with deep concave bowl	90x70x30
			645	dense SHC with irregular top and possibly microporilly base	120x105x55
			375	2 pieces 60%? of SHC with maroon smooth blown top to slabby form, base granular	130x100x40
			196	part of small SHC with fairly well-develop basal crust	100x75x25
			231	low density slight irregular SHC with lots of rusting around its granular top,	105x70x40
			170	attachment area of dense slag onto wall/tuyère - no clear evidence which - it is an arcuate piece - but not clearly a made edge	
			207	2 slabs of vitrified lining	
010	012	4 of 4	196	15 pieces of slag	
			1001	dense SHC with well-formed dense bowl and dense top slab, base rusty granular, top smooth	130x125x65
			522	slabby irregular SHC attached to good straight length of wall 105mm wide	120x105x60
			744	double layer SHC with deep dense bowl and raised dense slabby top (burger), granular between	105x80x65
			558	incomplete low-density SHC with enormous internal voids lined with delicate platy olivine, probably little missing weight	120x(100)x80
			492	lowish density SHC attached to straight wall (as with other one this slopes up from wall!), attachment 110 wide	90x115x75
			655	strange SHC with dense Fe-rich slabby flat base, granular centre then raised deeply dimpled gravelly top	130x90x80
			321	thin SHC rich in gravel	110x90x35
010	015	metallic debris	53	small slag fragments - few fines compare to other retents	

	Mucklagh	Prior Park Cricklade -130 11 th – 13 th	Prior Park Cricklade -128 13 th -15 th	Prior Park Cricklade total	Marsh Leys Farm Roman	Carmarthen Roman	Worcester Deansway (period 8) 11 th – 13 th	Worcester Deansway (period 9) 13 th -15 th	Burton Dassett 14 th - 15 th	Ballykilmore
count	66	10	7	17	30	136	61	32	60	43
min	98	156	172	156		100	168	144	130	80
max	1206	794	436	794	824	820	1490	1800	1670	4033
average	373	329	277	329	333	227	492	499	550	898
<500	77%	70%	100%	82%	77%	94%				51%
<1000	95%	100%	100%	100%	100%	100%				74%
>1000	5%	0%	0%	0%	0%	0%				26%
>3000	0%	0%	0%	0%	0%	0%				7%
Modal class	100-200									400-500

Table 2: Comparison of the Mucklagh SHC assemblage with other British and Irish blacksmithing SHC assemblages. Burton Dassett from McDonnell 1992; Marsh Leys Farm from Young 2005; Carmarthen from Crew 2003; Prior Park, Cricklade from Young 2008b; Worcester Deansway from McDonnell & Swiss 2004.

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