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Evaluation of Archaeometallurgical
residues from the M7/M8 Contract 1:
Parknahown 5 (E2170)

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Abstract

The assemblage from Parknahown 5 comprises 100kg of archaeometallurgical residues, principally from iron working (smithing), but with a minor component from iron smelting. There were no metallurgical features recorded within the enclosure; the residues derive from accumulations within the enclosure ditches and from the dump of material down slope at the north of the site. Both the ditch of the early univallate enclosure and the inner of later ditches of the bivallate enclosure contained slags. The outer ditch of the bivallate phase contained almost no residues, suggesting that activity was focused on the interior of the enclosure. Disposal of residues was concentrated to the north of the site, with over two thirds of residues recovered from this area.

Smithing residues are dominantly smithing hearth cakes of a fairly small size. There is a marked upper cut-off at 490g, with 70% of SHCs being below this weight. Larger SHCs range up to around 2.9kg, but are rare. In addition to more normal textures of SHC, the site yielded evidence for the use of hearth with a large stone in its base. Development of the SHC took place with a burr-like feature on the base of the SHC which appears to have eaten into the basal stone. Distally the SHCs from this hearth pass in material which has flowed across the surface of the stone, giving an internally flow-lobed sheet with a shiny, non-wetted basal surface.

Iron smelting slags were difficult to discriminate from smithing slags on this site, for both processes may produce slags which are agglomerations of small prills. Some material of this type contains moulds of large pieces of wood or charcoal associated with amalgamated flow slags; these are more confidently ascribed to iron smelting and resemble smelting slag cakes from slagpit furnaces on other sites. No large pieces of these smelting slag cakes were recovered, but small pieces suggest that the cakes may have had a shallow, plano-convex form with gently sloping sides, at least towards the blowing side, suggesting a rather shallow slagpit.

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Methods

All investigated materials were examined visually, using a low-powered binocular microscope where necessary. All significant materials were summarily described 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

1. Materials associated with iron-working

1a. Smithing Hearth Cakes (SHCs)

The SHCs from Parknahown are mainly fairly small, but are very variable in terms of morphology and structure. The size-frequency distribution is given in Table 2 and illustrated in Figure 1, with the summary of the statistics given in Table 3.

Textures vary from dense, compact forms, through to rather open-structured prilly cakes with abundant included charcoal. Most of the larger examples are of forms with a dense, coarsely crystalline thick crust.

One curious form of SHC noted in the assemblage has a well-fluxed bulbous zone (somewhat similar to the burr on a conventional SHC) apparently within the lower crust. This form is explained by a specimen from F20 which shows development of an SHC immediately above a flat sandstone slab. The base of the SHC has impinged on the sandstone and resulted in the corrosion of a hole into the sandstone. The reaction of the iron-rich slag with silica of the sandstone has generated a very fluid fayalitic slag that has flowed away from the reaction zone (presumably away from the tuyère). This slag adheres tightly to the sandstone close to the hollow, but rapidly changes to show a non-wetting, lobate, surface similar to the textures commonly seen on the sides of the slag mass from a slagpit smelting furnace. Such lobate slags with a shiny, planar contact were recovered from various contexts and presumably came from this, or a similar, hearth.

1b Other smithing slags

Very few slags, besides the SHCs, could be attributed to smithing. The exceptions were rounded balls of slag, similar to those in the SHCs, that could be interpreted as hearth slags. The generation of detached slags in the smithing hearth outside the SHC is less common in charcoal hearths than in coal hearths, and it is possible that hearth slags such as these may either be incipient SHCs or fragments of SHCs that have been moved and deformed when hot.

1c Technical ceramics

Small fragments of vitrified and/or slagged clay occurred in many contexts. A proportion of these could be identified positively as sherds from ceramic tuyères. All of the material was compatible with such an origin and it is unlikely that any of the sherds are not from tuyères.

The small size of the pieces from Parknahown meant that it was difficult to estimate the external diameters of the tuyères with any confidence. Some sherds suggested a rather low degree of curvature of the outer face, indicating either the use of large tuyères or of tuyères with non-circular cross sections.

1d Iron

Various concretions around pieces of iron were recorded, but none was indicative of the form of the contained iron.

2. Material from iron smelting

Certain iron smelting slags formed only a small proportion of the Parknahown assemblage. The two most easily recognisable features of iron smelting slags from slagpit furnaces in Ireland are the characteristic dense flow slags (formed from the flow of slag trickles through the fuel within the slag pit) and the moulds formed by the flow of the flow slags around the very large pieces of wood (or charcoal) with which the basal pit was packed. At Parknahown these features are recognisable, but not in their classic forms. Many of the flow slags are of rather low density slags (and may also be rather badly altered). No really large wood moulds were found, although there are flow textures delimiting medium sized moulds, particularly of roundwood. Some of the specimens showing these features (e.g. from sample 990) appear to show them occurring near the margins of slag cakes with gently sloping sides, meeting the upper surface at a very acute angle.

This suggests that the identified smelting slags may be from with the main slag cake, rather than the situation at most sites where it is the dense isolated slags from lower in the pit that are more easily recognisable than the agglomerated prills of the main slag mass.

Not enough of the slag cakes survives at Parknahown to be able to determine much about their morphology, but the lack of isolated slags might suggest either different patterns of disposal of the pit fines and the main slag mass (a feature suggested by other sites where only the pit slags survive), or that, in this instance the smelting furnaces were very small and the main slag mass actually impinged on the pit base.

3. Indeterminate slags

This category includes all the slags not specifically identifiable to the other categories. This includes material that is simply too fragmented to identify, as well as pieces that are of non-diagnostic textures.

The problematic textures at Parknahown are particularly the rather friable slags, formed of amalgamations of small prills. Both the smelting slags and some of the SHCs show such textures, so for fragments without any indication of external form, discrimination was usually impossible.

4. Distribution of the residues

A summary of the distribution of the residue classes is given in Table 5. Despite the simplifications inherent in this division of the stratigraphic record, it seems ironworking activities continued through the early medieval history of the site.

Residues are associated with the enclosure ditches and in the bivallate phase it is the inner ditch which received the residues, not the outer, suggesting activities were within the enclosure. Two thirds of the residues derive from the northern end of the site – suggesting either metalworking occurred in this area, or that downhill disposal of the residues was preferred.

It is noteworthy that almost no metallurgical residue was recovered from the cemetery. This indicates exclusion of such activities, in contrast to the situation at Ballykilmore (Young 2009b), for instance, where the graveyard appears to have spread within the enclosure over areas previously involved with iron production.

Interpretation

The residues from Parknahown 5 are indicative of both iron smelting and smithing. Given the large area of the enclosure that was excavated, the total quantities of residues are not very great. Quantification of blacksmithing activity is always difficult, for assessing the degree of completeness of the record is impossible. Thus, only a minimum level of activity can be calculated – in this instance there is sufficient slag to be equivalent to perhaps just one smelt and 150 smithing sessions – but the real level of activity will have been much higher. None-the-less, despite the substantial assemblage of 100kg of residues, the metalworking activity need have been no more than intermittent.

The evidence from the SHC assemblage would suggest that end use blacksmithing was a more significant activity at Parknahown than the refining of raw blooms, which may have happened only rather rarely. Smelting also occurred, but the level of residues is very small.

In detail the SHC assemblage shows similar characteristics to the small assemblages from Carrigoran (Young 2006b; another site showing some evidence for occasional smelting alongside smithing), Navan (Young 2007; which had no evidence for smelting) and Moneygall (Young 200b; also with no evidence for smelting). Sites with mean SHC weights above 1kg are all believed to have been involved with bloom refining.

The lack of any identified hearths within the enclosure may mean they were outside the excavated area, or perhaps were raised hearths, or that they have been removed, either by general agricultural truncation or because they were situated on the enclosure bank. The location of the discovery of the stone-floor of a smithing hearth (F20, sample 922), which was unlikely to have been transported far, may help with locating a hearth of at least one period.

Evaluation of potential

The Parknahown assemblage does have useful potential to further understanding of small-scale early medieval iron smelting. Further analysis of both the probable smelting slags and some of the other flow-lobed residues would be useful.

Detailed analysis of the smithing residues would be rather less useful since they are both not particularly well-preserved and relatively straightforward to interpret.

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context	sample	weight	notes	SHC details	
				% of orig.	Orig. Wt.
box 1					
1	892	22	dense slag		
1	893	36 19	weathered irregular slag sheet clinkery slag		
1	894	11 2	rounded lump of fired clay tuyère sherd		
1	895	355 481 355 84 202	90x80x50mm of which bowl 30mm, neat dense SHC rather rusted 110x110x50mm (bowl 25mm) discoidal SHC, rather irregular slag on top of bowl, neat base rather amorphous lump of slag which, might be a twisted and folded SHC, - if so unclear whether it is complete SHC crust fragment 4 pieces of iron slag	100 100	355 481
1	896	21	iron slag indet		
1	897	1280	large irregular block of slightly granular slag - probably from SHC		
1	898	118	SHC crust fragment		
1	899	6	dense slag indet		
1	900	8	vitrified clay		
1	901	124	probable SHC crust - might even be almost entire small SHC		
1	902	9	highly blebby dimpled prill		
1	903	10 167	2 pieces of dark possible flow slag 7 fragments of vesicular probably hearth slag		
1	904	31 15 81	small scraps of fresh dark slag low density lining slag bleb curious very dark well flowed lobate slag attached to crust - probably an SHC fragment but could be flow slag - very fresh		

context	sample	weight	notes	SHC details	
				% of orig.	Orig. Wt.
1	905	11	granular slag fragment		
1	906	159	part of small SHC - not enough to give dimensions but well-formed and dense		
1	907	7	slag indet		
1	908	106	dense slag with rounded blebs, dark - possibly coal-fuelled smithing slag?		
1	909	1	tiny slag bleb		
1	910	12	corroding nail head		
1	911	15	slightly flowed dense slag with flat non-wetted base		
1	913	11	iron slag, dense, indet		
1	914	1	coal		
1	915	21	dense slag bleb with attached iron		
1	916	31	dense microprilly slag fragment		
1	917	349 30	19 pieces of indet slag 3 pieces of vitrified clay - probably tuyère sherds		
1	918	320	SHC fragment		
1	919	97	2 rounded, possibly hollow, certainly very vesicular slags, dark with rounded blebs, just possibly coal fuelled slags		
17	920	59	3 indet slag fragments		
17	921	281 257 297	4 rounded lumps of slightly granular hearth slags 90x90x45mm small SHC with central void, slightly biconvex but would have been more so before collapse of central void base of granular cake - presumably SHC	100	257

context	sample	weight	notes	SHC details	
				% of orig.	Orig. Wt.
20	922	3730	stone slab broken in two forming the base of a hearth. This piece ties in various other types of residue seen in these contexts. It has a dense burr type of area in a deep rounded hollow in the stone, probably around 150x180mm or so, distally of this the slag is initially attached to the planar face of the sandstone, then lifts off with a non-wetted surface, then rises off the stone with a brownish somewhat flowed slag layer/sheet. No good directional flow so presumably this is a flat hearth base, rather than a vertical side. The slag shows a cavernous/coralline/clotted texture in many areas suggesting some draining from main slag area - perhaps associated with flow outwards, there is fired clay associated with the proximal edge and left side of the main stone - the slag also appears at lower level to the left of the main stone - suggests hearth was complex- perhaps with a just a stone centrally in a clay hearth even?		
22	924	91	slag indet		
28	925	594	130x90x40mm double layer SHC - upper dimpled irregularly-shaped slab, rusty, lower dense layer is sheet like - and may have extended further, microprilly	100	594
26	926	215 158 8 28 33 142	probably SHC fragment - in 3 pieces internally prilly slag block charcoal-rich slag fragment possible flow slag slagged margin of small (c100mm) tuyère tip small cavernous, slightly gravelly, lining slag mass - possibly small SHC	100	142
32	927	323 38 143 434 186 403 1668	16 sherds of fired ceramic - 3 of which are positively identifiable as coming from a large diameter tuyère slagged tuyère sherd 7 pieces of flowed slag - all could be flow slags or just dribbles in the smithing hearth curved slab with a planar slightly flowed face and a convex microprilly face. 130x80x50mm, probably an SHC - but inverted could be a furnace floor - same problem as 222g piece from c34 80x50x45mm, probable small SHC - has slightly flowed dense planar surface and microprilly strongly convex base block of microprilly - granular slightly friable slag - no clear external surface 42 pieces of iron slag indet - some probably SHC fragments	100 100	434 186
32	928	358 148 154 503	30 sherds of tuyère plus a substantial slag beard on a tip. Curvature of several pieces suggests 180-200mm diameter irregular lump of microprilly/granular low density slag granular slag passing down into thin crust, dense 30 pieces of iron slag indet		
32	929	75	90mm long slag rod - possible a poker cast?		
32	930	381	dense burr broken in 3 - must have been from a large cake		
32	931	96 127	7 sherds of tuyère tiny low density SHC - prilly with inclusions of lining lag	100	127

context	sample	weight	notes	SHC details	
				% of orig.	Orig. Wt.
		271	2 pieces of dense vesicular slag with planar base - another stone based SHC?		
		256	15 pieces of slags indet		
33	932	203	18 sherds of tuyère		
34	933	732	folded and snapped slag sheet, microprilly on lower, glass on upper- suggests this is a very flat SHC	100	732
		222	90x70x40mm small SHC with lobate margins, somewhat soft and brown (alternatively possibly a low slag piece)		
		260	80x70x60mm small irregular SHC	100	260
		170	slab of basal crust with some low slag like material adhering to inside of bowl, brownish		
		74	possible flow slag bleb		
		52	probable flow slag		
		82	probable flow slag		
		101	crust like 170g piece above		
		96	possible flow slag		
		117	brown weathered cavernous slag indet		
		46	brown weathered slag indet		
34	934	330	block of irregular charcoal-rich slag, one side smoothish with wood impression and red rust, body is prilly with up to 70mm charcoal/wood moulds		
36	935	372	90x75x55mm of which bowl 25mm, small dense SHC with one end raised or twisted up, micro-dimpled base, rusty top	100	372
36	936	402	rounded prilly vaguely triangular piece with smooth top, probably a very odd SHC, with most present, 100x80x60mm	100	402
		383	small SHC with deeply dimpled top, 90x75x45mm	100	383
		250	block of friable internally prilly material with smooth top, could be from a thin crust SHC or even from a smelting cake		
		386	100x80x55mm curiously shaped piece- possibly a SHC with glassy top and slightly prilly base with an earlier inclined disc-like SHC stuck to distal end	100	386
		26	friable slag fragment - possibly from 250g piece above		
		62	SHC fragment		
		120	another friable piece, curved, this has some poorly developed crust, but is contorted, making interpretation difficult		
36	937	92	2 pieces of good dense low slag		
		84	flow slag attached to more charcoal-rich material		
		148	3 fragments of charcoal-rich material of varying density		
		1166	massive concretionary lump enclosing some somewhat flowed slag of uncertain nature and size		
		2308	another concretionary lump - protruding curved crust suggests it contains an SHC		
37	938	1843	20 fragments of a friable slag cake with internal flows and moulds of very large fuel fragments, shows mould to curve of base of pit in one piece - this must be "furnace bottom"		
		217	80x80x35mm, small rather blebby looking SHC	100	217

context	sample	weight	notes	SHC details	
				% of orig.	Orig. Wt.
		203	irregular slightly lobate sheet - could be an odd SHC?	100	203
		400	70x90x45mm dense slightly dimpled plano-convex SHC	100	400
		92	55x40x25mm tiny plano-convex slag lump - possibly an SHC	100	92
37	939	144	broken piece of low density flow slag		
		106	low density slag probably associated with above pieces		
box 2					
47	940	403	prilly mass - possibly an SHC equivalent - but wide and deep, 50x130x70mm. Top very rusty but smooth, full of charcoal and white chalky ash	100	403
		352	wide shallow coralline SHC, central part of dish top glassy, raised coralline texture all round (except proximally) 110x125x35mm. Glassy drop has flown as drip down straight fracture on bowing side	100	352
74	941	3	small chert piece - silicified burrow? Not slag		
100	942	81	curiously superficially prilly curved sheet of slag - possible part of a small SHC or a beard from a tuyère tip		
104	943	371	13 pieces of indet slag, variable but possibly all SHC fragments		
104	944	253	3 pieces of grey very dense slag - probably SHC fragments		
110	945	103	probably most of a small SHC broken into 3 pieces		
111	946	113	2 pieces of probably weathered small SHC		
		30	blebby piece that may be a flow slag		
122	947	83	contorted dark, almost purple, slag sheet - probably a folded tiny SHC or part of an SHC		
122	948	880	dense SHC with really neat dished dense upper layer, sitting on much more irregular lower part, 120x110x60mm	100	880
		251	5 SHC fragments		
122	949	1159	double layered very thick crust SHC, about 40% probably, c170mm diameter, bowl to 60mm deep	40	2898
		587	18 pieces of irregular hearth slags		
		374	130x100x30mm, either gently curved crust from a large SHC - or a flat entire SHC		
		113	SHC fragment		
		133	SHC fragment		
		70	charcoal-rich slag indet		
1	950	93	rounded slag lump with smoothly lobate top, indet, but just possibly a tiny SHC?		

context	sample	weight	notes	SHC details	
				% of orig.	Orig. Wt.
		5	indet slag		
122	951	105	SHC fragment		
		110	dense slag lump		
		421	110x100x30mm crust or SHC with eroded top?		
		130	SHC fragment		
		103	SHC fragment		
		1006	140x130x35mm medium sized very dense SHC, smooth planar top, fairly smooth but finely porous base	100	1006
		444	130x95x35mm SHC. Prilly base but absolutely smooth puddle top - must have been a very fluid lag. Prills large and locally pale	100	444
		665	mass of finely charcoal-rich soft material similar to 960g block below		
		330	60x110x60mm microprilly mass with knife-sharp planar surface to rear - possibly formed against stone - SHC equivalent	100	330
		151	thin crust with smoothly lobate upper surface		
		220	part of small dense SHC - maybe about half	50	440
		777	150x130x70mm very irregular ashy block, possibly a SHC	100	777
		960	large block, possibly deformed of friable soft brown charcoal-rich slag		
122	952	54	2 piece of probable dense low slag		
123	953	178	lobed slag set in ashy matrix - a bit like some smelting floor material, but could be a prilly SHC fragment		
		134	2 pieces of charcoal-rich ashy slag		
		45	dense flow slag		
		21	2 pieces of slagged ceramic surface		
132	954	4	rusty concretion		
135	955	96	very fresh fragment of microprilly/granular slag with microprilly base		
142	956	74	prob SHC fragment		
145	957	487	100x100x50mm (30mm bowl) almost plano-convex SHC, very neat shape, slight central cavity	100	487
		662	100x110x70mm quarter circle shape SHC, very deep central part of top is iron rich disc	100	662
149	958	52	SHC crust fragment		
		16	slag indet		
149	959	932	large irregular block from the centre of an extremely large double layer cake, probably double layer because there are two superimposed cakes rather than an intrinsically two layer structure		
		372	probably complete small SHC, very iron rich lower lumpy part and more slaggy, smaller upper layer, 80x80x55mm of which iron rich layer 25mm	100	372
		103	part of small SHC		

context	sample	weight	notes	SHC details	
				% of orig.	Orig. Wt.
		124	iron slag indet		
149	960	550	115x140x55mm neat dense transverse SHC	100	550
		443	80x110x40mm probably an SHC, but has area of crust or burr rather low down giving an odd appearance	100	443
		938	110x90x50mm slight irregular but very dense SHC	100	938
149	961	118	lobate slag sheet, rough base, smooth top, probably vestigial SHC, 75x75x25mm	100	118
		37	indet slag		
149	962	163	dense small burr or base of SHC, grey slightly vesicular shaped - curved but overall form not known		
149	963	15	rusty slag fragment		
		31	charcoal-rich slag fragment		
		97	SHC burr/lip with very smooth top		
		321	ferricrete on much of small SHC		
		933	90x125x65mm dense deep SHC probably 90%, parts of lower crust seem missing	90	1037
		924	120x155x50mm dense neat SHC with fairly smooth top	100	924
		572	60% of dense plano-convex SHC, 130x(80)x45 of which bowl 30mm, crust 15mm	60	953
149	964	1224	160x135x40 very flat SHC	100	1224
149	965	398	4 blocks of grey dense slag with small vesicles. At least two pieces appear to be from a burr		
149	966	300	110x80x50mm of which bowl 35mm, rather irregular SHC	100	300
		265	dense double layer mass- possibly a small deep intact SHC	100	265
		52	indet slag in 2 pieces		
		162	probably entire small SHC - odd shape 60x50x40mm, rounded quarter circular top, angular base	100	162
149	967	1462	140x120x80mm dense neat almost plano-convex SHC - just very slightly dished top, very dense, deepest proximally	100	1462
		444	100x100x45mm plano-convex SHC dense, neat	100	444
		36	indet slag fragment		
		114	slag broken from tuyère tip, tuyère is of very low curvature		
		113	70x50x30mm tiny dense plano-convex SHC	100	113
		79	indet vesicular slag fragment		
		248	small SHC with thin crust and charcoal-rich interior, badly fractured on extraction - originally 100x90x40mm	100	248
		251	dense indet slag with lobate flows above flat base - just a small fragment though		
1	968	9	dense blebby dimpled slag with purple surface in rounded lump		
167	969	27	rusty concretion		

context	sample	weight	notes	SHC details	
				% of orig.	Orig. Wt.
		47	nub of charcoal rich slag		
161	970	380	curious prilly slag mass with various smooth surfaces, probably a low density SHC, 90x100x60mm	100	380
		29	dense slag rich in tiny charcoal		
		18	dimpled slag fragment		
		481	110x100x50mm probably a very irregular dense SHC	100	481
Box 3					
427	343	7	dimpled slag bleb with one large charcoal mould		
165	971	9	corroded iron artefact		
165	972	109	dense slag fragment with dimpled base and smooth top. Strange grey-purple colour, very coarsely crystalline, possible chert fragments included - almost entirely fayalite		
167	973	13	dimpled small slag bleb		
180	974	20	sherd from margin of tuyère face - only small area of edge but suggests 100mm diameter, oxidised fired internally		
184	975	518	large slab of curved crust with 3 tool marks on base (cf Frocester). crust to 20mm no bowl contents, no true edges		
		367	charcoal rich friable slag with planar basal contact		
		20	small lobate fragment		
		158	charcoal-rich crust with bend - deformed?		
		63	SHC fragment		
165	976	4	small fragment of ashy possible flow slag		
194	977	45	4 pieces of rusty blebby slags, one with possible planar floor contact		
213	978	4	bog iron ore fragment?		
		15	charcoal-rich microprilly slag - curves around a larger void - so might just be a flow slag		
		16	ferricrete on slag or iron?		
224	979	465	block from the centre of a large SHC with crust 30mm thick, microprilly base irregular (charcoal?) top is not the top of the cake		
		1101	11 pieces of a prilly friable cake, a bit weathered, one piece has a possible burr but little overall sign of shape - but presumably large		
		568	9 lumps of dense slag, some probably with included iron		
224	980	538	6 pieces of dense slag apparently containing iron		

context	sample	weight	notes	SHC details	
				% of orig.	Orig. Wt.
		42	lumps of iron		
		508	plano-convex prilly cake - not clear if it is an SHC or part of something larger? 120x120x50mm		
		536	ferricrete block - probably mainly prilly slag, but obscured		
		677	5 pieces of large thinnish crust SHC with crust to 20mm, with tubular vesicles, below deep porous bowl fill to 60mm? Proportion of cake unknown		
231	981	453	130x100x40mm elongate triangular SHC or tongue, top glassy, base iron rich and prilly	100	453
		27	dense slag with smooth charcoal dimples		
		58	lower density iron slag with enclosed charcoal lumps		
		1224	180x115x65mm SHC, of which bowl 40mm, plano-convex, slab of lining rich material resting on proximal end, elongate, dense, smoothish base, top has slight concentric lineations	100	1224
		47	dense rather blebby or prilly slag lump		
		49	dense rather blebby or prilly slag lump		
234	982	1128	large accreted block of slag with one perfectly smooth face - looks like an accumulation on, or flow over, stone, but no real detail		
		452	irregular dense slag lump		
		159	clean piece of flow with a smooth, but non-wetted lobate base. Upper part broken -not good lobes like true flow slag		
		442	axe head shaped fragment from a SHC, has moderately thick crust with brittle fractures. Must have been a large SHC		
		106	ferricrete on slag		
		309	biconvex SHC with central void, similar to material above, this is probably 80% of a cake - very dense slag lower crust to 10mm, 100x60x45mm	100	309
		470	SHC broken off then folded double with tongs on extraction, dense, size not determinable	100	470
		373	neat small SHC, plano-convex bowl with spherical lump of slag stuck on top at one end, 110x80x60mm of which bowl 25mm, base dimpled	100	373
		200	part of small SHC crust		
		178	part of crust of an SHC		
		209	dense slag with flow lobes onto planar surface		
		319	very dense rather granular appearing slag lump		
		451	probable SHC fragment		
		332	probable SHC fragment		
234	983	832	large block representing the burr region of an extremely thin crust cake with micropilly/granular crust, curvature suggests cake of c250mm across		
		150	prilly/lobate slag with sediment contact on one side and medium-large voids, probably charcoal voids		
		188	lobate slag around medium charcoal moulds, rusty		
		394	large block of porous slag with several denser crust-like horizons, has one possible basal surface at low angle to these and a possible blown surface at a high angle - could be side of large bowl with inclined layers		
		103	low density charcoal rich slag lump		
		1058	curious almost plano-convex presumably SHC formed of lobes, rusty top with hollow, lobate base, 150x110x50mm	100	1058
		810	130x130x50mm triangular SHC with dished blown top and strongly lobate base, extending distally well-beyond top	100	810

context	sample	weight	notes	SHC details	
				% of orig.	Orig. Wt.
		1058	margin with burr of large cake with neatly inclined base, but orientation hard to establish; it could be a relatively flat SHC with a disturbed proximal area, perhaps folded up, or it could be a steep sided piece - perhaps even from smelting, very difficult, but SHC probably best interpretation		
		276	very weathered piece which is probably most or all of deeply dished low density SHC, rusting hints there might have been loss of metallic iron from this though	100	276
		303	rounded lump of charcoal-rich slag, with a rounded blown surface, might be deformed SHC but hard to be certain		
		252	porous rusty weathered slag - possibly from lip of large bowl		
		314	prilly SHC, now low-density, cut through centre at angle so either 50% of a cake - or one which formed as a semicircle against an inclined wall	100	314
		908	part of a large flat dense SHC, possibly 60% but very tentative, 130x150x50mm, bowl 30mm deep, but horizontal dimensions not known because broken	60	1513
234	984	863	120x110x45mm, very dense neat SHC, plano-convex, smoothish base	100	863
		1213	150x140x65mm, prilly SHC, with slightly double-layered form, lower bowl 25mm deep some lateral lobing, upper part prilly with blown hollow	100	1213
		127	piece of basal crust with large lobes above between moderate charcoal moulds		
		131	rusty, prilly slag lump		
		101	broken slag ball, dense with central void, probable lower crust has somewhat tubular vesicles		
		41	rusty low density slag lump		
		26	dimpled slag fragment		
		162	dense crust from cake with lobate form, non-wetted sides show lobes, massive internally, cake base has a distinct angle suggesting possible base of wall?		
		214	SHC fragment from small dense SHC, possibly around one third	33	642
		208	lobate to granular slag with smooth blown face, base is very smooth as if in contact with stone - so may be from vertical wall - difficult to orient		
		280	c90% of small irregular SHC with hint of multiple layers	90	311
		82	iron-rich prilly slag lump - possibly contorted		
		117	probably most of small SHC with well flowed smooth top, very thin 80x60x20mm	100	117
		141	fragment from lip of large dense SHC with open deep bowl, interior smooth, top of lip has charcoal dimples, tubular vesicles in crust, base microprilly		
		428	110x70x50mm, transverse biconvex rather microprilly SHC	100	428
		273	80x100x30mm, probably most of small transverse SHC, 90%?, rough, very rusty	90	303
		98	roughly lobate slag piece		
		208	fragment from medium-sized two layer cake, oddly the upper layer has tubular vesicles		
235	985	83	lump of decomposed charcoal-rich slag		
1181	986	21	horn shaped brown slag bleb - probably originally hollow but now one end has collapsed		

context	sample	weight	notes	SHC details	
				% of orig.	Orig. Wt.
	236	987	150 complicated block of fired (reduced) and vitrified ceramic. Presumably tuyère related, but very hard to orient, backing of reduced fired material with possible "brick" edge - and slag in front has large (now missing) oxidised fired piece of clay		
		28	second piece of vitrified clay - note oxidised fired clay in front could just be matrix		
	244	988	98 prilly slag with what appears to be a lower contact surface at right angles to blown surface, could be top of side of smelting cake, but there are other possibilities		
		109	plano-convex prilly piece 110x70x40mm. Top smoothish and blown,		
		83	prilly/dimpled slabby low density slag		
		452	double layer cake - upper layer very iron-rich. Not clear if this could be a standalone cake or part of something larger. 70x80x90mm	100	452
		453	medium dense SHC, probably transverse, 80x100x50mm, possibly gravel base but could be accretion	100	453
	270	989	113 probable SHC fragment, dense slag, would be from small SHC		
box 4					
	122?	990	1617 obscured by accretion - but appears to be dense SHC, 160x140x60mm	100	1617
	(Given	178	rounded lobate lump - probably an odd prilly SHC, 65x50x50mm	100	178
	as	251	110x100x35mm, probably an SHC - thin triangular sheet-like crust overlain by lobate materials	100	251
	F291	270	obscured but probably SHC 80x80x30mm	100	270
	on				
	label,	1350	140x120x80mm of which 40mm bowl, charcoal-rich upper but dense SHC, micro-dimpled base	100	1350
	but	1407	140x120x70mm SHC with another crust attached low down to one side overall 170x100x100mm	100	1407
	that is	1371	130x160x80mm very dense thick crust SHC, probably 75% preserved	75	1828
	p/hole	63	dense flow slag		
	cut,	823	8 blocks of brown flow slag with large moulds, impression is of cake with gently sloping sides		
	p-trace	1756	17 pieces of similar cavernous thin crust cake without flow or large charcoal moulds		
	label	295	sub-blowhole piece with straight oxidised wall attachment, curving crust internally, prilly below, hint of glass on top. This is brown like the slags above, but the whole looks as if it may be an SHC attachment to tuyère front		
	gives				
	F122)	306	80x70x45mm slag ball with corroding iron - probably a small SHC	100	306
		233	70x80x40mm most of small microprilly SHC	100	233
		1486	9 fragments of SHC crust		
		93	flow slag with moulds		
		239	3 pieces of indet iron slag		
	317	991	278 lower part of clinkery-looking charcoal-rich SHC with dimpled base		
		130	dense sheet from distal edge of well flowed SHC - could be another of the ones from stone base		
		92	3 SHC fragments probably		
	317	992	846 120x100x55mm neat slightly two layer very prilly SHC	100	846
	318	993	473 100x120x50 brown weathered prilly SHC	100	473

context	sample	weight	notes	SHC details	
				% of orig.	Orig. Wt.
319	994	100 388	SHC crust with attached lump of iron decomposing small poorly-compacted biconvex SHC, exploding, 110x80x55mm of which bowl 30mm	100	388
324	995	44	2 pieces of dark dense prilly slag flown between small charcoal		
324	996	454 268 267 249	80x130x60mm, probable SHC but very irregular very dense SHC starting to explode, probably 70% 3 pieces of indet dense slag 90x70x40mm exploded plano-convex rough slag block - very irregular but probably a piece of flow slag - has 15mm diameter moulds - flow or SHC - difficult to tell	100 70	454 383
324	997	76 82 33	concretion around iron - has exploded concretion around iron concretion around iron		
324	998	10 7	3 tiny slag fragments accretion on small piece of iron		
324	999	173 102	disintegrated lump of rusted iron 3 indet slag fragments		
339	1000	496	rounded large slightly dimpled block - probably a large burr		
341	1001	81	slightly granular rounded nub of hearth slag		
342	1002	42 50 44	4 pieces of blebby prill dense slag with flat base - cf other stone based materials slag indet.		
343	1003	46	4 pieces of brown friable porous slightly prilly slag		
347	1004	402	80x130x35mm, rather fluid appearing SHC, thin puddle on top of more charcoal rich material, some marginal lobation	100	402
347	1005	56 323 86 127 153	corroding iron 5 slag lumps all probably SHC fragments 60x65x25mm tiny SHC? 60x50x35mm tiny SHC? 70x60x30mm tiny SHC - v dense	100 100 100	86 127 153

context	sample	weight	notes	SHC details	
				% of orig.	Orig. Wt.
348	1006	4	thin slag sheet from large vesicle in flow over flat base		
348	1007	279	80x85x55mm of which bowl 35mm, small dense SHC	100	279
348	1008	7 244 250 366	possible poker mould iron in accretion - worth X-Ray 23 fine scale flow slag pieces 11 slag fragments - all probably SHC debris		
353	1008	307	small biconvex SHC, exploded into 3 from corrosion of central iron fragment, 80x95x50mm of which bowl 35mm	100	307
356	1009	1683 827 199 114 357 159 129	160x190x75mm, 80% of original cake, folded/lobate smooth top - non-directional, internally seems to have lots of flow lobes, very dense cake. This is interesting, has moderate charcoal moulds - long stick like pieces of low diameter max 17mm very dense slag flow with thick burr areas at one end extending out into very irregular sheet form with lots of holes and charcoal moulds. Burr area to 55mm thick - reminiscent of SHC attached to stone block from c20 75x80x45mm, small neat low density SHC, slightly biconvex SHC crust? granular to microprilly slag block, irregular, has a long stick charcoal mould margin of very dense SHC probably entire small granular/microprilly SHC, 70x70x30mm	80 100 100	2104 199 129

Table 1: Summary catalogue of residues by context and sample.

<100	2			
100-200	12			
200-300	11	0-500	62	
300-400	18			
400-500	19			
500-600	2			0-1000 75
600-700	2			
700-800	2	500-1000	13	
800-900	4			
900-1000	3			
		1000-1500	9	1000-2000 12
		1500-2000	3	
				2000-3000 2
				total 89

Table 2. Distribution of smithing hearth cakes by weight (g) for cakes from Parknahown 5. Each class interval runs from the lower limit up to, but not including the upper figure. 1000g class intervals are shown for entire assemblage, with additional detail for the smaller SHCs.

<i>n</i>	89
<i>min</i>	86g
<i>max</i>	2898g
<i>average</i>	567g

	<i>number</i>	<i>%</i>
<500	62	70%
<1000	75	84%
>1000	14	16%
>3000	0	0%

Table 3. Summary statistics for the smithing hearth cakes from Parknahown 5, for which the total weight could either be measured or estimated.

	Coolamurry	Navan	Moneygall	Carrigoran	Parknahown 5	Trumra 4	Clonmacnoise (NG)	Ballykilmore	Woodstown 6	Clonmacnoise (WWS)	Clonfad	Lismore/ Bushfield 1
date	C10-12	E. Med.	E.Med- Med.	C10?	C5-C10?	C5/6	C7-10	C10-15?	C9-10	C10?	C7-9	E. Med?
SHC count	41	17	22	18	89	57	117	30	140	38	381	23
SHC min. wt		60	114		86	92	100	94	68		60	426
SHC max. wt	2588	2990	1800	3866	2898	3163	7815	4033	6310	5540	11000	4390
SHC mean wt	386	507	527	553	567	727	843	1022	1060	1087	1302	1737
% <500g	83%	82%	55%	72%	70%	47%	50%	47%	40%	39%	30%	4%
% <1000g	95%	88%	95%	89%	84%	75%	78%	73%	71%	68%	61%	39%
% >1000g	5%	12%	5%	11%	16%	25%	22%	27%	29%	32%	39%	61%
% >3000g	0%	0%	0%	6%	0%	2%	3%	10%	7%	8%	9%	13%
Modal 100g interval	100-200	100-200	200-300	100-200	400-500	100-300	400-500	200-300	200-300	300-400	300-400	500-600

Table 4. Comparison of the Parknahown 5 SHC assemblage with other Irish smithing assemblages.

Assemblages ordered by mean SHC weight.

Coolamurry from Young, 2008a; Navan Site 1 from Young 2007; Moneygall from Young 2008b; Carrigoran from Young 2006b; Parknahown, this study; Trumra 4 from Young 2008d, Clonmacnoise New Graveyard site from the author's work in progress; Ballykilmore from Young 2009b; Woodstown from Young, 2006a; Clonmacnoise Waste Water Scheme from Young 2005; Clonfad from Young 2009a; Lismore/Bushfield 1 from Young 2008c.

The assemblages from Coolamurry, Navan, Moneygall, and Carrigoran are interpreted as being dominantly blacksmithing residues. The assemblages from Trumra, Clonmacnoise, Ballykilmore, Woodstown, Clonfad, and Lismore/Bushfield are interpreted as including bloomsmithing residues.

		SHC	other smithing	smelting	indeterminate slag	tuyère	iron	other	<i>total</i>
Period 2 phase 1									
F106	enclosure	5905	0	2068	2829	21	9	4	10836
F156	same as F106 on north?	7222	0	0	1386	0	671	0	9279
F134	internal ditch	0	0	0	45	0	0	0	45
slot 282		113	0	0	0	0	0	0	113
pit 183		581	0	0	545	0	0	0	1126
pit 186		0	0	0	0	20	0	0	20
Period 2 Phase 2									
F29	inner ditch	7386	281	634	5218	1051	0	0	14570
F391	same as F29 on the north?	0	0	0	217	0	0	0	217
F24	outer ditch	0	0	0	81	0	0	0	81
Period 2 General									
F257	bank	41843	882	2789	13056	292	42	0	58904
Grave-fills		0	0	0	28	0	0	0	28
topsoil		3369	0	0	1282	51	12	1	4715
non-archaeological contexts		1223	0	0	87	0	0	3	1313
	<i>total</i>	67642	1163	5491	24774	1435	734	8	101247

Table 5. distribution of residue classes at Parknahown 5 by feature and phase

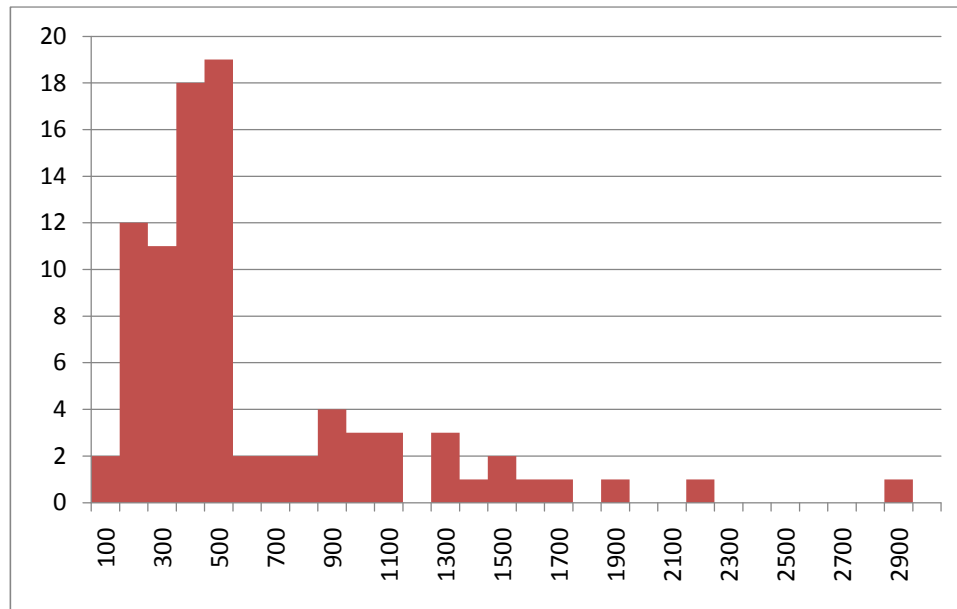


Figure 1. Size-frequency distribution for the weight of SHCs from Parknahown 5. Weight classes are 100g intervals up to the labelled value.

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