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Assessment of archaeometallurgical residues from Newtonmountkennedy, Co. Wicklow (14E0132)

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Abstract

The assemblage comprised approximately 15.6kg of 'lump' material. The 'lump' material included some residues that were largely free of matrix, but most was formed of iron-rich concretion (ferricrete) of the type that is sometimes referred to as 'smithing floor'. Such ferricretes do not necessarily form on the smithy floor, but may also form in other accumulations of iron-rich smithing waste. Much of the secondary iron minerals that bind the original sediment will have been formed from the corrosion of small metallic iron fragments. The ferricretes comprise macroscopic slags, iron lumps, smithing microresidues, charcoal with some natural sediment (pebbles, sand and silt). The concretionary material also overgrew organic material present in the deposit and there is some very good mouldic preservation (including an ear of cereal).

Most of the lump material was thoroughly scrubbed to improve the identifiability of the macroresidues and the washings from this, together with the fine 'dust' present in the sample bags, was processed for microresidues (by wet sieving and magnetic separation). Approximately 1kg of fine-grained (<10mm) magnetic material was separated. Much of this was microresidues, dominantly flake hammerscale. After cleaning 8.9kg of the assemblage were identifiable macroresidue pieces and 6.7kg remained as fragments of concretion.

The residues were from ironworking (smithing). The macroresidues were dominated by smithing hearth cakes (SHCs), including both complete and fragmentary examples. These were identified with confidence for nine examples weighing 116g to 408g and with a lower degree of confidence for six less well-formed examples ranging from 58g to 156g.

Alongside the dense iron slag, were 0.9kg of slagged and vitrified hearth ceramic, together with a further 1.4kg of low-density slag derived mainly from the ceramic. Several of the pieces of technical ceramic showed a convex surface, which in at least one case included a transition from a vitrified to non-vitrified nature. Although there are no completely unambiguous pieces, such forms are typical of the ceramic tuyères, which were employed for smithing in Ireland from the early Christian period (5th-6th century AD) until, at least locally, well into the post-medieval (18th century?).

The relatively small size of the SHCs would be compatible either with a date in the Iron Age, or from the later medieval onwards; most assemblages form the 5th to 13th centuries (and locally later) contain at least a proportion of much larger SHCs. It would appear likely that most smithing in the Iron Age produced small SHCs, but from the early medieval period onwards small SHCs are related to the end use of iron (blacksmithing) rather than from the working of raw iron to produce useable bar iron (bloomsmithing). The probable tuyère material would favour a medieval age, a period in which SHCs from blacksmithing became smaller, probably because of the trade in finished iron, rather than part-refined bloom fragments. A date in the medieval period would also be favoured by the provisional identification as Leinster Cooking Ware of two sherds of pottery recovered from amongst the slag assemblage of c14.

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Methods

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

Most of the macroscopic lumps (those with a clear residue core) were given a further aggressive cleaning with a toothbrush to clarify the nature of the underlying residue fragments. Sine there were no deliberately-taken samples to test for microresidues, the washings derived from this process and the 'dust' from the sample bags were sieved at 100µm and separated magnetically.

The examined materials are listed in Table 1. This assessment was conducted in August 2017.

This project was commissioned by Paul Duffy of IAC.

Results

Description of materials

Concretionary material
A very large proportion of the submitted material, particularly that from the fills of Pit [12] comprised fragments of the type of ferricrete commonly known as smithing floor. These concretionary masses contained macroscopic slags, microresidues, charcoal fragments and the moulds of other vegetation in a matrix of sandy silt with occasional small pebbles and an iron oxide cement. The organic moulds included straw (in one case with an ear of cereal) and woody material.

Some of the concretionary masses showed sedimentary layering, suggesting the fills of the features were not emplaced during single events.

Although the amount of concretionary material was most in the fills of Pit [12], the other contexts showed somewhat similar materials to varying extents.

Smithing hearth cakes
The macroresidues were dominated by smithing hearth cakes (SHCs), including both complete and fragmentary examples. These were identified with confidence for nine examples weighing 116g to 408g and with a lower degree of confidence for six less well-formed examples ranging from 58g to 156g. The total weight of SHC fragments amounted to 54% of the identifiable residue fragments by weight.

There were nine complete conventional dense SHCs. These were small, with a weight range of 116g to 408g (mean 242g). They showed a range of morphology, with varieties with charcoal moulds on the upper surface, with a glassy veneer on the top, and with a smooth haematised top.

The smaller probable SHCs are formed of low-density, strongly ceramic-influenced material in a lobate morphology. Whether these should be termed SHCs in a strict sense is debateable, so the weight frequency data have been quoted on Tables 3 and 4 both with (in parenthesis) and without these low-density examples. Inclusion of these low-density examples in the statistics, gives a weight range of 58g to 408g (mean 185g).

The complete SHCs totalled 2180g (2740g with the inclusion of low-density examples), with a further 2kg of identifiable fragmentary examples.

Other dense slag
The 1.3kg of material assigned to this category in Table 2 includes material that did not show the characteristic morphology of SHCs. This may be because the fragment was not sufficiently large to display such features, or because the slag showed a different morphology. Many of these pieces are blebby, slightly flowed, slags forming either crude blebby prills or rounded lumps.

Lining slag
There were 1.4kg of slags classified here as 'lining slags'. These are materials that are mostly partially melted hearth ceramic, fluxed by the addition of some iron from hearth contents. Many of these pieces would have been directly associated with the hearth ceramic as down-wall flows (see discussion below of what 'wall' might mean in this context), but others are blebby material that probably cooled in the hearth away from the wall, either as a result of flow, or as a result of physical disturbance (e.g. by the smith removing slag flows from the blowhole).

In some instances, the input of iron into the hearth was sufficiently low that the formation of slag cakes in front of the blowhole was restricted to material of a 'lining slag' composition, rather than the more iron-rich compositions that form more fluid slags capable of

generating the classic SHC. Accordingly, many of the small, problematic possible SHCs are formed of lobate lining slags.

Hearth ceramic
The assemblage included approximately 900g of hearth ceramic, mostly deeply vitrified and slagged. The identification of this material is slightly problematic, for although there are many pieces with a curved, convex, vitrified surface, there are no pieces that are unambiguously from tuyères. However, equivalently, there are no pieces that are certainly not from a tuyère.

The curved pieces include two distinct fabrics: one a gritty clay, with many examples and secondly a few pieces with an organic temper and no grit. This latter fabric occurred in material that mostly did not show slagging – although this may simply be coincidental.

Microresidues
The magnetically-separated microresidues were dominated by flake hammerscale (the oxidised surface layer that forms on hot iron, which becomes detached for thermal reasons or during hammering). There was a low proportion of spheroidal hammerscale (the oxidised surface layer that has become molten and is 'splashed' during hammering and particularly the closure of forge welds). There were a moderate number of larger spheroids (2-5mm diameter), but it was unclear what proportion of these were larger examples of spheroidal hammerscale and what were simply slag droplets. There appeared to be few, if any, examples of slag flats.

The separates were also contained dimpled slag spheroids (sometimes called 'coffee bean spheroids'), which may be products of slag dripping through the fuel bed of the hearth.

Distribution of materials

The features producing the residues were primarily Pit [9] (0.60m x 0.55m x 0.21m deep) and Pit [12] (1.0m x 0.76m x 0.28m deep). Small quantities were derived from stakeholes [22] and [26], a spread overlying some of the features (16) and a pit in separate section of the site approximately 30m from the main cluster [174].

Another burnt feature in the same area of the site as the main cluster was Pit [6] (1.21m x 1.53m x 0.34m deep), which yielded no slag.

Within Pits [9] and [12] the residue-rich fills overlay charcoal-rich materials (contexts (11) and (15) respectively). The charcoal-bearing basal deposits are likely to represent the 'use' contexts of the features and the residue-rich fills 'disuse' contexts

Interpretation

The residues clearly indicate an assemblage produced during the smithing of iron. The combination of the possible Leinster Cooking Ware, the probable tuyère fragments and the small size of the SHCs together suggest a potential date for the assemblage of approximately 12th - 14th century. At this date, small SHCs would indicate that the site was used for blacksmithing (the end use of iron for making or repairing artefacts).

An interpretation of the use of the features for blacksmithing would also be supported by the microresidue assemblage. This was dominated by flake hammerscale, with a low proportion of spheroidal hammerscale, suggesting the lower temperature processes dominated, rather than than tasks employing much forge welding.

The associated burnt cut features are not dissimilar to those of other sites of the 12th - 14th century. Two of the features contained significant residue assemblages: Pit [9] (0.60m x 0.55m x 0.21m deep) and Pit [12] (0.60m x 0.55m x 0.21m deep). In Ireland, smithing hearths of this period are mostly approximately equant, although some are elongate, typically with a long-axis of approximately 1m and a short axis just slightly less (e.g. Cornamucklagh: 11th- 13th century, 0.82m by 0.54m and 0.99m by 0.21m, Young 2014a; Coolamurry, 12th-13th century, 1.0m by 0.9m, 0.92m by 0.82m and 1.2m by 0.8m, Young 2008, McCullough & Young in review; Garryleagh: 13th – 14th century, 0.90m by 0.87m, Young 2009b; Aghavea: 1.1m and 0.8m diameter, Young 2014b). Pit [12] corresponds closely with the dimensions of these comparative examples, with Pit [9] being only slightly smaller.

In Britain, hearths of this age are known from NW Wales at Hen Gastell (Kenney 2017; Young 2016) and Porth Trafadog (Longney 1991); both sites are dated to the 11th – 12th centuries. The hearth at Hen Gastell was small and sub-circular, 0.47 x 0.40m and 0.20m deep. An adjacent, slightly larger, pit was interpreted as the location of an anvil base. The features lay within the footprint of a post-built building occupying much of the interior of the defended site. The probable smithing hearths at Porth Trafadog were variably of 0.30m up to 1.0m diameter.

The SHC assemblage from Newtonmountkennedy is very small for detailed comparison with those of other sites, but broad comparison may be made (Tables 3 and 4).

In Ireland (Table 3), locations with both iron smelting and smithing produce assemblages with many large SHCs from the refining of the raw blooms (e.g. Table 3, assemblages from Gortnahown and Ballykilmore; Young 2009b, 2012). Purely blacksmithing assemblages of early medieval age usually also include examples of large SHCs that have similarly been implicated in the *chaîne operatoire* of iron production (e.g. Table 3, assemblages from Blackchurch, Young & Kearns 2010a and Ballyellin, Young & Kearns 2010a). This implies that blacksmithing sites were undertaking some of the final processing of the iron, perhaps because iron was distributed at this period in the form of part-processed iron (like the 'cloder' of Denmark; Pleiner 2000). Such assemblages therefore have a high mean SHC weight, such as seen in the assemblages from Blackchurch. Large SHCs continue to be found on later medieval sites wherever there was a close association with smelting, but increasingly blacksmithing residues do not include the largest examples (e.g. Table 3, assemblages from Garryleagh, Young 2009b; Aghavea, Young 2014b; Gorteens, Dabal & Young 2011; Ballykillaboy, Young 2010). This trend has been attributed (Young 2009b) to the increasing distribution of stock iron in fully processed form.

11th and 12th century SHC assemblages from Britain show a broadly similar weight-frequency distribution (Table 4). The British examples differ from the Irish in the use of a blowhole through a simple clay wall, rather than that of the cermaic tuyère that dominated Irish

ironworking from the 6th century onwards. The similarity in residues despite this technological difference is, however, striking and may suggest the change in Irish iron distribution may have an association with Anglo-Norman influence. This influence may have effected change in distribution networks and perhaps in the social context of blacksmithing, even if it did not change the style of hearth construction employed by blacksmiths.

If, on the other hand, the initially-proposed prehistoric (Iron Age) date were to be verified, then the assemblage would be largely without parallel. Although numerous Iron Age iron smelting sites have been located in recent years, there remains no significant, described SHC assemblage.

Further work

Further archaeometallurgical work on the smithing residues could be undertaken to investigate further the types of iron being worked. Suites of associated macro- and micro-residues in association with evidence for the form of the hearth and its ventilation are also potentially valuable to enhance the broader understanding of early ironworking process.

The potential of the current assemblage to be provide enhanced understanding of both the site and of the process may be slightly lessened by the stat of preservation. Both macro- and micro-residues appear from visual inspection to have suffered some degree of corrosion, so it is uncertain at the current state of knowledge whether the fine scale of observation and analysis required might be compromised.

In the event that site proves to be prehistoric, then it is recommended that a full programme of scientific investigation of the residues is undertaken, to fill the complete lack of such work in the Irish Iron Age. If the material proves, as is currently anticipated, to be medieval, then it is rather less unusual. Analysis would still be valuable, but a balance would need to be struck between the cost of such investigation and the uncertainty over the quality of the preservation of the residues.

It is recommended that any decision over further investigation should be reviewed once the scientific dating evidence is available.

Whatever the date of the assemblage, this is an important collection and worthy of full deposition with the site archive.

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Glossary

Blacksmithing: the working of iron and steel. Often restricted to the secondary smithing – i.e. the smithing of iron to produce or repair artefacts, as opposed to the smithing involved in the production of billets or bar iron from raw iron blooms.

Bleb: a small rounded particle or textural component, often a droplet or prill.

Bloomery: a furnace for smelting iron from ore in which iron is produced as a solid material. The bloomery process was employed mainly prior to the introduction of the later blast furnace from the late 15th century.

Bloomsmithing: The process of reworking a raw bloom, through repeated reheating and hammering, to reduce its content of slag, to remove unwanted inclusions and to draw out the remaining slag into elongate inclusions. The end product may be a bar or billet. Usually taken as an alternative term for bloom-refining.

Blowhole: A hole through a furnace or hearth wall through which air is blown.

Burr: the zone of interaction between slag and the hearth or furnace wall just below the tuyère/blowhole. Typically seen as a dense lunate slag, with attached highly indurated ceramic, forming a protuberance on the margin of an SHC or FB.

Flake hammerscale (FHS): flake-like particles formed by the surficial oxidation of hot iron in air (Young 2011c). The iron oxide layer will detach from the workpiece because of differential thermal contraction or during deformation of the workpiece when hot-worked at the anvil. The thin scales fall from the workpiece and will accumulate mainly close to the anvil (although some will be lost elsewhere in the forge and even in the hearth). Flake hammerscale has planar surfaces, one of which is typically very smooth and reflective, the other only slightly less so.

Forge welding: the joining of two pieces of metal into one by hammering together at just below the metal's melting temperature. Since forge welds require close contact between the metal surfaces, any oxidised surface scale layer on the metal must be removed – usually by heating to make it molten so it will be squeezed out on closure of the join (sometimes with the additional use of a flux, such as quartz sand, to lower the melting point of the scale). The expelled molten scale will chill in flight to form spheroidal hammerscale.

Lining Slag: Slag formed from the complete or partial melting of hearth or furnace lining.

Prill: a small aggregate of a material, either a spheroidal droplet or a runnel, formed from a melted liquid and either occurring as a discrete particle or as an inclusion within another material.

Slag flat: a small slag body that has been in contact with a planar surface, usually the surface of the work piece. They are usually broadly tabular, although the external surface may be very gently convex. Slag flats may be produced during the working of slag-rich bloom, or may be produced by slag adhering to the surface of the metal workpiece, or may even be formed from the deliberate addition of a ceramic coating to the outside of the workpiece for metallurgical reasons.

Slag spheroids: sub-spheroidal particles, often dimpled (coffee bean spheroids), dull in lustre, and less perfectly spherical the spheroidal hammerscale. These spheroids are typically up to about 10mm in diameter. These are mainly slag droplets formed by the dripping of slag within the fuel bed of the hearth. Isolated spheroids may form in non slag-tapping smelting furnaces as a variety of sparse flow slag, but are more common in smithing hearths.

Smithing: the activity involved in forming a metal object, including, but not limited to, forging metal and joining metal by welding.

Smithing floor: a form of ferricrete comprising residues from smithing (macro- and micro-) together with fuel, substrate and other materials, typically cemented after deposition by iron oxides derived from the weathering of iron inclusions or of iron-rich slags. Such deposits may form on smithy floors (hence the name), but may equally be generated in waste pits, slag-dumps and other cut features.

Smithing hearth cake (SHC): the slag cake formed in a smithing hearth by reaction of iron oxides lost from the workpiece with silicate material from hearth ceramic and/or fuel, below and in front of the tuyère/blowhole. They are very variable in form, but are typically plano-convex in shape (although concavo-convex and biconvex forms are common), frequently with a dense lower crust and a less well consolidated upper part. In some cases the top is formed of glassy slag.

Spheroidal hammerscale: tiny (typically <2mm) particles of air-chilled spatter formed by the expulsion of molten scale from a forge weld.

Tuyère: a tubular structure of ceramic or metal to convey the blast from the bellows into a hearth or furnace.

Vesicle: a void or pore, usually rounded and formed as a preserved gas bubble in a solidified melt.

Table 1: Summary catalogue of material. Abbreviations used: Assm. = assemblage, SHC = smithing hearth cake. Weights in g.

C	S	s wt.	item wt.	item no.	notes
10	3	4000	252	1	dense, neat SHC with small amount of adhering concretion; 80x95x35mm; plano-convex; surface details not well seen; accretion includes cereal ear
			260	1	dense neat SHC with dished, very smooth, haematised top; 65x100x35mm; base microdimpled
			282	1	SHC with some adhering concretion obscuring top; both top and base appear to have charcoal moulds; 75x100x40mm; plano-convex
			132	1	part of small dense SHC
			208	1	most of small SHC; has smooth haematised proximal area, from which outer parts incline outwards gently; base very irregular - possibly because of multiple tool-marks; 75x90x35mm; approximately plano-convex
			120	1	irregular lobate mass of slag; mostly lining-influenced; smooth surface to upper lobes; possibly an irregular small SHC
			212	1	majority of medium sized SHC; base with strong tool marks; top obscured by accretion but may be thin glassy veneer
			300	1	concretion holding central section of probable large SHC with distinct basal crust
			164	2	concretion fragments and stones
			394	11	SHC fragments
			228	9	blebby dense iron slag fragments
			450	70	lining slag fragments
			12	4	indeterminate slag scraps
			84	1	block of oxidised-fired lining with convex outer face; just possibly a tuyère fragment, but not certain,
			60	1	block of oxidised-fired lining with convex outer face and descending slag sheet falling over undercut area; just possibly a tuyère fragment, but not certain,
			76	1	fragment of dense slag attached to gritty purplish ceramic
			130	1	block of oxidised fired lining with attached variable slags, probably proximal attachment of SHC
			140	Assm.	fine washings - non-magnetic: grit, sand, mica, charcoal, burnt clay, hard peds
			24	Assm.	fine washings - magnetic: fired clay, hard peds, slag debris, charcoal, trace of flake hammerscale
			226	Assm.	coarse washings - (not divided): mostly stone, lining slag and fired clay
13?		3280	842	Assm.	fragments of concretion not further washed
			408	1	well-formed SHC; 115x95x60(40)mm; dense SHC with plano-convex form; slightly lobate base and dimpled top, overlain by raised proximal zone of lining-dominated slag
			278	5	SHC fragments

C	S	s wt.	item wt.	item no.	notes
			82	3	concretions
			446	20	rounded slag lumps and fragments
			110	1	block of vitrified oxidised lining - possibly but not certainly tuyère margin
			68	2	curved pieces of vitrified lining
			40	4	fragments of vitrified lining, with oxidised ceramic
			178	1	contact of very dense SHC and wall; broken in 2
			38	1	puck of 45x45x20mm; dark lining slag; incipient SHC?
			78	Assm.	coarse washings - magnetic: very rich in hammerscale
			216	Assm.	coarse washings - non-magnetic: sand, fired clay, some slag debris
			90	Assm.	fine washings - magnetic: very rich in hammerscale
			92	Assm.	fine washings - non-magnetic: sand, fired clay, some slag debris
14	7	12779	234	1	dense SHC; 80x90x35mm; plano-convex; top with rusted accretion containing plant remains, several small hollows forming crude horseshoe shape; base has fine grit, slight dimples; a few slight pendent lobes on proximal margin; some small charcoal inclusions on base; probably more strongly prilly under the accretion then is apparent
			152	1	crudely plano-convex mass of gravelly lining slags; stone fragments to 20mm; glassy material very dark; grey with dimples on base, black glassy, with local maroon bloom on top
			46	1	irregularly prilly dark mass of gritty lining slag, base dimpled and lobate, top dark and very glassy
			94	1	porous mass of dense slag; prilly; probably a fragment of prilly SHC
			156	1	prilly mass of dense slag, partly encrusted in scale-rich inclusion; crudely plano-convex mass; top slightly dished but has various raised lobes; surface is glassy, lobes more crystalline; possibly a crude SHC
			142	1	heavily accreted lump of prilly dense slag; probably part/all of SHC
			156	1	curved sheet of dense slag with some overlying lobes; possibly an SHC equivalent; 65x80x35mm; base finely dimpled
			30	1	small puck of gritty lining slag; base with deep fuel dimples; top darker smooth, glassy
			98	1	elongate block of dense slag; slightly flow lobes; slightly maroon top; base dimpled; possibly SHC, but unusual top if so
			90	1	small porous plano convex mass, 40x65x30mm; with abundant medium sized charcoal; possibly tiny SHC; partially encrusted in scale-rich accretion
			116	1	55x70x35mm, small SHC; slightly gravelly/gritty somewhat prilly base; moderate hollows on upper surface
			84	1	irregular triangular pad of lining slag; greenish, gritty; base sediment-rich with medium charcoal moulds

C	S	s wt.	item wt.	item no.	notes
			80	1	tiny dense SHC, with large gravel piece embedded in top; plano-convex base; 70x65x20mm; gravel piece is 20mm diameter; SHC has slightly dimpled base; stone has green glaze
			70	1	irregular angular fragment of coalesced sheets; finely dimpled base; most/all of small open SHC, 50x65x40mm
			58	1	45x55x35mm, rounded SHC; dimpled lobate base; irregular slightly glassy top; texture suggests it may be internally gravelly
			66	1	slightly irregular small mass; grey slightly dimpled uneven base; top wispy and irregular; with gravelly/gritty material in black glass; 45x70x35mm; approximately plano-convex
			52	1	irregular slag nub; dense slag on one face; gritty glass on the other
			558	49	fragments and blebs of gritty/gravelly dark lining slag
			210	11	stones
			422	20	blebs and fragments, often prilly, of denser dark iron slag
			48	2	fragments from margins of dense SHCs, dense iron slag with concave tops, no vesicles and rough bases
			90	1	prilly lining slag within large lump of accretion
			38	3	slagged/glazed pebbles
			4545	Assm.	concretionary lumps without clear slag core or major content
			692	10	concretionary lumps containing larger dense iron slag pieces
			50	1	concretion cored on iron fragment
			84	1	plano-convex concretion suggestive of small SHC, coarse charcoal moulds visible on its planar surface
			222	1	planar concretion on dense slag, possibly a complete SHC
			156	1	plano-convex concretion, possibly cored on small SHC
			104	1	gravelly concretion possibly cored on small SHC
			136	1	very dense concretion, iron core
			108	1	concretion on what may be 2-layer SHC fragment, prominent dished grey glassy top; charcoal-bearing iron slag on lower leaf
			234	1	concretion bearing large fragment of SHC, seen in section
			30	1	small prilly slag flow containing cuboidal stone piece
			40	1	exploded slag fragment, contains iron piece, now fractured into three
			186	14	vitrified lining with oxidised ceramic to rear
			270	1	80x110x45mm lining-rich SHC; essentially a burr attached to some lining slag and wall; rather irregular in form
			36	1	sub-conical section of 'hood' above angular-sided blowhole (dimensions not determinable); dark glass on oxidised ceramic
			44	1	two conjoining pieces of curved gritty grey ceramic, with green glaze and rust appearing obliquely across face; possible margin of tuyère
			10	1	sherd of grey gritty ceramic identical to item above, but no vitrification
			32	1	curved piece of oxidised ceramic with slightly reduced surface and abundant visible organic temper (possible tuyère, but in a different fabric to items above)
			24	3	small fragments of orange oxidised ceramic with possible organic temper

C	S	s wt.	item wt.	item no.	notes
			24	9	small scraps of lining slag or vitrified layer without ceramic backing
			82	2	concretions with prominent fragments of vitrified lining, but also containing other dense slags
			484	Assm.	fine washings - magnetic: fine amorphous debris plus abundant fine flake hammerscale, rare spheroidal hammerscale
			330	Assm.	fine washings - non-magnetic: fired clay, mineral debris, very rare pale slag droplets
			390	Assm.	coarse washings - magnetic: abundant coarse flake hammerscale, slag droplets/spheroids, plus some other debris
			368	Assm.	coarse washings - non-magnetic: stone, lining slag, fired clay
16	9	94	28	1	gravelly concretion
			56	1	fragment from small dense SHC
			10	1	blebby flowed slag
17	16	194	150	1	dense slag puck; 60x65x35mm; gravelly lining slag attached; probably below main SHC, but way up not entirely certain; overall height 60mm
			24	5	blebby lining slags
			20	2	dense slag in flattened lump
23	13	56	56	2	blebby dense slag lumps
27	15	20	10	1	fragmented bleb of sandy lining slag
			8	1	dense greenish grey slag bleb impressed over fuel
			2	1	iron-rich concretionary material, on maroon-surfaced slag lobe fragment
175	56	280	60	1	maroon-topped, partially flowed slag mass; glassy and sandy on margins, denser in centre
			76	9	denser slags with some signs of flow
			52	9	concretionary material, stones, charcoal and organic moulds and iron, but no scale seen
			42	5	dense slags with a sintery appearance
			50	15	lining slag fragments

Table 2: summary of weight of macroscopic residue classes by context. Abbreviations: SHC = smithing hearth cake. Weights in g.

C	S	Context notes	SHC	other dense slag	lining slag	indet. slag	lining	other concretions	*total*
10	3	Upper fill of Pit [9] (0.60m x 0.55m x 0.21m)	2160	228	450	12	350	164	*3364*
13?		Upper fill of Pit [12] (1.00m x 0.76m x 0.21m)	902			446	218	82	*1648*
14	7	Lower fill of Pit [12] (1.00m x 0.76m x 0.28m)	1514	836	870	0	356	6413	*9989*
16	9	Spread	56	10				28	*94*
17	16	Fill of cut [21]	150	20	24				*194*
23	13	Fill of stakehole [22] (0.12m x 0.10m x 0.11m)		56					*56*
27	15	Fill of stakehole [26] (0.09m x 0.08m x 0.13m)		8	10			2	*20*
175	56	Fill of pit [174]		178	50			52	*280*
		total	*4782*	*1336*	*1404*	*458*	*924*	*6741*	*15645*

Table 3: Summary statistics for SHC weight, compared with those for assemblages from selected other relevant Irish sites.

Site	Ballykillaboy	Gorteens	Newtonmount-Kennedy	Garryleagh	Clonmacnoise	Coolamurry	Aghavea	Gortnahown 2	Blackchurch 48	Ballyellin 1	Ballykilmore 6
County	Kilkenny	Kilkenny	Wexford	Cork	Offaly	Wexford	Fermanagh	Cork	Kildare	Wexford	Westmeath
Age	16th-17th	17th-18th		13th-14th	medieval	12th-13th	e-med/med	e-med	7th-9th	9th-10th	e-med/med
minimum	50	52	116 (58)	84	68	62	8	78	108	143	80
maximum	478	748	408	802	1457	2588	1335	3450	2450	1525	4033
% <500g	100%	93%	100%	76%	79%	80%	79%	68%	53%	33%	52%
% <850g	100%	100%	0%	100%	94%	93%	79%	87%	80%	67%	71%
% >1kg	0%	0%	0%	0%	6%	5%	11%	8%	19%	24%	24%
% >3kg	0%	0%	0%	0%	0%	0%	0%	2%	0%	0%	7%
mean	134	206	242 (183)	316	341	386	403	498	629	684	887
count	106	27	9 (15)	25	33	41	38	98	70	33	42
smelting?	no	no	no	no	no	no		yes	no	no	yes
Ref.	Young 2010	Dabal & Young 2011	This report	Young 2009b	Author's unpub. data	Young 2008a & McCullough & Young in review	Young 2014b	Young 2009b	Young. & Kearns 2010a	Young. & Kearns 2010b	Young 2012

Table 4: Summary statistics for SHC weight, compared with those for assemblages from other relevant British sites.

Site	Worcester 35 Mill St.	Newtonmount-Kennedy	Hen Gastell	Tidworth	Worcester Willow St
County	Worcs.	Wexford	Gwynedd	Wiltshire	Worcs.
Age	12th		11th-12th	Saxo-Normanl	12thl
minimum	74	116 (58)	72	80	86
maximum	782	408	1000	680	770
% <500g	91%	100%	86%	75%	82%
% <850g	100%	100%	86%	100%	100%
% >1kg	0%	0%	0%	6%	0%
% >3kg	0%	0%	0%	0%	0%
mean	233	242 (183)	260	341	327
count	23	9 (15)	7	12	28
smelting?	no	no	no	no	no
Ref.	Young 2009a.	This report	Young 2016b	Young 2016a	Young 2007

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