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Evaluation of Archaeometallurgical residues from the M7/M8 Contract 2: Derrinsallagh 3 (E2179)

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Abstract

Derrinsallagh 3 yielded 65.5kg of archaeometallurgical residues. The residue distribution shows an extremely strong geographical zonation:

- *only one single tiny fragment of slag was recovered from within the enclosure, a mixed assemblage of slag of about 10kg was recovered from the enclosure ditch.*
- *immediately outside the enclosure to the E, the rectangular ditch 436/736 and associated features yielded almost 45kg of residues, over half of which were positively identifiable as being derived from iron-working (smithing) and the remainder was possibly so.*
- *50m outside the enclosure to the SE, various features yielded small quantities of slag totalling just under 8kg, 98% of which was identifiable as being produced during iron smelting, and the remainder possibly so.*

The smithing residues were dominated by fragments of extremely large smithing hearth cakes (SHCs), although only 7 cakes were sufficiently complete for estimation of their original size (766, 950, 1439, 1480, 3300, 6830 and 10220g). Despite the small sample size this is interpreted as being indicative of an origin for these SHCs during bloom refining, rather than blacksmithing. The pits C738 and C517 cut into ditch 436 are tentatively interpreted as smithing hearths, although re-examination of the field records is recommended to clarify their morphology and function.

The iron smelting residues are indicative of use of a non-slag tapping furnace. Further examination of the field records for pits C638, C640, C641, C805 and C819 is required to interpret the detailed nature of the smelting furnaces, but furnace c819 at least appears to have had an arch connecting it to a working hollow, C641.

Although there is an absence of dating evidence for the iron working, the circumstantial evidence would suggest it was early medieval and that the two components, smelting and bloom refining, are directly related to each other. The small amount of residue recovered, together with the limited range of features, but their tight clustering, suggests that iron production may have been undertaken on site for only a relatively limited period of time.

The metallurgical activity at the site can therefore be interpreted as iron production; there is no evidence for "end-user" blacksmithing.

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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

Material

Smithing hearth cakes (SHC): material identifiable as smithing hearth cakes comprises almost half the total weight of residue recorded from the site (30.7 kg out of 65.5 kg). The SHCs represented are mainly large, although generation of a full statistical treatment of the weights is prevented by the small number examples. Weights recorded for complete cakes, or estimated for reasonably complete examples were 766, 950, 1439, 1480, 3300, 6830 and 10220g. A further example must have had an original weight substantially greater than its surviving 4969g.

The SHCs were mainly dense, although the 4969g example had an open porous coarsely crystalline structure. The largest examples had thick dense crusts (slag puddles) of up to 65mm thickness, with the bowl part of the SHC being up to 230x350x110mm, often with raised slags on the proximal side of the upper surface.

Flow slags: flow slags make up 10.6kg of the total assemblage. Flow slags vary from fine delicate individual drips and prills from either horizontal or vertical flow, through coalesced prills, into flow lobed blocks often incorporating moulds of large fragments of wood or charcoal. The prills vary from pieces which appear to have been very fluid, which are often in the form of dense, shiny slags, through to more irregularly blebby material which appears to have been less fluid and typically forms dull-surfaced, lower density slags. Many of the dense prills appear to have formed up in the fuel bed, from slag trickling down into the pit from above, whereas much of the more blebby material appears to have solidified at or near the base of the furnace and its appearance may be due to interaction with the ash there.

The small individual prills and blebs have been mainly recorded from within the smelting furnaces, where they have remained since the furnace was last used. Larger blocks of flow slags, like SHCs, form pieces of slag which can be convenient thrown away, so may occur isolated in the fills of pits and ditches.

Floor fines: these are assemblages of slags and related materials from the floor of the smelting furnace. They may include small prills and sub-spheroidal slag drips (often dimpled from contact with fuel particles, and hence informally described as "coffee-bean spheroids") which are gradational with the flow slags described above.

In addition these assemblages may also include material described as "sinter" (e.g. C805, C811, C864). This material is possibly not a true sinter although texturally similar, for the precise mechanism of

induration is unclear. Where these have been examined on other sites (e.g. Cherryville; Young 2008b) they have been to comprise a mixture of bog ore particles and charcoal dust bound by iron oxides. They represent fine materials (dust) accumulating on the floor of the smelting furnace pit during use and becoming indurated, either through sintering caused by the heat from the descending slags, or by subsequent diagenesis.

Floor fines may also include other particles, including burnt or glazed stones and ceramic (e.g. C805) as well as concretionary ashy materials (e.g. C823).

Very similar material, including coffee-bean spheroids and sometimes small vertical prills (although not in abundance), but not sinter or horizontal prills, may derive from the base of a smithing hearth. In the absence of hammerscale such assemblages differ from smelting fines only in what is absent, so they are classified in this study as indeterminate (e.g. C739).

Indeterminate slags: This class of material includes both complete slag bodies which are not referable to another class through being non-diagnostic and pieces of slag which have become too fragmented to permit identification (particularly porous charcoal-rich slags).

Such indeterminate material usually includes fragments of the main slag mass from the upper part of the basal pit of the smelting furnaces (sometimes called a furnace bottom; FB). However, in this assemblage potential FB material is absent and there is a very strong correlation between indeterminate material and SHCs, suggesting that in this instance most of the indeterminate material is fragmented smithing hearth cakes.

One class of indeterminate material, mentioned above are slag fines from C739, C758 and C774 which are probably fines from the base of a smithing hearth. However, these assemblages lack hammerscale (c.f. equivalent hearth floor residues from Coolamurry; Young 2008a), and are therefore not strictly differentiable from smelting furnace floor fines without analysis. These fines contain small prills, sub-spheroidal particles, fired clay and glazed stones.

Wall: this category has been used for all fired and/or vitrified ceramic fragments, whether from the superstructure of the furnace or from the wall of the basal pit of a smelting furnace. In practice these are not usually distinguishable. The majority of the material in this category came from smithing hearth fill C775 and may have been removed during excavation from the structure of the hearth rather than being clasts in a fill.

Lining slag: this category of slag is only represented in the assemblage by a single occurrence of eight tiny fragments from c347. Lining slags are slags derived mainly or wholly from the melting of the technical ceramics of the hearth or furnace (including the tuyère). In this instance the slags are of undetermined origin.

Distribution (Table 2)

Iron Smelting: Apart from one large block from the SW sector of the enclosure ditch, most of the iron smelting residues derive from an area 50m outside the enclosure to the ESE. The metallurgical features involved are here C640, C819, C881, the bases of

smelting furnaces and C641, probably the working hollow associated with furnace C819. A small quantity of smelting residues derive from a fourth furnace, C805, some 20m NE of this complex. Small quantities of smelting slags occur in the same general area in pit C638, pit C644, slot trench C645 and one of the fills of cereal kiln C859.

Iron working (smithing): One large SHC was recovered from the main enclosure ditch, and two pieces from ditch C004 NW of the enclosure. Most of the smithing slag came from ditch C436 (10.4kg) and from two pits, probably hearths dug into ditch C736 (13.4kg).

Structures

Field interpretation of early metallurgical structures is often difficult. This section of this report draws together the descriptions of metallurgical contexts and features in the draft stratigraphic report and attempts to synthesise and interpret them in the light of the associated archaeometallurgical residues. It is intended that this discussion may allow better interpretation of the structures and facilitate comparison between sites.

Iron smelting:

Furnace C819 and pit C641

Plate 35 of the draft report shows the relationship between "bowl furnaces" C641 and C819. What this image appears to show is a furnace of similar construction to the example excavated in detail from Derrinsallagh 4 (C397; Young 2008h), with C819 being the basal pit of the furnace and C641 being the external working pit, linked into the furnace via an arch. In this type of furnace the working pit/hollow provides an area into which the slag can be raked from the base of the smelting furnace. This permits easier cleaning of the pit before its reuse. The arch into the furnace may even be used for removal of the bloom. Allowing slag and/or bloom removal through a furnace arch removes the chance for accidental furnace damage always present during removal of these materials through the top of the furnace. It also allows the furnaces to be taller, since they are no longer limited by the need for the operator to be able to reach the base through the top. The morphology of the furnace would resemble that of a slag-tapping furnace (except that the floor of the bottom of the furnace is usually below the level of the floor of the arch). Use of such furnaces has been investigated and reconstructed by Crew (1991) building on excavated examples at Crawcwellt and Bryn-y-castell (Crew 1987, 1989, 1998) from the Iron Age of North Wales.

C640 was not apparently linked to C641, but this might be a function of the level of truncation. C881 is apparently the base of a smelting furnace truncated by the later working hollow C641.

In detail C819 and its fills are described in the draft stratigraphy report as:

819 Bowl furnace sub-circular in outline measuring .45m x .40m x .22m deep. This measurement includes the halo of oxidized clay around the edge. The break of slope at the top and base was sharp. The sides had a gradual slope and the base was rounded. It was filled by C818, C835, C845 and truncates C641

818 Upper fill of bowl furnace C819. It consisted of moderately compacted, mid brown, clayey silt that contained a moderate amount of charcoal inclusions and occasional iron slag fragments. The deposit measured .36m x .35m x .06m deep. The fill was under C002, over C835 and contained within C819.

835 Second fill of bowl furnace C819. It consisted of moderately compact, orange yellow, silty sand that contained occasional inclusions of charcoal flecking and iron slag. The deposit measured .28m x .35m x .1m deep. It was located under C818 and over C845.

844 Layer of red oxidized clay located at the edge of pit C819. This oxidized clay may be associated with the activity within the pit, which was a possible bowl furnace. The oxidized clay was present for a length of .16 x .1m deep. It contained no inclusions. It was under C818 and part of C819.

845 Red oxidized clay halo around bowl furnace C819. The clay was .06m deep and was 18m x .1m.

846 Lower fill of bowl furnace C819. It consisted of moderate to loosely compacted, dark brown, sandy silt that contained frequent inclusions of charcoal flecking. The deposit measured .22m x .28m x .1m deep. It was located under C835 and in the base of the furnace pit.

Despite the inconsistencies in these descriptions, it would appear that there were three main fills to the furnace, a lower deposit (C846) representing the remains of residues left in the furnace after use, a middle fill (C835) possibly derived from decay of the superstructure and an upper fill (C818). The upper fill is described as 0.36 x 0.35m, presumably the working size of the slagpit at the level of truncation.

The working hollow is mainly filled with dark stony slag- and charcoal- rich deposits (C816 and C817), with a basal layer of disturbed fired clay rich material (C880).

Furnace C881

This furnace was truncated by working hollow C641, with only the basal 0.02m of the slag pit preserved; consequently it adds little to understanding of the furnaces on the site.

881 Sub-circular pit measured 29m x .23m deep. The break of slope at the top and the base was moderate. The sides were moderate to steep and the base was uneven. It was filled by C886 and truncated by a later pit C641.

885 Oxidized clay located around the north, west, and southwest edges of the bowl furnace C881. It was present for a maximum length of .1m x .02m thick.

886 Moderate to loose, mid dark brown, silty sand that contained a moderate amount of charcoal flecking as inclusions. The deposit measured .24m x .22m x .03m deep and located along the base of the pit. It was under C880 and within C881.

Furnace 640

This furnace lies just to the west of working hollow C641 according to the plans, so the location comment in the context description appears to be erroneous.

- 640 *Sub-circular bowl furnace measuring .4m x .38m x .19m deep. The break of slope at the top was sharp and the base imperceptible. The sides were gradual and the base was uneven. It was filled by C811, C812, C813, and C847. The bowl furnace was isolated and located c.3m NE were a series of cremation pits.*
- 811 *Upper fill of C640. It consisted of softly compacted, light brown, silty clay that contained occasional fragment of iron slag, charcoal flecking and small stones, and flecks of oxidized clay. The fill measured .32m NS x .3m x .06m deep. The fill was located under C002, over C812 and contained within C640.*
- 812 *Middle fill of C640. It consisted of compact, dark brown/black, silty sand that contained occasional fragments of iron slag, charcoal flecking and small stones. The deposit measured .28m NS x .28m x .14m deep. The fill was located under C811, over C847 and contained within C640*
- 813 *Basal deposit of C640. It consisted of softly compacted, black charcoal rich, silt that contained occasional flecks of clay. The deposit measured .22m WE x .2m x .17m deep. The layer was under C847 and within C640.*
- 847 *Oxidized red clay located at the base of bowl furnace C640. The oxidized clay had inclusions of charcoal flecking and was .04 - .08m deep. It was located under the fills of the pit and contained within C640.*

It is to be assumed that C847 is the fired substrate or lining and did not overlie C813 (as per description of C813) but underlay it (as per description of C847). C812, the middle fill probably represents detritus remaining in the base of the furnace after its last use, whereas C811, with its flecks of oxidised fired clay, would be a product of degradation of the superstructure.

The upper and middle fills are of similar dimensions so suggest a working diameter of about 0.30m.

Furnace C805

This furnace lies some distance (20m) away from the others.

- 805 *Irregular oval shaped pit measuring .4m wide x .14m deep. The break of slope at the top and base was moderate to gradual. The sides had a gentle slope and the base was flat. It was filled by C806 and cut into the subsoil. A bowl furnace, but not in association with other features.*
- 806 *Fill of bowl furnace C805. It consisted of softly compacted, black silt that contained frequent inclusions of iron slag and charcoal, and sparse flecks of oxidized clay. At the base of the pit there was a layer of oxidized clay .05m thick. The slag was confined mostly to the centre of the pit. The fill was*

located under C002 and contained within the pit.

It remains unclear from this description whether the 0.40m diameter includes the oxidised natural or not.

Summary

Four smelting furnaces are known:

- Furnace C819 and pit C641 : slagpit pit dimensions 0.36 x 0.35m, connected via arch to pit of 1.14m x 1.0m x .2m deep.
- Furnace C640: adjacent to pit C641, slagpit dimensions of 0.32 x 0.30m.
- Furnace C881: truncated by pit C641, dimensions of top of slagpit therefore unknown.
- Furnace C805: isolated 0.40 x 0.40m slagpit.

Smithing: The smithing area is complicated and interpretation remains rather tentative. There appear to be two possible hearths, one cut into the other and both incised into ditch C736, a few metres outside the entrance to the enclosure. In detail, interpretation is more complicated; there are inconsistencies in the context descriptions in the draft stratigraphic report, the apparently earlier pit, C738, is not shown on the draft plan (Figure 12) and Plate 34 which claims to show "Bowl furnace C517" actually shows slot trench C645. Pit C738 yielded most of the slag in this area, whereas the "bowl furnace" C517, yielded mainly fired clay from the structure of the hearth. It would be very useful to unravel this stratigraphy using the site's original stratigraphic records. It seems highly likely there are one or two smithing hearths here and much useful morphological evidence may be gained.

C517 is described as measuring 0.8m x 0.75m x .17m deep and C738 as a "sub-rectangular pit located within the linear ditch C736 measuring 0.76m NS x 0.34m deep".

Bloom refining hearths are not well known, and many have been identified in the past of rather suspect grounds. In this case, if these two structures (or either one of them) can be confirmed as a smithing hearth then this would be a useful step forward. The large amount of slag present in C738 presumably represents a refilling of the hearth (if indeed it is one) with the smithy waste pile on its abandonment.

A rectangular or subcircular hearth of 0.7 – 0.8m across is quite small for smithing, but there are parallels and it is possible the task of bloom refining did not require a conventionally shaped blacksmiths hearth. Early floor level smithing hearths interpreted as being associated with blacksmithing are known from recent excavations at, for instance, Coolamurry, Moneygall, Navan and possibly Trumra:

- Coolamurry had three smithing hearths: Hearth A, 1.0 x 0.9 x 0.2m, Hearth B, 0.92 x 0.82 x 0.30m and Hearth C, 1.20 x 0.80m, (Young 2008a).
- Moneygall had a hearth (C905) which was 1.06 x 0.70m and 0.17m deep (Young 2008c).
- Navan (Young 2007) had a smithing hearth constructed within a partly silted ditch that was 0.78m diameter.

- Trumra 4 had two pits, one 1.98x1.28x.33m the other 0.92x0.78x.12m. Although the smaller pit was 14C dated to the Bronze Age, it contained a sherd of medieval style tuyère, and much more evidence of heat than the larger pit. A reinterpretation of this site might be that the date is spurious, the small pit the smithing hearth and the large pit a charcoal production pit into which slag was later dumped.

Interpretation

Derrinsallagh 3 shows a very tight geographical discrimination of iron working activities. Iron smelting was undertaken in an area well to the ESE of the enclosure. Evidence was found for four probable slag pit furnaces, at least one of which appears to have possessed an arch and associated working hollow (comparable with the furnace examined in detail at Derrinsallagh 4; Young 2008h).

Smithing was probably undertaken in hearths cut into a partially filled ditch (C736) close to, but outside the entrance to the enclosure. Slag also occurs in the continuation of the ditch (C436) further from the enclosure, so was presumably being undertaken during the main lifespan of the enclosure and its satellite ditches.

The large size of the surviving SHCs indicates that the smithing being undertaken was bloom refining, rather than end user iron-working. The largest SHC was estimated to have originally weighed over 10kg, which is extremely large, and two other cakes at 6.8kg and substantially >4.5kg are also very large. SHCs over 8kg have only so far been recorded by the author from Clonfad (maximum size 11kg; Young 2006a) and possibly on the current scheme from Shanboe 6 (Young 2008d). Many sites interpreted as being associated with bloomsmithing have much smaller maximum recorded SHC size (Table 3); the significance of the sites with the largest SHCs is uncertain, although for Clonfad at least (Young 2006a) it has been argued that the large SHC size reflects that very large blooms were being worked, at least on occasion.

It may be significant that the current scheme has produced several sites (Killeany 1, Young 2008f; Lismore/Bushfield 1, Young 2008d; Trumra 4; Young 2008g) besides Derrinsallagh 3 that have small collections of large SHCs. This provides a suggestion of specialist, if possibly temporary, bloom refining at these sites. These sites appear not to have been significantly involved in the handling of finished iron or of "end-user" blacksmithing.

The smelting activities have not been dated directly, but there are various threads of circumstantial evidence:

1. The co-occurrence of smelting and bloom refining side-by-side is strongly suggestive that the two activities happened together for the production of raw iron.
2. Smelting slag occurs in small quantities in the fills of both the large pit C644 and the associated slot trench C645, which must therefore be coeval with the nearby smelting or be later. A fill of C644 has a 14C date of AD640-900.

3. Cereal kiln C639 (14C dated to C12-C13) lies within the cluster of iron smelting features, and is unlikely to be contemporary with them.

On balance an early medieval date for the iron production at Derrinsallagh seems likely, although the dates from the cereal kilns indicate that activity on the site continued until at least the 14th or 15th century, so a later date for the iron production cannot be ruled out.

The total amount of residue recovered from the excavations is fairly small, particularly given the high proportion of the site excavated, so it would appear that iron production was not a major component of the economy of the site and/or was undertaken for only a short period of time. The tight clustering of features favours the latter interpretation.

Evaluation of potential

The Derrinsallagh 3 metallurgical assemblage is significant in that it may contain both smelting and bloom refining residues. Being able to trace associated assemblages of the two components of the iron production process is not particularly common. The relatively small size of the assemblage also increases the likelihood of the collected material being representative of contemporary processes. On this basis a programme of detailed analysis of both suites of residues would be recommended. Unfortunately, the lack of dating of the residues detracts somewhat from the significance of any potential results, although it is likely that this could be rectified.

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F	sample	sample wt	wt	no	notes	SHC propn	SHC orig. wt.
4	277	100	100	1	dense piece, probably from the margin of a small SHC		
115	278	230	230	1	grey vesicular slag in odd-shaped block - possibly twisted		
193	279	1150	1155	11	broken weathered vesicular block with lots of comminuted charcoal, weathered to some strange maroon colours, shape of original block uncertain		
279	133	9895	3500	1	block with burr and flow slags to foot of wall		
279	133		4455	1	thin crust bowl with coralline contents (missing top) and good concentric structure, 260x240x110.		
279	133		846	1	pieces of charcoal mould rich slag similar to SHC above		
279	133		128	1	pieces of charcoal mould rich slag similar to SHC above		
279	133		262	1	piece of 4455g SHC above		
279	133		252	1	piece of 4455g SHC above		
279	133		260	1	dense slag with charcoal moulds - indeterminate origin		
304	280	10	10	1	grey vesicular slag fragment		
347	116	6	6	8	slightly rusty glassy slags - some quite gravelly, lining slags		
347	281	766	766	1	dense deep rusty SHC of transverse shape, 80x110x65	1	766
438	282	10464	1480	1	SHC, complete, 170x130x80, of which bowl 55, fairly flat top with raised lump proximally	1	1480
438	282		4100	1	part of thick crust SHC, c 250 diameter probably about 60% but uncertain, 140 deep, crust 40	0.6	6833
438	282		3065	1	part of similar large cake, originally 230x350x140?, bowl 110, crust 65, small raised area on margin, top weathered but seems flat and blown. Approximately 30%	0.3	10217
438	282		1755	1	small part of another large cake with a complex crust - possibly an early moved crust around later bowl?		
438	282		64	1	fragment		
449	167	382	382	1	charcoal-rich slag block, with rounded outline and twisted(?) shape		
738	285	18086	1295	1	possibly almost complete wide SHC, 120x170x60 - other interpretations may be possible		
738	285		1525	1	complex apparent bowl margin piece - but possibly broken and possibly deformed.		
738	285		758	1	elongate fragment from large cake		
738	285		738	1	dense bowl fragment		
738	285		1325	1	very dense bowl fragment - uncertain of original size		
738	285		252	1	amorphous fragment		
738	285		668	1	fragment from very large thick bowl SHC, bowl to 50mm		
738	285		436	1	bowl fragment		
738	285		380	1	bowl fragment		
738	285		678	1	bowl fragment		
738	285		478	1	cake margin fragment		
738	285		586	1	amorphous fragment (these pieces are probably indicative of hot extraction)		
738	285		526	1	possible small SHC - but may more likely be fragment of a larger one, bears large chert? pebbles - suggesting this is indurated margin from a much larger cake		
738	285		6103	90	pieces as above but indet >30mm		
738	285		2158		debris <30mm (some of this is manganese mottled)		
738	285		180	2	manganese mottled sediment lumps - full of small slag debris		
739	#1	950	950	1	SHC, 120x140x100mm, of which the bowl forms the upper 45, mushroom shaped, with descending micropilly "stalk" on proximal side	1.0	950

F	sample	sample wt	wt	no	notes	SHC propn	SHC orig. wt.
739	191	720	720	c350	mainly dull blebby slags, occasional shiny flowed material, a few fired stones and one rounded lump of charcoal rich material, probably furnace/hearth floor material		
739	205	12255	1650	2	conjoining fragments of a large thick crust cake, similar to fragment in f738, at least 230 diameter by 90 deep. This and f738 piece both have very strange granular microstructure - not the normal fayalite morphology - needs examination	0.5	3300
739	205		8335	c400	indeterminate slag pieces, not flowed, not certainly SHC		
739	205		238	31	small fragments of flows and prills		
739	205		218	2	part of dense very smooth SHC, proportion not identifiable		
739	205		276	1	fragment from dense SHC		
739	205		270	1	fragment from dense SHC		
739	205		394	1	fragment from dense SHC		
739	205		168	1	fragment from dense SHC		
739	205		156	1	fragment from dense SHC		
739	205		464	1	dense slag with crust in strange twisted shape		
758	192	394	394	c200	small slag fragments - some blebs and prills, but mainly sheet fragments. Some rounded, manganese-rich lumps look like ore, but may be furnace/hearth floor accretions., not diagnostic.		
774	201	202	202		coarse sand with amorphous slag fragments. Few good microresidues, but the occasional large spheroid		
775	199	2345	2345	c60 plus debris	variably fired and indurated gravelly clay		
775	202	16	16	7	small worn slag fragments, slightly maroon - possibly furnace floor material since have comminuted charcoal and resinous appearance		
805	197	280	248	45 plus bits	flow slags and sintery material, one tiny fragment of ceramic with green glazed stone on surface		
805	197		32		gravel with lots of fragments of resinous sinter material, some blebs and a few good spheroids		
806	283	24	24	3	small pieces of dense blebby flow slag		
811	208	534	534	c2000	small pieces of flow slag, sinter, blebs and amorphous fragments. No good coffee beans or big flows		
812							
813							
812	209	2690	2690	c500	good flow slag collection - from sintery collections of blebs, through fragile prills to coalesced masses around moulds of wood		
816	216	466	210	1	amorphous block with hint of flow lobes protruding from one edge		
816	216		228	8	flow slag in large blebby prills		
816	216		28	4	fired clay, reduced, except for largest piece which is oxidised and has vitrified surface		
816	217	22	22	18	slag blebs, both shiny and dull and amorphous slag fragments		
817	219	90	90	82	flow slags in short lengths of prill, sandy material with lots of charcoal (furnace floor?) and other small slag fragments		
818	220	98	98	11	flow slag in the form of substantial prills		
818	221	3	3	3	slag blebs		
823	203	10	10	20	small ash-covered complexly dimpled slag pieces, most not clearly well-flown		
823	204	510	372	2	dense flowed smelting slags in coalesced prills running around wood fragments		
823	204		72	1	vitrified wall		
823	204		66	1	resinous rounded lump of slightly purple slag with charcoal		
835	231	78	78	c65	flow slags and associated materials		

F	sample	sample wt	wt	no	notes	SHC propn	SHC orig. wt.
835	235	152	152	2	dense slag flown around wood		
845	232	76	76	c140	blebs, spheroids and short prills		
845	234	718	718	63	flow slag, almost entirely as delicate prills		
864	245	126	126	12	9 pieces of good dense low slag prill, 2 pieces of sintery floor, 1 spheroid		
880	248	194	194	12	curious indurated sandy ceramic adhering to slag. Slag has cast of large wood fragment, some of ceramic is wall, some may be concretionary adherence to slag		
888	286	1542	732	2	large blocks of dense slag with large wood mould fragments		
888	286		704	1	extremely dense slag block adhering and undercutting a lining fragment, probably from pit at foot of blowing wall		
888	286		106	4	flowed slags		
900	284		298	1	pile of flow lobes with slightly dimpled base - looks just like tap slag		

Table 1. Summary catalogue by context and sample

<i>F</i>	<i>context description</i>	<i>SHC</i>	<i>indet</i>	<i>flow</i>	<i>floor fines</i>	<i>wall</i>	<i>lining slag</i>	<i>total</i>
The enclosure ditch								
115	fill of enclosure ditch - middle fill of secondary cut, NW quadrant		230					230
279	fill of enclosure ditch - lower fill SW quadrant	5943	260	3500				9703
449	fill of enclosure ditch - middle fill SE quadrant		382					382
	total	5943	872	3500				10315
Inside the enclosure								
304	fill of curvilinear slot trench 015, W side of enclosure		10					10
	total		10					10
Outside the enclosure to the NW								
4	linear ditch extending NW of enclosure	100						100
347	fill of ditch 004	766					6	772
	total	866					6	872
Outside the enclosure entrance to the E								
438	upper fill of rectangular ditch 436, NE of enclosure	10400	64					10464
738	cut of sub-rectangular pit 738, .76m NS x .34m deep, within ditch 736	9393	8513					17906
739	fill of sub-rectangular pit 738	4082	9757					13839
758	middle fill of sub-rectangular pit 738		394					394
775	fill of hearth 517, 0.8x0.75x0.17m, cut into 736/436		16			2345		2361
	total	23875	18744			2345		44964
Outside the enclosure to the ESE								
823	fill of pit 638, 1.32x.82x.2m		76	372		72		520
811-813	fills of pit 640			3224				3224
816	fill of pit 641 (1.14x1.0x.2m) - pit is truncated by "bowl furnace" 819, 0.45x0.32x0.22			460		28		488
817	fill of pit 641				90			90
880	oxidised clay on base of pit 641			194				194
888	upper fill of pit 644 , 3.35x1.5x1.5m			1542				1542
805	cut of slapit 805 (0.4x0.4x0.14m)				280			280
806	fill of pit 805			24				24
818	fill of furnace 819 (upper fill)			101				101
835	fill of furnace 819 (lower fill)			230				230
845	fill of furnace 819 (basal oxidised clay)			718	76			794
864	fill of slot trench 645			126				126
900	fill of cereal-drying kiln 859, 12m SE of the enclosure			298				298
	total		76	7285	446	100		7911
Other								
193	non-archaeological		1155					
	total		1155					1155

Table 2. Summary of distribution of residue classes by area, feature and context.

<i>Site</i>	<i>N</i>	<i>SHC weight</i>		<i>reference</i>
		<i>Mean</i>	<i>Maximum</i>	
Carrigoran	18	553	3866	<i>Young 2006c</i>
Trumra 4	57	727	3163	<i>Young 2008f</i>
Clonmacnoise NG	117	843	7815	<i>Young unpub. data.</i>
Ballykilmore	43	898	4033	<i>Young 2006b</i>
Woodstown 6	140	1060	6310	<i>Young 2006d</i>
Clonmacnoise WWS	38	1087	5540	<i>Young 2005b</i>
Clonfad	513	1153	11000	<i>Young 2006a</i>
Killeany 1	10	1597	5000	<i>Young 2008e</i>
Lismore/Bushfield 1	23	1737	4390	<i>Young 2008c</i>
Derrinsallagh 3	7	3569	10220	<i>This report</i>

Table 3. Count of SHCs (n), mean and maximum SHC weights for selected sites interpreted as Being involved in bloom refining. Ordered by mean SHC weight.

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