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Abstract

Excavations at the post-medieval site in Gorteens produced 15.2 kg of archaeometallurgical residues derived from iron-working. The majority of the material (14.9kg) was found in a trench to the west of the castle, (cut 3, F. 28). There were also very small quantities of materials found in a trench to the north of the castle (cut 1 ext, F.4) and in a second trench to the west of the castle (cut 2, F.64). The assemblage from cut 3 is characterized by a variety of macro- and micro-materials, dominated by smithing hearth cakes (SHCs) which comprise 58% of the assemblage by weight. The complete SHCs are generally very small, with a mean weight of 206g. Therefore, the assemblage can be interpreted as waste from a blacksmithy producing or repairing iron artefacts from stock iron. The site is therefore close to a 17th-18th century smithy undertaking light repair and fabrication work.

Contents

Methods

All investigated materials were examined visually. Macroscopic and microscopic remains were described and recorded to a database (summarised in Table 1). All the examples of smithing hearth cakes (SHCs) that were complete, or sufficiently complete that the original weight could be estimated, were weighed separately (Tables 2 & 3).

The archaeometallurgical residues were not studied with the use of any high-magnification optical inspection, nor any other form of instrumental analysis. Therefore, the description of materials in this report is limited and must be regarded as provisional.

Results

General nature of the archaeometallurgical residues

The majority of the archaeometallurgical residues were collected from the trench which was curving to the west of the castle (cut 3, F. 28). There was also a very small quantity of materials that were found in two other trenches: cut 1 ext, F4 and cut 2, F63 &F.64.

Trench three yielded a total of 14.5kg of macro-residues of which 58% (by weight) was identifiable as being slag from SHCs, 28% was other forms of smithing slag, 6% was lining slag, 4% was indeterminable objects, and 4% was slagged or vitrified clay. Small quantities of micro-residues, such as hammerscale, coal and very small rusted iron fragments were also found.

Trenches one and two provided a total of 259g of archaeometallurgical residues of which 91% was clinker fragments, 6% was rusty iron objects and 3% coal.

Description of the residues

A variety of archaeometallurgical residues has been found at the site and can be divided into the following classes:

Smithing hearth cakes (SHCs)
The SHCs comprised 8436g (58%) out of the 14.5kg of macro-residues from the F28, and it is likely that much of the 4014g of "other smithing slag" was material from SHCs that was too fragmented to be recognised as such.

Twenty seven SHCs (total weight 5504g) were sufficiently well-preserved to allow measurement or estimation of their original weight. Their size distribution is illustrated in Table 2 and Figure 1. This collection included 23 complete SHCs with a maximum weight of 748g, and a minimum weight of 52g. The average weight of whole or estimatable SHCs from Gorteens was 206g. The weight-frequency statistics for these materials are presented in summary in Table 4.

The SHCs have a variable shape and thickness. In general they can be characterised by being dense. Many of the SHCs show inclusions of small charcoal bits, coal particles and small pebbles attached to their surface. Most of them have the impressions of small charcoal particles on their bases. This suggests that the smith may have used two kinds of fuel (charcoal and coal). Furthermore, many examples show tool marks (probably after tongs). A large proportion of the SHCs of between 200g and 300g are strongly deformed (folded or rolled-up). These kinds of deformations have to be made when slag was hot and, like the SHCs with impressions after tongs, can be linked with hearth clearance.

The SHCs from Gorteens are characterised by bright colour and rusty appearance. These features indicate a heavy weathering of the archaeological materials.

Other smithing slag
The slag lumps, which are too small for certain identification or which are deformed parts of larger slag lumps, are classified as "other smithing slag". These materials comprise about 28% of the overall macro-residue assemblage. They consist of 249 slag particles which weigh 4014g. It is very likely that a large part of these residues is derived from broken SHCs, but other material may be slag formed within the smithing hearth but outside the main SHC.

Lining slag
Lining slag contribute 862g of macro-residues (<7% by weight). It is formed by the collection of 41 small pieces of iron-poor lining slag in deferent shape, weight and thickness. They all are characterized by dark black/green glossy surface with partially-melted white quartz grains and small pebbles.

Lining slags are likely to have been formed from material melting from the tuyère or blowhole area (depending on hearth morphology). Such material normally contributes to the formation of the hearth slag (SHC), but in some situations, particularly where there is only a small loss of iron from workpiece into the hearth, then relatively iron-poor slags may be formed. These may form attached to the ceramic (tuyère or blowhole wall; e.g. as 'tongues', Young 2009a) or may be separate.

Slagged & vitrified ceramic
5% of the macro-residues (594g, 20 pieces) have been identified as slagged and vitrified ceramic. They have variable size, shape and weight (minimum 9g, maximum 204g). They are characterized by fired clay with a dark/green glossy glaze. The glaze coats only one side of the clay fragments and contains relict, sometimes partially-melted, quartz grains and small pebbles inherited from the hearth materials. The colour of the ceramics vary from pale yellowish to dark orange/red.

Clinker
In trenches one and two a small amount of clinker (the partially melted residue from the burning of coal) was found (235g). This collection includes 19 fragments with a maximum weight of 100g and minimum 0.08g. They are characterized by an irregular shape, a glossy maroon surface with partially melted quartz grains and a vesicular texture.

Indeterminable materials
Some objects from Gorteens were not classifiable because of bad preservation caused by weathering. Twenty six rusty fragments of indeterminate slag or iron (595g) constitute 4% of macro-residues from the site. They were characterized by thick crust of rust with attached small sand grains, pebbles and charcoal. Some are weakly magnetic. It was not possible to determine whether the iron fragments are materials associated with the ironworking or unassociated finished artefacts (or fragments of artefacts).

Micro-residues
Small quantities of flake hammerscale (flat sheets of iron oxide formed on the iron surface during forging), spheroidal hammerscale (rounded "drops" of iron oxide formed during welding) and slag flats (flat sheets of slag formed on the surface of the workpiece) were found in the magnetic part of the soil sample (which was otherwise a mixture of fine and coarse sand, small stones, charcoal, small slag fragments and coal). In trenches two and three 22 small rusty iron fragments (15.9 g) were also found. This kind of material is characteristic of deposits created on the smithy floor, especially around the anvil, but may also occur in dumps generated by fine-grained debris swept from the smithy floor.

Interpretation

The described materials from Cut 3 are all certainly from iron-working (blacksmithing). There are no materials in the collection which can be attributed with any other activity (such as iron smelting). The size distribution of SHCs from Gorteens is closer (Table 4) to that of sites interpreted as showing evidence of blacksmithing (e.g. Moyveela, Co. Galway, Young 2009c; Ballykillaboy, Co. Kilkenny, Young 2010) than to those having a significant component of bloomsmithing (e.g. Ballykilmore, Co. Westmeath, Young 2009b). Moreover, the relatively small size of the SHCs and the statistics of their size frequency distribution suggest that only light fabrication and repair tasks were taking place at the site. The size of the SHCs probably exclude large scale forging and welding operations, which would tend to cause larger loss of iron material to the hearth (Young 2009c) and hence larger SHCs.

There is a large amount of fragments of slagged and vitrified ceramic but none of the material permits certain identification of a precise origin within the hearth. The development of substantial and well-formed SHCs indicates sufficient slag formation that the hearth almost certainly had a ceramic tuyère or

blowing-wall. A lack of fragments certainly from tuyères has been noted elsewhere in later post-medieval smithing assemblages (e.g. Mucklagh, Co. Offaly, Young 2008a; Moyveela 3, Co. Galway, Young 2009c). Young (2009c) suggested that it is possible that the light forge work causes less damage to the tuyère so they were thrown-away less often, but it is equally possible that differential patterns of residue disposal may account for the observed lack.

The material contains clear evidence for the employment of coal as well as of charcoal as fuel for the smithing.

The assemblage therefore includes evidence for some of the changes that occur in post-medieval blacksmithing. The small size of the SHCs suggests that the work entailed forging from a fully formed stock iron as raw material (rather than the partially-refined bloomery iron that was the raw material for rural smithies in the medieval period according to Young 2009f). The use of coal as a fuel (at least in part) is a change from earlier practice. The adoption of coal in Gorteens may reflect its coastal location and easy access to imported materials, although an origin for the coal within Co. Kilkenny is also possible. In contrast, the slightly earlier (15th-17th century) smithy at Ballykillaboy, Co. Kilkenny (Young 2010) did not provide any evidence for coal use.

On the other hand, the apparent use of a ceramic tuyère or blowhole is the continuation of earlier practice. In some parts of Britain and Ireland the use of an iron tuyère was well established by the 18th century (e.g. Moxon 1703). Well-formed SHCs at several Irish post-medieval sites suggest that ceramic tuyères continued in use well into the 18th, if not the 19th century, at least in rural areas.

The final aspect of evolving forge technology was the introduction of the waist-level raised hearth. The evidence from Gorteens does not address this particular facet.

The archaeometallurgical materials from trench one and two were insubstantial. These cannot be treated, therefore, as significant evidence for any local metallurgical activity.

Evaluation of potential

Archaeometallurgical materials from Gorteens have the potential to help develop understanding of the process of smithing in the 17th-18th century Ireland.

Later post-medieval smithing slags have been studied less than those of earlier periods and there is a need of investigating them. In particular the evaluation of evidence for the stock iron would aid the determination of the nature of the process of replacement of bloomery iron by wrought iron. Additional understanding of the introduction of coal as smithing fuel is also required.

Whilst the Gorteens assemblage is a useful addition to knowledge, the relatively poor control on the date of the assemblage, the small size of the assemblage and the lack of a direct link between the residue assemblage and any metallurgical features, reduce the potential of the assemblage to assist the major aims of metallurgical research. Further investigation of the assemblage would be unlikely to enhance site interpretation.

Accordingly, no additional analysis is recommended, although the assemblage is sufficiently significant to merit retention in full.

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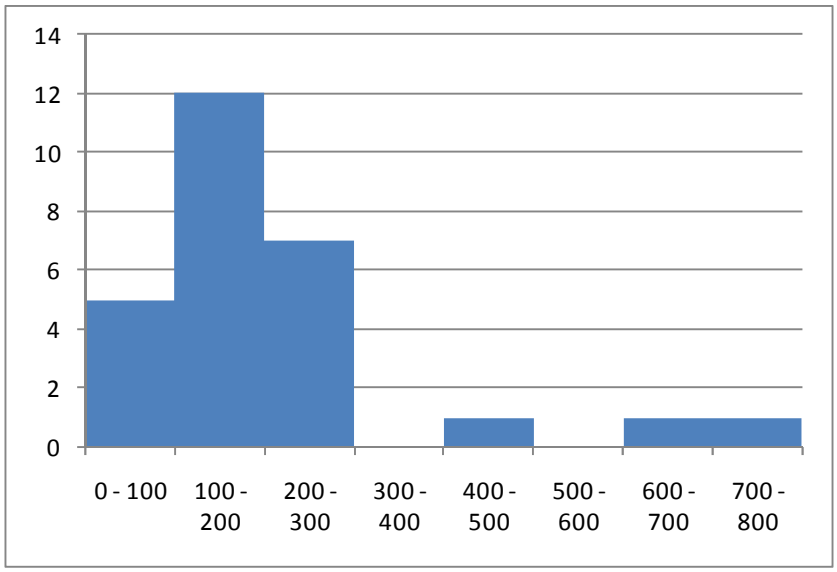

Figure 1. Bar chart of frequency of SHCs per 100g weight intervals.

Table 1. Distribution of archaeometallurgical residues from Gorteens (93E0013)

Context		**material class**										
		macro-residues						**micro-residues**			**total**	
		SHC	*Other smithing slags*	*Indet.*	*Lining slag*	*Clinker*	*Slagged/ vitrified clay*	*Iron*	*Coal*	*Magnetic fines*	*macro-*	*micro-*
cut 3												
F28	*no.*	55	249	26	41		20	2	8	1bag	391	10 + small bag
	wt (g)	8436	4014	595	862		594	6	2	17	14501	25
	% (weight)	58%	28%	4%	6%		4%					
cut 2												
F64	*wt (g)*					226		15	9		226	24
F63	*wt (g)*					6					6	
cut 1												
F4	*wt (g)*					3					3	

Table 2: catalogue of SHCs sufficiently complete for measuring or estimation of original weight. Estimated weights given in parenthesis)

context	sample nr	wt (g)	description
cut 3, F.28, 413	GO05 0	748	plano-convex irregularly oval-shaped SHC. 130 x 115 x 45mm. Rusty and rough surface. Lining slag (probably from the tuyère), glossy black, with melted quartz grains, on upper surface.
cut 3, F.28, 413	GO05 1	416	plano-convex, irregularly oval-shaped SHC. 105 x 105 x 45mm. Rusty and porous surface, large charcoal marks on the top surface, the bottom surface with small charcoal marks and attached pebbles; weakly magnetic,
cut 3, F.28, 413	GO05 3	550 (611)	part (90%)of folded SHC. 115 x (95) x 65mm. Rusty, porous surface with charcoal prints, marks after tongs and attached pieces of hearth lining. Vesicular structure visible on breaks.
cut 3, F.28, 413	GO05 5	254	elongated oval-shaped, plano-convex SHC. 130 x 50 x 45mm. Top surface is very rough compare to the bottom one. Both sides are rusty with attached very small charcoal pieces and charcoal prints.
cut 3, F.28, 413	GO05 6	232	irregularly triangular-shaped, plano-convex SHC. 104 x 80 x 45mm. Rusty surface with charcoal prints on bottom, rough top side with marks after tongs.
cut 3, F.28, 413	GO05 7	224	irregularly triangular-shaped, plano-convex SHC. 90 x 85 x 40mm. Rough rusty surface with charcoal prints, enclosed stones and very small coal pieces. Probable marks after tongs.
cut 3, F.28, 413	GO05 8	194	irregularly triangular-shaped SHC. 90 x 70 x 45mm. Rusty, very rough surface with marks after charcoal, amalgamated stones and charcoal.
cut 3, F.28, 413	GO05 9	220	irregularly triangular-shaped SHC. 90 x 65 x 60mm. Very rough, rusty surface with charcoal prints and marks after tongs.
cut 3, F.28, 413	GO05 10	204	plano-convex, irregularly oval-shaped SHC. 90 x 50 x 60mm. Rusty rough surface with charcoal and tong marks.
cut 3, F.28, 413	GO05 11	152	elongated oval-shaped, plano-convex SHC. 95 x 65 x 35mm. Both surface rusty and rough with attached very small charcoal and stone pieces. Both have got marks after charcoal.
cut 3, F.28, 413	GO05 12	186	irregularly oval-shaped SHC. 75 x 70 x 45mm. Rusty and rough surface with small stones and charcoal bits attached to it. Top has marks after tongs.
cut 3, F.28, 413	GO05 13	134	irregularly oval-shaped SHC. 75 x 70 x 45mm. Rusty and rough surface with charcoal prints and small stones and attached charcoal fragments.
cut 3, F.28, 413	GO05 14	118	plano-convex, irregular oval SHC. 75 x 70 x 40mm. Rusty surface with charcoal and small stones attached to it.
cut 3, F.28, 413	GO05 15	234 (293)	Incomplete (80%) SHC. 80 x (65) x 40mm. Rusty surface with charcoal imprints and small fragments of charcoal and pebbles attached to the side. locally maroon.
cut 3, F.28, 413	GO05 16	146	plano-convex irregularly shaped SHC. 85 x 75 x 30mm. Rusty surface with charcoal prints and attached pebbles.
cut 3, F.28, 413	GO05 17	182 (192)	part of (95%) plano-convex SHC. 75 x (70) x 40mm. Rusty, rough surface with marks after charcoal and attached small fragments of charcoal.
cut 3, F.28, 413	GO05 18	110	plano-convex irregularly oval-shaped SHC. 80 x 70 x 30mm. Rusty and rough surface with charcoal prints. Top partially covered by black glossy lining slag.
cut 3, F.28, 413	GO05 19	140	plano-convex irregularly oval-shaped SHC. 70 x 55 x 35mm. Rusty surface with attached small bits of charcoal, pebbles and coal.
cut 3, F.28, 413	GO05 20	128	plano-convex irregularly oval-shaped SHC. 75 x 60 x 35mm. Rusty and rough surface with charcoal prints and attached small pebbles and charcoal bits.
cut 3, F.28, 413	GO05 21	162	Irregularly- shaped SHC. 80 x 65 x 40mm. Rusty and rough surface with charcoal prints and marks after tongs.
cut 3, F.28, 413	GO05 22	130	plano-convex oval-shaped SHC. 70 x 65 x 35mm. Rusty and rough surface with marks after charcoal. To both sides are attached small fragments of charcoal and pebbles.
cut 3, F.28, 413	GO05 23	204	plano-convex irregularly triangular-shape SHC. 110 x 80 x 35mm. Rusty very rough surface. Top partially covered by glossy black slag with melted quartz grains and attached small pebbles.
cut 3, F.28, 413	GO05 24	68 (74)	Incomplete (95%) plano-convex oval-shape SHC. 75 x 45 x 30mm. Rusty surface with attached particles of charcoal, coal and pebbles. Internally low density and porous.
cut 3, F.28, 413	GO05 25	74	plano-convex oval-shaped SHC. 65 x 55 x 30mm. Rusty surface with charcoal prints and amalgamated in pebbles and charcoal.
cut 3, F.28, 413	GO05 26	82	plano-convex oval-shaped SHC. 55 x 40 x 25mm. Rusty surface with charcoal marks and with small fragments of charcoal and pebbles attached to it. Some parts of the top have black/green glossy lining slag.
cut 3, F.28, 413	GO05 27	52	plano-convex oval-shape SHC. 60 x 45 x 25mm. Very rusty surface with some charcoal fragments.
cut 3, F.28, 414	GO05 28	76	plano-convex oval-shaped SHC. 60 x 45 x 35mm. Rusty surface with charcoal prints and small charcoal fragments attached to the bottom.

Table 3: catalogue of partial SHCs

context	sample nr	wt (g)	Description
cut 3, F.28, 414	GO05 29	190	part of plano-convex SHC. 84 x 53 x 54mm. Rough surface with attached charcoal, stones and fragments of furnace lining. Internally dense slag with large crystals.
cut 3, F.28, 414	GO05 30	158	part of plano-convex SHC. 80 x 70 x 55mm. Rusty and porous surface. Base has charcoal prints and hearth lining. Internally porous slag with visible crystals.
cut 3, F.28, 414	GO05 31	124	plano-convex oval-shaped SHC. 70 x 65 x 40mm. Rusty and rough surface with attached small fragments of charcoal and pebbles and charcoal prints.
cut 3, F.28, 413	GO05 2	424	part of folded SHC. 110 x (90) x 55mm. Rusty, porous surface with charcoal prints, marks probably after tongs and attached pieces of hearth lining. Internally shows layer of fired clay attached to the black glossy lining slag with melted white quartz/chert grains.
cut 3, F.28, 413	GO05 4	424	part of irregular oval, plano-convex SHC. 110 x (100) x 50mm. Rough, rusty surface with small fragments of coal and charcoal, base shows small marks after charcoal. The broken edges reveal a dense slag structure.
cut 3, F.28, 413	GO05 32	3016	23 parts of SHC. Deferent size and shape. Rough and rusty surface with attached small fragments of charcoal, pebbles and sometimes coal.

Table 4. Comparison of the Gorteens SHC assemblage with other Irish medieval and post-medieval smithing SHC assemblages.
Coolamurry (Young 2008b), Garryleagh (Young 2009d). Ballykilmore (Young 2009b), Ballykillaboy (Young 2010), Moyveela (Young 2009c), Mucklagh (Young 2008a).

	Coolamurry Co. Wexford	Garryleagh Co. Cork	Ballykilmore Co. Westmeath	Ballykillaboy Co. Kilkenny	Gorteens Co. Kilkenny	Moyveela Co. Galway	Mucklagh Co. Offaly
Date	12th-13th	13th-14th	14th-18th	15th-17th	17th-18th	Post-medieval	18th/19th?
SHC count	41	25	43	113	27	15	66
SHC min. wt	62	84	80	50	52	44	98
SHC max. wt	2588	802	4033	478	748	388	1206
SHC mean wt	386	331	898	139	206	134	373
%<500g	83%	76%	51%	100%	93%	100%	77%
%<1000g	95%	100%	74%	0%	100%	0%	95%
%>1000g	5%	0%	26%	0%	0%	0%	5%
%>3000g	0%	0%	7%	0%	0%	0%	0%

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