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Evaluation of archaeometallurgical residues from Moneygall, Co. Offaly, 06E0321.

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Abstract

This assemblage comprises approximately 30kg of macroscopic slag specimens, together with 6.5kg of residues from the processing of bulk samples, including both picked and unsorted fractions. Archaeometallurgical residues occurred in 30 contexts.The material was derived from variety of features both inside and outside the northern half of the enclosure. The features probably vary widely in age from early medieval through to late medieval or early post-medieval.

The archaeometallurgical residues are almost all derived from the working of iron (blacksmithing) although one hearth showed evidence that it had also been used for working with copper alloy. The majority of contexts yielding the smithing residues contain a sparse assemblage of smithing hearth cakes (SHCs), smithing slag lumps and other less identifiable macro-slag material. A few contexts, in contrast, yielded an assemblage of small-scale residues, of a type that are commonly found within hearths. Such residues include a limited amount of hammerscale, slag flats, slag coatings from both round and square cross-sectioned tools, sub-spheroidal droplets and fuel ash slags. Such assemblages are likely to either be found within hearths or within waste deposits from the cleaning of hearths. They were identified particularly in contexts c904, the fill of a probable smithing hearth inside the NE part of the enclosure in Area 9.

A second cluster of possible metallurgical features was found just outside the enclosure in Area8. This cluster contains shallow pits with burnt bases, of the appropriate size to be hearths, which contained slag in their fills, but which did not yield large assemblages of microresidues.

Significant quantities of slags were also associated with one of a series of penannular ditches (c890) outside the enclosure to the NE, and with a complex cut feature outside the NW of the enclosure (C006/007). Approximately one third of the slag assemblage from the site was contained within this single feature. Some of the material from this assemblage is possibly, but not certainly, from iron smelting.

A further area of occurrence of metallurgical activity was in Area 3, where linear (1074) contained slag and pit (1084) yielded some hearth microresidues; in neither case is the feature interpreted as a hearth.

The smithing hearth cake assemblage from the site is small and possibly multi-period, so comparison with other assemblages must be made with caution, but it is broadly comparable with other blacksmithing assemblages of medieval age from Ireland. The total residue assemblage is not particularly large, and taken together with the multiple apparent foci of activity, this suggests that smithing was an intermittent activity over a long period of time.

Contents

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

Description of the residues

The catalogue is presented in Table 1. The assemblage comprises some 30kg of hand-collected macroscopic slags and other residues, together with a small quantity of microresidues from processed bulk samples.

The assemblage is dominated by material to which can be assigned an origin during iron-working (blacksmithing) with a high degree of confidence. There are a very few pieces which cannot be assigned to iron-working, as opposed to iron-smelting, with such a degree of confidence, and their origin is equivocal, but there are no pieces certainly from iron-smelting. One feature yielded a few small blebs to indicate that copper alloy was worked in that hearth as well as iron.

Smithing hearth cakes: the SHCs in the assemblage are very variable, ranging from extremely dense examples, which must represent the presence of fluid slag puddle in the hearth, through forms with only a very thin crust at its base and a body of charcoal-rich slag, to forms with no basal crust at all, merely being charcoal-rich agglomerations. SHCs comprise 64% of the total assemblage by weight, and fragments too small for confident identification probably make up much of the 30% of the assemblage which is indeterminate.

The basic mode of formation of an SHC is broadly the same across all these morphologies – when the workpiece is placed in the hearth it will undergo some superficial oxidation, and occasionally more serious breakage, which results in iron metal and iron oxides being lost to the hearth. Here the iron oxides will be fluxed by molten ceramic material from the hot tip of the tuyère and possibly by deliberate additions of sand flux too, with the resulting iron silicate melt forming the slag. The common origin means that SHCs typically have a bowl-like form (concavo-convex, plano-convex or even occasionally biconvex). They generally form with a small area of contact between the slag bowl and the ceramic of the tip of the tuyère or the hearth wall. This zone of contact may have enhanced reaction, leading to a particularly dense slag (the burr).

The size and density of the SHC will be controlled by the mount of iron lost, the temperature the hearth is being run at, the rate of loss of the tuyère, the period of working and the way in which the smith manipulates the hearth.

The SHC assemblage from Moneygall is derived from a wide variety of contexts, but amounts to only 22 examples which are either complete, or for which an estimate of completeness can be made. The weight distribution of the SHCs is presented in Table 2.

The Moneygall examples show a range from 114 to 1800g, with the larger examples unfortunately being extrapolated weights from quite modest fragments. The mean weight is 527g. 55% of the SHCs weigh less than 500g and 95% less than 1000g.

Some of the SHCs show some evidence for the manner of their clearance from the hearth. There are examples where the SHC has been folded, indicating they were still soft when extracted, and there are examples suggesting that some were broken hot from the hearth, resulting in fluid slag flow across the break between the SHC and the adjacent ceramic (tuyère tip in most cases).

Other Smithing slags: This category includes slag types associated with smithing but not SHCs. Such material may include assemblages with larger specimens of slag flats and blebs or other materials related to the microresidues.

Rather more amorphous slags, lacking the bowl-like morphology of SHCs are often termed smithing slag lumps. In most cases these are slag masses that either formed separately from the main SHC, or instead of an SHC in a rather slag-poor system. At Moneygall, such probable smithing slag lumps cannot completely unambiguously be assigned to smithing so are included more objectively within the indeterminate category.

Indeterminate slags: This category will also tend to include some fragments of SHCs and smithing slag lumps which cannot be recognised as such, particularly where the SHC has disintegrated during extraction from the hearth by the smith. Also within this category will be fuel ash slags and slags with a strong input from melted hearth or furnace lining, which may not be attributable to a particular process.

Possible iron smelting residues: Context 889 yielded a few pieces of slag that might be from iron smelting rather than smithing. They include a 462g block of dense flow-lobed slag with the impressions of large pieces of wood or charcoal, a 193g piece with flows around charcoal lumps, an internally prilly cake margin weighing 472g and some dense horizontal prills. None of these pieces is certainly from iron smelting, but the impressions of large wood or charcoal pieces is suspicious. Early iron smelting in Ireland was almost entirely in low-shaft slagpit furnaces. In these furnaces the shaft is continued below ground into a slagpit, where slag collects during the smelt. Before use, the slagpit may apparently be packed with large pieces of wood, forming a regular packing (e.g. Young 2005).

Tuyères: The assemblage includes a small quantity of small fragments of tuyère, but no complete examples. Material from (c875) suggests a tuyère with an outside diameter of about 80mm, and examples from (c823) suggest bores of about 19mm. These suggest that the Moneygall tuyères were fairly small (approximately the same size as the smallest examples from Clonmacnoise water treatment works(Young 2005) and Woodstown (Young 2006b), but smaller than any from Clonfad (Young 2006a).

Microresidues: The microresidues have not been quantified, but are indicated on table 3 merely by presence/absence. The slag fines include a great deal

of rather amorphous slag debris, but there are several classes of residue that are more significant:

1. *sub-spheroidal droplets* – these are formed from drips of slag passing through the fuel bed. They are distinct from, and much larger than, spheroidal hammerscale.

2. *slag flats* – the particles are thin sheets of slag that have formed on the surface of the workpiece. They typically have a planar surface and a rough surface. They are not shiny as flake hammerscale, but there may be a gradation from the thickest, most slag-rich hammerscale up into slag flats.

3. *slag blisters* – these are similar to slag flats but have blistered away from the metal to give them a concavo-convex form, often grading laterally at their edges into material similar to slag flats.

4. *slag coatings* – this collection shows two forms of slag coating. One is essentially a thick form of slag flat, but shows a re-entrant right angle on the inner face. This is interpreted as a slag lump which has become attached to a tool, probably tongs, within the hearth, although it is not possible to exclude it as having formed on the corner of the workpiece. The second form of slag coating is in the form of a tube of slag with a wall thickness of about 1mm and marked striations on the outside. This is interpreted as having been formed when a poker has been pushed through liquid slag and the resultant slag film has chilled rapidly. Such films may result from the poker being used to manipulate the slag in the hearth, or as a result of the poker being used to clear a slag blockage from the tuyère.

5. *hammerscale* – there are two categories of hammerscale: *flake hammerscale*, formed by the surficial oxidation of the workpiece during heating, which spalls off the workpiece during hammering and accumulates around the anvil, and *spheroidal hammerscale* which is air-chilled spatter formed from slag expelled from the workpiece during hammering, particularly during forge welding.

Hammerscale was identified in c900 and c904 (flake hammerscale only), as well as in c902, where both flake and spheroidal hammerscale were present.

The Moneygall assemblage is noticeably lacking in finds of hammerscale. This may be a genuine feature of the archaeology (no survival of smithy floors and no survival of deposits from the sweeping of the floors), or it may be an artefact of the environmental sampling technique (sieving being undertaken at too coarse a grain size for retrieval of these commonly sub-mm particles).

Concretions: this class includes materials which may not necessarily be true archaeometallurgical residues, but comprise small concretions formed around decayed metallic iron. In some cases this may be iron debris lost during iron-working, but in others it may be artefactual material.

Copper alloy residues: copper alloy residues are represented solely by some rather altered sub-spheroidal blebs from c904. They most likely represent drops of metal lost during the handling of liquid copper alloy for casting, but other alternatives are possible. The material occurred in a hearth apparently primarily used for iron-working and such usage of the smith's hearth is probably quite usual.

Distribution of the residues

A summary of the distribution of residue type by context is shown in Table 3.

There are five discrete areas of the site which have yielded most of the residues:-

1. contexts c900, c902 and c904, the fills of a cluster of features inside the NE part of the enclosure in Area 9. These contexts, in contrast to most on the site, yielded an assemblage of small-scale residues, of a type that are commonly found within hearths. Such residues include a limited amount of hammerscale, slag flats, slag coatings from both round and square cross-sectioned tools, sub-spheroidal droplets and fuel ash slags. Such assemblages are likely to either be found within hearths or within waste deposits from the cleaning of hearths. C904 also yielded blebs derived from the working of copper alloys, showing that this area had processed non-ferrous metals as well as iron.

2. A second cluster of possible metallurgical features was found just outside the enclosure in Area8 (c833, c835, c830). This cluster contains shallow pits with burnt bases, of roughly the appropriate size to be hearths, which contained slag in their fills, but which did not yield large assemblages of microresidues. The interpretation of any of these features as a hearth is therefore uncertain. An array of nearby pits (c845, c855, c867, c876) also yielded slag, but probably as a result of dumping.

3. Significant quantities of slags were also associated with one of a series of penannular ditches (c890) outside the enclosure to the NE. This assemblage was the only one to yield material that was possibly from iron smelting as well as from smithing.

4. a complex cut feature outside the NW of the enclosure (C006/007). Approximately one third of the slag assemblage from the site was contained within this single feature.

5. A further area of occurrence of metallurgical activity was in Area 3, where linear (1074) contained slag and pit (1084) yielded some hearth microresidues; in neither case is the feature interpreted as a hearth.

The nature of the metallurgical features

Several of the features associated with the residues are possibly or likely to be of metallurgical origin and are worthy of further comment. Descriptions here are taken from McCarthy & Moloney (2006), with added commentary:

Features in Area 9:

C900 is described as the fill of c901, a circular pit 0.48x0.37m and 0.28m deep, from which a linear feature (c903 filled by c902) 1.25m long by 0.4 wide and 0.05m deep extended south-eastwards.

1m southwest of c901 was pit c905, filled by c904, which was 1.06 x 0.70m and 0.17m deep. This pit was had burnt natural on its base at the southern end and contained a large stone.

Pit c905 has appropriate dimensions and features for a floor level smithing hearth. It is similar to those recorded at Coolamurry (Young 2007) and contains very similar residues. The interpretation of the stone in

the hearth as being an anvil stone seems rather unlikely, and may have been associated with delimiting the main working area of the hearth.

Rectangular hearths of about a metre or slightly more by rather less than a metre seem to be quite typically of early floor level hearths, and are essentially similar in size to a recent blacksmiths hearth. As with a modern hearth, the hot area would normally only comprise a small part of the whole – hence the burning of the natural at just one end (the end where the bellows and tuyère would have been).

Associated features are likely to include an anvil – and the pit c900 might conceivably be an anvil base. However, even floor level hearths would not normally be external, so there also the possibility that associated features might be structural.

Features in Area 8:

There are several cut features in Area 8 which show burnt bases and fills containing iron slag. However it would not appear that any of these have the typical size and shape of metallurgical hearths, and given the iron slag is mainly in the upper fills it is likely that these features had other origins. However, given the complexity of such features in this area re-examination of excavation records to check the intercutting pits for examples that might fit the dimensions of hearths might be worthwhile.

Interpretation

The residues from Moneygall show that the main metallurgical activity being undertaken was iron working. There is no conclusive evidence for iron smelting from the site and the SHC assemblage is suggestive of blacksmithing rather than bloomsmithing (the refining of raw blooms). Thus the smiths at Moneygall can be seen as end users of iron, rather than creators of raw metal. The exception to this may, but not certainly, be the deposit c889 in the late medieval (?) ringditch c890, which contained some possible pieces of smelting slag, as well as evidence for the largest SHC from the site – so iron smelting may have been undertaken in a small way at this period.

The smithing hearth cake assemblage from the site is small and possibly multi-period, so comparison with other assemblages must be made with caution, but it is broadly comparable with other blacksmithing assemblages of medieval age from Ireland. In comparison to other blacksmithing assemblages, Moneygall appears to lack a high proportion of very small cakes, but this may possibly be due to the difficulty in recognising the small cakes, and differentiating them from fragments of larger ones, within this assemblage. It may be significant that the largest SHC was retrieved from the same context as the possible smelting slags – so might possibly represent residue from bloom refining.

The tiny amount of copper alloy debris recorded, taken with a total lack of non-ferrous technical ceramics (moulds, crucibles...) suggests that this was not a major activity. Loss of a small amount of copper alloy in a hearth such as this may show that small castings were being made, or repairs to existing artefacts, or it is possible that the copper alloy was being employed in joining or finishing iron objects. Brazing is well established as an early medieval technique being employed for small artefacts, for instance in Dublin (Bayley pers. comm. 2006), as well as for large objects such as the Christian handballs being produced at Clonfad (Young 2006).

The low volume of residues, despite the multiple foci of activity across the site, and the potentially long time periods involved, suggests that smithing may have been an intermittent activity, rather than a major part of life in the settlement.

The association of metalworking with early medieval enclosures containing cemeteries is fairly common, but it has not been demonstrated that it is any more frequent than an association with any other sort of occupation.

The dating of the metallurgical activity at Moneygall is problematic. Only one piece of slag is associated with the main enclosure ditch, and no slag was recovered from any contexts directly associated with the cemetery. Radiocarbon dates suggest that some at least of the activity outside the enclosure to the north is of later medieval to early post-medieval date. And stratigraphic relationships show the penannular ditches as being later than some of the major linears. It is possible therefore that much of the archaeometallurgical activity associated with the ring-ditches and elsewhere outside the enclosure might be of this relatively late date.

The complex of features in area 9 within the enclosure is not dated either by absolute or relative methods. At least one of these features, c905, appears to represent a floor level smithing hearth, similar to those from Coolamurry.

Comparative assemblages may be found amongst other early medieval rural settlements such as Navan site 1 (Young 2007), Coolamurry (Young 2008b) and Carrigoran (Young 2006c). The comparisons between the SHC assemblages at these sites are made in Table 2. Coolamurry also presents the best analogue for the assemblage of smithing fines, and in general a good case exists for similar techniques and technology at the two sites. A rather similar fines assemblage is also known from Rochfort Demesne (Young 2008a).

The smithing hearths (as evidenced by c905 and the Coolamurry examples) would have been a shallow pit approximately 1.0m in length by 0.70m wide, similar in size to a modern blacksmith's forge hearth. Air would have been taken from the bellows into the hearth via a ceramic tuyère. No part of the hearth surround would have reached significantly elevated temperatures, so that the tuyère becomes the only source of the observed vitrified ceramic fragments and indeed the major source of the silicate component of the smithing slags.

Evaluation of potential

The potential of the assemblage is limited in mainly comprising dumped smithing assemblages, without any link to structures, and without a firm date. In general smithing assemblages provide less additional information on detailed analysis than do smelting assemblages, and this is particularly true where the assemblages are small.

There are two areas of this assemblage where there is a stronger case for further analysis: firstly further investigation to determine whether the possible smelting slags are indeed of that origin, and secondly

further investigation of the microresidue assemblage to facilitate comparison with other material, particularly that from Coolamurry.

However, both of these areas are themselves rather limited in potential. Determination of the possible smelting slags would add little to the story from the site, in which end use of iron is dominant, since the slags are so few, and not associated with any physical evidence for smelting furnaces. Further investigation of the smithing fines would be interesting, but would be hampered by an apparent lack of sampling of the finest grade material (the hammerscale) and by a lack of firm dating for the fines assemblage.

One further aspect of the site which might enhance the research interest in the residues, is if the dating on the features external to the enclosure is confirmed as being later medieval to early post-medieval, for iron working of this period is rather poorly known in the area.

It is therefore recommended that further instrumental analysis of this assemblage would not currently be justified by the research potential.

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status	area	context	find	sample	bag	sample weight	weight	notes
(not on list)	1	7	7		1 of 2	9612	878	SHC, 150x120x40mm, elongate away from deepest point. Top full of charcoal holes, but otherwise flat, base rough.
							779	Roundedly biconvex SHC, 140x105x60mm (bowl 40mm) top full of charcoal, base not well seen
							265	Small SHC, 90x95x35mm bowl 30mm, charcoal rich top, fairly charcoal rich base too
							474	75% of really dense SHC, (65)x100x40mm smoothly dimpled top, all thick crust, base small dimples.
							506	A large burr with attachment 145mm wide and 35mm deep (140)x(50)x(60)mm SHC or whatever snapped off immediately in front of attachment
							394	(90)x(5)x45mm slab of SHC crust with crystal terminations. Proportion of original not determinable, crust 15mm thick
							478	80% of flat topped SHC with some messy slag on top of proximal side. (110)x(105)x50mm crust to at least 25mm, smooth top dished
							146	2 small fragments of fairly thick crust SHCs
							603	4 amorphous lumps of slag that may be very irregular small SHCs or parts thereof
							120	75x65x30mm - probably small dished charcoal-rich SHC - but just possibly a central fragment of something larger
							294	115x70x40mm rounded lump - probably an entire elongate SHC, top dished, fairly charcoal rich
							227	100x75x25mm rounded slab of slag which is probably an SHC
							961	14 pieces slag
							1005	25 pieces
							315	5 pieces
(not on list)	1				2 of 2		816	11 pieces
							332	18 pieces
							268	The burr region from a charcoal-rich SHC
							271	90x80x45mm small dense triangular SHC with slightly dished top, slightly prilly base with charcoal inclusions
							385	90x90x60mm block of granular open-textured slag with one surface showing poorly developed flow lobes. This could possibly be a smelting slag, although it would be hard to rule out a thin-crust SHC
							95	Burr fragment from small SHC with fairly thin crust
	1	7		2	metalworking debris	20		Fine slag debris - mainly highly weathered
	1	7		2	slag fragments	33		Approximately 8 pieces of extremely rotten concreted slag

status	area	context	find	sample	bag	sample weight	weight	notes
(not on list)		55	1			464	464	Approximately half of an incredibly dense SHC, (60)x(90)x60mm - of which bowl 43mm, massive dense slag, raised top vesicular
	1	61		10	metalworking debris			Natural
	1	63 (labelled 62)		8	metalworking debris	<1		2 pieces of chert, 1 natural concretion
	5	521		4	metalworking debris	<1		1 piece possible burnt bone, 1 piece of slag flat
	5	523		5	metalworking debris	<1		5 grains all probably natural
	7	721	2			79	79	This piece is a curved dense slag, with a maroon tint on inner face of curve where there is a smooth surface. One face show fuel clasts - most of which look more like coal than charcoal, but not all. A curious piece- would easily be classed as clinker. This could be a coal-fuelled smithing slag, or a dense clinker - but probably a true slag.
	7	756		1	metalworking debris	1		Possible rotten slag - but may be natural concretion
	8	803	1			67	67	Part of the tip of an SHC, probably a very small one
	8	817	4			2350	726	Poorly consolidated charcoal rich SHC deepest at proximal end, 110x110x85mm of which bowl 60mm, all brown and a rather friable
							392	Chert block
							114	Poorly formed biconvex and partly hollow probable SHC 110x60x50, probably a flat plate-like SHC folded double during extraction to create apparent central cavity
							698	10 poor SHC fragments and other slag pieces
							20	Probable concretion around small iron piece
	8	823	1			540	80	heavy dense slag from tuyère face surrounding 19mm diameter blowhole
							33	4 tuyère sherds, 2 forming parts of c19mm diameter blowholes
							371	14 pieces of brown fairly fresh slag, lots of charcoal, probably broken up crude SHCs, but somewhat amorphous
							11	curious very dense granular rusty material - almost like sintered ore, but may be a granular slag
							45	Bits and dust

status	area	context	find	sample	bag	sample weight	weight	notes
(not on list)	8	827	1			271	37	Rottenstone (decalcified impure limestone with crinoid fossils)
							6	Vitrified tuyère sherd
							157	Curiously lobate very fresh dark dense slag lump - probably a SHC of sorts, all made of rather prilly blebs, often filmy between fuel moulds, with small dense upper slab, 90x60x35mm
							44	Approximately 10 pieces of slag probably broken from above poor SHC
							23	2 rounded rusty slag blebs
							4	Iron concretion
	8	827		4	metalworking debris	1		Small dense prill fragment
	8	827		4	slag fragments	26		6 small pieces of low-density slag, 1 possible ferruginous concretion
	8	828		5	metalworking debris	26		Ashy altered slags, mainly small in hearth blebs and films, but one larger lump of slightly flowed material
	8	829		6	metalworking debris	1		Fragments of three "lining slag/fuel ash slag" blebs and 2 denser spheroids
	8	832	1			594	414	28 pieces of variable iron slag, most smithing lumps, but some parts of small SHCs
							49	3 low density lining slag lumps
							11	3 small tuyère sherds
							5	Small rusty granular piece – fine charcoal and sand inclusions in thin sheet
							2	3 small pieces of bone
							60	4 natural stones
	8	844	1			1238	472	100x80x60mm block from large double layer SHC (the top layer might just be folded over basal layer but that is unclear) cake far from complete in either interpretation
							355	95x120x35mm of which bowl 25mm, wide flat SHC. Shows signs of flowage at proximal end in curved area possibly adjacent to the blowhole. Lower face has reduced-fired sediment attached and cake may this have formed down a steep wall.
							290	Most (80%?) of small dense SHC, (90)x(70)x40mm
							121	Broken rounded mass of highly vesicular slag with a central cavity
	8	854	1			3140	302	3 pieces of stone
							385	Part of very dense thick crust SHC with pot-handle like extension, crust to 20mm, has dense vesicular slag on top, proportion of original not determinable
							692	130x100x55mm, most of a very regular SHC probably 80-90%, smoothly dimpled top, somewhat lobate internally

status	area	context	find	sample	bag	sample weight	weight	notes
							394	piece of a medium sized SHC with a vesicular internal slag texture. Very dense, proportion of original not known
							118	Fragment of small SHC - probably c 30%
							177	Dense ?water-worn or corroded slag lump - probably part of an SHC
							132	Small fragment of burr region of an SHC
							119	Another part of 692g piece above - probably
							662	17 small slag fragments most/all probably from smithing cakes
								note animal jaw ?dog in here too
	8	854		7	slag fragments	41		Natural concretions - in part iron-rich - on bone, tubes and 1 tiny piece of possible slag
	8	854		7	metalworking debris	824		Essentially gravel. Small amount of ferruginous concretions, some charcoal, including nut shell
(not on list)		856	1			414	206	55x100x35mm pyramidal dense SHC, flat top, fuel dimpled base with some pale glassy material forming a wedge shaped inclusion on one side
							208	70x70x25mm dense square of slag with odd dimple, probably most of small SHC, weathered
(not on list)		862	1			161	161	Highly weathered fragment from a vesicular SHC
	8	866		8	metallic debris	<1		Not slag
(not on list)		875	2			596	68	7 pieces of bone
							87	3 pieces of chert - 1 with rusty concretion attached
							5	Iron rich concretion
							241	Part of low-density, pale lining-rich SHC with pale grey glassy top and cream colour base with charcoal dimples. One end shows a curved contact which may be a tuyère margin, 100x(65)x37mm, ceramic curve suggests tuyère of 80mm diameter.
							67	Small fragment (worn?) of vesicular charcoal-rich weathered slag
							128	Very deeply weathered piece of vesicular charcoal-rich slag. Pale buff colour. Has rounded face so may be SHC fragment
	8	889		12	metallic debris	922	462	Probable SHC, top part rather worm and coated in oxides but shows remnant of smooth surface - which might be a wood/charcoal contact. Base is a stack of flow lobes with non-wetted contacts onto large pieces of wood/charcoal. If not SHC this might be a worn block of smelting slag if both top and bottom show wood/charcoal moulds.
							91	Curiously granular slag with fine charcoal, with lobed form, with partial maroon surface,
							63	Irregular fragment of granular slag, lots of very fine charcoal

status	area	context	find	sample	bag	sample weight	weight	notes
							63	small dense slag nub - probably a section through an SHC
							18	fine granular slag grading into smooth (blown?) surface
							219	smaller slag debris - including some gravelly lining influenced slags
	8	889	1			5745	2590	77 pieces indeterminate slag fragments and very small crust pieces
							66	3 pieces of dense, flowed horizontal prills
							193	Slag lump with flows around medium charcoal pieces- probably a smelting slag
							82	Elongate lining slag fragment - probably off lower edge of tuyère?
							9	Lining slag fragment
							50	Part of stone disc
							168	Chert
							472	135x60x30mm elongate smoothish block of microprilly slag - could be the margin of a thin-crust or smelting slag cake
							219	Part of a rusted low density SHC, (60)x90x40mm
							295	(60)x105x40 most of small platy SHC with flowed edges, crust to 17mm, main disc/bowl 70mm across, but has partially flowed extension to one side
							80	Small thin SHC crust fragment
							222	Fragment, possibly burr, from margin of a large cake. Has large internal voids, 90x40x40mm (could just be smelting slag but probably not)
							202	Fragment of thin platy SHC
							133	Fragment of thin platy SHC
							352	Thick crust SHC fragment, crust to 37mm thick, smooth puddled top, unknown proportion but much less than 20%
							221	100x60x35 small SHC with smooth dimpled top, micro-dimpled base and spiky flowed margins
	8	891		11	metalworking debris	94		A few slag pieces, but mainly concretionary ash and charcoal. Slags not diagnostic
	8	900		9	Metallic debris whole sample	1890		This is probably around 50% archaeometallurgical residue. It is very rich in slag flats, blebs and general debris, but there are also a few large pieces of flake hammerscale, and more of the slag tube (poker coating) seen in the picked material. Remainder is fine gravel
	8	900		9	slag fragments	388		Assemblage of small slag fragments including bleb and prills, many slag flats, small fragments of probable smithing floor, couple of small tuyère sherds, coatings from pokers/tongs etc
	8	900		9	prill	13		Sub-spheroidal slag droplets
	8	902	1			448	364	Assemblage of c60 small slag pieces, mainly very dense, 2 tiny pieces of fired clay, 1 prill, 1 sub-spheroidal particle and one slag flat. Also piece with right angle in vesicular slag - this is a slag coat from tongs or poker

status	area	context	find	sample	bag	sample weight	weight	notes
							21	Sherd from outside of small vitrified tuyère, fabric dark maroon with lots of grit - including chert
							63	Small rounded slag piece with smooth top - probably the distal tip of a SHC
								dust has spheroidal and flake hammerscale
	8	904	1		slag from fill of furnace	2035	568	A collection of pieces of basal crust from a fairly thin crust SHC, original dimensions uncertain
							1417	Other material, mainly probably SHC related, often very charcoal rich with gravel, one shiny prill looks fairly viscous
(not on list)	8	904	2				10	Copper dross fragments
	8	904		10	Metallic debris whole sample	1685		Sample dominated by gravel - slag maximum of 10%. Most of slag is fragile vesicular blebby material. Magnet picks up flake hammerscale.
	8	904		10	metallic debris	1		Small slag pieces plus 2 tiny corroded Cu-alloy droplets
	8	904		10	slag fragments	378		Assemblage of amorphous to partly flowed slags, indurated ash, sandy slags, and slags with exploding iron particles, resembles Celbridge-like smelting slag assemblage but ambiguous
	8	904		10	slag	90		Assemblage of lower density materials - lining drips or something similar - low density highly vesicular blebs (fuel ash slag?), but mainly filmy slags from within charcoal bed.
	8	904		10	prill	2		Sub-spheroidal slag droplets
	8	912		14 (labelled 13)	metalworking debris	<1		Ashy charcoal fragments
	3	1004	1			2447	536	Most of a rather charcoal-rich SHC with microprilly base - folded double on extraction -100x90x70mm - originally around 100x160x40mm maybe, one edge missing - maybe be 95% complete
							89	Charcoal rich slag lump
							643	Dense slag block, not identifiable by form
							874	140x120x50mm, well formed SHC with charcoal rich top. Lobate margin and lobate/prilly base
							305	2 blocks of chert
	3	1012		2	metalworking debris	1		BOM

status	area	context	find	sample	bag	sample weight	weight	notes
	3	1022		15	metalworking debris	<1		Mineralised charcoal
	3	1022		15	prill	3		Dense slag bleb - probably from within ash bed.
(not on list)		1024	2				52	Broken up gravelly red fired clay
	3	1030		5	metalworking debris	1		Approximately 15 small pieces of concretionary material, no true slag
	3	1035		7	metalworking debris	2		Mainly stones, a little charcoal
	3	1045		11	metalworking debris	1		Stones, charcoal, burnt bone
	3	1050		9	metalworking debris	<1		Charcoal
missing	3	1054		13	metalworking debris			
	3	1060		12	metalworking debris	1		Natural concretions
	3	1075		17	slag	13		Various small dense slag prills and blebs, together with some slag flats, also many chert fragments
	3	1075		17	metalworking debris	21		Various rather low density slag blebs, also one dense piece with maroon surface, could be clinker, also one small possible tuyère sherd
	3	1075	1			442	217	Amorphous fragment of dense weathered slag
							117	Small glass topped tongue or SHC,70x70x30mm, contact with sand with flowage on one side, charcoal rich beneath
							26	Vitrified ceramic
							39	Amorphous vesicular slag fragment
	3	1078		18	metalworking debris	7		Mainly pieces of concretionary material and rotten stone, but has two large rounded slag blebs, one dull the other with a shinier, locally maroon, surface

status	area	context	find	sample	bag	sample weight	weight	notes
	3	1085		19	metalworking debris	21		Mainly frothy, blebby within-hearth slags, also more amorphous slag debris
	3	1085		19	slag fragments	29		Various dense rather fresh looking slags, probably all hearth slags of one sort or another, includes some dimpled crust fragments
	3	1085		19	prill	1		10 sub-spheroidal slag droplets
(not on list)	3	1085	1			239	239	Slab of crust from a fairly thin crust cake. Good internal crystal terminations. Crust to 15mm locally, mainly thinner. Outside rough with irregular surface, but locally smoothly micro-dimpled. Must be from very large cake or hearh floor crust.
	3	1087		20	metalworking debris	13		1 tiny concretionary lump, plus 13g piece of elongate amorphous slag
	3	1103		21	metalworking debris	23		Dominantly natural materials (stone, concretion), but contains a couple of weathered slag fragments - all appear to be rather sandy.

Table 1. Summary Catalogue. Grey background indicates those materials which are s from the processing of bulk samples and comprise mainly very small particles which are not individually described.

	Moneygall	Navan Site 1	Carrigoran	Coolamurry	Clonfad	Clonmacnoise (Waste water scheme)	Woodstown 6	Clonmacnoise (New Graveyard site)
count	22	17	18	41	513	38	140	117
min	114	60					68	100
max	1800	2990	3866	2588	11000	5540	6310	7815
average	527	507	553	386	1153	1087	1060	843
<500	55%	82%	72%	83%	29%	39%	40%	50%
<1000	95%	88%	89%	95%	64%	68%	71%	78%
>1000	5%	12%	11%	5%	36%	32%	29%	22%
>3000	0%	0%	6%	0%	7%	8%	7%	3%
modal class	200-300	100-200	100-200	100-200	300-400	300-400	200-300	400-500

Table 2: Comparison of the Moneygall SHC assemblage with other Irish early medieval assemblages. Navan Site 1 from Young 2007, Carrigoran from Young , 2006c; Coolamurry from Young, 2008b; Clonfad from Young, 2006a; Clonmacnoise Waste Water Scheme from Young 2005; Woodstown from Young, 2006b; Clonmacnoise New Graveyard site from the author's work in progress.

The early medieval assemblages from Navan, Carrigoran and Coolamurray are interpreted as being dominantly blacksmithing residues. The early medieval assemblages from Clonfad, Clonmacnoise and Woodstown are interpreted as including bloomsmithing residues.

area	*context*	*SHC*	*smithing*	*indet*	*?smelt*	*clinker*	*tuyère*	*micro*	*concretion*	*copper alloy*	***total***
1	*7*	6183	0	3482	0	0	0		0	0	***9665***
1	*55*	464	0	0	0	0	0		0	0	***464***
5	*521*	0	0	0	0	0	0	y	0	0	***0***
7	*721*	0	0	0	0	79	0		0	0	***79***
7	*756*	0	0	1	0	0	0		0	0	***1***
8	*803*	67	0	0	0	0	0		0	0	***67***
8	*817*	1538	0	0	0	0	0		20	0	***1558***
8	*823*	371	0	11	0	0	113		0	0	***495***
8	*827*	201	0	50	0	0	6		4	0	***261***
8	*828*	0	0	26	0	0	0		0	0	***26***
8	*829*	0	0	1	0	0	0	y	0	0	***1***
8	*832*	0	0	468	0	0	11		0	0	***479***
8	*844*	1117	0	121	0	0	0		0	0	***1238***
8	*854*	2679	0	1	0	0	0		0	0	***2680***
8	*856*	414	0	0	0	0	0		0	0	***414***
8	*862*	161	0	0	0	0	0		0	0	***161***
8	*875*	241	0	195	0	0	0		5	0	***441***
8	*889*	1787	0	3072	1193	0	0		0	0	***6052***
8	*891*	0	0	10	0	0	0		0	0	***10***
8	*900*	0	0	0	0	0	0	y	0	0	***0***
8	*902*	63	364	0	0	0	21		0	0	***448***
8	*904*	1985	0	468	0	0	0	y	0	10	***2463***
8	*912*	0	0	1	0	0	0		0	0	***1***
3	*1004*	1410	0	732	0	0	0		0	0	***2142***
3	*1022*	0	0	3	0	0	0		0	0	***3***
3	*1075*	117	0	277	0	0	26		0	0	***420***
3	*1078*	0	0	7	0	0	0		0	0	***7***
3	*1085*	239	0	50	0	0	0		0	0	***289***
3	*1087*	0	0	13	0	0	0		0	0	***13***
3	*1103*	0	0	1	0	0	0		0	0	***1***
	total	***19037***	***364***	***8990***	***1193***	***79***	***177***		***29***	***10***	**29879**
		63.7%	1.2%	30.1%	4.0%	0.3%	0.6%		0.1%	0.0%	% of residue

Table 3: Summary of distribution by residue class and context. All weights in g.

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