GeoArch

Report 2005/18

Evaluation of archaeometallurgical residues from Carrigoran, Co. Clare (98E0338)

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5th June 2006

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Abstract

The assemblage of metallurgical residues from this site includes material produced during both iron smelting and iron working. The macroscopic assemblage totals 30.4kg, of which 12.2kg is slag from smithing hearth cakes (SHCs), 8.4k of slag from iron smelting and 8.1kg of indeterminate iron slag. Vitrified and/or slagged lining material comprises 0.6kg and is mainly derived from tuyères. 1.1kg of clinker, coal and related materials was also present, occurring in topsoil and other recent deposits.

Iron smelting appears to have been undertaken during Phase 3 in two smelting furnaces, the basal slag- pits of which are represented by C887 in Area A/B and C767 in area G. The two pits interpreted as the bases of furnaces contain rather different slag assemblages. C755, the fill of C767 contains a typical macro-slag assemblage from an Irish iron-smelting furnace, with prills of slag descending between large blocks of wood and just a small quantity of porous sintered fines. The fills of C887, in contrast, are dominated by large quantities of sintered material, with only a small proportion of surviving prills. The differences between the two may lie in the degree of cleaning and the number of uses of the furnaces.

Iron working is represented by SHCs, the size and weight of 18 of which can be measured or estimated. These have a modal weight in the range of 100-200g and a maximum estimated weight of approximately 3.9kg with a mean of approximately 550g. The SHCs occur in stratified contexts (Phases 3 and 5) in Area G, within wall rubble in Area A and in unstratified contexts across the site. The assemblage of SHCs is small, but appears to lie between those from sites dominantly involved in primary iron production and those involved solely with blacksmithing.

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Methods

All the macroscopic material from the collection was inspected visually (and with a low-powered stereo-microscope where necessary) and recorded to a spreadsheet. All complete, or substantial parts of, smithing hearth cakes were weighed individually and the proportion they represented of the original cake was estimated. This database is reproduced as the catalogue in this report.

Representative material from the slag collection, plus all tuyère material and all microscopic residue assemblages were retained and collated into a separate collection, for use in the Stage 2 of the investigation of archaeometallurgical activity on the site.

Results

Residue description

Iron smelting residues

Residues from iron smelting recovered from the site fall into two broad categories, macroscopic slags and sinter:

Macroscopic smelting slags: these materials include descending prills in a brittle, silvery appearing slag, often showing evidence for penetration between large fragments of wood or charcoal. In the case of the material from C755, the wood fragments were at least 10mm square by 80mm in length, and may have oriented vertically with the furnace base. This slag facies comprises about one quarter of the slag from the furnace fill C755, but is not well represented in furnace C887.

Dense crusts comprised about half the assemblage from C755. They had a sintered lower face, variously indicating contact with sediment or with charcoal, and an upper face with coarse olivine crystals indicating contact with liquid slag. The precise origin of this material is unclear.

Less diagnostic slags also occur in C755 and indicate slag flowage through a charcoal bed. The occurrence of these slags within the furnace assemblage suggests an origin in smelting, but if found isolated these pieces would not be attributable to smelting with any certainty.

C888 yielded a block of finely prilly slag, which resembles the texture seen in large "furnace bottoms" produced during iron smelting (e.g. Tullyallen 6; Young 2003c).

Sinter: material resembling a sinter occurs in large sheets across the floor of furnace C887 and as smaller pieces in the overlying deposits.

This finely porous material is iron-rich, but includes abundant small pieces of charcoal and fired ceramic. Broadly similar material is known to occur in large masses on the base of probable smelting furnaces on other sites (e.g. Ballykilmore 6; Young 2006d), although small sinter particles are more common in certain smelting furnaces (e.g. Celbridge 5 and Cherryville 12; Young 2003a). No analysis of this facies has yet been undertaken on other sites, but it seems likely that it is the result of percolation of small partially-reduced ore particles to the base of the furnace. It may be indicative of the use of fine grained bog ores.

Iron smithing residues

Iron smithing residues are dominated by smithing hearth cakes (SHCs). Most of the SHCs from this site are fairly dense, rather conventional plano-convex cakes, although there is some variation. The extremely dense type of SHC, common on some sites, with evidence for a large molten slag puddle, is largely absent here, with a single example from C749 together with a few small fragments from other contexts (listed in the catalogue as "thick crust" SHCs). The large, porous, SHCs with only a thin basal crust and charcoal-rich cores, which comprise the majority of the largest SHCs at sites interpreted as refining iron from raw blooms (e.g. Clonfad 3, Clonmacnoise and Ballykilmore 6; Young 2006c, 2005b and 2006d), are also fairly rare, with a good example from C3.

There are only 18 SHCs for which the total weight can be measured or estimated (statistics and comparisons given in Table 2). The mean weight is 553g, with a maximum estimated weight of approximately 3.9kg. Only 2 SHCs (11%) exceed 1kg, including the sole example of a "thick-crust" puddle-type SHC at 1690g and the only "thin-crust" SHC at 3.9kg. 72% of the SHCs weigh less than 500g, with the modal 100g class interval being from 100-200g, containing 39% of the SHCs.

These statistics contrast markedly with sites like Ballykilmore, Clonfad and Clonmacnoise, at which >30% of the SHCs exceed 1kg and the modal class interval is 300-400g. The Carrigoran SHC assemblage bears much closer comparison with those of sites like Coolamurry Site 7 (Young 2006a) that appear to have been involved in iron-working but not iron production. The presence of the outliers in the SHC distribution at Carrigoran presumably indicates that refining of iron was undertaken on the site (not unsurprisingly given the evidence for iron smelting), but it does not seem to have been the primary purpose of the metallurgical activity in Area G.

One interesting facet of the SHC assemblage from Carrigoran was the high proportion of SHCs that had been deformed during extraction from the hearth. Some examples were so deformed there was some doubt as to whether they represented complete SHCs or not. One example bore poker holes.

Tuyères

Evidence for the use of tuyères at Carrigoran is rather restricted, with certain material only from the furnace C887, although possible tuyère material is recorded from other contexts.

In general, the evidence from a wide range of sites of Early Christian age has suggested that the use of tuyères was mainly associated with smithing rather than smelting. In particular sites with an apparent focus on bloomsmithing have yielded a high proportion of tuyères. The occurrence of tuyère material in a probable smelting furnace is therefore interesting. It may be significant that the comparative example quoted above for a probable smelting furnace containing a large mass of "sinter" (Ballykilmore; Young 2006d) also contained tuyère fragments.

Other slags

The collections contained a significant proportion of slag material that was not referable to a particular process with certainty. Much of this material probably derives from broken SHCs.

Clinker and related materials

The topsoil and other modern deposits yielded a small quantity of coal debris and clinker derived from coal-fired processes. It was not possible to determine with certainty whether the clinker was derived from a metallurgical process or from the cleaning of coal fires (the cleaning of the fireboxes of steam traction engines was a common source of clinker in agricultural settings, and domestic coal residues were often spread on small-holdings).

Iron Ore

Two small pieces of iron ore were recovered, one from the Phase 5 destruction deposits in Area G, C727, the other from wall rubble in Area D, C111. The piece from C727 was a dense nub of oxide ore; the piece from C111 was also oxide, with pale vuggy areas, possibly a piece of oxidised sulphide mineralisation. There is no contextual evidence to necessarily implicate either material with the iron smelting on the site and they may be natural erratics.

Residue distribution

There were two main areas from which the metalworking evidence was derived, one in Area A/B and one in Area G.

Area A

The evidence in Area A comprised a pit (C887) below the baulk separating Areas A and B. The pit is described as circular, 0.77m in diameter and 0.20m deep. As described above, the residue assemblage from the pit includes a basal layer (C888) of hard "sinter", with a particularly indurated zone probably representing a "burr" below the air blast (although it is not possible to determine the original location of this within the pit). This layer was overlain by unconsolidated fines and charcoal, containing many small pieces of "sinter" (C886). The uppermost fill was an unconsolidated deposit containing residue fines and several pieces of a large tuyère.

The identification of in-situ burning and the adhesion of the "sinter" sheet to the fired clay substrate clearly indicate that this was a metallurgical feature, and the provisional interpretation is that it is the basal pit of a smelting furnace, although further work is desirable to confirm this.

The basal "sinter" deposits are clearly in-situ and indicate that the furnace as not completely cleared out after use, although the lack of macroscopic slags may suggest that it was at least partially cleared. The upper deposit with the tuyère would most likely represent dumping into the abandoned feature – although whether the tuyère was originally associated with this feature remains unclear.

It may be significant that the only large fragment of a "thin-crust" type of SHC was derived from Area A (from wall debris, C3), along with several other smaller fragments. This cake type is tentatively associated with bloomsmithing.

Area G

The evidence from Area G derives from two adjacent cut features (elongate pit C768 and smaller circular pit C767). Adjacent walls and stone surfaces also contain a significant quantity of slag.

The context descriptions imply that no firm evidence for in-situ heating was discerned, so the interpretation of the two cut features as hearths/furnaces cannot be certain.

The smaller feature, C767, yields an assemblage of slags characteristic of iron-smelting in a low shaft furnace with a basal slag-pit. Such assemblages have now been recognised from a wide range of sites and the general furnace type was discussed by Young (2003b) and updated by Young (2005c). The prilly slags may represent material not cleared from the slag pit after use, or may represent material dumped into the abandoned feature upon disuse.

The larger cut feature, c768, yields a slag assemblage of which all characteristic pieces are derived from smithing. A broadly similar assemblage occurs from various contexts of the surrounding area, including deposits within the linear stone feature (C714) and various destruction deposits of Phase 5. The abundance of smithing slags strongly suggests the presence of a smithing hearth in the area, and although it cannot be proved, identification of the hearth with C768 seems possible. The material found within the fills of C768 would be unlikely to have accumulated during the use of a smithing hearth, so may represent material dumped back into the feature upon its disuse.

The close proximity of the two cut features would seem to make it rather unlikely that they were coeval. One would normally expect the wall of a smelting furnace to be at least 0.1m thick.

Interpretation

In Area G two cut features (C767 and C768) may represent the basal pit of an iron smelting furnace and a smithing hearth respectively. At 0.5m in diameter C767 is similar in size to many other examples of iron smelting furnace in Ireland. C768 is an elongate pit approximately 1.15m x 0.77m. This is comparable to the three probable smithing hearths at Coolamurry Site 7 (Young 2006a) for instance (1.2 x0.8m, 0.92 x 0.82m and 1.0 x 0.9m). Smithing slag assemblages from C768 and the surrounding area are suggestive of blacksmithing rather than bloomsmithing, and are broadly similar to the assemblages from Coolamurry Site 7.

In Area A a cut feature C887 with a basal deposit of hard "sinter" might be interpreted as the basal pit of a smelting furnace, and bears some similarity with a similar feature at Ballykilmore 6 (Young 2006d). C887 is large for a smelting furnace (0.77m diameter), a feature also shared with F979 and F1183, the "sinter"-bearing furnaces at Ballykilmore (1.0x0.7m and 0.7x0.7m respectively). A further link between these sites is the presence of tuyère fragments, an unusual occurrence in a smelting furnace, in both C887 and in F979 at Ballykilmore. The furnaces at Ballykilmore are late, probably early post-medieval. Further investigation is required on both sites to determine the nature of these features.

The overall interpretation of metallurgical activity at the site would appear to be that some primary iron production took place there, but that most of the metallurgical activity was blacksmithing (i.e. artefact production or repair).

Evaluation of potential

The assemblage from Carrigoran has potential to provide useful data on both a local and national scale.

On a local scale, chemical characterisation of the smelting residues may help to establish the nature of the ore being smelted.

On a national scale, the site has potential to contribute to understanding the nature of the “sinter” from the furnace bottom of C887, because this material has not yet been properly investigated on any other site. The investigation of the Carrigoran assemblage is particularly valuable in view of the contrasting assmeblages from the two probable smelting furnaces

The possible role of the tuyère in the “sinter” bearing furnace should also be investigated through analysis of the chemical contribution of the ceramic to the slag, and through the analysis of the slags identified as possibly having formed attached to tuyères on the site.

The smithing activity is worthy of some further characterisation, both in its own right, to establish comparisons with other sites, but also as an aid to understanding the chemical signature of smithing on the site, which may be of use in interpreting the problematic “sinter”.

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context	area	fn	weight (g)	notes
Area G metalworking				
C768, a 1.15long x 0.3m deep pit has two fills 754 and 756 and overlying deposit 748				
756		2774-2802	80	fragment of dense smithing hearth cake, with long bladed olivines, platey olivines in glassy top surface
			66	part of sub-blowhole zone - concentric zones of slag below 26mm diameter hole. Ceramic bears organics, not clear if tuyère or blowhole
			194	26 variably blebby and prilly Fe-slag with included charcoal
			4	glazed pebble with a maroon bloom (like clinker)
			2	green lining slag
			62	irregular slab of lining and charcoal-rich slag
			88	piece from irregular smithing hearth cake, dimpled base, charcoal impressions on top - rather like slag attached to b/h fragment above
748		2919-3078	280	?burr, dense, small area of maroon blown top preserved. Burr appears to extend down rather than laterally?
			124	thin sheet of slag with charcoal rich hemisphere of slag below middle - possibly an odd tiny shc
			202	one side of a thin crust cake torn through middle, lower part prilly,
			322	neat dense plano-convex conventional shc, 100x70x35mm, top smooth slightly dimpled with some attached lining slag, base mainly rough, smooth distally
			256	large part (50%) of fairly dense but vesicular small shc, base rough, top lobate around margins
			224	block from large thin crust cake with charcoal-rich core
			516	37 pieces of lobate debris
			704	12 pieces from thick crust cakes
			192	3 pieces of slag with well-flowed top, dense, but large charcoal inclusions, so differs from usual tapslag - probably a cross-floor flow
			262	7 pieces of slabby sheets with dimpled surfaces, oval in plan - could be minimal shc?
			842	83 small piece of slag, mainly high charcoal conent
			136	2 thin crust fragments
			98	curious irregular slag fragment, partially with microprilly structure - possibly accumulated on sloping furnace/hearth floor
			42	8 small scraps of normal-looking vitrified lining
			44	small piece of small dense shc with very smooth blown maroon top
			38	5 small pieces of lining slag
			16	small piece of pale lobate flown slag, probably a cross-floor flow, charcoal impressions on underside

			26	fragment of thin crust deformed, highly polished appearance
			42	concretion around 4 tiny pieces of iron - at least 2 were thin sheet

C767, a 0.5m diameter, 0.11m deep pit, 0.1m NW of C768, filled by C755

755	G2	2824-2857		assemblage of distinctly silvery slags - including smelting slags with large charcoal moulds and also vesicular furnace base material
		includes	232	17 pieces of pale surface descending prills and sheets around 10mm sq x at least 80mm long fuel pieces, apparently aligned vertically
			554	4 pieces of dense crust, lower face sintered, gravelly with green glass (1) or charcoal impressions (3), upper face coralline with very large olivine crystals. Lots of adhering charcoal and ash - without any scale
			236	14 variable small pieces of slag, includes some blebby material, some lining dominated, mostly flowed, some charcoal rich

C714 "passageway"

738		2803-2805	240	shc 80x80x35 quite dense, small upper attached area 10 thick may be broken remnant of a second upper cake
			132	shc 65x70x25 plus small raised part, pale glassy top looks like added sediment
			52	small prilly/dimpled sub blowhole mass
740	g	2587	128	shc 80x70x30 with one side bent up in extraction, top glassy with lots of sandstone clasts, small attachment area, base green, lobate distally, proximally fused to sandy sediment
769	G	2806-2823	680	20 pieces, 14 small pieces total 118g; 124g lip of small shc, very dense slag crust, dimpled base, slightly granular top; 32g twisted slag piece, fairly well flown; 24g iron-rich slag, rusty; 38g well flown top, dimpled base; 118g, 98g, 122g substantial parts of slightly twisted charcoal-rich shcs

Area A/B metalworking

C887, a 0.77m diameter, 0.2m deep pit, filled by C888, 886, 881

881	B	sample 287 burnt clay from 881	120g large tuyère piece; 82g 15 small pieces plus lots of debris, tuyère irregular but probably at least 160mm diameter

881			soil sample	264	washed - 94g dried residue, 16.73g of this magnetic - granular, some spheroids, flake almost absent
886			soil sample	396	washed - 20g stones; 96g coarse material of reduce-fired porous ceramic; 78g fines - 4.09g of this magnetic, almost no scale, granular with slag
886	A/B baulk	none			large bag of material labelled approx 93 pieces
					768g fines, 100 g of fines separated out, only 22g of this was non-magnetic
					the dominant fines are tiny charcoal fragments cemented by a rusty material
					non magnetic fines include grey reduced fired clay, quartz/lithic sand and charcoal. With a few slag pieces
					coarse material 1960g, dominantly the hard sintery charcoal rich material that dominates the fines, but also the grey fired ceramic including two large pieces from a tuyère block, also a couple of pieces of lining slag, some dense slag including a descending silvery prill
887 (=888?)	base of cut			4720	iron rich deposit, typically 50 but up to 80mm thick attached to reduced fired clay. At least two pieces also show small burr development. Deposit is the "sinter" seen elsewhere - it has lots of fine charcoal and small grey particles which are probably ore dust
				316	irregular block of microprilly slag. No clear orientation - but quite dense
				702	fines from washing
103	B	1491	cleaning near cut 887	26	nub of slightly granular iron slag

Area G Phase 5 - destruction of phase 3 features

749	G	2858-2918		568	prob 80% of slightly multilayer dense cake, 100diameter , 40mm thick
				224	80x90x20, slab like slightly irregular shc
				188	80x60c20 slab of slag, possibly an unusal shc
				506	small part (<30%) of thick crust cake, crust 30mm in centre, >130mm diameter, base rough with tool marks, top smooth in thin skin, with intermittent void immediately below a few mm deep max, with crystal terms on its base.
				96	prob sheet like tiny shc deformed on extraction, incomplete
				714	5 fairly conventional shc fragments
				236	burr region from a large shc
				34	slag piece from lower part of tuyère face
				24	small piece of backflow from under tuyère
				34	small bur fragment
				756	49 small slag pieces, amorphous through small irregular blebs to one or two small prill framgents

			26	4 pieces of lining influenced slags
			138	2 balls of dense slag, probably hearth slags
750	G	2034	238	slightly double layer beefburger-like shc, larger basal layer like burger, smaller upper layer has green glassy top, 80x80x45
727	G2	2739-2771	162	70x70x20mm small burger-like smithing hearth cake
			632	26 various piece of dense probable smithing slag but not entirely diagnostic
			88	3 pieces of green glassy lining slag
			4	vitrified lining
			72	piece of well flown slag in contact with lining, possibly a smelting slag,
			322	4 pieces of dimpled and charcoal-rich dense slag - possibly deformed small smithing hearth cake fragments
727	G	1268-1269	70	stone
			148	irregular dense slag lump, v variable - probably a fairly dense shc twisted and broken in extraction
727		2704-2736	186	26 pieces of dense, undiagnostic iron slag
			34	broken fragment of dense dark granular slag
			54	3 pieces of vitrified lining
			122	bowl shaped concavo-convex fragment, prilly and dimpled base, internal/upper surface with extremely large olivines in voids
			20	lobate flowed slag, flown over slightly convex surface (like smelting slag but not conclusive)
727	M	1455	58	worn nub of dense Fe-ore
Unstratified/modern/minor contexts				
1		1255	288	shc 90x85x40, top smooth with slight charcoal impressions, base dimpled with better impressions, very dense
1	8	2625-2656	18	stone
			22	dense tapslag-like flow lobes
			4	glazed pebble
			70	3 pieces of slagged lining or tuyère
			178	dense slag looks like highly contorted and broken shc
			43	shc fragment with abundant 10mm fluxing clasts in greenish matrix
			146	probable shc fragment

			76	3 probable smithing slag pieces
1	H	1180	116	clinker? Attached to fired and bleached shale block with plant fossils
1	A T1 north ext	2665-2668	96	1 piece iron slag with large charcoal moulds (could be smelting), 1 piece blebby slag very rich in iron (including possibly metallic iron to judge by amount of rust), 1 piece indeterminate iron slag, 1 piece sandstone
1	a	1188, 1190	112	1 small glazed pebble, 1 irregular slab of Fe-slag with abundant charcoal, rather rusty, very dense
1	H	1428-1450	400	24g 6 pieces coke, 1 piece dense Fe-slag with shale chips, rest low density clinkers
1	E	1043	56	shale rich clinker
1	J	1452-3	74	i1 piece of platey slag, the other moderately well-flown around charcoal, v dense
1	B T8	2625-2656	576	(not recorded)
1	J T7	1423	24	dense dimpled slag nub with included sediment grains
1	D	755	1	black glass coffee bean (so probably coal fired)
1	north of bank 56 area 5	1276-1288	220	162g 7 nubs of dense sag, varibly dimpled; 6g lining/tuyère with vitrified surface; 36g 3 small concretions- around corroding iron?
1	d	1467	60	contorted nub of dense slag, vesicular dense grey
1	D	2678-2685	104	114g slaggy clinker, 4 main pieces; 46g 2 stones; 152g piece from deformed slag cake, charcoal-rich in top, bent during extraction
1	D	1376-1379	66	5 pieces of slaggy clinker
1	D	2637-2638	26	2 stones
1	G	1373-1374	25	1.7g nail shank; 23.7g small section of thin shc
2	t1	2669-2677	666	214g small folded shc with two poker tubes across base to extract; 198g irregular charcoal dimpled slab - probably a folded shc; 244g 7 pieces of vesicular charcoal-rich slag
2	J	1262	68	dense, concreted, worn(?) slag nub, with some charcoal
3	A	2639-2664	974	11 pieces of rather granular, charcoal-rich slag, with somewhat lobate surface. Not clearly identifiable, but these are likely to be from a smitihing hearth
			134	38 tiny pieces of indet iron slag
			70	3 pices of slag with large equant olivines giving an open granular texture, but also containing charocal moulds, and lobate/prilly structures
			586	dense irregular rounded slag block with charcoal. Probably a small piece from one of the cakes as seen elsewhere in this context. Some rusting suggests some included iron
			326	iregular slag block, probably part of a thin crust cake folded on extratction. Very rusty of one side suggesting included iron
			258	5 pieces of dense slag, have somewhat lobate internal structure, sometimes with a puddle base, sometimes lobate to the base. Charcoal impressions on base, large internal vesicles, could be very fluid shc or could be a smelting slag.
			458	slab of charcoal-rich slag, possibly from the interior of a thin crust cake.
			2320	large block apparently of a thin crust shc, has various intersecting curved lower faces so overall shape and size v difficult to reconstruct. Most likely c60% of a dense thin crust cake, with a small thin crust cake base welded to base.

			530	small block similar to above - same smooth but charcoal rich base and charcoal-rich dense body. Shape not determinable
4	H	1181-1183	232	1 small piece with dense flow lobe, 1 piece of dense platey slag, 1 larger piece with abundant charcoal
4	J	1454	150	irregular mass, probably formed from coalesced shc fragments at odd orientations, looks as if fused by slag rather than corrosion
5	area 20 cutting 1	1352, 1325	56	2 small pieces of iron slag
9	A	953	15	tiny piece of slag with iron corrosion starting to explode
44	a	1194	106	poorly flown lobe of iron slag, irregular top, base with very fine charcoal moulds, probably a smithing slag
62	5	2615-2624	116	60g 6 pieces fired orange lining with vitrified surface, largest piece at least might be from tuyère; 56g three pieces of slag with attached concretion and one small dimpled fragment of probable smithing slag
103	B	2491	40	nub of dense vesicular and charcoal-bearing slag
111	D	2696-2698	132	large block 118g is well flown dense slag with angular base - flown between stones or timbers. Some large charcoal impressions. Other 2 pieces are tiny finy slag fragments
111	D	1388	10	iron ore - curious texture, pale slightly vuggy areas or inclusions. May be oxidised sulphide
122	D	931	116	broken burr from small cake, very coarse olivine inside vesicular (coralline) burr, moderately large large charcoal below cake and smaller above
127		2699-2708	126	120g 9 pieces of coke/clinker; 4g coal; 2g Fe-corrosion
132	D	2686-2695	302	9 pieces of slag, not very diagnostic dense Fe-slags with dimples
601	H	1424-1426	46	3 pieces of clinker
603	H	1451	164	large block of clinker
605	ext H	1456-1466	12	small piece bone, 1 piece coke, 1 piece indeterminate Fe-slag, 8 pieces of shaley clinker
unstrat	D	1069	540	slightly granular topped slag with dense bowl base - probably a shc deformed on extraction

Table 1. Catalogue of residues from Carrigoran by bag.

	<500	*<1000*	*>1000*	*<3000*	*Max wt (g)*	*n*	*Mean wt (g)*	*Modal 100g int.*	
Carrigoran	72%	89%	11%	94%	3866	18	553	100-200	Early Christian. 1687, 3866 are outliers
Ballykilmore	43%	69%	31%	89%	4033	35	1099	300-400	Post-Medieval?
Clonfad	30%	65%	35%	92%	11000	375	1177	300-400	Early Christian
Clonmacnoise	39%	68%	32%	92%	5540	38	1087	300-400	Early Christian
Coolamurry Site7	83%	95%	5%	100%	2588	41	386	100-200	Early Christian. 1533, 2588 are outliers
Marsh Leys Farm	77%	100%	0%	100%	824	30	333	100-200	A Roman site in the English East Midlands, typical of the waste products from an early smithy (Young 2005a)

Table 2 . Summary statistics of the size of SHCs at Carrigoran. Comparative data are provided from the author's unpublished work at four Irish sites, for which the SHC size distribution is very different, and one Romano-British site with a rather similar SHC size distribution (although lacking the large outlying SHCs).

Area G metalworking

Table 3. Summary of distribution of archaeometallurgical residues.

C768, a 1.15m long x 0.3m deep pit has two fills 754 and 756 and overlying deposit 748									
756/748	*shc*	*other*	*smelting*	*tuyere*	*lining*	*iron/conc.*	*ore*	*clinker*	
	2486	*1259*	*208*	*66*	*42*	*42*	*0*	*0*	***4103***
C767, a 0.5m diameter, 0.11m deep pit, 0.1m NW of C768, filled by C755									
755	*shc*	*other*	*smelting*	*tuyere*	*lining*	*iron/conc.*	*ore*	*clinker*	
	0	*0*	*1022*	*0*	*0*	*0*	*0*	*0*	***1022***
C714 "passageway"									
738/740/769	*shc*	*other*	*smelting*	*tuyere*	*lining*	*iron/conc.*	*ore*	*clinker*	
	962	*264*	*0*	*0*	*0*	*0*	*0*	*0*	***1226***
Area G Phase 5 - destruction of phase 3 features									
749/750/727	*shc*	*other*	*smelting*	*tuyere*	*lining*	*iron/conc.*	*ore*	*clinker*	
	3236	*2206*	*72*	*58*	*54*	*0*	*58*	*0*	***5684***
overall	***6684***	***3729***	***1302***	***124***	***96***	***42***	***58***	***0***	***12035***

Area A/B metalworking

C887, a 0.77m diameter, 0.2m deep pit, filled by C888, 886, 881									
	shc	*other*	*smelting*	*tuyere*	*lining*	*iron/conc.*	*ore*	*clinker*	
	0	*26*	*6996*	*204*	*0*	*0*	*0*	*0*	***7226***

Unstratified/modern/minor

shc	*other*	*smelting*	*tuyere*	*lining*	*iron/conc.*	*ore*	*clinker*	
5533	*4353*	*118*	*60*	*78*	*40*	*10*	*1099*	***11291***

30402	***total excluding corroded iron and ore***	***30552***

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