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Evaluation of archaeometallurgical
residues from the N8 Fermoy-
Mitchelstown, Gortnahown 2, Co.
Cork, (E2426)

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Abstract

Gortnahown 2 yielded a total of approximately 158kg of archaeometallurgical residues. Both primary iron production and the end-use of iron are attested by the residues. There were 79kg of certain smithing slags, 37kg of iron smelting slags, plus a further 34kg of indeterminate iron slags.

The iron-working was concentrated in two areas of the site: the first about 25m west of the Structures A and B and the other 20m to their north.

Iron smelting was undertaken in slagpit shaft furnaces, of which one was identified with certainty and two probably. Smithing hearths were identified with less certainty, with two potential examples being rather complex structures. There were no certain examples of tuyères, despite the large quantity of smithing debris, which is unusual for an early medieval site. Smithing hearth cakes (SHCs) included many of a size indicative of blacksmithing (end-use of iron), but a few ranged up into sizes more commonly associated with bloomsmithing. Even these were, however, rather moderately sized (up to approximately 3.5kg), compared with typical early medieval examples. The SHCs from the western metalworking area were even more restricted than those from the northern, with a maximum weight of only 956g.

The most interesting facet of the ironworking was the occurrence of a substantial quantity of fragments of brazing shroud (166 fragments, 4.8kg). These fragments are from the clay coating applied to the iron during the brazing (coating and sealing by copper alloy) of small iron bells. The technology is similar to that employed in the manufacture of ecclesiastical hand-bells, but the small size of the majority of the bells at Gortnahown would indicate that they were probably for animals.

The northern metalworking area comprised a series of features to the north of the roundhouses, including at least one iron smelting furnace [c548], a possible second smelting furnace [c566] and two large smithing hearths (hearth [c575] and hearth [c545]). Significant quantities of residues were also recovered from the adjacent slot trench [c586] and drainage ditch [c540]. The occurrence of various postholes in this area suggests that it may have been enclosed as a workshop. Most of the brazing shroud fragments were recovered in this area.

Some 10m NW of the probable workshop was a cluster of large pits, together with another slagpit iron smelting furnace (furnace [c703]). Two large burnt pits ([c771] and [c778]) are more problematic to interpret; both features could possibly have been charcoal-production kilns. Pit [c778] has given a ¹⁴C dates within the 5th-7th centuries AD and its upper fills contained a few sherds of brazing shroud.

The western metalworking area appears to have been more strongly truncated than the northern area, with several features represented by scorched subsoil, rather than surviving features. As with the northern area, much of the residues were recovered from a drainage gully [c228]. The residues from the gully included both iron smelting and smithing slags. Although the residues included a significant proportion of smelting slags, no identification of a smelting furnace could be made, probably due to the truncation in this area.

The site presents a fascinating insight into iron working at the very beginning of the early medieval period. This picture may become further enhanced with additional ¹⁴C dating.

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Methods

All investigated materials were examined visually, using a low-powered binocular microscope where necessary. For microscopic residues a general statement of the nature of each assemblage was recorded (Table 1). As an evaluation, the materials were not subjected to any high-magnification optical inspection, nor to any other form of instrumental analysis. The identifications of materials in this report are therefore necessarily limited and must be regarded as provisional.

Results

Description of iron smelting residues

The site produced approximately 37kg of iron smelting slags.

The residues were typical of those from non-slag tapping slag pit furnaces. There were three facies of slag present:

1. **Flow slags:** flow slags occur as spheroids, blebs and prills, typically of dark dense slag, with smooth surfaces. This material is interpreted as cooling during or after descent through the packing of the basal pit of

the slagpit furnace. The smallest particles are individual frozen droplets of slag. They may show impressions (dimples) from contact with the packing or fuel (and are then given the term “coffee bean spheroid”). In some instances aggregates of individual spheroids may form. More persistent flow results in the formation of a prill. These may involve vertical flow or horizontal flow on the pit floor. Aggregates of prills may form, and these may form moulds around the pieces of wood/charcoal present in the pit packing. Further aggregation leads into a continuum with the more massive slags described below.

2. **Aggregated/massive slag:** where flow slags have completely amalgamated, particularly close to the blowing side of the furnace, they may generate more massive-appearing slags (sometimes still revealing a flow lobed contact with the pit wall, or internal chilled surfaces). At the foot of the blowing wall these may include moulds of large wood fragments. At the top of the blowing-side of the pit there may be a large burr developed below the blow hole. These slags may show significant local interaction with the wall even below the burr.

3. The **“furnace bottom”**: there appears to have been a substantial slag cake developed in the top of the pit, just below the bloom. This material is typically rather fragile, but is equivalent to what is sometimes called a “furnace bottom” (although not actually formed at the very bottom of these furnaces). Although the best studied examples of complete slag cakes of this type have been from the early Iron Age, there are substantial pieces of similar material at Gortnahown, with a characteristic internal texture of amalgamated prills around charcoal fragments. There are no complete cakes of this type (probably because they were typically broken on extraction from the furnace), but pieces weighing 2905g ([c544]), 1550g ([c585]), 932g and 414g (both [c764]) are all substantial fragments.

Gortnahown currently lacks evidence for the assemblages of fine residues (spheroids, ore dust, “sinter” and fine flow slag debris) commonly found on the base of the basal pits of slagpit furnaces (e.g. Ballinamona 2; Young 2009). This probably reflects a different sampling strategy at Gortnahown, rather than a difference in actual residues. Several features are identified as smelting furnaces (see below), and others might possibly be similarly identified if environmental samples were to be investigated for microresidues.

Description of iron smithing residues

The majority of the residues attributed to the smithing of iron are examples of smithing hearth cakes (SHCs) of parts thereof. A total of 98 SHCs could either be weighed, or were sufficiently complete that the original weight could be estimated. The majority of the SHCs were relatively small, with 67% of the measurable examples weighing less than 500g, 91% less than 1000g and with 22% of the assemblage lying between 100 and 200g. The mean weight was 519g. The maximum recorded weight was 3450g.

The smaller SHCs were very conventional in form, being concavo-convex to plano-convex, mainly sub-circular in plan, with dense bowls. Several SHCs showed some evidence for flowage, particularly for some lobate flowed slags at the proximal end.

The larger SHCs are mainly rather conventional in appearance. There are a few examples of SHCs (e.g. a 942g block from [c539] and a 362g broken block from [c538]) with particularly thick crusts which have the terminations of the olivine crystals protruding from their upper surface (due to shrinkage of the melt during solidification). Such cakes occur on other sites where bloomsmithing is believed to have been undertaken, but the precise significance of the maintenance of such deep slag puddles in the hearth remains currently unknown.

The assemblage also includes some 30 examples of pro-tuyère tongues, together with numerous fragments probably from tongues. This material comprises the majority of the "other smithing slag" category of Table 5. Tongues are a rather enigmatic component of smithing assemblages, distinguished from SHCs (Young 2009a) by having an upper layer mostly or entirely of glass (often containing clasts of quartz or other materials derived unmelted, or incompletely melted, from the hearth lining or tuyère tip) and a lower layer of descending prills of much more iron-rich slag. They also typically have a slab-like, or wedge-like, morphology, rather than the classic bowl-shape of the SHCs.

The 30 tongues from Gortnahown 2 range from 40g up to 296g in weight, with mean weight of 124g. They are variable in texture, with several examples containing abundant gravel derived from the hearth ceramic. Some examples showed attachments to the hearth ceramic, although these were insufficient to determine whether the ceramic was a tuyère tip or simply the earth lining around a blowhole. Some showed abrupt proximal ends with suggestions of non-wetting flows descending in front of the ceramic.

The tongues occur as fairly constant proportion of the overall smithing assemblage at Gortnahown at about 15%, except in [c539], where tongues only comprise about 5%. This distribution suggests that the proposed explanation (e.g. Young 2009a) of tongues as intermediate zones of reaction between melting hearth ceramic and iron from workpiece with the main slag accumulation lower down in the hearth may either be wrong, or not applicable in all instances. It seems much more likely that the Gortnahown tongues are simply instances where there was little iron input into the generation of slag. This could be because the work being undertaken was causing little iron to be lost (perhaps at low temperature), or perhaps because the iron input was swamped by rapid loss of ceramic. It seems unlikely, given the distribution and association of the tongues, that they are to be particularly associated with non-ferrous metalworking.

Description of hearth/furnace ceramics

Gortnahown 2 produced a rather small proportion of hearth/furnace ceramics. There was about 1.35kg of hearth/furnace lining and a further 1.25kg of slag derived mainly from the melting of technical ceramic.

The material contained no pieces which were diagnostic of their originating structure, whether furnace or hearth. There were no pieces which were certainly identifiable as being from tuyères. There were some pieces of slag which were inconclusively suggestive of having been attached to tuyères (e.g. a dense slag piece from [c539] (the fill of ditch c540) which had a curved proximal edge suggesting had been attached to a tuyère), but otherwise the absence

of certain tuyère sherds was a significant feature of the assemblage.

The assemblage included three pieces which provided evidence for the nature of blowholes:

1. [c124] (a fill of ditch c228) contained pieces of oxidised-fired lining, one has part of a blowhole c20mm diameter
2. [c585] (the fill of slot trench c586) yielded a fragmented slightly bulbous section of vitrified oxidised-fired lining, forming part of disc 50mm radius, in the centre of which is a blow hole of 20x17mm. There were no preserved original edges so it is doubtful if this is a tuyère
3. [c60] contained a piece of gravelly slag on oxidised lining, with the margin of 18mm diameter blowhole

None of these pieces gave clear evidence for whether the blowholes had been set in a clay wall (whether furnace or hearth) or within a tuyère. The relatively small diameter would suggest these examples are from smithing hearths rather than smelting furnaces (where diameters of 20-25mm are more frequent).

Description of indeterminate residues

Material classed as of indeterminate origin is mainly slag that has been fragmented to an extent where it no longer shows diagnostic textural criteria. This is particularly the case with very charcoal-rich slags, for which distinction between examples formed during smithing and smelting is very difficult if the overall form of the slag piece is unknown.

Description of brazing residues

The site produced a large quantity of debris from clay brazing shroud (tables 3, 4 and 5). In total 161 sherds with a weight of 4.6kg were recovered from 10 stratified contexts, with a further 5 sherds weighing approximately 190g from the topsoil.

The sherds all appear to relate to the brazing of iron bells. The brazing of iron bells in early medieval Ireland has recently been investigated in detail at Clonfad, Co. Westmeath (late 7th-8th centuries; Young 2009a, forthcoming). At Clonfad, the principal find was the almost complete shroud from a large ecclesiastical hand-bell, but the sherds from Gortnahown mostly indicate the manufacture of much smaller bells, of a size similar to modern goat or sheep bells, although debris from the brazing of larger bells is also present (although frequently with indications of over-firing).

The shroud fabric is very similar in appearance to the material from Clonfad, with a pale grey to cream sandy fabric, usually with a grey internal surface, occasionally showing a thin vitrified or slaggy veneer, passing outwards into paler vesicular vitrified material, with a vitrified outer surface showing dimples where fuel particles have dented the soft ceramic. The outer surfaces show a varying degree of vitrification, with the shroud covering the upper part of the bell typically more vitrified than that at the lip, suggesting the bells were fired in an inverted position (as at Clonfad). Where deeply vitrified the outer layers may be dark and slaggy, but where the degree of vitrification is less, then the external glaze tends to be paler and greener. One detail not preserved in the material from Clonfad, is that the shroud curves over the lip of the bell, before

terminating around 5mm up the inside of the bell. The vitrification decreases rapidly around the lip of the bell, with the shroud on the inner surface apparently not vitrified.

Although much of the shroud is of a similar thickness to that from Clonfad (where it ranged from c15mm at the lip of the bell, 20mm over much of the sides, increasing to 30mm where the shoulders of the bell curve inwards), the smaller size of the Gortnahown bells means that there are more rapid lateral thickness changes, and parts of some shrouds, particularly near the lip, are much thinner than the Clonfad example. The typical bells being brazed at Gortnahown were small. No complete profiles are preserved, although it may be possible to reconstruct a profile from fragments. At present, the indications are the bells were mainly 80-100mm high at the shoulder, and about 65mm wide and perhaps little more than 18mm wide at the shoulder (Figure 1). They appear to be roundedly quadrilateral in plan, with probably only a rather slight widening towards the lip where most examples may have been 60-80mm by 30-40mm. The long sides are relatively planar, with one lip 80mm wide showing a maximum bowing out of the side of about 10mm compared with a chord between the angles.

The handles of these small bells appear to have been mainly 10mm in width and 4-6mm thick, with a rectangular cross section with only a very slightly (if at all) concave outer face. Where the relationship of the handle to the bell was seen, the insertion of the handle appears at 4-20mm from the shoulder, a surprisingly large degree of variation. The handle rises vertically for 5mm before in-curving, or is slightly inwardly inclined from the top of the bell. Sherd #75 shows part of a handle with an approximately 40mm radius of curvature.

Apart from sherd #51, which showed a possible rivet, the rivets, which are so prominent on the ecclesiastical bells, were not observed on the present material. The overlap of the side seam was observed on many pieces, and the absence of evidence for rivets may mean that they were of reduced size, or finished to be more flush with the surface of the sheet iron in comparison with those on the ecclesiastical bells, or even that no rivets were used.

The step seen on the narrow sides is rarely more than 1mm (#64) and the evidence from the shroud coating the lip of the bells suggests iron 1-1.5mm (#83), 2.5mm (#34) and 2.5mm (#4). The shoulder flap on sherd #53 appears to extend to 15mm below the shoulder and protrudes about 3mm.

Some sherds appear to come from rather larger bells: sherd #19 may be from the shoulder of a bell 60mm thick (close to the equivalent dimension of the Clonfad bell), sherd #150 shows part of a large handle >14mm wide and >9mm thick, sherd #24 was large slab of failed shroud, sherd #158 is from the side seam of bell at least 70mm wide, sherd #164 appears to show a handle with a width of 25mm and an external concavity 6mm deep and sherd #5 shows a bell with a narrow side with a planar 35mm wide, probably with more gently curved angles than on the smaller bells, with an overall width of >65mm. Almost all the evidence for larger bells comes from [c539], where it is associated the common occurrence of material which shows deeper vitrification on the internal face of the shroud, sometimes associated with possible runnels eroded into the ceramic. Some shroud material shows

evidence for vitrification on all surfaces (indicating fracture in the hearth) and plastic deformation. Six sherds showed good evidence for the use of a fabric wrapping for the workpiece inside the clay shroud and a further six sherds possibly showed this. Of the 6 examples of certain fabric impressions, 5 were from large bells and/or deeply internally vitrified samples. It is not clear whether the use of fabric was preferentially employed in the brazing of large bells, or whether the degree of vitrification in the large examples has preferentially preserved the evidence for fabric use.

Description of other Cu-alloy residues

The assemblage included a very small quantity of material associated with use of copper-alloy. This includes a small quantity of blebs of corroded copper-alloy metal from [c539], together with two small pellets of copper-alloy from the same context.

Three sherds of crucibles were recovered, two of which were from large triangular crucibles, the third an indeterminate body sherd. All three had colouration suggesting the handling of copper alloy. Find 544:7 was a large crucible base, 30mm in height, with walls to 8mm thick. Find 555:7 was a crucible rim, showing 25mm height of a strongly splayed rim from near angle of a pyramidal crucible. Both sherds derive from fills of hearth [c545]. The two sherds probably come from similar crucibles, if not from the same one, with a morphology similar to, for instance examples from Lagore (e.g. Comber 2004, p. 140, no. 6). Triangular crucibles range in Ireland from the Iron Age through into the early medieval period. The third sherd [c539] was from a thinner-walled crucible of indeterminate form.

Distribution of residues

The distribution of the residues is summarised in Table 6.

The area including the central structures (A and B) produced only a very small quantity of residue. Since the 14C evidence suggests that structures A and B were contemporary with the metalworking, this indicates a strong segregation of activity. The features with the larger, although still very small, quantities of residues were in general those closest to the metalworking are to the north.

Apart from a single tiny fragment from a stakehole within Group 8 (an isolated hearth with associated post- and stake-holes) and single piece of slag from ditch c15, most of the assemblage (>99%) came from the two metalworking areas: 38.9kg from that to the west of the central structures and 108.6kg from that to the north.

Very few of the residues are believed to be *in-situ* (see the following "Metallurgical Features" section), with almost all features (whether interpreted as of metallurgical origin, features of structural origin or possible waste pits) containing assemblages of mixed origin (smelting, smithing, brazing...). This suggests that features received dumped waste. It is not known whether waste was dumped directly into the various negative features, or whether waste dumps were secondarily redeposited into disused features.

A few features of the broad pattern of distribution of the residues may be significant.

Firstly, the brazing residues are only found in the features of the northern metalworking area; they are absent from the western area.

Secondly, although the features of the overall SHC size-frequency distribution were discussed above, the distributions of the two metalworking areas appear somewhat different if considered separately. The reduced size of the sub-assemblages gives certainty to their statistical interpretation. For the SHCs from the western area, there were 26 examples, with a maximum weight of 956g and a mean weight of 381g. There were 62 SHCs from the northern area, with a maximum weight of 3450g and a mean weight of 578g. 13% of the SHCs from the northern area weighed more than 1000g, 5% more than 2000g and 3% more than 3000g (see Table 7).

Description of metallurgical features

Slagpit iron smelting furnaces: the features identifiable as being the basal pits of slagpit iron smelting furnaces were all in the northern part of the site.

The core of the northern metallurgical area, which probably represents a workshop, includes one probable iron smelting furnace [c548] together with a possible second smelting furnace [c566].

Furnace [c548] is recorded as having a lower fill [c553] and an upper fill [c535]. The pit was recorded as having measured 0.75 x 0.43 x 0.28m, but fill [c525] measured 0.48 x 0.46 x 0.09m, which is more likely to have been the working volume of the pit. Such dimensions are entirely compatible with those of the basal pit of a slagpit furnace. The fill [c535] is described in the register as having *in-situ* slag and the assemblage from this context is rich in flow slags, interpretable as being from smelting, and presumably the slags recognised as being *in-situ*. A large SHC, from smithing, was also present within the furnace and presumably represents material dumped into the abandoned furnace pit.

Nearby pit [c566] may also have been from a smelting furnace. The pit is described as being 0.65 x 0.50 x 0.30m, with lower fill [c580] 0.52 x 0.40 x 0.05m, middle fill [576] 0.62 x 0.44 x 0.02m and upper fill [c537] 0.72 x 0.50 x 0.20m. The lower fill again indicates a working volume appropriate for a slagpit furnace. The lower fill yielded only a small quantity of indeterminate slags, the middle fill no slags, but the upper fill was dominated by smelting slags.

Post-excavation photographs of the site show little signs of firing of the natural around either of pits [c548] or [c566].

Some 10m NW of the probable workshop was a cluster of large pits, together with another slagpit iron smelting furnace (furnace [c703]). This had a pit recorded as 0.52 x 0.44 x 0.19m, a lower fill [c693] 0.52 x 0.44 x 0.11m and an upper fill [c692] 0.51 x 0.42 x 0.08m. The upper fill [c692] contained 2.5kg of mainly fairly small scale flow slags, suggestive of an *in-situ* slagpit assemblage.

Smithing hearths: two possible smithing hearths were located in the northern metalworking area: hearth [c545] and hearth [c575]. Both pits show complex internal stratigraphy which makes interpretation very difficult. The form of neither feature corresponds closely to that of a typical early medieval smithing

hearth. The complexity of the stratigraphy means that reconstruction of the original hearth morphology from the site records is difficult.

Hearth [c545] was an elongate structure, with slight widening at one end, with overall dimensions of 1.40 x 0.60 x 0.30m. The overall cut is elongate NW-SE. The feature appears to have been filled quite distinctly in its two halves, apart from a probable upper sag fill [c538] and one of its basal fills [c554]. At a superficial level (e.g. mid-ex plan 12) the cut shows a construction close to its midpoint, which was not seen at deeper levels.

In the base of the cut, an "iron oxide layer" [c561] lay in the bottom in the SE half and a dark layer abutted the NE wall in the same area. This asymmetric distribution resembles that of slag and alteration produced by the lateral blowing arrangement found in many smelting furnaces. There is, however, no other evidence from residues or any other source that this phase of the feature represents a smelting furnace, although the mid-length constriction of the cut at a superficial level (see above) might just be a remnant of an original furnace arch. Indeed, there are actually no firm indicators at this level that this is a metallurgical feature at all.

The subsequent fill [c554] is of clay and stone, resembling redeposited natural and (according to the given dimensions) covering the base of the entire feature. The following fill, [c555] a dark brown silty clay (hence possibly a usage deposit), was restricted to the SE end, yielding a few fragments of residue (including a crucible sherd and two fragments of brazing shroud) of similar character to the material in the overlying deposit [c544], which yielded 8.2kg of residues including a second crucible sherd, a further 7 pieces of brazing shroud, 5.2 kg of smelting slags and 2.1kg of SHCs. The rich and diverse nature of this assemblage clearly indicates this is a mixed waste deposit, and represents a microcosm of the metallurgical activities of the site as a whole.

The relationship between [c544] in the SE half of the feature and the softer charcoal-rich deposit in the NW half [c543] is unclear from the plans (although the context register lists 544 as overlying 54, the shape of the contact on the mid-ex plan 12 suggests the opposite may be true; the two deposits clearly were closely abutting). The charcoal-rich deposit [c543] contained a smaller residue assemblage (4.4kg) than [c544], but which was also mixed, albeit with a much lower proportion of smelting slags and just 4 pieces of brazing shroud.

Hearth [c575] lay between the two possible smelting furnaces [c548] and [c566]. It shows a much stronger degree of alteration of the clay around the hearth than either of those features. Like hearth [c545] described above, it was an elongate structure, with complex fills and the latest activity concentrated in one end (the NE).

The latest phase of the structure comprised a sub-circular pit hearth (filled with an upper fill [536] and *in-situ* deposits [569]) with a stone forming its floor (the stone having been emplaced during an earlier phase of the feature). The *in-situ* slag is attached to the stone and the NW pit wall. These deposits overlay what appears to have been material from an earlier phase of use [c606] and a repair to the NW hearth side [c574]. These two phases appear to have employed a rather similar hearth morphology, with the later sub-circular pit of c. 0.50x0.55m, being a smaller version of the

earlier, more elongate, c. 0.70 x 0.55, pit, with both utilising the stone as the base.

The SW side of the later hearth was formed by a deposit of white clay, bearing large stones [c612]. This deposit continued to the SW into a shallow extension to the hearth with a rising floor, also oxidised and with a thin skim of charcoal-rich usage deposit [c626].

The overall original cut [c575] was therefore 1.02 x 0.72 x 0.25m with the basal stone towards the NE end and has a neatly rounded form.

Hearth [c575] yielded few residues apart from the slag attached to the walls and basal stone. Identification of such basal crusts is very difficult, but the occurrence of some highly haematised slag fragments, suggests use as a very strongly-blown smithing hearth for the later phases of this structure. The purpose of the earliest form of the hearth, and the reason for its partial infill with the white clay and stone layer [c612] remains unclear. Although it is possible that the hearth was a simple smithing hearth from the outset, the presence of the stone in the base is unusual. The best parallel for such a stone is the basal stones within the two smelting furnaces at Knockbrack, Co. Kerry (Hull & Taylor 2006). However, the size of hearth [c575] only approaches that of the Knockbrack furnaces (0.37m diameter) in its final phase; the earlier phases are much larger and more open.

Hearth [c61]: In the western metallurgical area the occurrence of several areas of burnt subsoil suggests that archaeometallurgical features have been destroyed through truncation. One structure ([c61]) appears of an appropriate size to have been a smithing hearth.

Large burnt features:

Some 10m NW of the probable workshop was a cluster of large pits, together the slagpit iron smelting furnace [c703] described above. Two large burnt pits ([c771] and [c778]) are more problematic to interpret.

Pit [c771] was a large but shallow (1.70 x 1.20 x 0.26m) pit with in-situ burning interpreted as a hearth that did not contain any slag. The excavators suggested it might have been associated with pit [c784] to the north (0.82 x 0.52 x 0.12m), which contained slag and charcoal, possibly the waste material from "hearth" [c771]. However, the slag in pit [c784] is limited to a single SHC fragment.

Pit [c778] (1.73 x 1.60 x 0.88) is too large and too deep for a metallurgical hearth/furnace. Pit [c778] has given a ¹⁴C date on oak cal. AD 428-551 (lower fill [c780]) and a ¹⁴C date on cereal grains of cal. AD 593-655 (uppermost fill [c763]); its upper fills contained a few sherds of brazing shroud, providing the best evidence for late 6th to early 7th century brazing. The multiple fills of this pit strongly suggest its use for disposal of waste, but the initial *in-situ* burning probably indicates a different purpose for its construction. Both pits [c778] and [c771] could possibly be charcoal-production kilns; the depth of pit [c778] precludes any of the major metallurgical processes. The similarity of size of the two pits in plan hints that they may have served a similar purpose.

Interpretation

Gortnahown 2 is unusual for the variety of metallurgical processes being undertaken on the site and for several slightly unusual aspects of the metalworking.

Iron Smelting

The smelting slags are typical waste from iron smelting in a non-slag tapping furnace of the "slagpit" type. Very few of the smelting residues were recovered in-situ, but the assemblages are to be found in features close to the identified furnaces.

Interpretation of the basal pits of slagpit furnaces is often complicated by the difficulty experienced in excavating them rigorously. Identifying the original cut when the pit is surrounded by haloes of both oxidised- (externally) and reduced- (internally) fired natural is very difficult. Excavators often misidentify the reduced-fired zone as a deliberate clay lining to the pit. On the other hand, the pit may indeed have a lining, or at very least have had the cut surface smeared and smoothed to finish the structure neatly. Thus over-reliance on reported pit cut dimensions is unreliable to say the least. Far more beneficial is to consider the working volume of the pit. In the Gortnahown instances this is mainly judged through examination of the records of the charcoal-rich basal contexts (plus the overall recorded pit depth).

For the three likely smelting furnaces at Gortnahown the working dimensions were:

[c548] - 0.48 x 0.46 x 0.28m
[c566] - 0.52 x 0.40 x 0.30m
[c703] - 0.52 x 0.44 x 0.19m

These dimensions are quite large, and most closely resemble slagpits of earlier Iron Age date. Working diameters of >0.45m have been associated with furnaces that have been dated to 5th-1st century BC. The following sites have given evidence for large diameter furnaces within this period:

Furnaces with slagpits of greater than 0.40m diameter are known outside the current road scheme from earlier Iron Age sites at:

Ballydavid AR26 (Co. Tipperary), six furnaces with slagpit diameters >0.40m. Associated ¹⁴C dates suggest a date in the 3rd-1st centuries BC. An apparent 8th-5th century BC date for the isolated furnace c157 is suspiciously early. (Young 2009h)

Cherryville 12 (Co. Kildare): 320-200 cal. BC. Four slagpits 0.45 - 0.50m diameter. (Young 2008b)

Cloncollig (Co. Offaly): the pit (007) is described as being 0.57 x 0.60m and 0.32m deep. A ¹⁴C date on oak charcoal from the basal layer of the furnace gave a date of 261 - 94 cal. BC (Young 2008c)

Clonrud 4 (Co. Laois): the working dimensions of the two slagpits (0.41m x 0.39m and 0.46m x 0.41m) are moderately large. Two dates suggest 4th-1st centuries BC (Young 2008j)

Leap 1 (Co. Laois): F007 has a diameter of 0.40m. It is not directly dated, but there are earlier Iron Age ¹⁴C dates from adjacent features (Young 2009b)

Lismore-Bushfield 1 (Co. Laois): a cluster of 5 furnaces with diameters >0.40m. Furnace 3 gave a ¹⁴C date on alder charcoal of cal. 90BC to AD80. (Young 2008i)

Milltown/Ballynamorahan AR3 (Co. Kilkenny): a complex furnace structure, possibly with a central working hollow linking two furnaces with frontal arches, 0.45x0.55m and 0.40x0.50m; 1st century BC / 1st century AD (Young 2009j)

Morrett D (Co. Laois): 170 cal. BC- 30 cal. AD and 770-410 cal. BC for charcoal pits, 370-110 cal. BC and 400-200 cal. BC for ring ditches. (Young 2005b)

Newrath Site 35 (Co. Kilkenny): 400-200 cal. BC and 350-40 cal. BC (Eogan pers. comm. 2006)

Similar furnaces are known from the following sites, for which there is no direct dating, but for which an early age is suspected:

Adamstown 1 (Co. Waterford): Slagpit :0.53 x 0.47m and 0.15m surviving depth with 18.3kg of in-situ residues. Furnace undated but associated with Bronze Age features (Young 2006c).

Ballykeoghan AR9 (Co. Kilkenny), 2 slagpits, one 0.45m in diameter with 18.3kg of in-situ residues, the other 0.40x0.50x0.10m (undated) (Young 2009n)

Derryvorrigán 1 (Co. Laois): this site appears to have furnaces with working diameters of approximately 0.40m (Young 2008h).

Tullyallen 6 (Co. Louth): slagpit: 0.47 x 0.50m and 0.18m deep with 17.5kg of in-situ residues. (Young 2003b)

Furnaces of 1st century BC to 1st century AD seem to be typically a little smaller (e.g. Young 2008g, 2008m). Later Iron Age and early medieval iron smelting furnaces are, surprisingly, rather more poorly known than those of earlier periods and there are very few well dated examples. Those believed to be of this age are generally rather small (c. 0.3m working diameter). These include the undated furnaces at Derrinsallagh 3 (Young 2008f) and Cellbridge 5 (Young 2003a), as well as the furnaces at Cuffsborough 4 (Young 2009c) dated to between the 1st and 3rd centuries AD. Rather closer in age to the Gortnahown furnaces are a pair of furnaces from Knockbrack, Co. Kerry, each 0.36m in diameter, with ¹⁴C dates on oak of cal. AD 110-380 and cal. AD 260-290/320-450, but with a date from hazel of cal. AD 570-670 (Hull & Taylor 2006). These furnaces appear to have been carefully constructed with a clay lining added to the excavated pits and with a large stone placed as the floor. They were interpreted as slag-tapping furnaces by the excavators, and must at very least have employed a furnace arch for the clearance of hot waste and possibly the bloom. An apparently common feature in many of these sites, particularly of the first half of the first millennium AD, is the pairing of furnaces (e.g. Knockbrack, Clonrud 4, Derryvorrigán 1, Derrinsallagh 4), although this may possibly be confused in some instances with a furnace with an external working hollow.

A simple furnace of similar size to the Gortnahown examples (d=0.50m) was found at Carrigoran, Co. Clare (Young 2006d) and was dated to the late 9th-early 11th centuries.

Later medieval examples seem to be mainly relatively large and to include examples without deeply sunken basal pits and with frontal arches to facilitate slag (and bloom?) removal. These resemble the earlier Knockbrack example (see above), but apparently with

the furnace base itself raised well above the external working hollow. Problems exist with the interpretation of such furnaces, but there are probably similarities between the furnaces at Derrinsallagh 1 (14th-15th Century; Young 2008e), Farranastack (11th-13th Century; Dowd & Fairburn 2005), Ballykilmore (14th-15th Century; Young 2009d) and possibly Milltown/Ballynamorahan (7th-9th Century; Young 2009j)

The Gortnahown examples are therefore a welcome addition to the known examples, providing information about furnaces at a period when no other data is currently available.

Iron smithing

The smithing slags include a suite of SHCs which can be compared with the assemblage from other sites. A comparison is presented in Table 7 showing parameters of the overall SHC weight-frequency distribution from 13 other early medieval sites. The assemblage at Gortnahown is clearly very different from the apparently specialist bloomsmithing sites (Borris, Lismore/Bushfield and Ballinglanna). The assemblage lacks the very large SHCs seen on the larger "generalist" sites (Clonmacnoise, Woodstown, Clonfad). The overall assemblage resembles much more those sites interpreted as being mainly associated with blacksmithing, particularly a group including Moneygall, Carrigoran and Parknahown 5, which has a component of large SHCs, rather than sites such as Coolamurphy and Navan, which had assemblages dominated by very small SHCs.

It has been argued (Young, forthcoming) that the occurrence of medium-sized SHCs (in the 2-3.5kg range), derived from bloomsmithing, on sites which otherwise appear to have been purely blacksmithing, was due to the movement of iron from production site to end-user smith in the form of compacted blooms, rather than as finished bar iron. In the instance of Gortnahown, however, the co-occurrence of the evidence for smelting with that for smithing means that the assemblage must include primary bloomsmithing residues. In this instance, the medium-sized SHCs must surely be the primary bloomsmithing residues, and not evidence for processing of compacted blooms produced elsewhere.

This is an important observation (and one that needs clarify and testing by further analysis) and raises the question of why these SHCs are generally smaller than those interpreted as being from primary bloomsmithing on other sites. The answer to this may lie in the end product. At Clonfad, for instance, where one of the end products was presumably the production of iron sheet for forging ecclesiastical bells, the requirement was for a bloom of 8-10kg, sufficient for working down to a sheet weighing 4-5kg (allowing for roughly 50% weight loss in the process; Crew 1991, Sauder & Williams 2002) to allow for the manufacture of a bell 255mm tall at the shoulder. At Gortnahown, in contrast, the much smaller bells, many just 100mm tall at the shoulder, being forged required a much smaller starting sheet. For a 100mm high bell (excluding the handle) the estimated sheet weight would be approximately 0.5kg. This means that much smaller blooms needed to be worked (or much smaller bloom pieces), which would generate smaller SHCs if the relationship between SHCs and individual bloom compactions (Young forthcoming) is correct.

The smithing hearths at Gortnahown are of slightly unusual form. Unlike for iron smelting furnaces, there

are many good examples of smithing hearths from this period for comparison:

Trumra (Young 2008l)

F5 Cal AD390–550

Dimensions:

f5, 1.98m x 1.28m x 0.33m

f12, 0.92m x 0.78m x 0.12m (oval)

Clonfad (Young 2009a)

Phase 1b: 7th–8th century

c590, 0.80 dia. x 0.08m

c568, 0.75 x 0.65 x 0.15m

c577, 1.20 x 0.60 x 0.08m

c437, 0.90m dia. x 0.35m

The pit bearing the brazing material was:-
c464, 1.20m wide by 0.61m deep (truncated by later pit)

Moneygall (Young 2008d)

Early-medieval?

pit c905 1.06 x 0.70m and 0.17m deep

Coolamurra (Young 2008a)

9th–11th centuries AD

Hearth A, 1.0 x 0.9 x 0.2m,

Hearth B, 0.92 x 0.82 x 0.30m,

Hearth C, 1.20 x 0.80m

Navan (Young 2007)

0.78m diameter by 0.13m deep.

Derrinsallagh 3 (Young 2008f)

C517 0.8m x 0.75m x 0.17m

C738 0.76m NS x 0.34m deep.

Moycarky AR15 (Young 2009g)

(14th – early 15th century)

Cal. AD 1302 - 1418 AD

Cal. AD 1312 - 1433 AD

0.74m diameter

Borris AR36 (Young 2009i)

7th–10th centuries AD?

Eastern Group:

[c67] 1.25 x 1.00 x 0.29

[c65] 1.50 x 0.90 x 0.26

Southern Group:

[c77] 1.16 x 1.02 x 0.22

[c79] 0.58 x 0.55 x 0.10

[c75] 1.0 x 0.93 x 0.33.

Group by enclosure ditch:

[c71] 0.74 x 0.49 x 0.10

Killeany 1 (Young 2008k)

F237 1.37m x 0.9m x 0.16m

F264, 1.49m long, 0.94m wide and 0.17m deep,

Garryleagh (Young 2009m)

13th–14th century

Pit [c13] 0.9m x 0.87m x 0.15m deep

Thus hearths tend to vary from equidimensional in plan through to having a long axis up to 1.5x the short axis (Figure 2). The relatively small, intensely fired, hearth [c575] is extremely atypical in its phases 2 and 3 (although less abnormal in its original form), and further work is required to clarify the nature of this structure (or indeed if it is a smithing hearth at all). Hearth [c545] fits in with some of the more elongate, large hearths among the above examples, but is more elongate than most. However, as commented above, hearth [545] has a complex stratigraphy to its fill, and may not have all functioned as a hearth simultaneously.

Brazing

The discovery of an early bell-brazing operation is extremely significant. The dating of the brazing requires some clarification, but the available ¹⁴C dates for pit [c778] (which contains some typical brazing shroud debris, including sherd #26, the shoulder of a small bell) include a date of cal. AD 428–551 on oak charcoal and cal. AD 593–655 on cereal grains. Given the potential old wood problems with oak, the date on the cereal is likely to be more useful. An almost identical date was obtained from a slot trench belonging to structure B. Two later dates were obtained from structure A (cal. AD 664–725/738–771 and cal. AD 660–726/737–771), and it is not known yet whether any of the other metalworking features belong to this later phase. The evidence thus currently points to manufacture of small bells at Gortnahown within the late 6th or first half of the 7th centuries.

The production of wrought iron bells in early medieval Ireland is currently attested by finds from the monastic site at Clonfad, Co. Westmeath, particularly the almost-complete shroud from the brazing of a bell dated to cal. AD 643–771, and probably by some sherds of brazing shroud from Cathedral Hill, Armagh (Gaskell Brown & Harper 1984).

The basic technology of bell forging and brazing appears to be the same at Gortnahown as at Clonfad, although details of the riveting are not yet known. The basic process involved in fabricating the iron bell has been described by Bourke (1980, 1986, 2008). The process of brazing within a clay coat was mentioned by Theophilus in the 12th century, and similar process have been employed in various areas for the manufacture of animal bells until very recently (Björklund 1982, Jouffray 1993, Laurence 1991).

The wrapping of the workpiece in fabric before coating in clay is seen clearly on many of the Gortnahown shroud fragments. This was only observed on a few sherds at Clonfad, but is a feature commonly seen in Viking period brazing in Scandinavia (Söderberg and Holmquist Olausson 1997), but also in some material from Armagh (Gaskell Brown and Harper 1984) and Dublin (Bayley, forthcoming).

The small sizes of many of the Gortnahown bells suggests that these were animal bells, rather than ecclesiastical bells, although it should be remembered that the smallest ecclesiastical bell is only 82mm tall at the shoulder (the Kilmichael Glassary bell from Scotland, the ecclesiastical credentials of which are indicated by its subsequent enshrinement; Bourke 1983).

The production of bells of a variety of sizes is typical of manufacture for use by animals. Recent manufacturers have usually provided a range from sizes suitable for

sheep and goats up to those for use on cows (see Cooney *et al.* 2008 pages 36, 44, 46, 53, 54, 57 for images of the ranges of bells produced by 19th-20th century manufacturers in Australia).

Small iron bells are known quite widely in the early medieval period in Britain and Ireland. Very small examples include a 60mm high example from the Broch of Burrian (Scotland; Bourke 1983, MacGregor 1975), some tiny examples from Coppergate, York (Ottaway 1992) and a 50mm high bell from Ribbleshead, North Yorkshire (9th century; King 1978). Bells sized closer to the present examples are known from Sutton Courtenay (Berkshire), where two early Anglo-Saxon (c. AD500-650) examples were found, the better preserved being about 75mm tall (Leeds 1923, 1927) and from the 7th century Tattershall Thorpe (Lincolnshire) smith's grave (Hinton 2000). A larger (c. 160mm tall), but presumably secular, bell was recovered from the Flixborough tool hoard (8th-9th century; Ottaway *in* Evans & Loveluck 2009) and there is an unpublished c.140mm high bell from Repton (possibly ecclesiastical?). Perhaps most significantly, one of the few small Irish bells was found in a souterrain in Oldcourt ringfort, Co. Cork (Murphy 1961). This example was about 100mm tall at the shoulder.

One interesting observation is that the bells from York, Repton and Ribbleshead all appear to have brazed but not riveted seams according to Ottaway (1992). If the Gortnahown bells also lacked rivets, this might prove to be a distinction with the ecclesiastical bells.

The occurrence of bells in the Tattershall Thorpe smith's grave, the Flixborough tool hoard and further afield in the Mästermyr hoard from Gotland (Sweden) has led Leahy (2003) to suggest that, in addition to their ecclesiastical and agricultural uses, bells might also have been employed by travelling craftsmen to announce their arrival.

The brazing metal has not been documented on the ecclesiastical bells in recent times, with the only available analyses provided by Smith (1881-2). The presence of crucible sherds and droplets of copper alloy in association with the brazing shroud may give the opportunity to investigate the alloys being used.

The Gortnahown shroud fragments provide evidence for some areas of the bell covering not seen at Clonfad. In particular they demonstrate that the shroud curves around the lip of the bell and terminates on the inside. There was no continuous clay over the mouth of the bell.

The bell-making at Gortnahown represents the earliest evidence for bell manufacture in Ireland. Bourke (2008) commented on a lack of indigenous bells in pre-Christian Ireland and speculated an ultimately Roman origin for the use of bells and the technology of making them. The first evidence for the ecclesiastical use of bells in Ireland is

Summary

Gortnahown 2 has produced a so-far unique body of evidence for iron production and working at the very beginning of the early medieval period.

The lack of tuyères and the relatively small SHCs, particularly from the western metallurgical area are currently features that would be interpretable as being

"Iron Age", although there is currently a high degree of uncertainty over when the use of ceramic tuyères spread through Ireland. The presence of both smelting slags (indicating iron smelting) and brazing debris (indicating the end use of iron for artefact production) allows the SHC assemblage from the site to be understood in a way not possible at most other sites. The identification of slagpit iron smelting furnaces adds to the corpus of well-described examples and confirms the use of moderately wide pits in the early medieval period (previously only the poorly-known Carrigoran example was of this period; all other wide pits appear to be early Iron Age).

The morphology of the probable smithing hearths is problematic, but it is to be hoped that further investigation (particularly of the attached slag crusts in [c575]) may reveal further details of how they were used.

The evidence for brazing on this site is very important, for it is only the fourth location in Ireland (after Armagh, Clonfad and Dublin) so to do. Although further radiometric dating may enhance understanding further, it would seem likely that brazing was being undertaken here in the late 6th to early 7th centuries (although it may have been undertaken at other times too of course). This places it as the earliest evidence for brazing in Ireland and contemporary with the Early Anglo-Saxon (pagan) period bells known from Britain.

The history of iron bells is not well understood, although it is likely that brazed wrought iron bells were produced in the Roman Empire. The most common interpretation in the past has been that the wrought iron bell developed its ecclesiastical role from roots as an animal bell, within the Roman Empire and that religious icon was transferred, eventually, to Ireland. This new find of small bell manufacture challenges this view. Did the manufacture of brazed iron bells spread to Ireland in the pre-Christian or early Christian period as a secular item, only later developing religious significance? Or, did bell manufacturing spread to Ireland already possessing both secular and ecclesiastical dimensions?

Evaluation of potential

Gortnahown 2 has enormous potential for furthering understanding of early medieval ironworking. The range of processes being undertaken suggests that it may have been a largely self-sufficient site in terms of its use of iron, with iron being smelted on-site and processed right through to a demonstrable finished product (bells). Such a situation is unique in early medieval Ireland. The only sites with such a wide range of processes are places such as Clonmacnoise and Woodstown, which are likely to have participated in much wider trade networks and the direct line from smelting to product is not clear.

Although the smelting residues were mainly not *in-situ* in the furnaces, they form a tightly constrained body of residues which is well dated, and which is clearly associated with the furnaces. All facies of smelting slags are represented in the collection. Understanding the smelting activity is important in its own right (since early medieval smelting is surprisingly poorly known), but it is also vital to the interpretation of the smithing evidence. Analysis of a suite of smelting residues is recommended, with a view to characterisation of the process, interpretation of the nature of the ore, development of a mass-balance for the smelting

reaction (following the approach of Thomas and Young 1999a and b) and, if possible, quantification of the process.

The macroscopic smithing evidence from Gortnahown is good, with a large suite of SHCs which must include both blacksmithing and bloomsmithing activities. Chemical distinction between these two activities is becoming possible through the studies of SHCs from some of the major early medieval sites (e.g. Clonfad and Woodstown), but the detailed investigations have not yet been attempted on sites with such a close, direct relationship between smelting and smithing. Chemical data from the analysis of the smelting process will feedback into the recognition of smelting waste within the bloomsmithing slags. Detailed analysis of the in-situ slags from [c575] may help to elucidate the function of this feature.

The small quantity of non-ferrous residues from the site is significant for they may well present the copper alloy being prepared for the brazing process, and there are no analyses at all of the copper alloy coatings on iron bells (whether ecclesiastical or secular).

Further work on the brazing residues is highly desirable. Although they are fully catalogued, additional work to interpret the bells in more detail is required, with the morphological investigation of the bells going hand-in-hand with their illustration. The brazing shroud itself does not require additional scientific investigation.

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sample	context	feature	weight	no	Notes	propn	orig
	surface		40	1	weathered stone with very large ?pyroxenes		
			308	2	high grade box-stone ore		
			452	1	70% of SHC (80)x110x45mm, crust to 15mm, slight dished-topped SHC with partially smoothed (but not well preserved) vesicular top, base rough but planar one side so possibly a stone contact	70	646
			24	3	broken piece of dark glassy vesicular low-density flowed slag		
			2	1	Mn crust		
			6	2	dark slags of clinker-like appearance		
			176	4	slag pieces of rounded form with charcoal moulds and dimples - probably smithing hearth slags		
			202	1	part of small irregular vesicular SHC - proportion not certain because of irregularity		
			82	1	smooth-topped SHC fragment		
	surface	165.19E 121.12N	314	1	dense SHC, probably 80%, 100x(60)x30mm, dense flat slightly dimpled top, rough base	80	393
	surface	grid e110 n100	86	1	weathered stone with very large ?pyroxenes		
			100	4	small pieces of slag - all possibly SHC fragments but indeterminate		
			36	1	decomposed black glassy gravelly lining slag		
			94	1	dark glassy lining slag, like a tongue but has sandy back - so either formed on earth floor - or is a fired lining rather than a tongue		
			1	1	tiny fragment of dense flow slag		
	surface	e120 n120	90	1	sandstone		
			182	1	sandy charcoal-bearing ferruginous concretion		
			44	2	box-stone ores		
			170	8	small slag scraps - mostly probably SHC debris, but also one tiny piece of probable sub-tuyère backflow		
			90	1	chert		
			250	1	dense SHC, worn, probably 90%. Dense crust with coarse equant texture to upper parts (cf coralline) (80)x(60)x40mm	90	278
			254	1	dense SHC, 70%, 85x(60)x30mm	70	363
			150	1	very irregular block ,probably poor SHC, 90x65x25mm, very irregular (100%?)	100	150
			150	1	low density SHC or well-developed tongue, glassy top, 70x85x35mm, base rusty with deeply impressed charcoal	100	150
			106	1	65x65x24mm, small dished SHC, charcoal impressions above and below	100	106
			50	1	low density prilly mass, like tiny SHC, but probably tongue would be a safer description		
	surface	ne of site	388	1	large block with flow slag with coarse wood moulds below, overlain(?) abruptly by finely charcoal rich slag		
			426	1	part of medium SHC, smooth blown but lumpy top, dimpled base, quite lining rich on one side		
			564	1	central section of medium-density SHC		
			292	1	central section of a rather irregular medium-sized SHC, dense		

sample	context	feature	weight	no	Notes	propn	orig
			268	1	rounded lump from centre of good double layer SHC		
			212	1	fragment from very coarse-grained SHC, 20mm bowl overlain by coralline material		
			72	1	brown box-stone ore turning bright pink on one end - possibly euhedral quartz in pink area		
			512	8	probable SHC fragments		
			170	3	flow slag with large dense lobes		
			26	1	rotten limestone?		
			104	6	irregular lining slag fragments in rounded lumps/sheets		
			94	3	charcoal-rich slags - probably from "furnace bottom"		
			210	11	slag fragments		
			48	1	dark dense ore?		
			20	2	rusted slag scraps		
8	surface		182	1	80x70x30mm tongue-like SHC, glassy top	100	182
			220	2	dense flow slag		
			318	1	plate-like SHC, 110x110x20mm, charcoal on top	100	318
20	surface		322	1	dense SHC, 100x (60)x 30mm, charcoal on top surface	60	537
145	surface		26	1	dense thin sheet fragment		
367	surface		490	1	rounded worn block of very dense lobate slag- foot of blowing wall piece probably		
431	surface		26	1	dense flow slag with several horizontal narrow flow lobes		
			20	1	vitrified ceramic		
491	surface		32	1	black clinkery lobate slag with fragments of quartz and other rocks		
617	surface		6	1	reduced fired vitrified lining slag, coarse		
111	37	hearth c61	20	3	indeterminate slag		
199	37	hearth c61	14	5	slag scraps		
			30	1	small fragment, smooth top, dimpled base, probably margin of small SHC		
193	63	layer	386	4	SHC fragments, worn		
			104	2	flow slags		

sample	context	feature	weight	no	Notes	propn	orig
			72	1	thick crust SHC fragment		
			306	1	massive lump of thick crust slag worn and abraded by oxidising blast to smooth spike like form - not just a simple lip		
			66	4	slag scraps		
189	64	burnt subsoil	48	2	flow slags		
201	69	pit c82	138	2	SHC fragments		
			568	86	rusty and ferricreted indeterminate slags		
204	84	pit c85	32	2	indeterminate slags		
			54	1	tongue fragment		
208	86	burnt subsoil	294	6	SHC fragments		
			20	5	indeterminate slag		
376	94	pit c118	578	3	blocks of finely charcoal-rich slag		
			474	18	flow slag - from large blocks down to tiny prills		
			170	1	iron corroded onto stone		
			64	1	gravelly slag on oxidised lining		
			356	51	slag scraps		
364	95	pit c172	82	1	low-density slag sheet, one side dimpled with clay adhering, the other side is covered with parallel carbonised ?straw		
			8	3	flow slag blebs		
			100	2	dense slags, probably SHC fragments		
			10	1	vitrified lining lump or possibly vitrified stone		
			8	1	concretion on small piece of iron		
			94	1	dense iron slag, dimpled base, irregular top, surface with "micaceous" plates (?haematite flakes), in maroon slag		
239	107	ditch c228	20	1	oxidised fired vitrified lining		
			344	12	indeterminate slags		
239	107	ditch c228	148	6	flow slags		
			366	13	dense slags - possibly flow lags		
			164	17	indeterminate slags		
239	107	ditch c228	72	11	slag scraps		
			32	1	flow slag		

sample	context	feature	weight	no	Notes	propn	orig
			154	2	tongue fragments		
239	107	ditch c228	144	1	70x75x20mm planar dense tongue / SHC	100	144
			44	1	tongue fragment		
			582	20	indeterminate slags		
			92	3	flow slags		
239	107	ditch c228	322	12	poor flow slags - various blebs and lobes		
			274	2	dimpled slag sheet - SHC crusts?		
			778	67	indeterminate slags ,many very rusty		
239	107	ditch c228	282	1	100x70x40mm weathered SHC	70	403
			204	1	dense tongue attached to wall, with lots of corrosion		
			425	24	rusted debris		
			18	1	botryoidal goethite		
			226	12	slags with large charcoal		
			276	22	flow slags		
			66	2	tongue fragments		
239	107	ditch c228	180	6	poor flow slags		
			210	27	indeterminate slag		
239	107	ditch c228	172	1	75x100x20mm flat SHC, with charcoal in top	100	172
			58	1	dense rounded slag puddle		
			72	2	highly blown shiny sheets		
			148	1	possible deformed tongue		
			44	3	lining slag blebs		
			16	1	glazed pebble		
			130	3	poor flow slags		
			822	34	rusty indeterminate slags		
239	107	ditch c228	138	1	85x60x15mm, microprilly plano-convex mass - probably SHC	100	138
			196	1	50x80x30mm dense block, probably SHC	100	196
			120	1	55x70x20mm, small SHC	100	120
			134	1	small dense block of slightly reddened slag, tongue/SHC?		
			106	1	margin of low density prilly charcoal-rich SHC		

sample	context	feature	weight	no	Notes	propn	orig
			8	1	slagged oxidised lining - curved so just possibly tuyère side		
			96	2	parts of small SHCs		
			310	12	rusty indeterminate slags		
			72	4	flow slags		
239	107	ditch c228	30	2	concretions on iron		
			38	2	gravelly lining slag		
			102	12	indeterminate slags		
413	121	pit c129	74	1	dense flow lag		
			34	2	prilly lining slag		
			44	1	tongue material		
			64	9	indeterminate slag		
415	122	pit c136	102	1	sheet, curved, probably the margin of a fairly thin crust SHC		
			94	1	small somewhat low-density SHC, 60x70x25mm, very charcoal-rich	100	94
			70	1	small oval dense slag lump - just possibly a tiny SHC		
			240	23	indeterminate slag		
			2	1	oxidised fired vitrified ceramic		
			100	7	small scrappy flow slags, could be smelting but could also be from prilly SHC material		
			12	3	scraps of blebs of lining slags		
416	123	ditch c228	162	1	gravelly tongue		
			110	1	gravelly tongue		
			130	1	dense rather spiky tongue		
			110	1	dense tongue		
			714	54	flow slags		
			1265	c250	indeterminate slags		
			210	3	charcoal-rich slags - from a "furnace bottom"?		
			58	1	very smooth dimpled thin chocolate-coloured sheet - near blowhole?		
			470	4	SHC fragments		
			14	2	lining slag, gravelly fragments		
			76	4	gravelly slagged surface on oxidised fired lining		
416	123	ditch c228	584	1	140x90x35mm dense neat elongate SHC with charcoal-rich top	100	584
			276	1	80x70x35mm very well blown tongue/SHC, reddish top well developed upper layer sits on distinct prilly lower layer	100	276

sample	context	feature	weight	no	Notes	propn	orig
			460	1	90x110x45mm charcoal-rich SHC	100	460
			160	1	60x75x30mm rounded small SHC	100	160
			426	1	110x80x70 (40) charcoal-rich poorly-compacted SHC	100	426
			258	6	thin sheets with microdimpled bases, fine texture, smooth chocolate-coloured tops with wide dimpled with charcoal set in - looks well-blasted		
			66	2	rough slag sheet or thin crust		
			98	2	dense rounded, slightly lobate lumps - possibly tiny dense tongues?		
			306	3	rough charcoal-bearing slags with fine texture and uncertain affinity		
			314	30	flow slag, generally in small blebs		
			420	50	slag scraps		
417	124	ditch c228	896	1	medium sized, dense SHC	100	896
			709	4	fragments of smallish conventional SHCs		
			728	34	flow slags, mainly blebby rather than prilly		
			114	2	strongly vitrified oxidised-fired lining. No evidence for/against tuyère		
			420	1	large part of medium-sized SHC		
			134	1	probably small microprilly SHC 75x60x30mm	1	134
			258	1	sheet with external glassy red material in places - probably blowing side of large SHC		
			38	2	gravelly lining slag balls		
			692	29	iron slag fragments, mostly scraps with dimpled surfaces		
417	124	ditch c228	854	39	flow slags grading into charcoal-rich material		
			944	1	115x145x60mm (of which bowl 35mm) dense SHC with charcoal-rich top, flat proximal end may be break	100	944
			506	1	burnt stone		
			510	1	110x145x45mm open-textured slag, prilly, some concentric structure	100	510
			478	5	probable SHC fragments		
			364	44	indeterminate slag pieces		
417	124	ditch c228	548	1	130x130x50mm dished SHC with bowl half filled - side that is filled has external extension too, giving a "saucepan" shape	100	548
			598	1	90x120x45mm neat plano-convex SHC with dimpled top	100	598
			224	1	gravelly well-developed tongue		
			354	30	flow slags		
			996	100	indeterminate slag fragments		
			290	4	SHC fragments		
			478	2	broken medium crust SHC with possible axe cut attempt in top	50	956
			162	2	pieces of oxidised fired lining, one has part of a blowhole c20mm diameter		

sample	context	feature	weight	no	Notes	propn	orig
			68	1	indeterminate slag		
			196	5	lining slag/ tongue fragments		
417	124	ditch c228	576	69	slag scraps		
			1085	84	flow slags		
			344	8	charcoal-rich slags compatible with "furnace bottom"		
			256	1	SHC fragment		
			310	1	charcoal-rich slag with rounded concretion		
			208	1	concretion		
			26	1	rounded dense slag lump		
			168	1	very altered small SHC 110x70x30mm	100	168
			510	6	slag lumps with internal prills possibly from a sub-blowhole mass - but could be from "furnace bottom"		
			120	3	3 small dense tongue pieces		
			60	2	tongue fragments		
374	142	pit c118	398	1	block rich in very fine charcoal - uncertain affinity		
			4	1	lining slag bleb		
375	154	pit c118	58	13	broken piece of charcoal-rich slag, shows hint of internal flow lobes		
			12	1	dense flow lobe		
			6	2	slag blebs		
			12	1	dense dark concretion		
443	170	ditch c15	804	1	(150)x(90)x60mm, incomplete irregular fairly thick crust SHC, has small bowl then a second dense crust block up towards tuyère end		
671	178	layer	60	1	gravelly slag on oxidised lining, margin of 18mm diameter blowhole		
455	181	stakehole c181	12	5	flow slag scraps		
414	117 (199)	stakehole c194	<1	5	broken slag debris		
420	200	ditch c228	200	1	SHC, irregular shape 9090x40	100	200
			212	15	ferricrete		
			6	1	flow slag		

sample	context	feature	weight	no	Notes	propn	orig
430	201	ditch c228	244	1	small SHC with charcoal-rich slag below	100	244
			76	2	tongue pieces		
			120	9	indeterminate slags		
499	237	pit c238	630	40	highly rusted and ferricreted slags - probably mainly flow slags, lots of adhering gravel		
506	240	ditch c228	636	1	wide flat SHC, (150)x(110)x30mm	70	909
			260	1	SHC fragment		
			144	4	flow slags		
			166	20	rusty slag fragments		
			96	2	tongue fragments		
503	241	ditch c228	238	9	heavily rusted slag lumps of indeterminate origin		
			80	4	heavily rusted slags with evidence for flowing		
			92	2	rusted lumps of gravelly glassy material, probably tongue fragments		
503	241	ditch c228	146	5	highly rusted and accreted dense slags	100	120
			120	1	small rusted tongue/SHC		
			30	2	flow slags		
			30	1	tongue fragment		
504	242	ditch c228	238	1	tongue-like SHC, good microporosity bowl, glassy top, triangular, 90x80x35mm	100	238
			276	1	80x100x30mm triangular SHC with deeply impressed charcoal on top	100	276
			234	5	corroded fragments of slag sheets/crusts		
			205	7	corroded slags indeterminate		
			105	2	very gravelly oxidised-fired vitrified hearth lining		
505	243	ditch c228	80	5	prilly dense slags		
			372	16	heavily accreted indeterminate dense slags		
			50	2	reduced fired heavily slagged probable tuyère fragments		
			6	1	oxidised fired vitrified ceramic		
502	515	ditch c531	4	1	slag scrap		
89	517	slot trench c527	14	1	charcoal- and Fe-rich concretion		
79	535	hearth c548	234	10	flow slag in rather blebby prills		

sample	context	feature	weight	no	Notes	propn	orig
			294	2	crude "birds foot" structures in flow slag		
100	535	hearth c548	1730	1	160x190x55mm plano-convex SHC with concentric rings on fairly smooth top, prilly base	100	1730
154	536	hearth c575	22	1	strange black very fine grained slag in finger-sized prill with very shiny surface		
161	537	hearth c566	786	39	flow slags		
			389	2	medium crust conventional SHC fragments		
			686	13	porous charcoal-bearing slags of amorphous form, some microprilly		
			112	2	similar slags attached to reduced lining		
			110	3	lining influenced bulbous dark slags		
161	537	hearth c566	492	34	low density clinkery mainly pale flow slags		
			712	50	denser flow slags, mainly blebby - no long prills		
			402	1	dense lobate flow slag block		
			210	2	slags with SHC-like crust		
			130	1	low density lunule-shaped tongue-like body		
			88	5	slagged pale to buff lining - very similar appearance to shroud in some cases but probably lining		
			124	15	indeterminate brownish dull slag blebs		
83	538	hearth c545	362	2	small part of large thick crust SHC broken in 2, crust to 35mm, crystal terminations		
			96	1	reddened tongue		
			458	25	indeterminate slag		
			34	2	lining slag lobes, pale		
			1	1	variably vitrified and slagged reduced lining		
83	538	hearth c545	52	1	irregular charcoal-rich slag lump		
59	539	ditch c540	16	1	low-density weathered glassy bleb		
84	539	ditch c540	32	1	stone with adhering rusty bleb containing droplet with copper weathering products		
84	539	ditch c540	2	2	small balls with Cu corrosion - mainly silt?		
			4	1	Cu-alloy bleb		
			0	2	Cu-alloy flecks in soil - too small to do anything with		

sample	context	feature	weight	no	Notes	propn	orig
85	539	ditch c540	6	1	SHC fragment		
85	539	ditch c540	392	1	100x100x40mm circular plano-convex neat SHC	100	392
			508	1	130x100x45mm plano-convex SHC with slightly concentrically ringed rough top	100	508
			732	5	SHC fragments		
			264	4	flow slag fragments		
			252	13	indeterminate slag fragments		
85	539	ditch c540	222	1	small fragment of thick crust cake		
85	539	ditch c540	104	8	flow slags		
			68	2	dense indeterminate slag lumps		
85	539	ditch c540	1000	1	dense SHC with slightly corrugated to deep dense bowl, microprilly base, 100x140x60mm proximal end missing	90	1111
			58	1	deep tongue, grey glazed top		
			580	3	SHC fragments		
			22	1	slightly slagged stone		
			84	2	dense slags indet		
			38	1	reddened dimpled slag sheet		
85	539	ditch c540	380	1	microprilly mass grading through a thin crust into slag with large charcoal - suggests (reworked?) top of smelting material		
			414	52	indeterminate slag		
			100	1	slag with pebble clast -possibly a tongue fragment		
			428	13	dense flow slag and large charcoal moulds		
85	539	ditch c540	402	1	dense SHC with dark glassy disc on top and prilly base	100	402
			280	1	finely microprilly slag of uncertain affinity with a single protruding flow lobes		
			196	7	flow sags		
			162	3	indeterminate slags		
85	539	ditch c540	392	1	80x90x50mm, dense layered SHC with flat proximal end with non-wetted flows, dark glass upper disc, base prilly	100	392
			40	1	flow slag		
			372	1	dense SHC modified by very strong blowing - red, smooth, completeness not determinable		
85	539	ditch c540	122	1	reduced fired gravelly clay with heavy slagging		
			1095	1	160x120x70mm, lower parts of fairly conventional SHC, proportion is unclear	80	1369

sample	context	feature	weight	no	Notes	propn	orig
			180	1	fragment from SHC with thin dense crust and clay contact below, some raised lobes on top		
			242	1	small fragment from large thick crust SHC		
			70	6	slag scraps		
			156	1	classic complete tongue, deepest near wall contact (non-wetting in this example) fairly low density, black in centre of top, grey margins, rusty coloured glass below		
			78	1	fragment of deeply dimpled, lobed, SHC base		
85	539	ditch c540	860	8	dense slags with very large charcoal		
			130	1	lobate base with internal layer of ?straw (send to botanist?)		
			146	1	small rounded lump, probably SHC, 70x50x25mm	100	146
			28	2	flow slag		
			476	12	indeterminate slag		
			22	1	vitrified oxidised fired lining		
85	539	ditch c540	76	1	50x60x25mm small SHC or tongue, dense slag sheet with glassy top and lobate base, fractured in two parts which have overlapped and welded		
85	539	ditch c540	478	1	quarter-round thick crust SHC fragment, crust to 30mm, dab of lining slag directly on top		
			36	3	flow slags		
			112	2	charcoal-rich slags		
			246	1	dense slag block - indeterminate - possibly a foot of blowing wall piece		
			96	5	rusty debris		
85	539	ditch c540	942	1	large block from centre of thick crust SHC, crystal terminations on rough top, base shows clay contact over about half		
			384	1	100x120x40mm SHC formed of two superimposed sheets with dimpled bases, top rusty, completeness uncertain	100	384
			186	1	70x100x30mm dense slag piece, rough top prilly base, curved proximal edge suggesting was attached to tuyère	100	186
			100	1	deeply vitrified reduced fired block - gravelly, so probably not a piece of shroud		
			66	3	slag scraps		
			110	1	70x50x20mm small lobate slag mass, lobes on top, prills beneath, SHC/Tongue	100	110
			16	1	vitrified oxidised fired lining		
			110	3	dense flow slags (probably from smelting)		
85	539	ditch c540	62	1	slagged tuyère(?) sherd		
			54	2	stones		
85	539	ditch c540	1480	1	130x110x100mm (of which bowl 70mm) deep thick crust SHC with additional material on top, hard to judge proportion	50	2960
			1620	1	160x140x50mm really neat plan-convex SHC with smooth, slightly lobate top, slightly detached early(?) crust on side	100	1620

sample	context	feature	weight	no	Notes	propn	orig
			242	1	80x70x35mm smooth rounded SHC	100	242
			316	1	80x70x40mm irregular gravelly SHC with well-formed microdimpled crust	100	316
			176	8	flow slags		
			124	8	indeterminate slag bits		
85	539	ditch c540	566	1	dense slightly concavo-convex SHC, smoothish top but rusted	100	566
			296	1	well-developed deep gravelly tongue - little iron involved. Grey in centre, pale marginally, gravelly base		
			392	1	small conventional SHC	90	436
			210	1	distal end of small SHC, proportion unknown		
			266	1	prilly deep tongue SHC	100	256
			118	1	red blown cake margin		
			582	16	flow slags		
			762	5	SHC fragments		
			754	54	indeterminate slag pieces		
			6	1	oxidised-fired vitrified lining		
85	539	ditch c540	2765	2	large SHC with charcoal-rich fill, thinnish crust but highly rusted and accreted	80	3450
85	539	ditch c540	30	2	slag scraps		
85	539	ditch c540	2	1	dense multiple spheroid		
			50	10	rusty and ferricreted debris		
85	539	ditch c540	8	1	bronze pellet		
			796	2	thick crust SHC fragments		
			288	17	slag fragments		
			172	4	dense flow slags		
			100	1	rusty lump attached to stone		
			24	2	oxidised vitrified lining fragments		
			1	1	iron ore?		
85	539	ditch c540	174	19	slag fragments indeterminate		
			88	1	gravelly tongue-type of glassy slag attached to possible tuyère face		
			132	1	dense SHC fragment rusted on to stone		
85	539	ditch c540	90	1	small tongue attached to tuyère front		

sample	context	feature	weight	no	Notes	propn	orig
			212	1	very dense small prilly block -could be small SHC but irregular		
			164	5	flow slags		
			18	5	scraps		
			32	1	hollowstone ore		
85	539	ditch c540	258	1	glassy slag mass attached to reduced fired ceramic with usual fine white gravel - not clear if this is a tuyère?		
			408	1	120x80x35mm small dense micropilly? SHC with folded over tip	100	408
			910	7	irregular charcoal-bearing micropilly slag blocks		
			604	1	irregular micropilly slag with charcoal coming down to definite margin -which has no real crust		
			114	1	small gravelly tongue		
			24	1	green glazed buff lining		
			158	5	slag scraps		
			156	1	fragment of small SHC		
			200	2	flow slags		
85	539	ditch c540	3140	1	lower bowl quite friable, dense layer at top with glass proximally, 220x180x140mm, bowl 50mm inclined top layer c30mm, proximal end of upper layer beyond bowl margin	100	3140
			956	1	SHC with heavy ferricrete coat	105	910
			262	1	100x80x30mm small dense plano-convex SHC, very compact	100	262
			640	45	indeterminate slags		
			276	9	thin friable slag sheet with abundant charcoal (v fine)		
			676	19	flow slags		
			44	1	gravelly tongue		
			60	1	dense small tongue?		
			184	1	charcoal-rich slag		
			432	5	indeterminate slags, rusty		
85	539	ditch c540	356	1	90x100x35mm, SHC with grey glass top, half of base smooth, half prilly	100	356
			594	1	120x90x40mm dense SHC	100	594
			334	1	100x80x60mm open-textured prilly mass with black glazed top	100	334
			102	1	small tongue attached to wall with small attachment area		
			542	2	large pieces of thin crust type SHC material		
			504	6	prilly slag in sheets - possibly SHC but not certainly		
			194	1	massive slag with large fuel voids		
			188	8	slag scraps		
			220	1	dense crust fragment		

sample	context	feature	weight	no	Notes	propn	orig
85	539	ditch c540	1400	1	massive foot of wall flow slag block 150x140x110mm (bowl-like part 40mm) - alternative explanation is this is an SHC with large fuel. Bowl is neat, characterised by pale greenish flow lobes of lining slag with sediment, top sloped down from highpoint on proximal side		
			44	8	slag scraps		
			492	14	flow slags		
			356	1	block with abrupt change of base angle - could be an SHC or could be a foot of wall slag		
			184	5	microprilly slags of uncertain affinity		
			14	1	Cu-alloy bleb		
			1	1	possible crucible sherd		
			126	4	dense slag sheet fragments - from near blowhole		
			176	1	60x80x40mm classic deep, flat-faced tongue mass		
			16	1	green low-density slag with large charcoal impressions, like the base of 1400g block above		
107	543	hearth c545	192	1	70x100x35mm semicircular dense tongue, dark glassy top a few haematitic prills escaping through base		
			306	1	100x90x45mm lining slag, hollow tongue partially filled with very dense slag mass		
			546	1	120x100x55mm dense but somewhat hollow SHC, slightly biconvex and prilly	100	546
			298	1	prilly slag mass		
			182	1	80x70x45mm semicircular tongue/SHC		
			88	1	lobate slightly haematised mass - tiny SHC?	100	88
			76	1	small irregular tongue		
			196	2	SHC fragments		
			30	2	dimpled lining slag sheets		
107	543	hearth c545	684	1	SHC 130x110x55mm dense conventional almost plano-convex, base dimpled	100	684
			194	1	70x70x45mm possible small SHC, very irregular, dense	100	194
			794	20	slightly amorphous open-textured slags with hints of lobing in places		
			86	11	slag scraps		
			64	1	iron ore		
			378	4	SHC fragments		
			138	6	dense flow slags		
#47	544	hearth c545		1	large crucible base, 30m height, walls to 8mm thick		
110	544	hearth c545	4	2	oxidised fired vitrified lining		
			30	1	possible failed brazing shroud or tongue		
			918	1	flow slag mass - possibly "furnace bottom"		
			614	1	probable SHC with one side folded over - original top deeply charcoal dimpled but thin, 120x110x40mm originally	100	614

sample	context	feature	weight	no	Notes	propn	orig
			402	1	large thick crust SHC fragment - looks as if it has been fractured by hammering		
			160	1	dimpled sheet-like SHC, 70x75x25mm	100	160
			122	1	70x50x20mm slag sheet with haematitic glass on top		
			88	1	irregular tongue fragment		
			86	3	indeterminate slags		
			34	1	thin slag sheet with possible straw impressions		
110	544	hearth c545	382	1	dense flow slag mass with dense broad flows between large wood		
			600	1	large curved block of charcoal-rich slag with no real crust - possibly from near wall of smelting pit?		
			280	1	70x70x55mm, wedge shaped mass of prilly slag	100	280
			528	1	prilly charcoal-rich SHC - possibly complete but uncertain	100	528
			70	1	gravelly slag with glassy surface from tuyère face or near blowhole		
			414	4	flow slags		
			134	1	charcoal-rich but dense 10mm slag sheet		
			256	2	prilly charcoal bearing amorphous lumps - smelting slags?		
			16	1	slag scrap		
110	544	hearth c545	2905	1	smelting "furnace bottom" - excellent large block 180x210x90mm		
#48	555	hearth c545		1	crucible rim, 25mm height of strongly splayed rim, near angle of pyramidal crucible		
117	555	hearth c545	42	1	part of very small charcoal-rich SHC		
			72	2	Fe-rich sandy charcoal-rich concretions		
			26	5	small slag fragments		
167	563	hearth c567	124	8	blebby slags and large rounded lumps with dimples		
			6	1	lining slag		
181	569	hearth c575 fill	334	3	3 pieces of a dense but thin slag crust - presumably from a thin crust cake, coming down to a facettted base, suggestive of a stone hearth base		
			46	3	porous coarse crystalline (coralline) slag fragments		
			32	1	slightly glazed slag ball		
182	569	hearth c575 in situ	1255	12	irregular slags bound to reduced fired clay, possibly shallow floor of smithing hearth, two pieces show smoothly lobate and reddened material - they must be close to blowhole - but no sign of that		
			122	2	rough slag with planar basal contact suggesting stone floor		
			66	1	rough slag in reduced fired clay as above		

sample	context	feature	weight	no	Notes	propn	orig
			294	2	dense lobate slags with bright red ceramic debris at one end- must be close below blowhole		
185	580	hearth c566	92	8	indeterminate slags		
191	585	slot trench c586	160	1	thick crust SHC fragment		
			130	1	flow slag		
			50	1	tongue fragment		
191	585	slot trench c586	1550	1	large block from a "furnace bottom", shows large wood clasts, some flows near wall, rather planar though small area wall contact, top appears to dip into furnace with concentric horseshoe-shaped ridges		
			884	38	indeterminate rusty slags		
			1145	22	flow slags, mainly large pieces of coarse blebby flows, "furnace bottom" with charcoal		
			112	5	slightly bulbous fragment of vitrified oxidised-fired lining forming part of disc 50mm radius, in centre is blow hole 20x17mm There are no good edges so it is doubtful if this is a tuyère		
			420	1	80x120x55mm prilly mass, probably an SHC	100	420
			244	1	60x90x40mm very dense prilly block attached directly to oxidised fired wall, probably classifiable as SHC	100	244
			88	1	dished slag piece possibly tiny SHC	100	88
			108	1	SHC fragment		
			48	1	glazed stones?		
			46	1	blebby lining slag or poor tongue		
191	585	slot trench c586	72	1	rough tongue		
			8	1	slag with big charcoal		
191	585	slot trench c586	6	2	vitrified surface. Slightly reduced on otherwise oxidised fired lining - planar		
			74	6	rusty slag fragments		
			58	1	dense plate-like tongue with lobate margin		
			78	1	dense PC mass - tiny SHC or tongue 50x60x20mm	100	78
			272	7	dense slags with some crust and micropills -probably SHC fragments		
			52	1	well-flowed reddened slag, probably from near tuyère rather than flow slag		
			118	8	blebby dimpled smooth slag varying from dense to lining influenced - probably tongue material		
			34	2	curved slag pieces attached to vitrified lining - just possibly from tuyère		
191	585	slot trench c586	140	2	rusty indeterminate slags		
194	585	slot trench c586	6	1	gravelly reduced fired clay - probably not part of the shroud		

sample	context	feature	weight	no	Notes	propn	orig
194	585	slot trench c586	4	1	gravelly reduced-fired clay - probably not part of the shroud		
407	588	posthole c704	66	1	small plano-convex lump of slag with dimpled base, possibly entire tiny SHC, but rusted and obscured		
366	591	slot trench c592	8	2	dense slag fragments		
220	598	pit c599	402	1	80x80x35mm, dense SHC	100	402
231	606	hearth c575 in-situ	320	6	fragmented lobe with very long crystals showing terminations in central void		
			700	3	medium crust SHC fused onto stone in hearth		
			226	4	irregular slag fragments with variable texture and some reddening - all this context might be one hearth clearance		
232	607	posthole c611	18	3	indeterminate slags		
242	608	hearth c620	222	8	indeterminate slags		
241	610	Posthole c611	16	1	flow slag		
260	612	hearth c575	4	2	dense thin prills		
			6	1	rock		
			50	1	thin slag sheet made of tiny coalesced blobs - one side may have straw impressions		
			14	1	slag sheet, highly polished surface, one side is convex curve - so suggests flow between charcoal and stone perhaps?		
259	621	pit c622	138	1	dense tongue, lining slag, green glaze creeps over edges onto base in places		
			506	2	dense SHC with markedly smooth top, concavo-convex bowl with slag piled on one end (110)x80x45mm (of which bowl 20mm)	100	506
			664	1	150x100x45mm square plano-convex SHC, dense with additional extension, possibly earlier SHC distally	100	664
			234	1	60x70x40mm very dense slag, flat proximal end	100	234
			286	1	lip of cake like 506g example - dense, haematised smooth surface, but larger		
			28	1	SHC fragment		
			20	2	scraps		
276	626	hearth c575 in-situ	384	28	fragments of thin shiny slag sheet, small attachment to a stone, probably one object		
289	627		24	1	sandy concretion		
			8	2	slag fragments		

sample	context	feature	weight	no	Notes	propn	orig
272	628	pit c622	108	1	tongue, short stubby, gravelly and glassy, dark colour, 40x80x35mm		
			40	3	glassy fragments, possibly broken from above tongue		
			142	1	corrosion around iron		
			18	1	low-density bleb		
			36	1	dense bleb of flow slag		
288	635	heath c575	50	2	strange black very fine grained slag in finger-sized prill with very shiny surface, slightly dimpled surface suggests these are horizontal flows		
330	646	hearth c648	2	1	granular ore, with purple dense and pink soft components		
328	660	layer	122	1	dense slag sheet to 10mm with odd raised blebs on top - probably part of the margin of a largish SHC		
			82	32	scraps, mainly of highly vesicular slag		
			14	1	highly curved very thin slag sheet		
			56	1	probably most of small dense SHC		
			28	4	blebby, rather low density flow slags, formed around small charcoal debris		
329	661	stakehole c661	8	3	low density flow slags		
334	662	pit c665	800	1	large flow slag block - foot of blowing wall type material		
			1310	70	flow slags		
			50	6	stones		
			448	1	large flow slag block		
			494	17	low density flow slags, some with wood impressions others in large bulbous hollow lobes		
			124	1	60x50x40mm probably tiny dense SHC	100	124
			258	1	60x100x35mm dense SHC semicircular, cut by smooth shiny re-entrant fracture suggests non-wetting contact with tuyère	100	258
			122	1	85x60x30mm prilly mass -probably tongue rather than SHC		
			176	1	60x85x25mm part of small very dense dished SHC	70	251
			164	1	90x55x40mm slightly lobate dense slag mass - possible small SHC	100	164
			68	1	60x40x30mm low density slag lump		
			136	1	60x75x35mm part of biconvex small SHC		
			348	50	slag scraps		
361	666	pit c682	56	1	slag fragment with curved dimpled base, possibly the end of a small SHC		
351	671	posthole c674	72	2	twisted slag tongue - glassy surface and iron-rich lobes contorted		

sample	context	feature	weight	no	Notes	propn	orig
350	675	posthole c674	578	6	SHC fragments		
			204	14	indeterminate slags - some are blebby and may be flow slags		
358	679	pit c681	448	16	flow slags		
386	692	hearth c703	2240	114	flow slags in stout stalactites and prills, coffee beans, some charcoal moulds		
			262	15	dull slag fragments, possibly from some sort of crust with slight lobing		
432	713	layer	28	2	fragments of oxidised lining, one with attached slag		
			94	5	flow slag		
			148	29	slags indet		
424	717	posthole c702	2	1	rounded slag bleb		
484	733	pit 738	350	1	plano-convex medium-sized SHC fragment with rather prilly/lobate structure		
484	733	pit 738	550	1	120x85x35mm very neat roundedly rectangular plano-convex SHC, irregular top, fairly smooth base	95	579
520	763	pit c778	354	1	80x100x35mm small dense SHC with minor charcoal	100	354
			286	1	iron oxides coating large granite pebble		
			456	1	80x120x35mm transverse SHC with dimpled top, rough base, dense	100	456
			328	1	thick crust SHC fragment		
			544	5	smaller SHC fragments		
			366	3	flow slags		
			22	1	vitrified pebble or lining bleb		
			262	11	indeterminate slags		
521	764	pit c778	290	1	120x70x50mm large tongue		
			148	1	small dense irregular SHC	100	148
			30	1	oxidised fired vitrified lining		
			938	7	flow slags grading into large-charcoal -rich mass		
			46	1	low-density inflated lobe from flow slag		
			78	1	small tongue		
			150	7	indeterminate slags		
			332	3	pieces of microprilly slag sheet - probably not SHC?		
			120	1	microprilly SHC fragment - or possibly part of the above material		

sample	context	feature	weight	no	Notes	propn	orig
544	764	pit c778	1240	1	150x120x85mm (of which bowl 50mm) neat SHC, with dense slag cake, prilly base, deepest near proximal end, top rough rises rapidly off puddle top, proximal part of top obscure but seems red and smooth	100	1240
			1640	8	rounded dimpled slag blocks - some of these might be very highly deformed small SHCs - one appears twisted another folded		
			80	6	slag scraps		
			198	1	SHC fragment		
			85	1	small semicircular tongue 60x90x15mm		
			42	1	dense flowed slag - possibly flow slag or maybe blowing lip piece		
546	764	pit c778	414	1	charcoal-rich block of "furnace bottom"	100	390
			932	1	charcoal-rich block of "furnace bottom"		
			194	1	microprilly lump		
			390	1	100x90x45mm, bowl distinct from upper glassy slab		
			140	1	dense tongue, single bleb on top of dense puddle, lobate dense below (as next 2)	100	140
			80	1	dense tongue, dimpled top, all dense no glass	100	80
			88	1	dense tongue, dimpled top, all dense no glass	100	88
			22	2	oxidised fired lining	100	88
			304	9	indeterminate slags		
536	779	pit c784	360	1	fragment of very dense thick crust cake with reddened smooth top and steep slightly prilly side		
522	781	pit c778	218	1	80x80x40mm neat conical SHC, dense	100	218
			636	1	120x100x25mm dense bowl, with 45 rising slag, rough below starting mid-length of cake but getting lining-rich & glassy towards the top 40mm outside proximal end of bowl and 20mm above	100	636
			120	1	60x70x25mm classic tongue	100	298
			138	1	60x90x30mm dense tongue/SHC with thin glass		
			306	3	flow slags		
			28	1	tongue fragment		
			96	1	small SHC fragment		
			672	12	indeterminate slags		
543	781	pit c778	298	1	70x90x45mm biconvex SHC with deeply dimpled top	100	298
			282	1	slab grading from flowed to sintery - probably down slope below tuyère		
			442	4	dense flow slags		
			330	5	charcoal-rich slags (quite coarse) gradational with the flow slags		
			156	2	indeterminate slag sheets		

sample	context	feature	weight	no	Notes	propn	orig
547	781	pit c778	476	1	circular tall cake of charcoal-rich slag, very unusual shape for an SHC - so it could just be the core of something else 90x90x60mm	100	476
			714	8	amorphous blocks of dense slag, all show at least some lobing - could be from "furnace bottom"		
			6	1	slagged curved ceramic - possibly from side of tuyère, ceramic yellow in colour		
523	782	pit c778	844	1	110x140x65mm, double layer SHC, dimpled base, thin crust, then charcoal rich, then rusty dimpled top slab	100	844
			356	1	100x120x35mm dense plano-convex SHC, some glass on upper surface	100	366
			570	1	margin of dense slag cake, form uncertain, appears to have dense flowed top and more open textured microporilly slag below		
			106	4	low density lining slag blebs		
			42	1	dense highly smooth lobe- possibly a blown SHC top?		
			182	6	flow slags, some with large wood impressions		
			156	7	slag fragments		
545	782	pit c778	46	1	tongue fragments	100	390
			150	1	possible small SHC, but probably just a fragment of one		
			390	1	90x90x60mm probably a poorly compacted charcoal-rich SHC		
			190	1	SHC fragment		
			82	1	dense tongue fragment		
			66	1	dense rusty slag fragment		
			50	1	small puddle of dense slag		
			60	1	very dense slag nub, flown		
524	783	pit c778	342	1	dense amorphous microporilly slags		
540	785 (285)	pit c778	16	4	slag scraps		
541	786	pit c778	26	3	slag scraps		

Table 1: summary catalogue by context and sample for all residues and associated materials except brazing shroud fragments (for brazing shroud see Table 3).

100g class up to	count	%
100	6	6%
200	22	22%
300	16	16%
400	13	13%
500	10	10%
600	12	12%
700	5	5%
800	0	0%
900	2	2%
1000	4	4%
1100	0	0%
1200	1	1%
1300	1	1%
1400	1	1%
1500	0	0%
1600	0	0%
1700	1	1%
1800	1	1%
1900	0	0%
2000	0	0%
2100	0	0%
2200	0	0%
2300	0	0%
2400	0	0%
2500	0	0%
2600	0	0%
2700	0	0%
2800	0	0%
2900	0	0%
3000	1	1%
3100	0	0%
3200	1	1%
3300	0	0%
3400	0	0%
3500	1	1%

Table 2: weight-frequency distribution for SHCs from Gortnahown 2

<i>Shroud fragment number</i>	<i>Sample/ find (#)</i>	<i>Context</i>	<i>NMI Find</i>	<i>Weight (g)</i>	<i>Thickness (mm)</i>	<i>Fabric impression?</i>	<i>Description</i>
13	#66	537	5	26.61	15	?	very degraded inner flattish surface
69	#67	537	6	8.15	10-20	n	sharp corner just below shoulder?
74	#70	537	7	2.23	10	n	scrap
76	#68	537	8	3.46	12	n	curved, very hard fired
7	#141	539	6	158	20-30	n	large block from lower side of bell? Shows slight slagging and possible rivulets, side 50mm high and 50mm wide before start of turn, not planar - all slightly curved
8	#143	539	7	52	30	n?	small piece with badly preserved seam or cloth fold - probably narrow bell edge, surface seen for 20x20mm
10	#151	539	8	30.05	25	?	piece broken into 9 fragments, inner face complex, but pieces too small to determine until reassembled
11	#159	539	9	56	30-35	n	flat inner surface, double layer crust - not clear if slagged or recoated
12	#148	539	10	12.05	20	y?	small piece of flattish surface broken in two
14	#150	539	11	7.96	12	n	right angled piece
15	#145	539	12	20.59	35	n	piece
16	#144	539	13	17.3	>22	?	scrap
17	#146	539	14	40.66	5-27	n	40x45mm, either irregular rim, or possibly sharply angled side with hint of shoulder flap, broken in 2
18	#147	539	15	18.92	20-30	n	piece, curved. Lightly vitrified inside
19	#142	539	16	72	16-22	n	highly vitrified inner surface with seam and possible top flap - if so from a big bell >60 thick
20	#155	539	17	36	28	?	no internal face
21	#157	539	18	14.53	>20	?	no internal face
23	#149	539	19	24.9	5-15	y	low on flat side of bell
47	#90	539	20	8.15	15	n	rim fragment
51	#84	539	21	33.5	5-20	n	overlapping side 20mm wide, possible rivet, 40mm length of seam, other side 10mm wide
54	#156	539	22	38.39	30	n	flat surface
55	#95	539	23	74	<15	n	large block, broken in two, showing bottom of bell side, 52mm high, 45mm wide
59	#88	539	24	19.1	>20	?	scrap
70	#96	539	25	34.44	12-20	n	sharp corner
72	#89	539	26	18.76	>30	?	scrap, no internal surface
79	#190	539	27	23.17	12	n	3 associated pieces from poorly fired rim
81	84	539	28	6.27	>15	?	scrap
103	85	539	29	6	10	?	scrap
104	85	539	30	6	10	?	scrap
105	85	539	31	8	10	?	scrap
106	85	539	32	2	12	?	scrap
107	85	539	33	6	35	?	scrap
108	85	539	34	4	>12	?	scrap
109	85	539	35	22	>25	?	scrap
110	85	539	36	8	>10	?	scrap
111	85	539	37	8	>12	?	scrap

<i>Shroud fragment number</i>	<i>Sample/ find (#)</i>	<i>Context</i>	<i>NMI Find</i>	<i>Weight (g)</i>	<i>Thickness (mm)</i>	<i>Fabric impression?</i>	<i>Description</i>
112	85	539	38	6	>22	?	scrap
113	85	539	39	12	>12	?	scrap
114	85	539	40	16	17	?	scrap
115	85	539	41	10	15	?	scrap
116	85	539	42	6	20	n	exterior surface of 10mm wide handle, poorly preserved
117	85	539	43	8	?	?	scrap
118	85	539	44	18	32	?	scrap
119	85	539	45	14	27	?	scrap
120	85	539	46	4	12	n	flat
121	85	539	47	3	>10	?	scrap
122	85	539	48	2	10	n	flat
123	85	539	49	4	>20	?	scrap
124	85	539	50	14	>22	?	scrap
125	85	539	51	14	>25	?	highly vitrified and grooved (runnels?) interior surface
126	85	539	52	38	32	n	flat
127	85	539	53	26	>30	?	scrap
128	85	539	54	16	>15	?	scrap
129	85	539	55	10	>15	?	scrap
130	85	539	56	6	18	?	scrap
131	85	539	57	4	>12	?	scrap
132	85	539	58	4	>15	?	scrap
133	85	539	59	10	>12	?	scrap
134	85	539	60	10	17	n	gently curved
135	85	539	61	4	10	n	strongly curved
136	85	539	62	4	>12	?	scrap
137	85	539	63	4	>8	?	scrap
138	85	539	64	6	>20	?	scrap
139	85	539	65	6	>10	?	scrap
140	85	539	66	30	20	n	gently curved
141	85	539	67	40	20	n	50mm flat side to gentle corner
142	85	539	68	70	?	?	failed shroud
143	85	539	69	28	?	?	failed shroud
144	85	539	70	46	?	?	failed rim?
145	85	539	71	26	27	n	gently curved
146	85	539	72	44	35	n	flat
147	85	539	73	32	20	n	flat
148	85	539	74	24	>25	?	scrap
149	85	539	75	34	>23	?	scrap
150	85	539	76	28	20-30	n	large handle, >14mm wide, >9 thick, only slightly concave

<i>Shroud fragment number</i>	<i>Sample/ find (#)</i>	<i>Context</i>	<i>NMI Find</i>	<i>Weight (g)</i>	<i>Thickness (mm)</i>	<i>Fabric impression?</i>	<i>Description</i>
151	85	539	77	18	<15	n	rim
152	85	539	78	110	>30-10	?	large slab, inner face rough
153	85	539	79	22	>20	n	top of shoulder flap
154	85	539	80	24	>26	?	scrap probably near handle
155	85	539	81	36	10-24	?	rim showing thickening on lip
156	85	539	82	128	30	?	highly vitrified angle
157	85	539	83	32	15-20	?	highly vitrified piece with slightly concave face
158	85	539	84	206	30	?	highly vitrified side seam from very large bell, bell must be at least 70mm wide
159	85	539	85	92	25-35	?	deeply vitrified section of side
160	85	539	86	260	35-55	y	very thick block of angle with fine fabric impression
161	85	539	87	114	30	y	deeply vitrified and internally slagged piece with fabric impression leaving object surface in grey area
162	85	539	88	34	34	y	small piece fabric covered
163	85	539	89	256	20-45	y	shoulder of bell (probably) with complex folded fabric
164	85	539	90	52	20-25	y	curved fabric covered handle exterior, 25mm wide, concave by 6mm
102	85	539	28 (to 91?)	8	12-15	n	flat surface
63	#42	543	3	32	17-22	n	flat side
77	#43	543	4	15.4	15	n	rim of bell
24		543	5	150	up to 25	?	large failed slab
25		543	6	6.25	>10	?	no internal face
27	110	544	1 (to 8)	24	5-20	n	rim
75	#46	544	1	15.79	17	n	concave outer surface of handle, 10mm wide, radius c 40mm
28	110	544	2	18	10-20	n	flat - probably near rim
29	110	544	3	82	30	?	interior not seen, very thick covering from handle area, strongly convex, some straw within fabric
30	110	544	4	28	5-20	n	handle and top of flap, handle springs just 4mm from flap, handle blackened, handle 10mm wide and 4mm thick, top of shoulder 9mm half width
31	110	544	5	20	>25	?	scrap
32	110	544	6	4	>12	?	scrap
165	#49	555	3	8.29	15-22	n	flat surface
71	#50	555	4	32.73	12-17	n	smooth, curved side - no planar area at all, 50x45mm seen
46	#100	585	20	7.08	20	n	handle and top of shoulder, handle 10mm wide springs vertically 12mm from shoulder, curves 17mm up
56	#101	585	25	23.94	20	n	broken in 2, flat surface
33	#102	585	7	44	5-35	y?	shoulder of bell - handle springs 20mm from corner, 40mm height of bell seen, handle 5mm deep, curves in by 5mm 15m up from bell top
9	#103	585	5	4.18	9	n	curved (transversely piece was concave, longitudinally was convex) piece with groove down length, possibly a bell handle, 10mm wide, 23mm length seen
73	#104	585	36	3.34	10	n	planar surface
68	#105	585	35	63	10-25	n	50mm wide central part of flat side
34	#106	585	8	56	<22	n	broken in 2, base, 2.5mm metal, 60mm high by 50mm length, corner tight, c15mm inturn to possible seam right on edge

<i>Shroud fragment number</i>	<i>Sample/ find (#)</i>	<i>Context</i>	<i>NMI Find</i>	<i>Weight (g)</i>	<i>Thickness (mm)</i>	<i>Fabric impression?</i>	<i>Description</i>
35	#106	585	9	4	5	n	base fragment probably associated with above
36	#106	585	10	18	15	n	60 mm height of narrow side of bell, seam not seen, 15mm wide
49	#107	585	22	7.76	10-15	y?	curious piece - could be 15mm wide handle springing 9mm from shoulder - or rim with irregular out-turn?
53	#108	585	24	80	10-25	n	large block of top of bell, with shoulder and handle, handle springs 10mm from tip of down-sloping shoulder, rises vertically 10mm then curves in, flap seen for 15mm down and sticks out 3mm, handle 20mm up 5mm in, roughly 4-5mm thick, no clay below, bell seen for 50mm wide
64	#109	585	31	22	18	n	seam with 22mm width of overlapping and 10mm on overlapped side, no rivets, step c 1mm
45	#110	585	19	28.19	10-17	n	part of long side with abrupt angle to narrow side, has thickened rim, suggests narrow side 35mm wide, step almost flattened out, slightly curving other end, 35mm high
39	#111	585	13	36	15-25	n	40mm height of angle of bell, gently curved angle radius 15mm leading to seam on overlapped side, strong internal slagging
61	#112	585	29	24	<27	y?	base of bell, 50mm height seen
62	#112	585	30	6	>15	?	scrap
37	#113	585	11	38	5-15	n	long length of seam, 85mm height, 35mm wide on overlapped side, lower 50mm seam clear, little seen on overlapping side
38	#113	585	12	12	16	?	failed fragment
6	#114	585	4	144	12-20	n	piece broken in 4 (2 just small chips). Shows side of small bell, planar side seen for 65mm wide and 55mm tall. Handle seen curving 20mm above bell and 50mm from opposite shoulder, suggests bell maybe maximum 60 wide at base
58	#117	585	27	8.87	15	n	curved surface
57	#118	585	26	7.69	20	n	seam fragment
60	#119	585	28	90	<27	y?	base of bell in 9 pieces, base appears to be 80mm between turns with 10mm bow out beyond this in centre, seen to about 55mm above rim
50	#120	585	23	10.92	10-20	n	small fragment of shoulder
48	#121	585	21	9.51	15	n	flat piece
67	#122	585	34	12.99	17	n?	curved corner
43	#123	585	17	20.98	10-20	n	narrow side with hint of seam and flap or possible rivet, overlapping side, 50mm long, planar 12mm from seam then 5mm starting to curve gently
22	#124	585	6	19.45	15-18	n	slightly slagged side seam, 30mm seen, small bell 30mm width seen, no turns
65	#125	585	32	10.42	20	n	flat surface
44	#126	585	18	12.97	10-15	?	internally vitrified piece
41	#127	585	15	9.54	7-15	n	gently curved surface
40	#128	585	14	18	10-17	n	shoulder of bell
78	#129	585	37	21.33	20	n	slightly curved with light internal vitrification
66	#130	585	33	11.75	24	n	flat surface
42	#134	585	16	16	20	n	possible side of handle - 5mm wide smooth patch
83	191	585	38	15	<10	n	rim of bell with metal 1-1.5mm in thickness
84	191	585	39	6	10	n	flange of ceramic apparently indicating small out-turn at base of bell
85	191	585	40	4	8	n	flange of ceramic with straight base to bell, slightly bowed
86	191	585	41	32	12-25	y?	deeply vitrified material showing side of handle, even curve, outer face very slightly concave 10mm wide 6mm deep, seen for length of 42 mm, striated so probably fabric covered
87	191	585	42	12	15	n	curved surface

Shroud fragment number	Sample/ find (#)	Context	NMI Find	Weight (g)	Thickness (mm)	Fabric impression?	Description
88	191	585	43	22	15	n	rim
89	191	585	44	8	15	n	curved
90	191	585	45	6	?	?	scrap
91	191	585	46	4	12	n?	flat
92	191	585	47	6	<12	n	rim
93	191	585	48	4	>5	?	scrap
94	194	585	49	10.81	15	n	43mm long - probably side slightly flaring to foot
95	194	585	50	8	>10	?	scrap
97	194	585	51	2		n	rim
98	194	585	52	8		n	narrow handle, 10mm, with concave surface
99	194	585	53	4		?	scrap
100	194	585	54	2		?	fired clay lump - failed shroud?
101	194	585	55	4		n	narrow handle, 10mm wide, with concave surface
52	#135	598	1	24.91	15	n	poor seam fragment
96	546	764	2	4	?	?	scrap
26		764	1	84	20-40	n	top of small bell, shows spring of handle 10mm in approx, no clear sign of flap, possibly shows a horned shoulder
80		781	1	1.21	>5	?	scrap
82		782	1	18.76	>15	?	scrap
1		A1	56	25.56	7-17	n	two almost planar surfaces meeting at 130°, possibly long edge of bell?
2		A1	57	8.93	>20	n	fragment of fairly thick coat not reaching inner surface
3		A1	58	4.04	5-10	n	slightly flaring, almost sub-conical surface, possible outer bell shoulder, very thin covering
4		A1	59	4.25	5-20	n	object flat 10mm wide with slightly curved edge 2.5mm thick, above this it may flare out, but unclear if an original surface, vitrification perpendicular to flat surface
5		A1	60	144	24-30	n	probable side of bell, flat 30-35mm wide, curving round on edges, maximum width 65mm but does not show whole curve, maximum height seen 50mm

Table 3. Catalogue of the pieces of brazing shroud from Gortnahown 2, organised by context

<i>Context</i>	<i>Feature</i>	<i>Weight</i>	<i>Number of pieces</i>
537	hearth [c566]	40.5	5
539	ditch [c540]	2959.7	86
543	hearth [c545]	203.6	4
544	hearth [c545]	191.8	7
555	hearth [c545]	41.0	2
585	slot trench [c586]	1059.7	52
598	pit [c599]	24.9	1
764	pit [c778]	88.0	2
781	pit [c778]	1.2	1
782	pit [c778]	18.8	1
A1	topsoil	186.8	5

Table 4: Summary of distribution of brazing shroud material

<i>context</i>	<i>feature</i>	<i>SHC</i>	<i>Other smithing slag</i>	<i>Smelting slag</i>	<i>Lining slag</i>	<i>Lining</i>	<i>Indet. slag</i>	<i>Iron ore</i>	<i>Iron</i>	<i>Crucible</i>	<i>Brazing shroud</i>	<i>Copper alloy slag/waste</i>	<i>Concretion</i>	<i>Stone</i>	<i>Total residue</i>
170	ditch c15	804													804
37	hearth c61	30					34								64
63	Layer c61	764		104			66								934
64	burnt subsoil c64			48											48
69	pit c82	138					568								706
84	pit c85		54				32								86
86	burnt subsoil c86	294					20								314
94	pit c118			474	64		934		170						1642
142	pit c118				4		398								402
154	pit c118						76						12		76
	<i>Pit c118 total</i>	<i>0</i>	<i>0</i>	<i>474</i>	<i>68</i>	<i>0</i>	<i>1408</i>	<i>0</i>	<i>170</i>	<i>0</i>	<i>0</i>	<i>0</i>	<i>12</i>	<i>0</i>	<i>2120</i>
121	pit c129		44	74	34		64								216
122	pit c136	196			12	2	410								620
95	pit c172	100		8	104		82		8						302
178	pit 179					60									60
181	stakehole c181			12											12
117	stakehole c194						1								1
107	ditch c228	1254	808	1618	98	28	4381	18	30						8235
123	ditch c228	2376	610	1238	14	76	2373								6687
124	ditch c228	6687	600	3365	38	276	3542						208	506	14508
200	ditch c228	200		6									212		206
201	ditch c228	244	76				120								440
240	ditch c228	896	96	144			166								1302
241	ditch c228	120	122	30			464								736
242	ditch c228	514				105	439								1058
243	ditch c228					56	452								508
	<i>Ditch c228 total</i>	<i>12291</i>	<i>2312</i>	<i>6401</i>	<i>150</i>	<i>541</i>	<i>11937</i>	<i>18</i>	<i>30</i>	<i>0</i>	<i>0</i>	<i>0</i>	<i>420</i>	<i>506</i>	<i>33680</i>
237	pit c238												630		0

<i>context</i>	<i>feature</i>	<i>SHC</i>	<i>Other smithing</i>	<i>Smelting slag</i>	<i>Lining slag</i>	<i>Lining</i>	<i>Indet. slag</i>	<i>Iron ore</i>	<i>Iron</i>	<i>Crucible</i>	<i>Brazing shroud</i>	<i>Cu alloy waste</i>	<i>Concretion</i>	<i>Stone</i>	<i>Total residue</i>
517	slot trench c527												14		0
515	ditch c531						4								4
539	ditch c540	25132	1284	6568	274	376	8676	33		1	2960	60	622	76	45364
538	hearth c545	362	96		34	1	510								1003
543	hearth c545	1890	952	138	30		1178	64			204				4416
544	hearth c545	2106	88	5219	70	4	526			(1 sherd)	192				8205
555	hearth c545	42					26			(1 sherd)	41		72		109
	<i>Hearth c545 total</i>	4400	1136	5357	134	5	2240	64	0	(2 sherds)	397	0	72	0	13733
535	hearth c548	1730		528											2258
537	hearth c566	389	130	2392	110	88	1132				40				4281
580	hearth c566						92								92
	<i>Hearth c566 total</i>	389	130	2392	110	88	1224	0	0	0	40	0	0	0	4373
563	hearth c567				6		124								130
536	hearth c575						22								22
569	hearth c575 fill	380	1737				32								2149
606	hearth c575 in-situ	700					546								1246
612	hearth c575						68							6	68
626	hearth c575 in-situ						384								384
635	heath c575						50								50
	<i>Hearth c575 total</i>	1080	1737	0	0	0	1102	0	0	0	0	0	0	6	3919
585	slot trench c586	1370	396	2833		162	1098				1060			48	6919
591	slot trench c592						8								8
598	pit c599	402									25				427
607	posthole c611						18								18
610	posthole c611			16											
	<i>P-hole c611 total</i>	0	0	16	0	0	18	0	0	0	0	0	0	0	34

<i>context</i>	<i>feature</i>	<i>SHC</i>	<i>Other smithing slag</i>	<i>Smelting slag</i>	<i>Lining slag</i>	<i>Lining</i>	<i>Indet. slag</i>	<i>Iron ore</i>	<i>Iron</i>	<i>Crucible</i>	<i>Brazing shroud</i>	<i>Copper alloy slag/waste</i>	<i>Concretion</i>	<i>Stone</i>	<i>Total residue</i>
608	hearth c620						222								222
															0
621	pit c622	1718	138				20								1876
628	pit c622		148				54		142						344
	<i>Pit c622 total</i>	1718	286	0	0	0	74	0	142	0	0	0	0	0	2220
627	slot trench 623						8						24		8
646	hearth c648							2							2
660	Layer c660	178					124								302
661	stakehole c661						8								8
662	pit c665	858	122	3052			416							50	4448
671	posthole c674		72												72
675	posthole c674	578					204								782
	<i>c674 total</i>	578	72	0	0	0	204	0	0	0	0	0	0	0	854
679	pit c681			448											448
666	pit c682	56													56
717	posthole c702						2								2
692	hearth c703			2240			262								2502
588	posthole c704	66													66
713	layer			94		28	148								270
733	pit 738	900													900
763	pit c778	1682		366	22		262							286	2332
764	pit c778	3616	761	2330		52	1222				88				8069
781	pit c778	1724	568	1792		6	828				1				4919
782	pit c778	2542	128	182	106		406				19				3383
783	pit c778						342								342
785	pit c778						16								16
786	pit c778						26								26
	<i>Pit c778 total</i>	9564	1457	4670	128	58	3102	0	0	0	108	0	0	286	19087

<i>context</i>	<i>feature</i>	<i>SHC</i>	<i>Other smithing slag</i>	<i>Smelting slag</i>	<i>Lining slag</i>	<i>Lining</i>	<i>Indet. slag</i>	<i>Iron ore</i>	<i>Iron</i>	<i>Crucible</i>	<i>Brazing shroud</i>	<i>Copper alloy slag/waste</i>	<i>Concretion</i>	<i>Stone</i>	<i>Total residue</i>
779	pit c784	360													360
A1	surface	5056	396	1388	234	26	419	472			187		182	334	8178
	Site total	68454	9426	36707	1254	1346	34105	589	350	1 (+2 sherds)	5478	60	1976	1306	157770

Table 5: Summary of residue classes and associated materials by context.

<i>feature</i>	<i>SHC</i>	<i>other smithing</i>	<i>smelting</i>	<i>lining slag</i>	<i>lining</i>	<i>indet. slag</i>	<i>crucible</i>	<i>brazing shroud</i>	<i>Cu alloy residue</i>	<i>total</i>
ditch c15	804									804
hearth c61	30					34				64
layer	764		104			66				934
burnt subsoil c64			48							48
pit c82	138					568				706
pit c85		54				32				86
burnt subsoil c86	294					20				314
pit c118			474	68		1408				1950
pit c129		44	74	34		64				216
pit c136	196			12	2	410				620
pit c172	100		8	104		82				294
pit 179					60					60
stakehole c181			12							12
ditch c228	12291	2312	6401	150	541	11937				33632
Total W working area	13813	2410	7121	368	603	14621				38926
Gp. 8 stakehole c194						1				1
ditch c531						4				4
hearth c567				6		124				130
pit c682	56									56
posthole c702						2				2
posthole c704	66									66
slot trench c592						8				8
slot trench 623						8				8
Structures A/B & area	122			6		146				274
ditch c540	25132	1284	6568	274	376	8676	1	2960	60	45331
pit 542								156		156
hearth c545	4400	1136	5357	134	5	2240	(2 shds)	397		13669
hearth c548	1730		528							2258
hearth c566	389	130	2392	110	88	1224		40		4373
heath c575	1080	1737				1102				3919
slot trench c586	1370	396	2833		162	1098		1060		6919
pit c599	402							25		427
posthole c611			16			18				34
hearth c620						222				222
pit c622	1718	286				74				2078
layer	178					124				302
stakehole c661						8				8
pit c665	858	122	3052			416				4448
posthole c674	578	72				204				854
pit c681			448							448
hearth c703			2240			262				2502
layer			94		28	148				270
pit 738	900									900
pit c778	9564	1457	4670	128	58	3102	0	108	0	19087
pit c784	360									360
Total N working area	48659	6620	28198	646	717	18918	1+	4746	60	108565
Total surface/topsoil	5056	396	1388	234	26	419		187		7706

Table 6: summary of major residues types by features and area (iron ores, concretions and iron metal are excluded from this table)

	All SHCs	Western metalworking area	Northern metalworking area
count	98	26	62
min	78g	94g	78g
max	3450g	956g	3450g
mean	498g	381g	578g
%<500	68%	69%	66%
%<1000	92%	100%	87%
%<2000	97%	100%	95%
%>3000	2%	0%	3%

Table 7: summary of weight-frequency distributions for the entire SHC assemblage, together with the sub-assemblages from the western and northern metalworking areas.

	Coolamurry	Navan	Gortnahown 2	Moneygall	Carrigoran	Parknahown 5	Trumra 4	Clonmacnoise (NG)	Woodstown 6	Clonmacnoise (WWS)	Clonfad	Borris (AR36)	Lismore/ Bushfield 1	Ballinglanna North 1
SHC count	41	17	90	22	18	89	57	258	140	38	381	88	23	64
SHC min. wt		60	78	114		86	92	54	68		60	154	426	86
SHC max. wt	2588	2990	3450	1800	3866	2898	3163	7815	6310	5540	11000	7440	4390	9267
SHC mean wt	386	507	519	527	553	567	727	762	1060	1087	1302	1618	1737	2854
% <500g	83%	82%	67%	55%	72%	70%	47%	52%	40%	39%	30%	22%	4%	17%
% <1000g	95%	88%	91%	95%	89%	84%	75%	78%	71%	68%	61%	41%	39%	22%
% >1000g	5%	12%	9%	5%	11%	16%	25%	22%	29%	32%	39%	59%	61%	78%
% >3000g	0%	0%	2%	0%	6%	0%	2%	3%	7%	8%	9%	16%	13%	42%
Modal 100g interval	100- 200	100- 200	100- 200	200- 300	100- 200	400- 500	100- 300	200- 300	200- 300	300- 400	300- 400	200- 300	500- 600	300- 400

Table 8. Comparison of SHC assemblages, ordered by mean SHC weight.

Assemblages ordered by mean SHC weight.

Coolamurry from Young, 2008a; Navan Site 1 from Young 2007; Moneygall from Young 2008d; Carrigoran from Young 2006b; Parknahown 5 from Young 2009d; Trumra 4 from Young 2008j, Clonmacnoise New Graveyard site from the author's work in progress; Woodstown from Young 2009e; Clonmacnoise Waste Water Scheme from Young 2005a; Clonfad from Young 2009a; Borris (AR36) from Young 2009g, Lismore/Bushfield 1 from Young 2008g, Ballinglanna North 1 from Young 2009i.

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

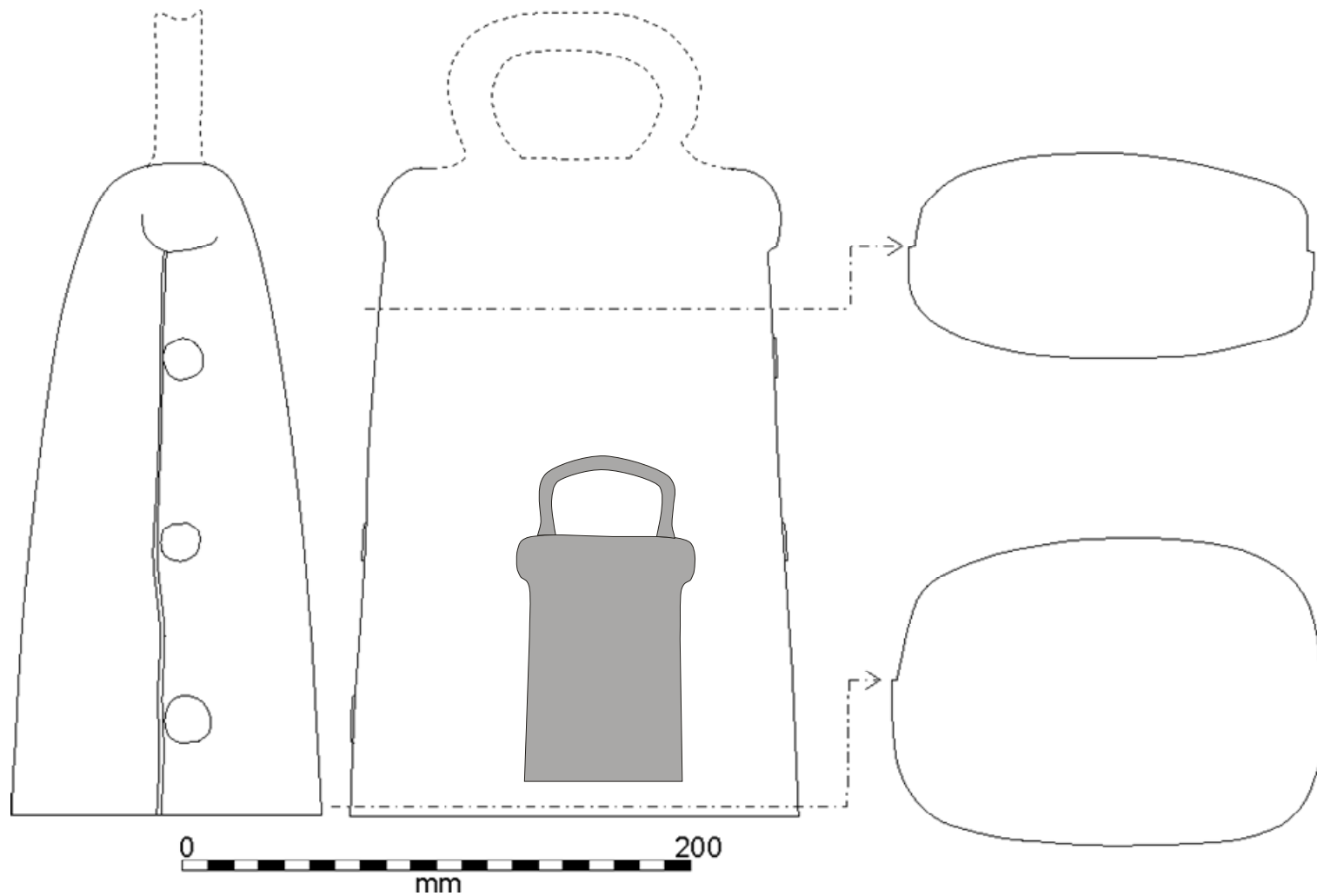


Figure 1: Comparison of a reconstruction of a small bell from Gortnahown (solid; reconstructed from data from several sherds) with the bell from Clonfad (outline; after Young forthcoming).

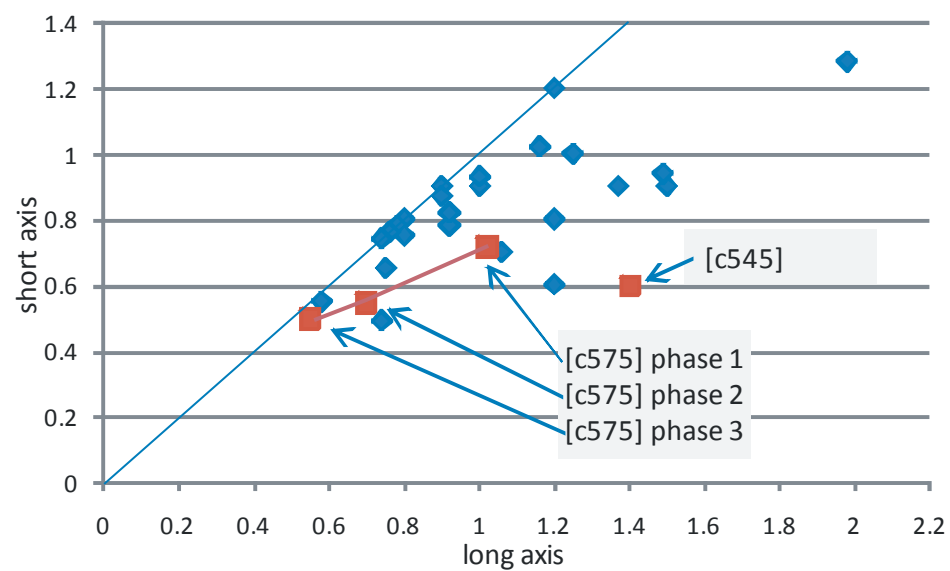


Figure 2: Plot of short axis vs long axis for smithing hearths (blue diamonds) compared with date for Gortnahown 2 [c545] and [c575] (red squares).

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